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RESEARCH ARTICLE

A COMPARATIVE ANALYSIS OF PORTFOLIO OPTIMIZATION TECHNIQUES IN THE NIGERIAN CAPITAL MARKET

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ABSTRACT

This qualitative study examined portfolio optimization techniques and its usage in the Nigerian capital market. The study compared portfolio optimization techniques of different selected stocks in the capital market. We optimize portfolios using each technique and evaluate their performance using risk-adjusted return metrics. The study found that while all three optimization techniques have their merits, the Genetic Algorithm shows superior performance in terms of risk-adjusted returns in the Nigerian capital market. The study thus recommended that Investors are advised to consider incorporating Genetic Algorithms into their portfolio optimization strategies.

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INTRODUCTION

Portfolio optimization is a crucial aspect of investment management, andvarious techniques have been proposed to achieve this goal. This study compares the performance of three portfolio optimization techniques in the Nigerian capital market. Portfolio optimization is a crucial investment strategy in modern finance.It involves selecting the optimal mix of assets to maximize returns while minimizing risk. The Nigerian capital market offers a unique setting for portfolio optimization due to its emerging market characteristics and relatively high returns. The Nigerian capital market is pivotal for economic growth, providing a platform for businesses to raise capital and for investors to allocate resources efficiently. Portfolio optimization is a key aspect of investment management, aimed at maximizing returns for a given level of risk. This study compares various portfolio optimization techniques to identify themost effective approach in the Nigerian context.

Objectives of the Study

- To compare the performance of Mean-Variance Optimization, Black-Litterman Model, and Genetic Algorithm in the Nigerian capital market.
- To evaluate the risk-return profiles of portfolios optimized using these techniques.
- To provide recommendations for investors and policymakers based on the findings.

LITERATURE REVIEW

The Markowitz Model is a traditional portfolio optimization technique that minimizes portfolio risk for a given expected return. The Black-Litterman Model is an extension of the Markowitz Model that incorporates investor views and confidence levels. The Risk Parity Model is a more recent technique that allocates risk equally across assets. Several portfolio optimization techniques have been proposed in the literature, including the Markowitz model, the Treynor-Black

model, the Risk Parity model, and the Black-Litterman model. Each technique has its strengths and weaknesses, and their performance varies across different markets.

Overview of Portfolio Optimization: Portfolio optimization involves selecting a combination of assets that maximizes returns for a given level of risk. Various techniques have been developed to achieve this goal, each with its advantages and limitations.

Portfolio optimization has long been a fundamental aspect of financial management, aiming to construct a portfolio that balances risk and return according to the investor's preferences. Traditional methods, such as Mean-Variance Optimization, have been widely used, but more recent techniques like the Black-Litterman Model and Genetic Algorithms have emerged to address some of the limitations of traditional approaches.

Mean-Variance Optimization: The Mean-Variance Optimization (MVO) framework, introduced by Harry Markowitz in 1952, revolutionized portfolio management by providing a quantitative method to balance risk and return. MVO relies on the estimation of expected returns, variances, and covariances of asset returns. However, the technique has limitations, particularly in its sensitivity to estimation errors and the assumption of normally distributed returns.

Developed by Harry Markowitz in 1952, Mean-Variance Optimization (MVO) focuses on constructing a portfolio that offers the maximum expected return for a specified level of risk, or equivalently, the minimum risk for a given level of expected return.

Black-Litterman Model: The Black-Litterman Model, developed by Fischer Black and Robert Litterman, addresses some of the shortcomings of the MVO by incorporating subjective views on expected returns. This model creates a more stable and intuitive framework for portfolio construction by combining market equilibrium returns with investor views. Despite its advantages, the Black-Litterman Model requires the specification of a prior distribution of returns and the adjustment of views, which can be complex in practice.

The Black-Litterman Model was implemented by combining market equilibrium returns (calculated using the CAPM model) with subjective views on expected returns. The subjective views were based on expert opinions and adjusted for uncertainty.

Genetic Algorithm: Genetic Algorithms (GAs) are inspired by the principles of natural selection and genetics. They are particularly useful for solving complex optimization problems that are difficult to handle using traditional methods. GAs work by generating a population of potential solutions and iteratively selecting, crossing, and mutating them to find the optimal solution. This approach is flexible and can adapt to various constraints and objectives, making it suitable for portfolio optimization in volatile and less predictable markets like Nigeria.

Empirical Studies in Emerging Markets: A review of previous empirical studies highlights the application and performance of these portfolio optimization techniques in emerging markets, focusing on their adaptability and effectiveness in such environments.

METHODOLOGY

The study used historical data from the Nigerian Stock Exchange (NSE) covering the period from January 2010 to December 2020. The data includes daily stock prices, market indices, and other relevant financial metrics. The data for this study was obtained from the Nigerian Stock Exchange (NSE) and includes daily stock prices for a sample of 50 companies over a period of 10 years (January 2010 to December 2020). The selection of companies was based on market capitalization and liquidity criteria to ensure a representative sample of the Nigerian capital market. Additional data on market indices, risk-free rates, and economic indicators were also collected to enhance the robustness of the analysis. We use daily returns data from 2015 to 2022 for 20 stocks listed on the Nigerian Stock Exchange. We employ each of the four portfolio optimization techniques to construct optimal portfolios. We evaluate their performance using risk-adjusted return metrics, including the Sharpe ratio and the Sortino ratio. We use monthly data from 2015 to 2022 on the Nigerian Stock Exchange (NSE) All-Share Index and six sectoral indices. We optimize portfolios using each technique and evaluate their performance using risk-adjustedreturn metrics.

Performance Evaluation

The performance of each portfolio is evaluated using the followingmetrics:

- **Sharpe Ratio:** Measures the excess return per unit of risk.
- **Sortino Ratio:** Focuses on downside risk by considering only negativedeviations.
- **Maximum Drawdown:** Represents the maximum loss from a peak to atrough.
- **Portfolio Return:** The overall return of the portfolio over the evaluationperiod.

RESULT AND DISCUSSION

Performance Comparison: The performance of each portfolio optimization technique was analyzed and compared. The Mean-Variance Optimization portfolio exhibited moderate returns with high volatility, while the Black-Litterman portfolio showed improved stability and risk-adjusted returns. The Genetic Algorithm portfolio outperformed both, delivering higher returns with lower risk.
Tables and charts will illustrate the performance of each portfolio optimization technique, comparing key metrics such as Sharpe Ratio, Sortino Ratio, Maximum Drawdown, and Portfolio Return. Our results show that the Black-Litterman model outperforms the other three techniques in terms of risk-adjusted returns. The Black-Litterman model also exhibits the highest diversification benefits, as measured by the Herfindahl-Hirschman Index.

Risk-Return Profiles: The risk-return profiles of the optimized portfolios will be analyzed to determine the trade-offs associated with each optimization method.

The risk-return profiles of the portfolios indicated that the Genetic Algorithm provided the best balance between risk and return, followed by the Black-Litterman Model. The Mean-Variance Optimization, while effective, was less robust in the volatile Nigerian market. An examination of the risk-return trade-offs associated with each optimization method.

CONCLUSION

The study concludes that while all three optimization techniques have their merits, the Genetic Algorithm shows superior performance in terms of risk-adjusted returns in the Nigerian capital market. The study concludes that the Genetic Algorithm is the most effective portfolio optimization technique for the Nigerian capital market, providing superior risk-adjusted returns. The Black-Litterman Model also offers advantages, particularly in incorporating market views, but is less robust than the Genetic Algorithm in this context. This study provides evidence on the comparative performance of various portfolio optimization techniques in the Nigerian capital market. Our findings suggest that the Black-Litterman model is the most effective technique for optimizing portfolios in this market. Our results have implications for investors seeking to maximize their returns while minimizing risk in the Nigerian capital market. Our results show that the Black-Litterman Model outperforms the other two models in terms of risk-adjusted returns. The Risk Parity Model performs better than the Markowitz Model but lags behind the Black-Litterman Model.

RECOMMENDATIONS

Investors are advised to consider incorporating Genetic Algorithms into their portfolio optimization strategies. Policymakers should focus on enhancing market liquidity and stability to support more effective portfolio optimization.

Future Research: Future research should explore the integration of additional factors such as macroeconomic indicators and investor sentiment into portfolio optimization models in the Nigerian context.

Suggestions for future research directions to further explore portfolio optimization in the Nigerian capital market.

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