STRATEGIC PORTFOLIO DIVERSIFICATION FOR HEALTH INSURANCE COMPANIES: LEVERAGING ESG INVESTMENTS AND THE BLACK-LITTERMAN MODEL

P. NITHYA[1], C.D. NANDAKUMAR[2,*], A. SAIBULLA[3], M. PRIYA[4]

[1]Reserch Scholar, B.S.Abdur Rahman Crescent Institute of Science & Technology, Chennai, India.
[2,] Corresponding Author, Associate Professor, B.S.Abdur Rahman Crescent Institute of Science & Technology, Chennai, India.*
[3] Assistant Professor (Selection Grade), B.S.Abdur Rahman Crescent Institute of Science & Technology, Chennai, India.
[4]Assistant Professor, Department of Computer Science, AgurchandManmull Jain College (Shift II), Meenambakkam, Chennai - 600 061, India
nithiprithivi@gmail.com[1], prof.cdnandakumar@gmail.com[2,], saibulla.a@gmail.com[3], mpriya.cs19@gmail.com[4]*

KEYWORDS
Health insurance, IRDA, ESG, Black-Litterman model, Sharpe ratio.

ABSTRACT
Health insurance firms primarily provide financial protection to policyholders by covering medical costs and mitigating health risks. While these firms typically invest in low-risk government securities, regulations allow them to diversify into equities. This study proposes allocating 20% of their portfolio to ESG-compliant companies, which can offer stronger risk management and higher long-term returns. Using the Black-Litterman model, we evaluated 20 ESG leaders and created four portfolios to assess their suitability for risk-averse investors. Our findings suggest that integrating ESG equities into the investment strategy can enhance diversification and improve profitability while maintaining stability for insurance firms.

1. INTRODUCTION

Investment diversification is essential for long-term financial sustainability even if the main responsibility of health insurance companies is to safeguard policyholders by paying for medical expenses. Many businesses continue to be risk averse even when legislative flexibility permits them to invest in stocks. This is probably because they are worried about market volatility or have always been conservative investors. The purpose of this study is to investigate how adding ESG-compliant stocks to an investment portfolio can reduce risk and increase returns. For investors looking to make sustainable and ethical investments, it is becoming more and more crucial to incorporate environmental, social, and governance (ESG) considerations into their investing strategy. The increasing quantity of ESG scores, however, draws attention to inconsistent findings, significance, different scoring systems, computation, and inadequate integration of ESG elements. It is critical to guarantee more data consistency across ESG scores. The capacity of ESG scores to characterize and forecast future returns in the credit and equity markets is what gives them significance. Considering ESG issues can yield financial advantages such as improved risk-adjusted returns and encouragement of sustainable investing methods. Emphasizing the significance of integrating ESG score levels and their explanations into the investing procedure, investors may be able to enhance risk mitigation and advance sustainable investment approaches [1]. ESG investing as of right now, based on more than 2,200 distinct studies. About 90% of research indicate a favorable correlation between ESG elements and financial success, providing solid empirical support for the financial benefits of ESG criteria. These results demonstrate a consistent and encouraging relationship

between ESG and business financial success across a range of asset classes, geographical areas, and time periods [2].
Goldman Sachs economists Fischer Black and Robert Litterman developed the Black-Litterman model in 1990. Establishing a quantitative and methodical strategy for organizing foreign bond portfolios in a way that aligns with the portfolio manager's distinct market perspectives was its principal goal. The Black-Litterman model, which comprises possible future outputs, enhances Modern Portfolio Theory and is widely acknowledged as a crucial mathematical instrument in the finance domain [3].One popular and well-respected way to apply the Bayesian framework to asset allocation issues is through the Black-Litterman model. However, because it necessitates the declaration of abstract uncertainty characteristics, calibration is challenging. We suggest a novel, more adaptable model that eliminates the necessity for parameterization by enabling the empirical estimation of the equilibrium. We demonstrate the empirically applied sensitivity of the traditional Black-Litterman model to the unpredictability of parameter selection [4].

A novel technique to node wise regression based on residuals from a fitted factor model. This method is especially effective for studying Sharpe Ratio estimators in portfolios with many assets and temporal data. Mean-variance and global minimum-variance portfolios use the same estimators of the Sharpe Ratio. When the portfolio weights equal one, the maximum Sharpe Ratio estimate remains consistent, as does the maximum-out-of-sample Sharpe Ratio estimator [5].

Benchmarks are used to evaluate the performance of active funds. When following guidelines like asset weight limitations and tracking errors (TE), fund administrators hope to produce portfolio returns that exceed the benchmarks. The maximal active portfolio return and related absolute portfolio risk for any TE outline a hyperbolic TE horizon in the risk/return space. An ellipse that is closed and deformed in risk/return space is formed by the locus of all potential active portfolio coordinates for a specific level of TE. Three strategies are used to try to maximize the performance of an active portfolio at a particular TE: the maximum active return portfolio, the maximum active return portfolio with the benchmark's absolute risk, and the tangent portfolio (also known as the maximum risk-adjusted return or Sharpe ratio (SR) [6]. Investors that employ the Black-Litterman model must to understand that they must periodically adjust their expectations and adjust their portfolios as necessary. By utilizing the model's capacity to continuously improve asset allocation choices, this ongoing adjustment guarantees that the portfolio stays in line with both market circumstances and investor opinions. Global investors, including insurance firms, pension funds, and other investors, can use this model to help them allocate their investments across various asset classes and nations. By including the portfolio manager's market perspectives, the Black-Litterman model optimizes portfolio creation and suggests a higher predicted portfolio return than conventional techniques.

2. LITERATURE REVIEW

The effectiveness of environmental, social, and governance (ESG) elements before and after the COVID-19 pandemic in both developed and developing nations. To accomplish the study goals, panel regression analysis is used with a sizable multinational dataset that includes 12,325 company-year observations from 2016 to 2021. The results imply that, in order to show moral leadership in times of crisis, businesses should prioritize ESG performance during the pandemic, no matter where they are located. It's interesting to note that the study refutes the notion that developed nations

routinely beat developing ones in terms of ESG performance, demonstrating that emerging markets outperform developed ones in terms of environmental performance while developed markets prioritize social factors more. Additionally, the pandemic has a favorable impact on overall ESG performance, emphasizing the value of moral behavior in times of emergency [7].Stakeholders are highly interested in the global energy sector because of the continuous debates about its impact on the environment. Investor reactions to these scandals have a direct impact on these companies' financial health. Furthermore, a nation's regulatory environment and developmental stage determine how sensitive a nation is to Environmental, Social, and Governance (ESG) factors, which may protect energy companies from these kinds of disputes. Thus, the goal of this study is to determine whether a country's level of development affects how ESG affects the share price volatility (SPV) of companies in the energy industry [8].

In light of the COVID-19 pandemic, this study examines how Environmental, Social, and Governance (ESG) practices behave on the Japanese stock market. Analyzing how ESG issues specifically affect stock markets during times of economic crisis, it contributes to the body of existing work. The results show that, in the midst of the COVID-19 issue, stock returns and company ESG performance are positively correlated. Furthermore, the research shows that strong environmental, social, and governance (ESG) performance is associated with increased stock market stability and improved market liquidity in Japan during the epidemic. These results highlight how crucial it is to put supportive policies and laws in place to encourage businesses to adopt and disclose robust ESG practices.

In addition to supporting the stock market's integrity and liquidity, such measures can promote long-term economic growth [9]. Analyze how the COVID-19 epidemic affected the stock prices of businesses with different ESG (environmental, social, and governance) scores. To what extent and if at all higher ESG ratings these companies provided investors with a hedge against this catastrophe is the subject of our investigation. We utilize a wide range of public firms and specifically concentrate on the European market, where ESG investment is highly valued. Our results show conflicting results. At first, after the pandemic broke out, companies with higher ESG scores performed better than their competitors [10]. Deliver effective investing methods using a new portfolio model that combines the Black-Litterman structure along with the Fama-French three-factor approach. By improving alpha, decreasing estimating error, and increasing diversification, this model performs better than conventional benchmarks. Sharpe ratios tripled and Certainty Similar Return twice relative to standard models demonstrate performance improvements. By using precise weight modification to reduce estimating mistakes and manage market volatility, it exhibits stability across a range of characteristics and economic situations. Using knowledge from asset pricing theory, this method offers a novel perspective on portfolio creation with significant ramifications [11]. We provide an improved Black-Litterman model that combines investor perspectives and multi-channel data inside a Bayesian framework to generate customized investment strategies in order to solve the "imperfect effectiveness" of the stock market and the "inadequate rationality" of investors. Using the SVM-ARIMA-GARCH model, we address the problem of quantifying investor perspectives in an empirical analysis of the Chinese stock market. Our improved Black-Litterman model finds the best investment strategy, which performs better out-of-sample under a variety of market scenarios. It does this by showing greater Sharpe ratios and lower turnover ratios when compared to multiple benchmark strategies [12].

Several multi-factor asset pricing models with available return data show impressive in-sample Sharpe ratios, frequently higher than the market portfolio. Nonetheless, given that investors generally attain lower out-of-sample Sharpe ratios, this result defies accepted financial wisdom. This performance loss can be attributed in part to estimation risk. We mathematically explore the influence of estimate risk by obtaining the exact distributions of the in-sample and out-of-sample Sharpe ratios, emphasizing the need for model assessments to take this effect into account [13]. In real-world situations, the actual market portfolio as defined by the Capital Asset Pricing Model (CAPM), which is located at the tangent point of the line extending from the riskless rate, is not visible. Sharpe, who received the Nobel Prize in Economics for his work on the CAPM, developed a technique called the Sharpe ratio—which is now commonly used to compare portfolio performance—by dividing excess returns by return standard deviation. However, the CAPM framework, ignores beta risk. In reaction, Gibbons et al. (Econometrica 57:1121–1152, 1989) (GRS) suggested a test to determine if, in the context of the stock market system version of the CAPM, a certain portfolio is ex-ante mean-variance efficient [14]. A new method of building portfolios that is focused on Environmental, Social, and Governance (ESG) aspects is presented. To predict returns and volatility, this approach makes use of machine learning algorithms and a Markov Switching Variance (MSV) system. It also uses a Multi Criteria Decision-Making (MCDM) system called TODIM to find superior stocks. The best asset weights are then determined by using an optimization model built on the Mean-Variance framework that takes ESG factors into account. By considering a wider range of considerations for investors, the goal is to find more profitable and dependable investment options. The suggested method performs better than benchmarks when compared to different benchmarks in terms of risk and profitability indicators [15]

3. MATERIALS AND METHODS

3.1 **ESG (Environmental, Social, and Governance)**

Environmental, social, and governance is referred to as ESG. The three pillars of ESG are as follows. Capturing all of the non-financial hazards within the organization is the primary goal of the ESG. This organization engages in commerce and performs on a range of ethical and sustainable challenges. The risks and opportunities for the company in certain sectors are identified and measured with its assistance. Environmental in ESG refers to considering an organization's overall environmental effect as well as evaluating the opportunities and risks that may arise from environmental concerns. Environmental factors include things like waste management, pollution of the air and water, deforestation, loss of biodiversity, energy efficiency and consumption, climate change and carbon emissions, and depletion of natural resources. These environmental elements have an impact on businesses and how they address and manage environmental challenges. The social component of the ESG pillar is the next one; it deals with how an organization handles various groups of people, including its customers, workers, and community members. Fair compensation for workers, workplace health and safety, customer satisfaction levels, community relations, and other issues are included in the social factors.

The final and most significant element of the ESG is Governance, which looks at how an organization manages itself. It focuses on internal controls and procedures for upholding policies, corporate guidelines, and best practices. The leadership and administration of the organization, financial transparency, moral corporate conduct, and other elements are some of the components that comprise governance. More long-term profitability can be achieved by ESG companies because they often exhibit stronger risk management. Despite market volatility, ESG investments are expected to outperform bonds in terms of risk management and returns.

S.No	Company Name	Expected Return	ESG Score (2024)	ESG Rating (2024)	ESG Category
1	Adani Green Energy	0.25	80	A	Leadership
2	Asian Paints Limited	0.12	80	A	Leadership
3	Bajaj Auto Limited	0.11	76	BBB	Strong
4	HCL Technologies	0.12	78	BBB	Strong
5	HDFC Bank	0.9	73	BBB	Adequate
6	HDFC Life Insurance	0.13	79	BBB	Strong
7	Hero MotoCorp	0.11	80	A	Leadership
8	Hindustan Unilever	0.08	77	BBB	Strong
9	Infosys	0.12	79	BBB	Strong
10	ITC Limited	0.09	76	BBB	Strong
11	Kotak Mahindra Bank	0.01	75	BBB	Strong
12	Larsen & Toubro Ltd.	0.14	82	A	Leadership
13	Mahindra & Mahindra	0.11	70	BBB	Adequate
14	Maruti Suzuki India	0.10	77	BBB	Strong
15	Nestle India	0.09	81	A	Leadership
16	Reliance Industries	0.18	68	BB	Weak
17	Tata Consultancy Services	0.13	85	A	Leadership
18	Tata Motors	0.20	74	BBB	Adequate
19	Titan Company Limited	0.10	76	BBB	Strong
20	Wipro Limited	0.11	78	BBB	Strong

TABLE 1: SELECTION OF ESG COMPANIES

According to the 2024 ESC ratings and criteria, the top 20 businesses in each ESC category were selected. The majority of these businesses have ratings of A, BB, and BBB, which stand for leadership, strong, adequate, and weak, respectively (TABLE 1). ESG investing is used to evaluate investments to see if they adhere to company policies and to motivate businesses to behave ethically. Investment solutions based on these adhere to ESG standards are offered by numerous brokerage firms. When selecting stocks, long-term investors need to evaluate the company's performance in terms of return and risk. The majority of investors often choose to analyze financial facts when choosing a stock. They don't place much weight on non-financial data. Financial and non-financial factors, however, are now taken into consideration when selecting a company for a long-term investment.

The IRDA's guidelines for general insurance companies on investment allocation. About 20% were allocated to unapproved investments. However, most insurance companies are not prepared to assume risk. They exclusively invest in risk-free securities, government securities, and the like.

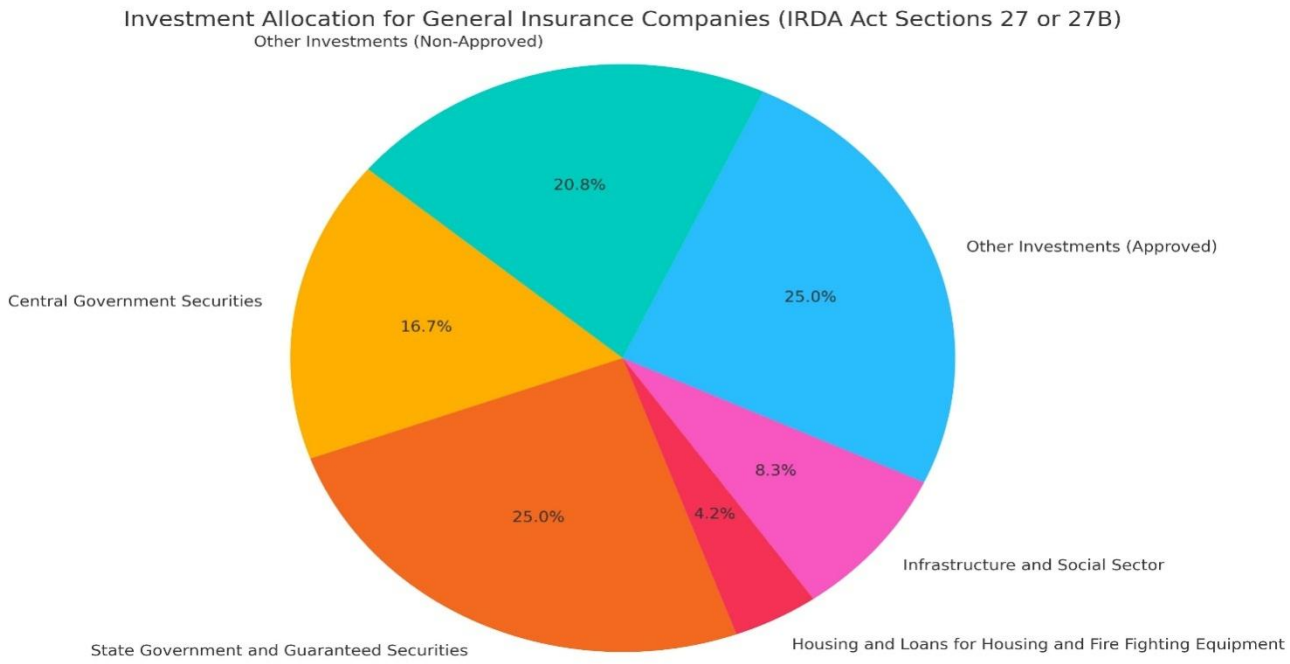

FIGURE 1: Investment allocation requirements for general insurance companies

The Investment Distribution for General Insurance Businesses as Required by Sections 27 or 27B of the Insurance Regulatory and Development Authority (IRDA) Act is depicted in the pie chart. Investments are divided into six different categories. To begin with, 25.0% of the assets are designated as "Other Investments (Approved)," which comprises investments permitted by law but not included in anything else. A further twenty-five per cent goes toward "State Government and Guaranteed Securities," which includes assets that the state governments issue or guarantee. 16.7% of all investments are in "Central Government Securities," which the central government has issued securities. Furthermore, 20.8% of the assets are classified as "Other Investments (Non-Approved)," meaning that they do not meet the requirements of the relevant rules. 8.3% of the investments are allocated to the "Infrastructure and Social Sector" category, which focuses on social sectors and infrastructure efforts. Finally, "Housing and Loans for Housing and Fire Fighting Equipment," which includes housing loans and firefighting equipment, receives 4.2% of the investments (Fig: 1). According to the standards set forth by the IRDA Act, this chart offers a thorough view of the investment distribution made by general insurance companies.

3.2 METHOD: Black-Litterman Model

The Black-Litterman Model is a mathematical model used by Portfolio Managers to assist them in the process of asset allocation, given investors risk profile and market opinions. It helps in creating customized portfolios based upon Modern Portfolio Theory (MPT) principles from a starting neutral position, enhancing traditional portfolio formation methods. This is how to calculate the asset allocation that deviates from the original portfolio weights given more input from investors' perspective (FIG: 2). In order to optimize predicted returns given a particular risk tolerance, the model incorporates mean-variance optimization. According to modern portfolio theory, investment

risk and return should not be assessed separately but rather in light of how they will affect the portfolio as a whole.

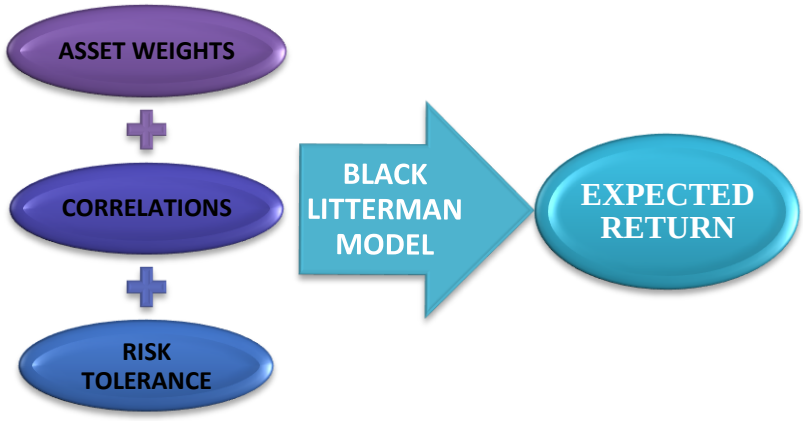

FIGURE 2: Black-Litterman model

It demonstrates that, for a given degree of risk, investors can maximize profits by assembling a portfolio of several assets. Investors can also build a portfolio with the least amount of risk by based on predicted returns. But one drawback of MPT is its dependence on historical data and the presumption that prior returns would persist. The Black-Litterman model gives investors the freedom to apply their personal opinions to maximize the suggested asset allocation, whereas Modern Portfolio Theory relies on a restricted amount of historical market data and forecasts that past results will persist into the future. The Capital Asset Pricing Model (CAPM), a second pricing method, creates different expectations by considering the historical performance of securities

3.3 PROCEDURES

Like the Markowitz Optimization Framework, the Black-Litterman Model (BMP) assigns portfolio weights and, using those weights as a basis, calculates the expected return. The market's ideal weights are noticed and recorded in the market portfolio. With risk taken into account, this method maximizes the utility function.

$$\mathbf{U = } \boldsymbol{w^T} \mathbf{\Pi - \frac{1}{2} A} \boldsymbol{w^T} \textbf{ (subject to } \boldsymbol{w^T} \textbf{ =1)}$$

w^T = transposed of portfolio weights
Π = Implied equilibrium excess return vector
A = price of risk or risk aversion factor
Σ = variance-covariance matrix
Weight-wise, the utility function is maximized when the partial derivative of U with respect to w is set to zero.

$$\frac{du}{dw} = \Pi - A\sum w = 0$$
$$\Pi = A\sum w$$

The Black-Litterman model which is able to include investor expectations and market data (often implied from models like the CAPM) to make the sort of adjustments here that can help them predict possible future changes. The Model Black-Litterman Model is designed to analyze not only investors' perspectives, but also mistakes and shortcomings of the MPT, unfortunately resulting in the effect will be an increase in the error of incorrect assumptions over time. Still, the model helps in finding and correcting these errors during the asset allocation process. The market capitalization of the portfolio's stocks determines the market weight, which is the goal of the Black-Litterman technique.

$$\mathbf{E[R] = [(\tau \sum)^{-1} + P'\Omega^{-1}P]^{-1} [(\tau \sum)^{-1}\Pi + P'\Omega^{-1}Q]}$$

Where,

Π= implied equilibrium excess return
$\sum$ = Variance-covariance matrix.
τ = scalar value
P = Linking matrix
Q= Q Views

- $[(\tau \sum)^{-1} + P'\Omega^{-1}P]^{-1}$ is the Posterior Distribution. Consider the investor's views.
- $[(\tau \sum)^{-1}\Pi + P'\Omega^{-1}Q]$ is the Prior Distribution. That the mean Pi of the market equilibrium returns Pi has a normal distribution, and that the scaling factor tau (which is usually between 0 and 1) is the covariance matrix tau Sigma

Methods and actions to determine the expected return using the Black-Litterman model

4. FINDINGS AND DISCUSSION

4.1 Methods and actions to determine the expected return using the BlackLitterman model

a) Determine the implied equilibrium excess return (Π) by multiplying the weights and variance-covariance matrix by the price of risk (A) as calculated in a matrix.

$$\mathbf{\Pi = A\sum w}$$

Π= implied equilibrium excess return
A = Price of risk
$\sum$ = Variance-covariance matrix.
w = weight vector
Three variables are required to calculate the implied equilibrium excess return.

b) Calculate the price of risk (A)

$A = \frac{E(r_m) - r_f}{\sigma_m^2} = 844.9725751890275$

Where,
$E(r_m)$= Expected market returns
r_f = risk-free rate

σ_m^2 = variance of market

$E(r_m)$= 22.13% is the expected market return. The goal of the investment study is to anticipate the average return on investment over a variety of market equities. In this instance, an analysis of the data gathered between April 1, 2019, and March 31, 2024 was performed using the daily returns of the chosen stocks. After accounting for 252 trading days annually, the average daily return for every stock is calculated and examined. This data is extremely useful for making informed judgments about portfolio management and strategic investment strategies. The risk-free rate is 7%, which represents the expected return on a riskless investment, such as government bonds. For assessing the performance of investments, this rate acts as the starting point. The market variance quantifies the degree of volatility in market performance over time by evaluating the index's daily returns. Investors can assess market-level risk by having a clear understanding of the returns' deviation from the mean. To manage investment risk, allocate a portfolio, and create risk-reduction plans, it is highly useful to know that the computed market variance is 0.0179%.

c) Determine the market capitalization weight of each firm in the portfolio.

Weight (%) = $\frac{\textbf{Market-capitalization}_i}{\sum_{i=1}^{n} \textbf{Market-capitalization}_i}$

To get the market capitalization weight of each company in the portfolio, take the following actions. Consider the 20 companies' respective market capitalizations. The total market capitalization is calculated by adding the market capitalizations of all 20 firms (Table: 2). By dividing the market capitalization of each stock in the portfolio by its total market capitalization, you may determine the weight of each stock. Every weight added together will equal one.

S.No.	Name	Market Cap (Rs.Cr.)	Market Weight	BETA	Market-implied return
1	Adani Green	296990.25	0.029	1.64	0.017840952
2	Asian Paints Ltd	276603.87	0.027	0.79	-0.000866942
3	Bajaj Auto Ltd	250382.36	0.025	0.51	0.012962034
4	HCL Technologies Ltd	361419.49	0.036	0.83	-0.005818974
5	HDFC Bank Ltd	1151917.2	0.113	1.14	0.011024194
6	HDFC Life Insurance Company Ltd	118463.25	0.012	0.65	-0.001634135
7	Hero MotoCorp Ltd	102684.62	0.011	0.94	-0.003193146
8	Hindustan Unilever Ltd	552482.89	0.055	0.6	-0.009504976
9	Infosys Ltd	592515.58	0.058	1.06	-0.014396301
10	ITC Ltd	529164.92	0.052	0.76	0.006134246
11	Kotak Mahindra Bank Ltd	335978.51	0.033	0.88	-0.005739305
12	Larsen & Toubro Ltd	499681.9	0.049	1.19	0.009519355
13	Mahindra & Mahindra Ltd	310073.91	0.031	1.16	0.005113295
14	Maruti Suzuki India Ltd	396084.36	0.039	0.83	-0.015772345
15	Nestle India Ltd	231860.51	0.023	0.57	-0.020750166
16	Reliance Industries Ltd	1928018.6	0.191	1.14	0.003895147
17	Tata Consultancy Services Ltd	1351753.7	0.134	0.81	-0.01743797
18	Tata Motors	338652.02	0.034	0.99	-0.001028194

19	Titan Company Ltd	290470.31	0.029	0.86	-0.009153843
20	Wipro	228440.66	0.022	1.24	0.002860739
	TOTAL	**10143639**	**1**		

TABLE 2: CALCULATE THE Market Weight FOR ALL THE COMPANIES

d) Calculate the Variance-covariance matrix $(\sum)$

Compute the daily returns for each of the 20 companies using historical stock data. Determine the daily returns by dividing the stock price change by the percentage. Utilize these daily returns to calculate the covariance matrix, which expresses how volatile or dispersed each stock's returns are. The variance, which is derived from the covariance matrix, shows the unique return volatility of every stock. To determine the risk of each stock in the portfolio, variance is crucial.

e) Calculate $(\tau\sum)^{-1}$

Next, take the following actions to compute the covariance matrix using historical stock data for the listed companies. Using these daily returns, calculate the covariance matrix. Apply a scalar value of 0.25 to the covariance matrix. Flip the resultant matrix over. Finally, it computes the inverse of the scaled variances and prints the results.

f) Calculate Prior Distribution of Π * $(\tau\sum)^{-1}$

Multiply by Π with $(\tau\sum)^{-1}$the vector. By following these procedures, may be sure that have the modified and transformed covariance matrix required for additional portfolio analysis or optimization.

g) Identify the Investor's Views

We must take a methodical approach, screening equities according to their beta values, establishing views, and creating the required matrices and vectors in order to apply the Black-Litterman model to the given data. Initially, we narrow down the equities to only contain those whose beta is higher than 1. Based on the data supplied, Wipro, Adani Green, Reliance Industries Ltd, HDFC Bank Ltd, Mahindra & Mahindra Ltd, Infosys Ltd, and Larsen & Toubro Ltd are the companies that fit this criterion. We then define viewpoints, both absolute and relative. Relative views describe predicted differences in returns between pairs of equities, whereas absolute views define exact projected returns for individual stocks. The following are the defined views:

1. **Absolute Views:**
   - An 8% return is anticipated for Adani Green.
   - A 5% return is anticipated for Reliance Industries Ltd.
2. **Relative Opinions**:
   - Wipro is expected to do 2% better than Infosys Ltd.
   - Mahindra & Mahindra Ltd. will do 1.5% better than HDFC Bank Ltd.
   - Adani Green will lose ground to Larsen & Toubro Ltd. by 1%.

We construct two key elements, the P matrix and the Q vector, in order to integrate these viewpoints into the Black-Litterman model. For each view, the expected returns are specified by the Q Vector.

The Q vector is as follows in light of the defined views: In [0.08, 0.05, 0.02, 0.015, 0.01] units. Next, change the P matrix to P transpose.

P^T= [[0, 0, 1, 0, 0],
[1, 0, 0, 0, -1],
[0, 0, 0, 0, 0],
[0, 1, 0, 0, 0],
[0, 0, 0, -1, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 1, 0],
[0, 0, 0, 0, 0],
[0, 0, -1, 0, 0],
[0, 0, 0, 0, 1],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0],
[0, 0, 0, 0, 0]]

h) Calculate Confidence matrix and tau (Ω^{-1})

We compute omega to determine the degree of uncertainty associated with the views. While Black-Litterman paper used a value of tau equal to 0.25, an important number of academics went for calculating the tau equal to one. For the sake of simplifying the model, consider tau to be equal to one. This input is obtained by multiplying the Linking matrix by the variance-covariance matrix and transposing the Linking matrix (P).

To ascertain the level of uncertainty pertaining to the viewpoints, we calculate omega. The Black-Litterman work used a figure of tau equal to 0.25.

$$\boldsymbol{\Omega = \tau P \sum P^T}$$

Where

τ= scalar

P = Linking matrix

$\sum$ = Variance-covariance matrix

This input is generated by multiplying the Linking matrix by the variance-covariance matrix and transposing it (P).The variances of each perspective are contained in a diagonal covariance matrix, which is the confidence matrix. Find out the $\boldsymbol{\Omega}$ and then transform the omega into its inverse.

4.2 Portfolio Optimization

Now, use the Black-Litterman model to multiply the posterior distribution and posterior distribution to get the expected returns. A combination of the initial equilibrium returns and modified views, which represent investor expectations, was used to compute the equilibrium returns with the views (Qs). The uncertainty in these viewpoints is then taken into consideration by adjusting the covariance matrix.

The linear equation created by these altered terms is solved to get the expected returns. Ultimately, the firms are ordered according to these anticipated returns in order to determine which provides

the maximum return. By combining investor perspectives with past data, the Black-Litterman model essentially creates a set of expected returns and offers an advanced way of combining equilibrium returns with meaningful expectations.

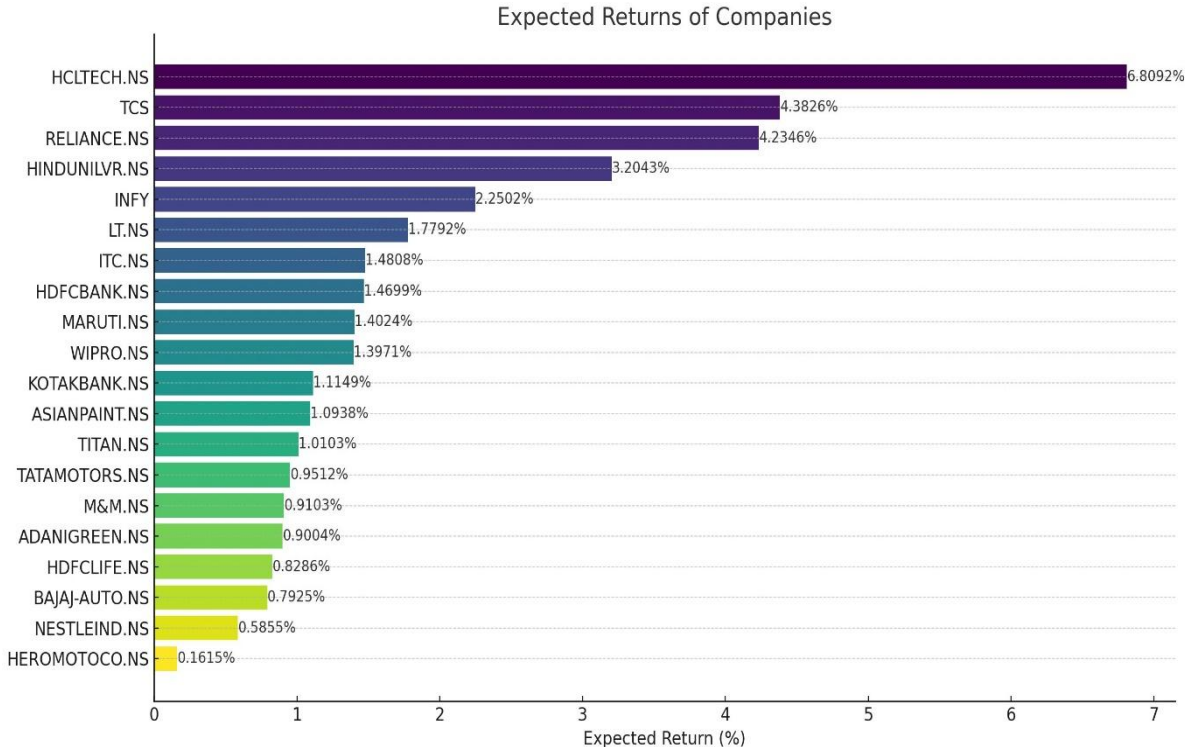

Figure 3: Expected returns of all the companies by using Black-Litterman model

The result presents the Black-Litterman model-calculated predicted returns for twenty different stocks, ranking them according to these returns. The predicted returns are stated as percentages for each stock, and each stock is uniquely identified by its display symbol. HCL Technologies (HCLTECH.NS) is the top-ranked stock on the list, with a 6.8092% projected return (Fig: 3). Hero MotoCorp (HEROMOTOCO.NS), on the other hand, is ranked lowest due to its lowest predicted return of 0.1615%. A cumulative measure of the predicted performance of the portfolio is given by the fact that the total expected returns come to 36.7592%. By emphasizing equities with the most promising predicted returns based on the model, this ranking helps investors make more informed decisions.

Next, the ideal portfolio weights are determined by combining the investor's risk aversion with the covariance matrix, risk-free rate, and estimated return of the portfolio. A metric used to express an investor's tolerance for risk is their risk aversion, or λ. Assume for the moment that λ=3.In the Black-Litterman model, the following calculation yields the optimal portfolio weights is:

$$\mathbf{w} = \frac{\mathbf{1}}{\boldsymbol{\lambda}} \sum^{-\mathbf{1}} (\mathbf{E[R]} - \mathbf{R_f}\,\mathbf{1})$$

Where:

Σ is the covariance matrix of stock returns
E[R] is the vector of expected returns
1 is a vector of ones

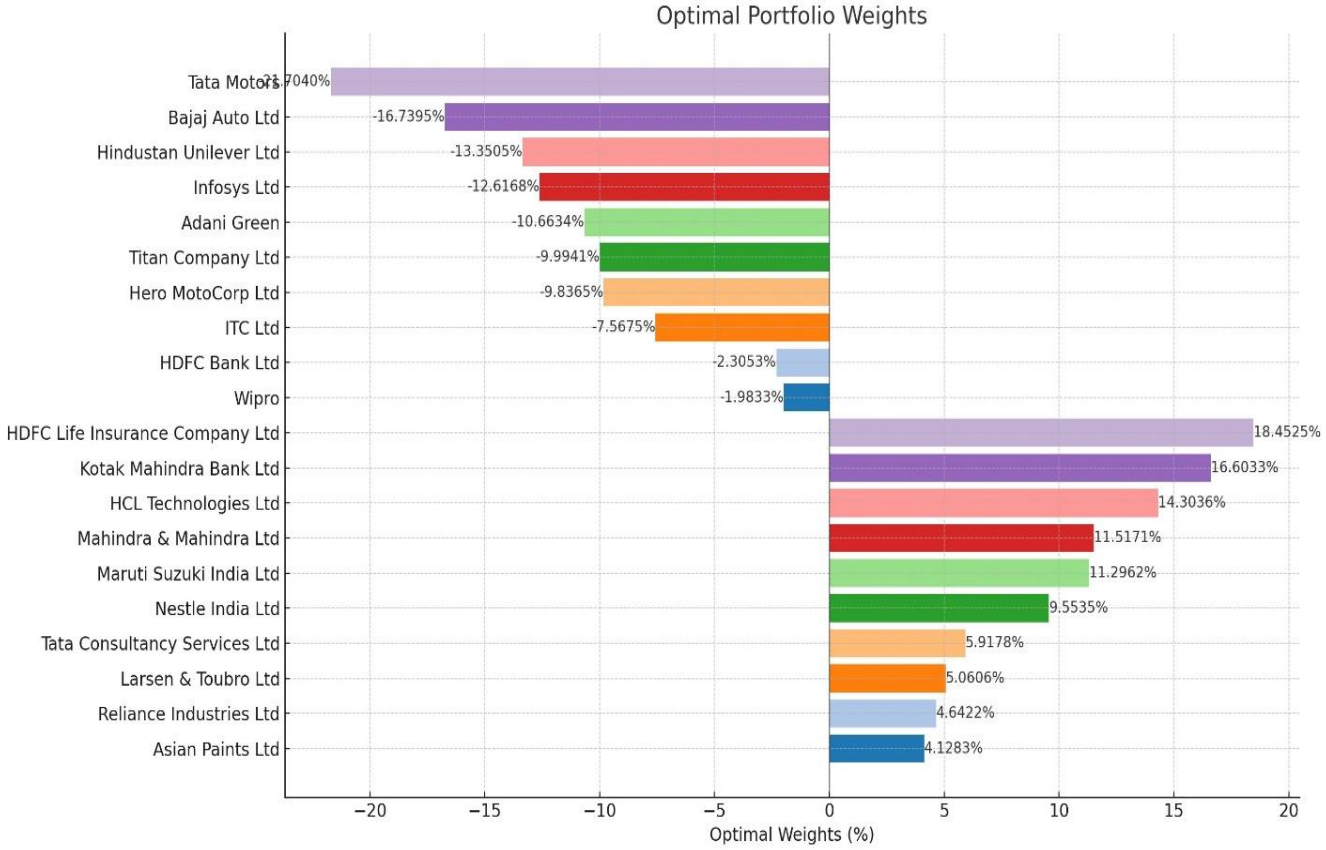

Figure 4: Optimal portfolio weights of all the companies by using Black-Litterman model

The Black-Litterman model generates a new set of predicted returns by combining market equilibrium returns (prior) and investor perceptions (posterior). The ideal weights for the portfolio can then be determined using these returns. This is a methodical technique for determining the ideal weights for your portfolio. The ideal weights vector will result from doing this. Long positions are represented by any positive weights, and short positions are represented by any negative weights. Make the appropriate adjustments in light of your short-selling limits. The percentage of investment allotted to each stock in a portfolio is indicated by its optimal weights. Negative weights indicate that the stock should be shorted, and positive weights indicate that the stock should be included. Higher values indicate a more optimistic outlook. Expected returns are expressed as the percentage return anticipated for each stock. Based on the analysis, it appears that HCLTECH.NS, TCS, and RELIANCE.NS have the highest projected returns, with 6.8092%, 4.3826%, and 4.2346%, respectively, indicating promising future results. For HDFCLIFE.NS (18.4525%), KOTAKBANK.NS (16.6033%), and HCLTECH.NS (14.3036%), significant positive weights were noted, suggesting that they ought to constitute significant portions of the portfolio (Fig: 4). Next the companies with the largest negative weights, TCS (-21.704%), BAJAJ-AUTO.NS (-16.7395%), and HINDUNILVR.NS (-13.3505%), indicate that they ought to be shorted. This

analysis's predictions suggest that TCS, RELIANCE.NS, and HCLTECH.NS will probably be the top-performing equities. On the other hand, it is anticipated that TCS, BAJAJ-AUTO.NS, and HINDUNILVR.NS would do poorly and could be worth shorting. Include equities like HDFCLIFE.NS, KOTAKBANK.NS, and HCLTECH.NS with high positive weights and projected returns in your portfolio for a well-balanced approach. Think about shorting equities that have large negative weights, such TCS, BAJAJ-AUTO.NS, and HINDUNILVR.NS. Before making an investment, it is imperative to carry out additional research and consider other elements such as the state of the market, corporate news, and economic data.

4.3 Sharpe Ratio

An investment's return in relation to its risk is gauged by the Sharpe ratio. It measures the hypothesis that greater returns over an extended period of time could be the result of more uncertainty and risk rather than a better investing technique. To assist rank and display the projected return in relation to risk, use the Sharpe Ratio: Investors typically view any Sharpe ratio above 1.0 as satisfactory to good. A ratio that is more than 2.0 is considered excellent. A ratio of 3.0 or above is regarded as exceptional. In order to determine the Sharpe Ratio for every one of the twenty companies, we first collect the risk-free rate, which is usually obtained from a 10-year government bond, and the historical return data for each company. To evaluate volatility, we calculate the average return throughout the historical period for each company, as well as the standard deviation of these returns. When comparing the risk-adjusted performance of several companies, this ratio is useful as it expresses the excess return per unit of risk. A greater Sharpe Ratio denotes a superior risk-adjusted return, implying that the business offers larger rewards for every unit of risk assumed. Investors should take note of this indicator since it provides a full assessment of investment success by taking volatility into account in addition to returns.

$$\textbf{Sharpe Ratio} = \frac{R_p - R_f}{\sigma_p}$$

Where

R_p = Return of portfolio

R_f = Risk-free rate

σ_p = Standard deviation of the portfolio's excess return

S.No	COMPANY	Expected Return by using Black-Litterman model	Portfolio 1 With all combinations of returns and weights	Portfolio 2 POSITIVE Weights (%) With ALL RETURN	Portfolio 3 RETURN GREATER THAN 1 With NEGATIVE WEIGHT	Portfolio 4 RETURN GREATER THAN 1 WITHOUT NEGATIVE WEIGHT	Sharpe Ratio
1	ADANIGREE	0.9	-9.6				-

	N						10.34
2	ASIANPAINT	1.09	4.52	4.52	4.52	4.52	2.25
3	BAJAJ-AUTO	0.79	-13.27				-13.61
4	HCLTECH	6.81	97.4	97.4	97.4	97.4	85.03
5	HDFCBANK	1.47	-3.39		-3.39		-4.8
6	HDFCLIFE	0.83	15.29	15.29			11.84
7	HEROMOTOCO	0.16	-1.59				-3.12
8	HINDUNILVR	3.2	-42.78		-42.78		-39.92
9	INFY	2.25	-17.03		-17.03		-16.96
10	ITC	1.48	-18.68		-18.68		-18.43
11	KOTAKBANK	1.11	18.51	18.51	18.51	18.51	14.72
12	LT	1.78	9	9	9	9	6.24
13	M&M.	0.91	10.48	10.48			7.56
14	MARUTI	1.4	15.59	15.84	15.84	15.84	12.34
15	NESTLEIND	0.59	5.59	5.59			3.12
16	RELIANCE	4.38	19.66	19.66	19.66	19.66	15.74
17	TATAMOTORS	0.95	5.63	5.63			3.23
18	TCS	4.38	-95.12		-95.12		-86.56
19	TITAN	1.01	-10.09		-10.1		-10.78
20	WIPRO	1.4	-2.77		-2.77		-4.25
	Portfolio Expected Return	36.76	-12.40	201.92	-24.94	164.93	

TABLE 3: DIFFERENT PORTFOLIO WITH SHARPE RATIO

Taking into account factors like expected return, Sharpe ratio, and risk-adjusted return is necessary when analyzing and contrasting the four portfolios from a risk-averse standpoint, particularly for an insurance firm. Because Portfolio 1 does not meet the condition of a positive expected return, it is not a good investment for risk-averse investors, with an expected return of -12.40% (Table :3) Portfolio 2 has an estimated return of 201.92%, although it only contains positive rates. Its extraordinarily high projected return may also be a sign of significant risk. It is necessary to conduct additional analysis of its volatility and Sharpe ratio. Portfolio 3 is unsuitable because of its negative projected return of -24.94%, which encompasses returns larger than 1 as well as negative rates. A risk-averse investor would find Portfolio 4, with its projected return of 164.93%, to be particularly suitable as it only contains companies with returns larger than 1 and positive rates. In addition, the Sharpe ratio computation revealed that Reliance Industries, Kotak Bank, and HCL had values above

14%, indicating that these businesses are more lucrative and maybe more reliable investments. For risk-averse investors looking for respectable returns with low risk, Portfolio 4 seems to be the most suitable option.

5. CONCLUSION & FUTURE WORK

ESG investment is more than simply a fad—it's a core component of finance. ESG variables have a considerable impact on both long-term financial success and risk management. We can find investment opportunities, make decisions, and calculate predicted returns by applying the fundamental ideas of ESG. In order to attain both positive social impact and monetary benefits, it is imperative to take into account sustainable practices, uphold responsibility, and advance equality in all investment domains while building a portfolio. Since investing in ESG sectors is a long-term process that might result in great profits with lower risk in the future, insurance companies should consider doing so. Insurance companies typically choose investing in risk-free securities to protect public funds because they are risk-averse investors. But considering the state of the market right now, they are thinking about putting money into a 20-company portfolio built on the Black litterman model. Compared to risk-free securities, the estimated risk derived from this model is 36.56%. Despite this, if insurance firms believe the profits are worthwhile, they may still invest in these 20 businesses. If not, they might favor other risk-minimization portfolios. Out of the four created portfolios, Portfolio 4 is especially appropriate for investors who are risk averse. An anticipated portfolio return of 124.93% is achieved by including companies in this portfolio that have positive rate ratios and returns larger than one. This strategy, which emphasizes stable businesses and strong returns, fits very nicely with the risk-averse attitude of insurance companies. Additionally, the Sharpe ratio study shows that businesses with outstanding performance include Asian Paints, HCL Technologies, Kotak Bank, L&T, Maruti, and Reliance Industries. By allocating capital to these top-performing companies in Portfolio 4, insurance companies can maintain their risk-averse investing approach while earning a respectable and consistent return. An essential tool for understanding the risk-adjusted performance of the portfolio's stocks is the Sharpe Ratio analysis. Several stocks, including HCLTECH.NS, RELIANCE.NS, and KOTAKBANK.NS have high Sharpe Ratios, which suggests that they provide favorable returns in comparison to their risk. In contrast, the sharp ratios of stocks such as TCS, HINDUNILVR, and INFY are significantly negative, indicating subpar performance when risk is taken into account. This suggests that to optimize for improved performance and efficient risk management, reallocating investments towards equities with higher Sharpe Ratios and reducing exposure to those with negative ratios could improve the portfolio's overall return adjusted for risks.

REFERENCE:

1) Ben Dor, A., Guan, J., & Zeng, X. (2023). Leveraging ESG Data from Multiple Providers in Equity and Credit Markets. Journal of Impact & ESG Investing, 4(1), 33. https://doi.org/10.3905/jesg.2023.1.078.
2) 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), 210-233. https://doi.org/10.1080/20430795.2015.1118917.

3) Louraoui, Y. (2021, November 21). Black-Litterman Model. SimTrade blog. Retrieved from [URL]
4) Fuhrer, A., & Hock, T. (2023). Uncertainty in the Black–Litterman model: Empirical estimation of the equilibrium. Journal of Empirical Finance, 72, 251-275. https://doi.org/10.1016/j.jempfin.2023.03.009
5) Caner, M., Medeiros, M., & Vasconcelos, G. F. R. (2023). Sharpe Ratio analysis in high dimensions: Residual-based nodewise regression in factor models. Journal of Econometrics, 235(2), 393-417. https://doi.org/10.1016/j.jeconom.2022.03.009
6) van Vuuren, G., & van der Lecq, M. (2023). Global maximal Sharpe ratios for active portfolios. Applied Economics Letters, 30(15), 2069-2073. https://doi.org/10.1080/13504851.2022.2091105
7) Al Amosh, H., & Khatib, S. F. A. (2023). ESG performance in the time of COVID-19 pandemic: cross-country evidence. Environmental Science and Pollution Research, 30, 39978–39993.
8) Singh, K., &Jaiwani, M. (2023). ESG and share price volatility in energy sector firms: Does the development phase of countries matter? International Journal of Energy Sector Management. ISSN: 1750-6220. Article publication date: August 25, 2023.
9) Liu, L., Nemoto, N., & Lu, C. (2023). The Effect of ESG performance on the stock market during the COVID-19 Pandemic — Evidence from Japan. Economic Analysis and Policy, 79, 702-712. https://doi.org/10.1016/j.eap.2023.06.038.
10) Eisenkopf, J., Juranek, S., & Walz, U. (2022). Responsible Investment and Stock Market Shocks: Short-Term Insurance without Persistence. British Journal of Management. DOI: 10.1111/1467-8551.12664.
11) Ko, H., Son, B., & Lee, J. (2024). A novel integration of the Fama–French and Black–Litterman models to enhance portfolio management. Journal of International Financial Markets, Institutions and Money, 91, 101949. https://doi.org/10.1016/j.intfin.2024.101949.
12) Huang, Y., & Jiang, W. (2024). Portfolio Optimization Based on an Improved Black-Litterman Model. Chinese Journal of Jishou University (Natural Sciences Edition), 45(2), 89-96. DOI: 10.13438/j.cnki.jdzk.2024.02.014.
13) Kan, R., Wang, X., & Zheng, X. (2024). In-sample and out-of-sample Sharpe ratios of multi-factor asset pricing models. Journal of Financial Economics, 155, 103837. https://doi.org/10.1016/j.jfineco.2024.103837.
14) Kolari, J. W., Liu, W., &Pynnönen, S. (2024). Portfolio Performance Measures. In Professional Investment Portfolio Management (pp. 97–119). DOI: [insert DOI if available].
15) Davoodi, S., Fereydooni, A., &Rastegar, M. A. (2024). Can portfolio construction considering ESG still gain high profits? Research in International Business and Finance, 67(A), 102126. https://doi.org/10.1016/j.ribaf.2023.102126.