ESG Factors in Financial Investment: Analysis and Application to Portfolio Optimization

Tianzi Zheng

NYC Department of Finance, New York City, United States
ztz971245805@163.com

Abstract: The concept of ESG (Environment, Social, and Governance) represents a corporate development philosophy and sustainable investment practice that places significant emphasis on environmental, social, and governance factors. In recent years, as understanding of sustainable investment concepts has been deepened, the application of this concept in international financial markets and portfolio construction has become increasingly widespread and in-depth. Whether ESG leads to a decrease in portfolio returns or an increase in volatility has also become a topic of widespread concern. The applicability of ESG factors in asset pricing models can help advance traditional asset pricing theory and provide theoretical support for guiding capital flows toward enterprises and projects aligned with sustainable development, thereby promoting social welfare improvement. In this paper, 10 stocks from industries such as technology, finance, and consumer goods were selected (NVDA, CSCO, INTC, GS, USB, TD CN, ALL, PG, JNJ, CL) to study the application of leverage and ESG factors in the Markowitz Model and Index Model, and to explore the impact of ESG factors on the return and risk performance of investment portfolios. The research data results indicate that ESG constraints indeed reduce the return of investment portfolios in the scenario of minimizing the portfolio's risk, with risk factor attributes. However, in the efficient risky portfolio, ESG constraints represent an increase in portfolio returns, and an increase in volatility does exist in financial markets.

Keywords: ESG Investment, Portfolio Optimization, Markowitz Model, Index Model, Efficient Frontier

1. Introduction

ESG investment, also known as Socially Responsible Investing (SRI), is an investment strategy that guides capital flows toward green enterprises by fully considering the three core elements of environment, society, and governance. Unlike traditional investment approaches that primarily rely on financial metrics, an increasing number of investors are excluding certain investment products that conflict with their personal religious beliefs or preferences during portfolio construction, opting instead for investment targets aligned with their values. This trend has driven the rapid growth of ESG investing. Specifically, environmental metrics include climate change, carbon emissions, and desertification; Social metrics include customer satisfaction and privacy protection; Governance indicators include board composition and audit committee structure.

In terms of asset pricing, in the short term, metrics such as asset prices, risk premiums, volatility, and value ratios may exhibit trends, consistency, and clustering, manifesting as sustained increases or decreases. However, in the long term, these metrics will revert to their long-term equilibrium levels, primarily determined by a company's economic foundation and financial fundamentals. When predicting asset performance, the primary characteristics analyzed are risk and return, including expected return, variances, and covariances. To investigate the impact of ESG factors on portfolio performance, a conclusion can be drawn by calculating the equity return or volatility after incorporating ESG factors and comparing it with the original relevant variables of the portfolio.

Therefore, this article selected several large-cap stocks from different industries to construct a new investment portfolio. Using the Markowitz Model and Index Model, different scenarios were simulated, including whether to incorporate ESG factors and whether to use leverage. The portfolio allocation weights were calculated under conditions of minimal variance and maximum Sharpe Ratio. Based on the different models, efficient frontier, inefficient frontier, and minimal variance frontier curves were plotted. The results were analyzed to draw conclusions regarding whether ESG factors influence portfolio allocation and returns.

2. Literature Review

The asset management market has increasingly emphasized ESG in recent years. Most studies suggest that companies with higher ESG scores perform better in terms of risk control and long-term returns, primarily because these companies can help investment portfolios avoid risks associated with neglecting ESG issues, such as legal disputes arising from environmental pollution, labor disputes, or conflicts of interest among senior management [1, 2]. During economic recessions, companies with high ESG scores often perform better due to their more forward-looking development strategies [3]. When facing external pressures, investment portfolios with higher ESG scores typically experience smaller market value losses compared to those with lower ESG scores, further underscoring the importance of ESG in risk management [4-6].

In over 1,000 publicly available research studies conducted between 2015 and 2020, approximately 58% of the studies revealed a positive correlation between ESG and corporate financial performance [7]. As ESG metrics continue to evolve, countries around the world are beginning to coordinate efforts to establish a common framework for sustainable finance [8]. The U.S. Securities and Exchange Commission (SEC) has concurrently revised fund naming regulations, requiring that at least 80% of the asset value of fund products specializing in a specific asset type be invested in that category [9]. In line with this global trend, research has begun to focus on the impact of ESG factors on the portfolio selection process, with the aim of optimizing sustainability. For example, Van Duuren [10, 11] and others studied how fund managers in various countries integrate ESG factors into their portfolio management processes. The results showed that there are significant differences in the views of fund managers in the United States, the United Kingdom, and Europe regarding ESG investing.

According to previous research, the growth of the ESG market can be attributed to two main factors. On the one hand, the 2008 financial crisis highlighted the central role of corporate social responsibility not only in financial markets but also in the global economy [12]. On the other hand, challenges posed by issues such as climate change, pollution, and the waste of natural resources have sparked widespread attention to the theme of global sustainable development, thereby generating a need for the establishment of relevant regulatory requirements and unified assessment methods on a global scale [13-15]. In 2015, the 21st Conference of the Parties to the United Nations

Framework Convention on Climate Change was held in Paris, where 196 countries adopted a legally binding international climate change treaty to limit further climate deterioration, known as the Paris Agreement [16].
This study aims to explore the impact of ESG on portfolio performance, so the data used in our analysis primarily focuses on the period following the Paris Agreement.

3. Methodology

3.1. Stock Selection

This time, 10 stocks from different industries were selected to construct a new investment portfolio as a sample for the subsequent model establishment and calculation. These 10 stocks are from the technology, finance, consumer defensive/healthcare industries, with the aim of minimizing the correlation between industries. In terms of company size, we primarily selected large-cap stocks. This is because large-cap stocks have a lower likelihood of being influenced by operational flaws or random factors, making them more advantageous in terms of the availability and stability of ESG data. Additionally, research indicates that large-cap stocks generally have higher ESG scores than small-cap stocks, resulting in greater comparability of ESG data within the large-cap segment. The S&P 500 Index is used to represent market returns. Table 1 provides detailed information on the 10 companies.

Sector	Company	Market Cap	Beta	EPS	Average Return	Standard Deviation
Technology	NVDA	4.34T	1.7995	3.10	38.83%	51.38%
	CSCO	266.59B	1.1667	2.61	10.11%	26.13%
	INTC	108.55B	1.0185	-4.77	6.86%	26.37%
Financial Services	GS	224.59B	1.4195	45.40	12.60%	29.54%
	TD CN	128.12B	0.7085	6.95	12.13%	17.15%
	USB	75.13B	0.9824	4.18	8.75%	23.41%
	ALL	54.16B	1.0286	21.25	11.25%	24.18%
Consumer Defensive / Healthcare	JNJ	431.79B	0.5334	9.34	7.90%	14.64%
	PG	371.66B	0.4610	6.51	8.70%	15.19%
	CL	64.46B	0.4890	3.56	7.49%	15.52%

Table 1. Basic Financial Information for 10 Companies.

3.2. Data Frequency and Distribution

In terms of specific return data selection, the monthly return data was primarily used for valuation modeling. This is because daily returns are significantly influenced by random factors, exhibit high volatility, and yield unstable results with more pronounced peaked fat-tail characteristics, whereas the monthly return data aligns more closely with the Gaussian distribution assumed in the modeling. The figures below illustrate the fit between daily data and the Gaussian distribution versus the fit between monthly data and the Gaussian distribution. It is evident that the monthly data exhibits a significantly higher degree of fit, which is more conducive to enhancing the accuracy and stability of the subsequent model.

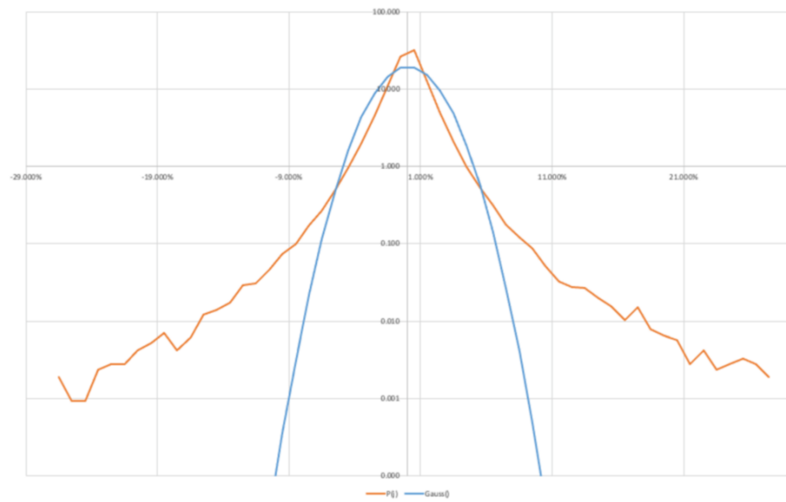

Figure 1. Comparison between Daily Returns and Normal Distribution.

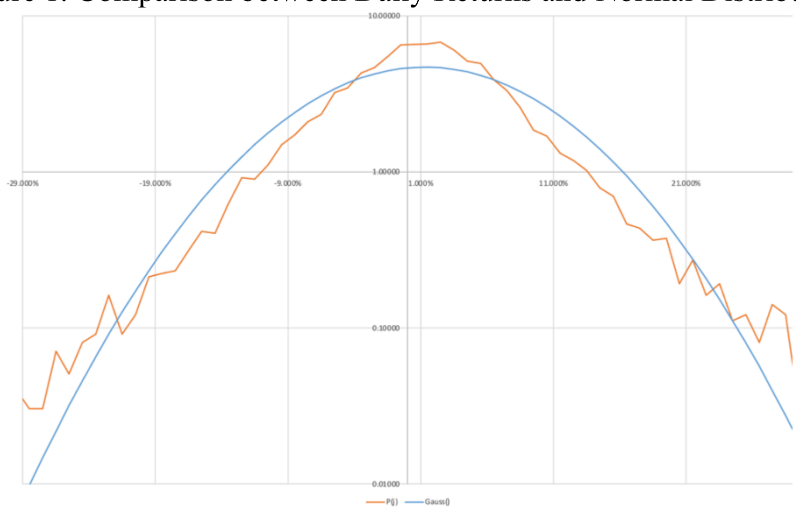

Figure 2. Comparison between Monthly Returns and Normal Distribution.

3.3. Model Selection

Currently, the most widely used asset pricing model is the Capital Asset Pricing Model (CAPM). However, the CAPM model relies on numerous assumptions, such as all investors having the same expectations regarding an asset's expected return, variance, and covariance, unlimited access to the risk-free rate, no transaction costs or taxes in the market, and so on. These assumptions often do not hold true in real-world scenarios. In 1952, Markowitz proposed the Markowitz portfolio theory in his paper. The core idea is that when constructing an investment portfolio, investors should not only consider the expected return but also the risk/volatility and achieve diversification of the portfolio through the correlation between assets. Therefore, this paper adopts the Markowitz Model and Index Model, which require fewer assumptions, to calculate the portfolio allocation ratios that minimize risk and maximize the Sharpe Ratio under different conditions, such as whether leverage is included and whether ESG constraints are applied. The table below lists the main categories of valuation modeling used in this paper.

Unleveraged	Without ESG Constraints	Min Variance
		Max Sharpe Ratio
	With ESG Constraints	Min Variance
		Max Sharpe Ratio
Leveraged	Without ESG Constraints	Min Variance
		Max Sharpe Ratio
	With ESG Constraints	Min Variance
		Max Sharpe Ratio

Table 2. Under Different Constraints to Solve Portfolio Allocation.

3.4. Mean-Variance Analysis

In general, the expected return of an investment portfolio is the weighted average of the expected returns of each asset:

$$\mathrm{E}(R_p)=\sum_{i=1}^{n} w_i\, E(R_i)$$

Among them, R is the expected return, and w_i is the proportion of the i-th type of investment in the total investment.

The variance of an investment portfolio depends not only on the risk of individual assets, but also on the correlation between assets. This means that if the correlation between assets is low or even negative, the overall risk of the portfolio can be reduced through reasonable asset allocation without adding leverage:

$$\sigma_p^2=\sum_{i=1}^{n}\sum_{j=1}^{n} w_i\, w_j \sigma_i \sigma_j \rho_{ij}$$

Among them, σ_i is the standard deviation of the return on asset class i, and ρ_{ij} is the correlation coefficient between the returns on asset class i and asset class j.

Based on these two calculations, we can obtain the Sharpe Ratio of the investment portfolio:

$$S=\frac{E[R\text{-}R_f]}{\sqrt{var[R]}}$$

A higher Sharpe Ratio is generally better, signaling higher returns for lower volatility.

3.5. Efficient Frontier, Inefficient Frontier, and Capital Market Line

The Markowitz Efficient Frontier is the set of all optimal portfolios. All possible combinations form a region on the risk-return plane. Every point on the Efficient Frontier curve represents an optimal portfolio, i.e., the highest return for the same risk, or the lowest risk for the same return. In contrast, every point on the Inefficient Frontier curve represents the lowest return for the same risk, or the highest risk for the same return. The portfolios on the Markowitz Efficient Frontier do not include risk-free assets. If the market portfolio and risk-free assets are combined, the result is the Capital Market Line. Each point on the Capital Market Line represents a portfolio that is more optimized than the portfolios on the Efficient Frontier curve. Thus, rational investors will invest part of their funds in risk-free assets and the rest in the market portfolio. The equation for the

Capital Market Line is:

$$E(R_C)=R_F+\sigma_C\frac{E(R_M)-R_F}{\sigma_M}$$

Among them, portfolio C is a combination of market portfolio M and risk-free assets, where R_F is the risk-free return, $E(R_M)$ is the expected return of market portfolio, σ_C is the investment risk of portfolio C, and σ_M is the investment risk of market portfolio.

4. Results Analysis

Based on Morningstar and company financial reports, the specific returns, risks, market sensitivity, correlation coefficients, and ESG scores of 10 companies can be compiled. Details are as follows:

	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL
Average Return	9.60%	38.83%	10.11%	6.86%	12.60%	8.75%	12.13%	11.25%	8.70%	7.90%	7.49%
Standard Deviation	14.80%	51.38%	26.13%	26.37%	29.54%	23.41%	17.15%	24.18%	15.19%	14.64%	15.52%
Beta	1.0000	1.7995	1.1667	1.0185	1.4195	0.9824	0.7085	1.0286	0.4610	0.5334	0.4890
Annualized Alpha	0.0000	0.2156	-0.0109	-0.0292	-0.0103	-0.0068	0.0533	0.0137	0.0428	0.0278	0.0280
Residual Standard Deviation	0.00%	43.93%	19.60%	21.63%	20.77%	18.34%	13.57%	18.79%	13.57%	12.32%	13.73%
E Score		5.64	3.89	6.26	4.17	1.63	2.49	0.58	5.35	7.64	6.76
S Score		4.20	3.52	2.31	3.55	1.67	2.40	5.76	3.01	5.75	3.34
G Score		6.89	8.06	6.93	8.53	8.20	7.54	7.29	7.87	7.10	8.29
ESG Total Score		16.73	15.47	15.50	16.25	11.50	12.43	13.63	16.23	20.49	18.39

Table 3. Specific Data Related to 10 Companies.

Correlations	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL
SPX	100.00%	51.85%	66.10%	57.18%	71.13%	62.13%	61.16%	62.97%	44.92%	53.96%	46.65%
NVDA	51.85%	100.00%	41.40%	41.67%	32.78%	19.06%	31.27%	18.44%	8.80%	10.37%	6.70%
CSCO	66.10%	41.40%	100.00%	53.73%	48.00%	41.78%	40.67%	43.87%	31.86%	29.55%	26.34%
INTC	57.18%	41.67%	53.73%	100.00%	39.88%	34.21%	40.70%	36.20%	19.18%	32.57%	16.70%
GS	71.13%	32.78%	48.00%	39.88%	100.00%	50.51%	48.09%	43.05%	19.88%	29.52%	23.09%
USB	62.13%	19.06%	41.78%	34.21%	50.51%	100.00%	53.68%	53.14%	32.54%	22.69%	25.41%
TD CN	61.16%	31.27%	40.67%	40.70%	48.09%	53.68%	100.00%	43.80%	23.75%	27.23%	23.06%
ALL	62.97%	18.44%	43.87%	36.20%	43.05%	53.14%	43.80%	100.00%	37.42%	49.48%	39.38%
PG	44.92%	8.80%	31.86%	19.18%	19.88%	32.54%	23.75%	37.42%	100.00%	52.46%	56.56%
JNJ	53.96%	10.37%	29.55%	32.57%	29.52%	22.69%	27.23%	49.48%	52.46%	100.00%	55.56%
CL	46.65%	6.70%	26.34%	16.70%	23.09%	25.41%	23.06%	39.38%	56.56%	55.56%	100.00%

Table 3. Correlations among the S&P 500 and 10 Companies.

First, the objective function of the study is to use the Markowitz Model to solve for the minimum variance and maximum Sharpe Ratio of the investment portfolio allocation. The constraints are layered in the following order:

(1) The portfolio is not allowed to have any short positions:

$$w_i \geq 0, \ for\ \forall i;$$

(2) Having the efficient risky portfolio for Scenario 1, add the following constraint on ESG:

$$\sum_{i=1}^{10}(E_i+S_i+G_i)w_i \leq 0.9*\sum_{i=1}^{10}(E_i+S_i+G_i)\widehat{w}_i\ ;$$

(3) The portfolio is allowed to have short positions, 50% or more of which are funded by account equity:

$$\sum_{i=1}^{10}|w_i| \leq 2;$$

(4) Having the efficient risky portfolio for Scenario 3, add the following constraint on ESG:

$$\sum_{i=1}^{10} (E_i+S_i+G_i)w_i \le 0.9* \sum_{i=1}^{10} (E_i+S_i+G_i)\widehat{w}_i \,;$$

By iteratively applying the Markowitz Model to the conditions, the following asset allocation results can be obtained:

Scenario 1	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	0.00%	2.09%	0.00%	0.01%	27.98%	0.00%	23.87%	26.48%	19.58%	9.17%	11.45%	0.8015
MaxSharpe	16.11%	0.00%	0.00%	0.00%	0.01%	32.01%	0.00%	26.45%	16.34%	9.08%	14.41%	14.28%	1.0094
Scenario 2	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	0.00%	1.41%	0.00%	7.15%	45.20%	0.00%	35.89%	0.00%	10.35%	10.11%	12.49%	0.8090
MaxSharpe	16.32%	0.00%	0.00%	0.00%	0.00%	48.67%	2.86%	32.14%	0.00%	0.00%	15.36%	15.63%	0.9827
Scenario 3	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.06%	-0.06%	3.25%	-2.73%	4.58%	29.70%	-9.62%	22.87%	31.25%	20.69%	8.83%	11.28%	0.7823
MaxSharpe	20.59%	-7.44%	-18.14%	-0.36%	-5.34%	44.86%	2.84%	30.41%	24.42%	8.16%	16.43%	15.40%	1.0674
Scenario 4	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	-1.27%	-1.38%	5.06%	-6.28%	8.44%	44.87%	-1.81%	34.00%	2.65%	15.72%	9.25%	12.16%	0.7604
MaxSharpe	21.93%	-9.13%	-19.25%	-2.49%	-3.82%	56.73%	9.45%	38.72%	4.42%	3.44%	17.55%	16.75%	1.0473

Table 4. Asset Allocation under the Markowitz Model.

Performing the same operations on the Index Model, the following results are obtained:

Scenario 1	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	13.83%	0.00%	29.26%	30.02%	26.90%	8.61%	10.34%	0.8328
MaxSharpe	0.00%	13.17%	0.00%	0.00%	0.00%	0.00%	30.46%	0.00%	25.90%	16.45%	14.02%	13.41%	13.67%	0.9808
Scenario 2	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	0.00%	0.00%	0.00%	0.00%	12.08%	37.02%	2.77%	32.04%	0.01%	16.09%	9.85%	11.95%	0.8247
MaxSharpe	0.00%	15.93%	0.00%	0.00%	0.00%	0.00%	48.37%	2.61%	27.36%	0.01%	5.72%	15.16%	15.83%	0.9575
Scenario 3	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	-3.52%	-2.43%	0.94%	-7.60%	2.31%	18.00%	0.98%	30.43%	32.51%	28.38%	7.33%	9.94%	0.7378
MaxSharpe	0.00%	14.47%	-5.68%	-9.74%	-5.24%	-4.51%	36.64%	3.45%	29.72%	22.49%	18.41%	13.90%	13.68%	1.0157
Scenario 4	SPX	NVDA	CSCO	INTC	GS	USB	TD CN	ALL	PG	JNJ	CL	Return	StDev	Sharpe
MinVar	0.00%	-4.66%	-2.64%	1.20%	-10.31%	13.46%	36.16%	6.01%	32.23%	8.88%	19.66%	7.93%	11.03%	0.7192
MaxSharpe	0.00%	16.27%	-6.25%	-11.07%	-6.55%	1.23%	50.09%	6.80%	30.70%	6.96%	11.82%	15.16%	15.24%	0.9944

Table 5. Asset Allocation under the Index Model.

The figures below provide a comparison of the minimum standard deviation and maximum Sharpe Ratio for portfolios simulated by two different models under four scenarios:

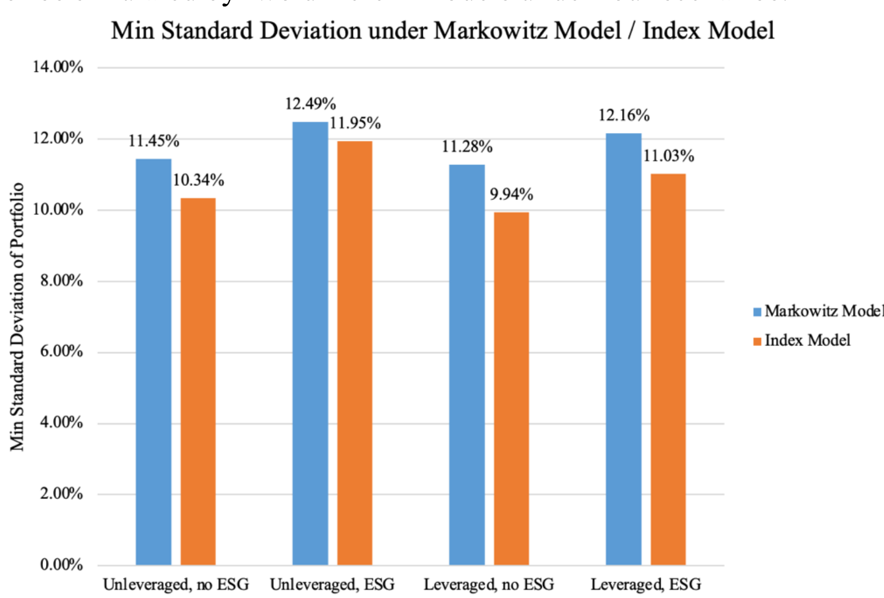

Figure 3. Min Standard Deviation under Markowitz Model / Index Model.

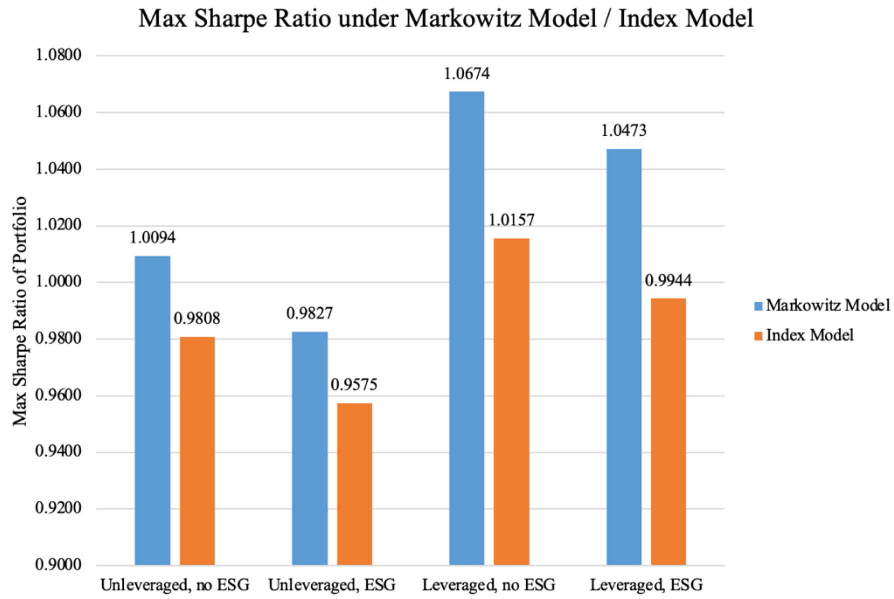

Figure 4. Max Sharpe Ratio under the Markowitz Model / Index Model.

Through the comparison of the figures, we can observe that both modeling approaches demonstrate the following: First, incorporating leverage into the portfolio helps reduce its risk and improve the Sharpe Ratio. Second, imposing ESG constraints on the portfolio increases its risk and lowers the Sharpe Ratio to some extent.

Next, based on the above four scenarios and two different models, we plot the corresponding curves, lines, or points:

(1) Efficient frontier, range for portfolio standard deviation: from 10% to 50% with a step of 0.5%
(2) Inefficient frontier, range for portfolio standard deviation: from 10% to 50% with a step of 0.5%
(3) Variance frontier, range for portfolio returns: from -10% to 50% with a step of 0.5%
(4) Capital allocation line
(5) Minimal variance portfolio
(6) Maximal Sharpe Ratio portfolio

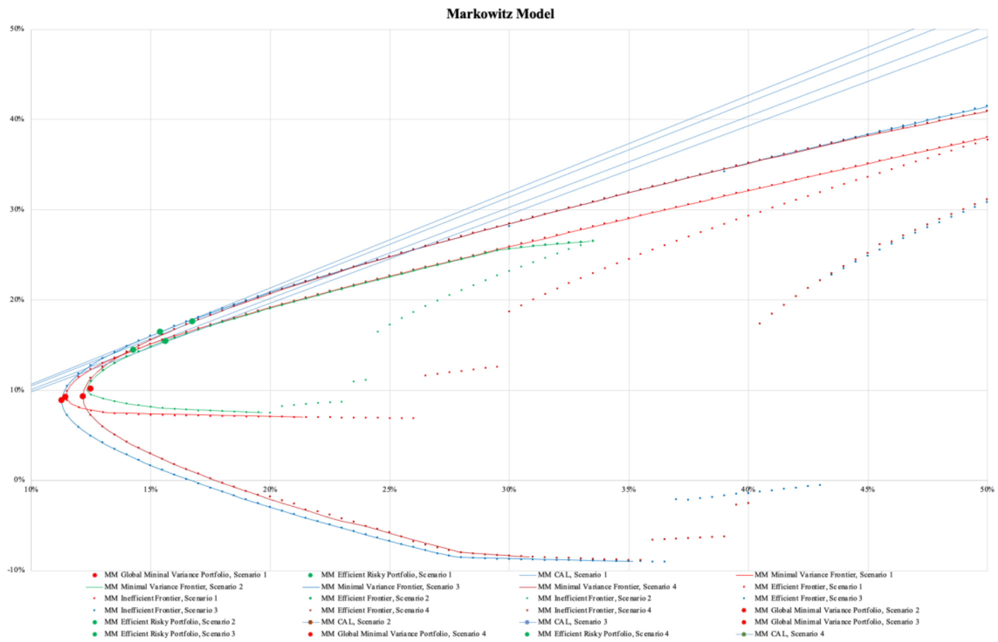

Figure 5. Efficient Frontier / Inefficient Frontier under the Markowitz Model.

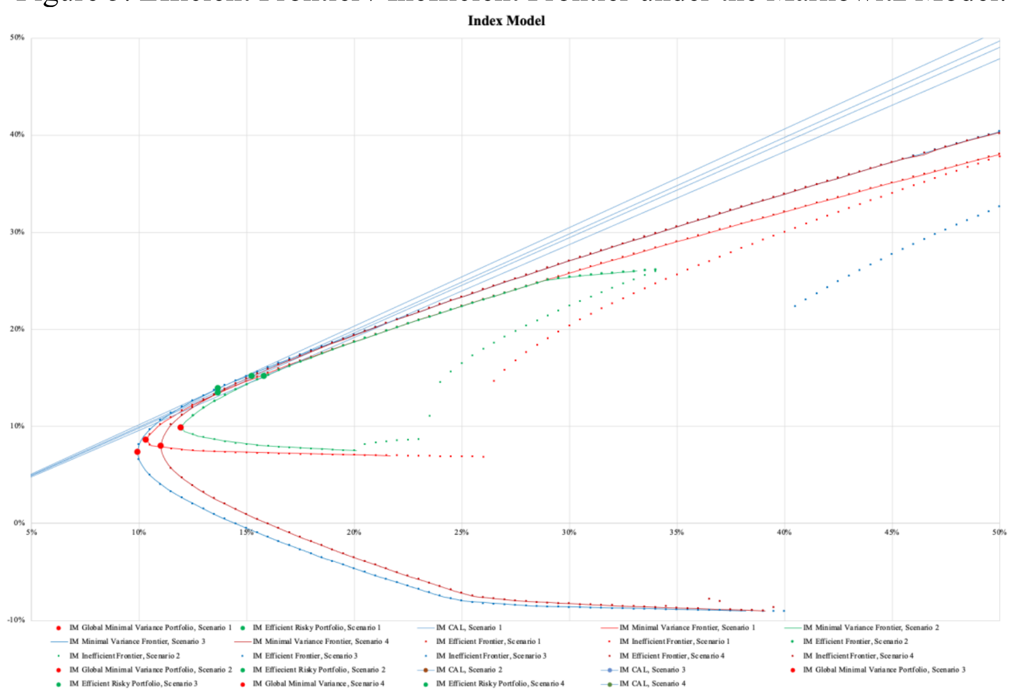

Figure 6. Efficient Frontier / Inefficient Frontier under the Index Model.

According to the calculation results, under the same risk conditions in the Capital Market Line:

$$E(R_3)>E(R_4)>E(R_1)>E(R_2)$$

For the portfolio with minimal variance, Scenario 1 and Scenario 3 under the Markowitz Model are relatively close, while under the Index Model:

$$E(R_2)>E(R_1)>E(R_4)>E(R_3)$$

And

$$\sigma_2>\sigma_4>\sigma_1>\sigma_3$$

In the Efficient Risky Portfolio, Scenario 1 and Scenario 3 under the Index Model are relatively close, while under the Markowitz Model:

$$E(R_4)>E(R_3)>E(R_2)>E(R_1)$$

And

$$\sigma_4>\sigma_2>\sigma_3>\sigma_1$$

The results indicate that leveraging can increase the expected return of an investment portfolio, but it also increases the corresponding risk. In an efficient risky portfolio, incorporating ESG constraints while comprehensively considering risk minimization, maximizing the Sharpe Ratio, and integrating risk-free portfolio factors enhances the overall return and risk profile of the portfolio.

5. Conclusion

Over the past few years, the international ESG investment market has experienced rapid expansion, reflecting to some extent the global consensus among governments and citizens that businesses should pursue sustainable development. Consequently, the international market has seen growing demand for regulatory oversight of asset management products. According to statistics from the Global Sustainable Investment Alliance (GSIA), the global sustainable investment portfolio exceeded $30 trillion in 2024, demonstrating ESG's extensive influence in capital markets. Owing to its universal applicability, quantifiability, comprehensiveness, and systematic nature, ESG has become a crucial strategy for investment institutions in evaluating investment targets, serving as a necessary and sufficient component of the green finance system. This paper demonstrates through comparative assessments of investment portfolios using the Markowitz Model and Index Model that ESG enhances overall portfolio returns for effective risky portfolios, establishing it as a vital metric for evaluating a company's comprehensive profitability. A growing body of empirical research indicates that ESG constraints influence portfolio performance in investment management. Therefore, enhancing the effectiveness of ESG information and establishing relevant policies and regulatory standards are key measures for continuously standardizing the ESG investment market and reducing portfolio construction costs.

References

[1] *Berry, T. C., & Junkus, J. C. (2013). Socially responsible investing: An investor perspective. Journal of Business Ethics, 112(4), 707–720. https://doi.org/10.1007/s10551-012-1567-0*

[2] *van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG integration and the investment management process: Fundamental investing reinvented. Journal of Business Ethics, 138(3), 525–533. https://doi.org/10.1007/s10551-015-2610-8*

[3] *Laokulrach, M. (2025). ESG integration in investment analysis. In M. Bednárová & K. Soratana (Eds.), Environmental, social, and governance (ESG) investment and reporting. Springer. https://doi.org/10.1007/978-3-031-84235-1_5*

[4] *Henke, H. M. (2016). The effect of social screening on bond mutual fund performance. Journal of Banking & Finance, 67, 69–84. https://doi.org/10.1016/j.jbankfin.2016.02.006*

[5] *Joliet, R., & Titova, Y. (2018). Equity SRI funds vacillate between ethics and money: An analysis of the funds' stock holding decisions. Journal of Banking & Finance, 97, 70–86. https://doi.org/10.1016/j.jbankfin.2018.09.005*

[6] *Lian, Y., Ye, T., Zhang, Y., & Zhang, L. (2023). How does corporate ESG performance affect bond credit spreads? Empirical evidence from China. Journal of International Financial Markets, Institutions and Money, 85, 101771. https://doi.org/10.1016/j.intfin.2023.101771*

[7] *Oikonomou, I., Brooks, C., & Pavelin, S. (2012). The impact of corporate social performance on financial risk and utility: A longitudinal analysis. Financial Management, 41(2), 483–515. https://doi.org/10.1111/j.1755-053X.2012.01190.x*

[8] *Pedersen, L. H., Fitzgibbons, S., & Pomorski, L. (2021). Responsible investing: The ESG-efficient frontier. Journal of Financial Economics, 142(2), 572–597. https://doi.org/10.1016/j.jfineco.2020.05.004*

[9] *Shafer, M., & Szado, E. (2020). Environmental, social, and governance practices and perceived tail risk. Accounting & Finance, 60(4), 4195–4224. https://doi.org/10.1111/acfi.12585*

[10] *van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG integration and the investment management process: Fundamental investing reinvented. Journal of Business Ethics, 138(3), 525–533. https://doi.org/10.1007/s10551-015-2610-8*

[11] *Garrigues, I., Paraskevopoulos, I., & Santos, A. (2021). ESG disclosure and portfolio performance. Risks, 9(9), 172. https://doi.org/10.3390/risks9090172*

[12] *Chatterji, A. K., Durand, R., Levine, D. I., & Touboul, S. (2016). Do ratings of firms converge? Implications for managers, investors and strategy researchers. Strategic Management Journal, 37(8), 1597–1614. https://doi.org/10.1002/smj.2407*

[13] *Compact, T. G. (2005). Who cares wins 2005 conference report: Investing for long-term value. https://www.scribd.com/fullscreen/16876744?access_key=key-mfg3d0usaiuaob4taki*

[14] *Carleo, A., Cesarone, F., Gheno, A., & Ricci, J. M. (2017). Approximating exact expected utility via portfolio efficient frontiers. Decisions in Economics and Finance, 40(1), 115–143. https://doi.org/10.1007/s10203-016-0176-2*

[15] *Derwall, J., Guenster, N., Bauer, R., & Koedijk, K. (2005). The eco-efficiency premium puzzle. Financial Analysts Journal, 61(2), 51–63. https://doi.org/10.2469/faj.v61.n2.2716*

[16] *Paris Agreement. (2015). United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/english_paris_agreement.pdf*