UNIVERSITY OF CAPE COAST

COMPARING MEAN-VARIANCE PORTFOLIO AND BLACK-LITTERMAN MODELS IN PORTFOLIO OPTIMIZATION USING SOME SELECTED STOCKS ON GHANA STOCK EXCHANGE.

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# ABSTRACT

This research explores the effectiveness of two prominent portfolio optimization models the Mean-Variance Portfolio (MVP) model and the Black-Litterman (BL) model using selected stocks from the Ghana Stock Exchange (GSE). The study aims to assess and compare the performance of these models in optimizing investment portfolios within the context of frontier market. Utilizing a quantitative research design, the study analyzes secondary financial data from the GSE, covering a ten-year period from 2014 to 2024. Descriptive statistics reveal significant variability across the assets, with the correlation matrix highlighting both positive and negative relationships, suggesting opportunities for risk reduction through diversification. The MVP model, grounded in Modern Portfolio Theory, demonstrates a more balanced approach with an expected return of 12.40%, annual volatility of 19.72%, and a Sharpe ratio of 0.63, indicating superior risk-adjusted returns. In contrast, the BL model, which incorporates subjective market views, offers a higher expected return of 16.40% but with increased volatility (25.70%) and a lower Sharpe ratio of 0.56. The findings suggest that while the MVP model is more suitable for risk-averse investors seeking stability, the BL model may be preferable for those with strong market insights and a higher risk tolerance. The study contributes to the theoretical understanding of portfolio optimization in frontier markets and provides practical recommendations for investors and portfolio managers. Future research is encouraged to explore the applicability of these models in other emerging markets and to incorporate alternative data sources to enhance model robustness.

# KEYWORDS

Mean-Variance Portfolio

Black-Litterman Model

Efficient Market Hypothesis

Capital Market Theory

Subjective Probability Theory

Emerging Market Finance

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# LIST OF ACRONYMS

BOPP Benso Oil Palm Plantation Plc

CAL CAL Bank Plc

CMLT Camelot Ghana Limited

CPC Cocoa Processing Company

GCB GCB Bank

GGBL Guinness Ghana Breweries

SIC State Insurance Company

SOGEGH Societe Generale Ghana

TOTAL TotalEnergies Ghana

TLW Tullow Oil Plc

# CHAPTER ONE

# INTRODUCTION

## 1.0 Introduction

In the realm of finance and investment, portfolio management is a critical aspect that influences the success and sustainability of investment strategies. As final year Bachelor of Commerce (Finance) students, we were introduced to the concept of constructing a diversified investment portfolio during our Investment Management course. This foundational knowledge highlighted the importance of diversification in mitigating risk exposure in the investment market. Motivated by this understanding, we aim to build investment portfolios using selected stocks from the Ghana Stock Exchange (GSE). Our study employs two prominent portfolio optimization models: the Mean-Variance Portfolio (MVP) model and the Black-Litterman (BL) model. By comparing these models, we seek to determine which approach offers superior optimization for an investment portfolio in the context of the GSE.

Investors seek to optimize their portfolios to maximize returns while minimizing risks. This endeavor becomes particularly challenging in volatile markets such as the GSE, where market dynamics can be unpredictable. The necessity to diversify investments to mitigate risk exposure is well recognized, yet achieving optimal diversification requires sophisticated models and strategies. The GSE, established in 1989, is Ghana's main stock exchange, facilitating capital formation and investment. The market is governed and regulated by the Ghana Stock Exchange Act 1971 (Act 384) and Securities and Exchange Commission. Currently, 37 companies across sectors like finance, manufacturing, mining, and pharmaceuticals are listed.

This study focuses on building an investment portfolio using selected stocks from the GSE, applying two prominent models: the Mean-Variance Portfolio model and the Black-Litterman model. The MVP model, developed by Harry Markowitz in 1952, revolutionized modern portfolio theory by quantifying the trade-off between risk and return. Despite its foundational significance, the Mean-Variance model relies heavily on historical data, which may not always accurately predict future performance, particularly in frontier markets like Ghana. To address the limitations of the Mean-Variance model, the Black-Litterman model, introduced by Fischer Black and Robert Litterman in 1992, integrates subjective views with market equilibrium, providing a more flexible and potentially more accurate approach to portfolio optimization. By incorporating investor's insights and current market conditions, the Black-Litterman model aims to produce more robust and stable portfolios.

Theoretically, this study will contribute to the body of knowledge in finance by validating and contrasting two key portfolio optimization models in the context of an emerging market. While extensive research exists on these models in developed markets, their applicability and performance in markets like Ghana remain unexplored. By filling this gap, the study not only enriches the theoretical framework but also provides a benchmark for future research in similar markets.

## 1.1 Background of Study

Constructing an optimal investment portfolio remains a paramount challenge in the realm of financial investment. This endeavor seeks to balance risk and return, ensuring capital preservation and growth in alignment with an investor's unique risk tolerance and financial goals. Portfolio optimization models have emerged as cornerstones of this process, providing quantitative frameworks for asset allocation decisions. Two prominent models, the Mean-Variance Portfolio model and the Black-Litterman model, have garnered significant attention.

The Mean-Variance Portfolio model, formulated by Harry Markowitz in 1952, revolutionized modern portfolio theory by introducing a mathematical approach to diversification. The model utilizes historical data to estimate expected returns, variances, and covariances of individual assets, subsequently optimizing the portfolio based on these risks and return characteristics. By plotting efficient frontiers, the Mean-Variance model helps investors identify portfolios that offer the maximum expected return for a given level of risk or the minimum risk for a given level of expected return. Despite its foundational significance, the Mean-Variance model carries notable limitations. Its reliance on historical data for return estimations may not accurately reflect future market behavior, leading to potential inaccuracies in portfolio construction. Additionally, the model's assumption of normally distributed returns and linear relationships between assets can be unrealistic in dynamic and often non-normal market environments.

To address these shortcomings, Fischer Black and Robert Litterman introduced the Black-Litterman model in 1992. This model incorporates both equilibrium market expectations and subjective investor views into the optimization framework, providing a more flexible and adaptive approach. The Black-Litterman model starts with a prior estimate of the market equilibrium returns, derived from market capitalization weights, and then adjusts these estimates based on the investor’s specific views on asset performance. By blending these perspectives, the model aims to produce more stable and realistic return forecasts, potentially leading to more robust and efficient portfolios. The ability to incorporate investor views allows for a tailored approach, aligning the portfolio more closely with the investor's insights and expectations.

Despite the theoretical advantages of the Black-Litterman model, its application in emerging markets, such as the Ghana Stock Exchange (GSE), remains underexplored. The GSE, established in 1989, has grown to become a key component of Ghana's financial sector, providing a platform for trading stocks, bonds, and other securities. However, the market is characterized by lower liquidity, higher volatility, and less comprehensive data compared to more developed markets. These factors present unique challenges and opportunities for portfolio optimization. Given the relative paucity of sophisticated portfolio optimization applications within the Ghanaian context, this study seeks to evaluate and compare the Mean-Variance and Black-Litterman models using selected stocks from the GSE. The primary aim is to determine which model offers superior optimization in terms of balancing risk and return in the Ghanaian market environment. By addressing this gap, the study intends to provide practical insights for investors and contribute to the theoretical understanding of portfolio management in emerging markets.

In summary, the study will assess the effectiveness of the Mean-Variance and Black-Litterman models in constructing optimal investment portfolios on the Ghana Stock Exchange. By doing so, it aims to enhance the practical toolkit available to investors in Ghana and expand the academic discourse on portfolio optimization in emerging market contexts.

## 1.2 Problem Statement

The primary problem that study is the limited application of sophisticated portfolio optimization models within the Ghanaian market context, specifically on the GSE. While globally recognized models such as the MVP model, developed by Harry Markowitz, and the BL model have proven effective in developed markets, their adoption in the GSE remains minimal. This discrepancy highlights a significant gap in the financial tools and methodologies utilized by investors in Ghana. The Mean-Variance model, a cornerstone of modern portfolio theory, emphasizes the trade-off between risk and return based on historical data. It assumes that past performance can reliably predict future returns and risk, an assumption that may not hold true in volatile and less mature markets like the GSE. The GSE is characterized by higher volatility, lower liquidity, and less comprehensive historical data, making the traditional Mean-Variance approach potentially less effective and riskier for investors.

On the other hand, the Black-Litterman model offers a more advanced framework by integrating market equilibrium with subjective investor views. This model adjusts the expected returns based on both historical data and current market insights, providing a potentially more accurate and stable approach to portfolio optimization. The incorporation of investor insights allows for a dynamic response to market changes, which is particularly advantageous in emerging markets like Ghana's, where market conditions can fluctuate significantly.

Despite its potential benefits, the Black-Litterman model's application in the GSE context is underexplored. This study will seek to fill this gap by conducting a comparative analysis of the Mean-Variance and Black-Litterman models to determine their efficacy in optimizing portfolios on the GSE. By evaluating these models' performance in the Ghanaian market, the study aims to provide valuable insights into their applicability and effectiveness, potentially guiding local investors towards more sophisticated and reliable portfolio optimization techniques. Addressing this issue is crucial for enhancing investment strategies in Ghana, ultimately contributing to the market's development and investor confidence.

## 1.3 Research Objectives

The main research objectives are to evaluate and compare the Mean-Variance Portfolio model and the Black-Litterman model in terms of their ability to optimize investment portfolios using selected stocks from the Ghana Stock Exchange. Specifically, the research objectives are:

* To construct investment portfolios using the Mean-Variance Portfolio model and the Black-Litterman model with selected GSE stocks.
* To analyze and compare the performance of the portfolios optimized by both models.
* To identify which model provides better optimization for reducing risk and maximizing returns in the Ghanaian market context.

## 1.4 Research Questions

The above objectives elicit the following research questions:

* How can investment portfolios be constructed using the Mean-Variance Portfolio model and the Black-Litterman model with selected GSE stocks?
* How do the performance outcomes of portfolios optimized by different models (MVP and BL) compare and contrast?
* Which portfolio optimization model (MVP and BL) performs better in terms of risk-adjusted returns on the GSE?

## 1.5 Significance of the Study

This study holds significant practical and theoretical implications, providing valuable insights for investors, portfolio managers, and researchers operating within the Ghanaian market and contributing to the broader discourse on global investment strategies and portfolio management. In the practical realm, this study offers actionable insights for investors and portfolio managers navigating the complexities of the Ghanaian market. By empirically comparing the Mean-Variance and Black-Litterman models, the research provides a basis for making more informed investment decisions. Investors can leverage the findings to optimize their portfolios, striking a balance between risk and return tailored to their specific objectives and risk tolerance. Moreover, the identification of the model that better optimizes portfolios can potentially lead to improved financial returns for investors, fostering a more vibrant and robust investment environment in Ghana. Local investment firms can benefit from the study by adopting more sophisticated portfolio management techniques, thereby enhancing their competitiveness and effectiveness in serving clients in the Ghanaian market.

Theoretical contributions of this research are significant in enriching the existing literature on portfolio optimization, particularly in the context of emerging markets like Ghana. While the MVP and BL models have been extensively studied in developed markets, their application and performance in frontier markets remain underexplored. This study addresses this gap by providing empirical evidence of the models' effectiveness in the Ghanaian context. By expanding the understanding of these models' applicability, the research contributes to advancing the theoretical framework of portfolio management. Furthermore, the comparative analysis offered by this study serves as a reference for future research endeavors in similar emerging market settings. It provides a foundation for exploring and refining portfolio optimization strategies tailored to the unique characteristics and challenges of emerging markets, thus enhancing the global discourse on investment strategies and portfolio management practices.

This study's significance lies in its dual impact: offering practical guidance for investors and portfolio managers in Ghana and advancing theoretical understanding within the broader field of portfolio management. By bridging the gap between theory and practice and shedding light on portfolio optimization in emerging markets, the study contributes to fostering a more informed and effective investment landscape in Ghana and beyond.

## 1.6 Limitations of the Study

Comparing the performance of the MVP Model and the BL Model in portfolio optimization using selected stocks from the GSE, several limitations may arise. Data availability and quality are significant concerns, as the GSE will have limited historical stock data and potential inaccuracies, impacting the robustness and reliability of the models. Model assumptions and parameter estimation also pose potential limitations. The Mean-Variance Model assumes normally distributed returns and a static investment environment, which may not be realistic in the GSE context. The BL Model, on the other hand, requires subjective inputs that could introduce bias. Errors in estimating expected returns, covariances, and other parameters can lead to suboptimal portfolio optimization, and the stability of these estimates over time can be a concern, particularly in a smaller market like the GSE. Comparative analysis constraints and external factors further complicates the study. Economic conditions and regulatory changes in Ghana over the specific time period can impact stock performance, affecting the models differently. Findings based on the GSE may not be generalizable to other markets, and practical implementation issues such as transaction costs and trading restrictions might not be fully captured

## 1.7 Delimitations

This study focuses exclusively on a selection of listed stocks on the GSE, which inherently limits the scope and generalizability of the findings. The selected stocks represent only a subset of the total market, and therefore, the results may not fully capture the dynamics and performance of the entire Ghanaian stock market. Consequently, the conclusions drawn from this research might not be applicable to other sectors or stocks within the GSE that are not included in the study. This research is constrained by the specific timeframe chosen for historical data analysis. The selected period may be influenced by unique market conditions, economic cycles, or regulatory changes that do not necessarily reflect long-term trends. As a result, the performance and optimization of the portfolios constructed using the MVP and BL models might be impacted by these temporal factors.

Moreover, the study’s focus on the GSE means that the findings may not be transferable to other emerging markets, which can have distinct economic, regulatory, and market environments. Each market has its own set of challenges and opportunities, and the effectiveness of portfolio optimization models may vary significantly across different contexts. Therefore, while the insights gained from this study are valuable for understanding portfolio management within the Ghanaian context, caution should be exercised when attempting to apply these findings to other markets or broader economic settings.

## 1.8 Organization of the Study

This research will be presented in five chapters. Following this introduction, Chapter 2 will provide a comprehensive review of relevant literature on portfolio optimization models and as well explore the theoretical frameworks underpinning the mean-variance and Black-Litterman models. Chapter 3 will detail the research methodology, encompassing data collection procedures, sample selection techniques, and model application processes. Chapter 4 will present the empirical analysis and discuss the results obtained and compare the performance of portfolios constructed using both models. Chapter 5 will address any limitations of the study and suggest areas for future research, offer a conclusion based on the research findings. Finally, will provide references and include an appendix containing any supplementary materials.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

A key component of investment management is portfolio optimization, and several models have been created to help in this process. This chapter offers a thorough analysis of the body of research on portfolio optimization, with a particular emphasis on the Black-Litterman and Mean Variance Portfolio (MVP) models. The Mean-Variance Portfolio (MVP) and Black-Litterman (BL) models are thoroughly reviewed in this chapter along with their theoretical underpinnings, practical uses, and drawbacks. By highlighting the major topics, theories, and conceptual frameworks that are pertinent to the subject, the review seeks to provide a strong basis for the research.

## 2.2 Conceptual Review

In the realm of financial portfolio management, optimizing assets allocation to maximize returns while minimizing risk is a fundamental challenge. The conceptual review for this study delves into two prominent portfolio models: the MVP model by Harry Markowitz and the BL model by Fischer Black and Robert Litterman. By leveraging historical financial data and incorporating investor insights and market equilibrium conditions, these models offer distinct approaches to portfolio construction. This review contextualizes these models within the GSE, highlighting the unique challenges and opportunities of optimizing portfolios in the emerging market characterized by higher volatility and lower liquidity. The objective is to provide a comprehensive understanding of how these models can be applied to the GSE, thereby offering valuable insights for investors and enriching the theoretical literature on portfolio optimization.

MVP Model developed by Harry Markowitz in 1952, this model emphasizes the trade-off between risk and return. It uses historical data to estimate expected returns, variances, and covariances of individual assets, aiming to identify portfolios that offer the maximum expected return for a given level of risk or the minimum risk for a given level of expected return.

BL Model introduced by Fischer Black and Robert Litterman in 1992, this model integrates subjective views with market equilibrium. It incorporates investor's insights and current market conditions to produce more robust and stable portfolios, potentially providing a more flexible and accurate approach to portfolio optimization compared to the MVP model. GSE established in 1989, is the main stock exchange in Ghana, facilitating capital formation and investment. It is governed by the GSE Act 1971 (Act 384) and the Securities and Exchange Commission. The GSE lists 37 companies across various sectors such as finance, manufacturing, mining, and pharmaceuticals. The GSE is characterized by higher volatility, lower liquidity, and less comprehensive historical data compared to more developed markets, making portfolio optimization more challenging.

The objective of this study hovers around the construction of investment portfolios using the MVP model and the BL model with selected stocks from the GSE; analyze and compare the performance of the portfolios optimized by both models and identify which model provides better optimization for reducing risk and maximizing returns in the Ghanaian market context. The study seeks to give practical insights for investors and portfolio managers in the Ghanaian market and enrichment of theoretical literature on portfolio optimization, particularly in emerging markets like Ghana.

## 2.3 Theoretical Review

Modern Portfolio Theory (MPT), introduced by Harry Markowitz in 1952, revolutionized investment strategies by emphasizing the importance of diversification to mitigate risk while optimizing returns. Markowitz's work laid the foundation for quantitative finance by providing a mathematical framework for portfolio construction (Markowitz, 1952). MPT posits that investors can create an "efficient frontier" of optimal portfolios offering the maximum expected return for a given level of risk, thereby quantifying the trade-off between risk and return (Elton & Gruber, 1997). This theory underpins the MVP model, which is used in this study to construct and optimize investment portfolios.

MPT have revolutionized the way investors approach portfolio construction. The cornerstone of MPT is the efficient frontier, a set of optimal portfolios that offer the highest expected return for a given level of risk (Markowitz, 1952). By leveraging diversification, MPT aims to minimize unsystematic risk while maximizing returns. This is achieved by combining assets with varying risk-return profiles, thereby smoothing out the overall portfolio risk. In the context of the GSE, MPT's emphasis on diversification is particularly beneficial. Frontier markets like the GSE are characterized by high volatility and sector-specific risks, making it imperative for investors to diversify their portfolios effectively (Mensah, Bokpin, & Antwi, 2017). By constructing a diversified portfolio, investors can mitigate some of the inherent risks associated with the GSE, thereby achieving a more stable and predictable performance.

However, one of the criticisms of MPT is its sensitivity to input assumptions, particularly the expected returns and covariances of the assets. Small changes in these inputs can lead to significant variations in the optimal portfolio. This limitation becomes even more pronounced in frontier markets, where market data can be less reliable and more volatile. The efficient frontier, a key concept derived from MPT, represents a set of portfolios that deliver the highest expected return for a given risk level. By plotting these optimal portfolios, investors can make informed decisions about the risk-return trade-off (Sharpe, 1964). The MVP model utilizes this concept to help investors identify portfolios that either maximize returns for a specified risk or minimize risk for a given return, providing a systematic approach to portfolio optimization (Fama & French, 2004).

To address the limitations of MPT, particularly its sensitivity to input assumptions, Fischer Black and Robert Litterman introduced the Black-Litterman model (BL) in 1992. This model combines market equilibrium with subjective views to create more stable and robust portfolios (Black & Litterman, 1992). It adjusts the expected returns based on both historical data and investor insights, thereby providing a flexible approach to portfolio optimization (Idzorek, 2004). The integration of subjective views allows for a tailored portfolio construction that aligns more closely with investor expectations and current market conditions (Satchell & Scowcroft, 2000). The BL model enhances the traditional MPT framework by incorporating both market equilibrium and investor views (Black & Litterman, 1992). The Black-Litterman model starts with a baseline of equilibrium returns, which are derived from market data, and then adjusts these returns based on the investor's views. This approach helps to mitigate the sensitivity to input assumptions that plagues MPT.

The incorporation of investor views is particularly valuable in the context of the GSE. Investors often have insights and expectations that are not fully captured by historical market data. By allowing these subjective views to influence the expected returns, the BL model creates a more robust and intuitive portfolio (Black & Litterman, 1992). This flexibility is crucial in a frontier market setting, where local knowledge and insights can significantly impact investment decisions.

Moreover, the BL model reduces the impact of estimation errors, resulting in more stable portfolios. This is achieved by blending the subjective views with the equilibrium market returns, thereby balancing the two sources of information. In a market like the GSE, where information asymmetry and inefficiencies are more pronounced, this stability is a significant advantage (Mensah & Prempeh, 2018).

The application of MPT and the BL model to the GSE offers several benefits. Firstly, the diversification principle of MPT helps manage the high volatility and sector-specific risks inherent in the GSE. By constructing a well-diversified portfolio, investors can achieve a more stable return profile, which is crucial in an emerging market context (Bodie, Kane, & Marcus, 2014). The BL model enhances the return expectations by integrating investor views with market data. This integration results in more realistic and achievable return targets, which can be particularly useful in a market where historical data alone may not provide a complete picture (Idzorek, 2004). The model’s ability to incorporate local knowledge and insights makes it highly adaptable to the unique dynamics of the GSE. Both models offer improved stability and robustness. While MPT provides a straightforward framework for portfolio construction, the BL model offers enhanced stability by reducing sensitivity to estimation errors. This robustness is particularly beneficial in the GSE, where market conditions can be unpredictable and volatile (Kritzman, 2000). These two models that will be used in developing a portfolio of stocks on the GSE, have some underlying theories and principles that underpins it existence and usage:

### 2.3.1 Capital Market Theory

Capital Market Theory (CMT) extends MPT by incorporating the risk-free asset and the Capital Market Line (CML). This theory assumes that all investors have the same information and access to risk-free borrowing and lending (Lintner, 1965). Both the MVP and Black-Litterman models operate under the assumption of market efficiency to some extent, utilizing available market data to optimize portfolios. Behavioral finance explores the psychological influences on investor behavior and market outcomes, challenging the traditional assumption of rationality in financial decision-making (Kahneman & Tversky, 1979). The BL model acknowledges these behavioral aspects by incorporating subjective views and sentiments of investors, thus blending objective market data with investor biases and expectations (Shefrin, 2000).

The fundamental principle of the risk-return tradeoff posits that higher potential returns are associated with higher risks (Sharpe, 1994). Both the MVP and BL models aim to optimize this tradeoff, with the MVP relying on historical data and the Black-Litterman model incorporating both market equilibrium and investor views to potentially enhance the optimization process (Levy & Roll, 2010).

### 2.3.2 Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) asserts that asset prices fully reflect all available information, making it impossible to consistently achieve higher returns without taking on additional risk (Fama, 1970). The BL model, by integrating market equilibrium returns, aligns with the semi-strong form of EMH, assuming that markets efficiently incorporate all known information into asset prices (Jensen, 1978).

### 2.3.3 Subjective Probability Theory

Subjective probability theory involves using personal beliefs or opinions to estimate the probabilities of different outcomes (Savage, 1954). The BL model leverages this theory by incorporating investor views and opinions, blending them with objective market data to derive expected returns, thereby providing a more comprehensive approach to portfolio optimization (Bawa, Brown, & Klein, 1979).

### 2.3.4 Emerging Market Finance

Frontier market finance studies financial markets in developing countries, characterized by higher volatility, lower liquidity, and distinct regulatory environments compared to developed markets (Bekaert & Harvey, 2003). The study’s focus on the GSE ties into this theory, exploring the application of portfolio optimization models in an emerging market context, which presents unique challenges and opportunities for investors (Harvey, 1995).

### 2.4 Empirical Review

In the study by Logubayom and Victor (2019), the primary focus was on optimizing the portfolio of selected stocks listed on the GSE using the Markowitz mean-variance approach. The authors analyzed historical data to construct an optimal portfolio that maximizes returns while minimizing risk. The findings revealed that applying the MVP optimization could significantly improve the performance of investment portfolios on the GSE by achieving a better risk-return trade-off compared to non-optimized portfolios. The study identified seventeen stocks listed on the GSE combined in the optimal portfolio, offered superior returns and reduced overall portfolio risk. The analysis underscored the benefits of diversification and quantitative methods in portfolio management within the Ghanaian context.

Logubayom and Victor (2019) employed the MVP, a foundational model in modern portfolio theory, to optimize the portfolio of selected stocks. This methodology involves calculating the expected returns, variances, and covariances of individual stock returns. The authors used historical price data from the GSE to estimate these parameters. The MVP optimization process aimed to find the portfolio weights that minimize the portfolio's variance for a given level of expected return or maximize the expected return for a given level of risk. The study utilized mathematical programming techniques to solve the optimization problem, ensuring that the resulting portfolio was efficient in terms of the risk-return trade-off.

Despite the valuable insights provided, the study by Logubayom and Victor has certain gaps and limitations. One significant gap is the reliance on historical data, which may not accurately predict future performance due to market volatility and economic changes. Additionally, the study's focus on a limited number of stocks on the GSE may not fully capture the broader market dynamics. The model assumes that returns are normally distributed and that investors have a quadratic utility function, which may not hold true in real-world scenarios. Furthermore, transaction costs, liquidity constraints, and other market frictions were not explicitly considered in the optimization process.

Thomas M. Idzorek's (2004) working paper, "A Step-by-Step Guide to the BL Model," is a comprehensive resource for understanding and implementing the BL model in portfolio management. The BL model, developed by Fischer Black and Robert Litterman at Goldman Sachs, addresses the shortcomings of traditional mean-variance optimization by integrating investor views with market equilibrium to produce more stable and intuitive portfolios. The paper provided a guide that detailed the mathematical foundations and practical applications of the BL model, beginning with a review of the Capital Asset Pricing Model (CAPM) and mean-variance optimization. These models have limitations, such as sensitivity to input estimates and a tendency to produce extreme portfolio weights.

The BL model enhances these methods by combining equilibrium market returns (implied returns) with subjective views to generate more balanced expected returns. A significant contribution of Idzorek's work is the step-by-step computational procedure, which makes the complex model accessible to practitioners. He explains how to derive implied returns from market capitalizations and the risk-free rate and how to incorporate investor views into the model, adjusting the confidence levels in these views appropriately. Despite its comprehensive nature, Idzorek’s guide has several gaps and areas for further research. The paper, rich in theoretical exposition and practical steps, lacks extensive empirical validation. Future studies could provide real-world data applications to demonstrate the robustness and practical benefits of the BL model compared to traditional methods. Additionally, the guide would benefit from a more detailed sensitivity analysis on the impact of varying confidence levels in investor views on final portfolio weights.

Understanding the model's sensitivity to input parameter changes could help fine-tune its application. As the number of assets increases, the BL model's computational complexity can become a constraint. Idzorek does not address scalability issues or potential solutions, such as dimensionality reduction techniques or more efficient computational algorithms. Moreover, the model primarily focuses on rational market equilibrium and quantitative views. Incorporating behavioral finance aspects, such as investor biases and irrational market behavior, could enhance the model’s realism and applicability in diverse market conditions. Lastly, the paper predominantly discusses traditional asset classes, without exploring the applicability and adjustments required for incorporating alternative assets like real estate, private equity, or commodities, presenting an avenue for future research.

Bessler, Opfer, and Wolff (2017) conducted a rigorous analysis comparing three prominent portfolio optimization approaches: BL model, MVP, and Naïve Diversification (ND). Their study focused on evaluating these strategies in terms of out-of-sample performance, which is crucial for practical investment decision-making. The BL model, known for its incorporation of investor views into the optimization process, was found to generally outperform both the MVP and ND strategies. This superiority is attributed to the BL model's flexibility and its ability to mitigate estimation errors inherent in the MVP.

The methodology employed by Bessler, Opfer, and Wolff (2017) involved several key steps. They collected historical financial data across multiple asset classes to construct portfolios under each optimization strategy. Subsequently, they implemented the BL, MVP, and ND models to build portfolios. The BL model specifically incorporated simulated investor views to assess subjective information's impact on portfolio performance. Out-of-sample testing was then conducted to evaluate how these portfolios performed under real-world conditions using unseen data. Performance metrics such as returns and risk-adjusted returns (e.g. Sharpe ratio) were computed to compare the effectiveness of each strategy.

Despite its contributions, the study identified several gaps and areas for future research. One significant gap is the sensitivity of the mean-variance approach to estimation errors, suggesting a need for exploring robust optimization techniques or Bayesian methods to enhance its performance. Additionally, the reliance on historical financial data could be supplemented by incorporating alternative data sources such as macroeconomic indicators or sentiment analysis to improve model robustness. Investigating dynamic rebalancing strategies that adjust portfolios in response to changing market conditions could also provide valuable insights. Moreover, the impact of transaction costs on portfolio performance, particularly for the more active BL model, was not explicitly addressed and warrants further investigation.

## 2.5 Conceptual Framework

### 2.5.1 Independent Variables:

Historical Financial Data, used in the MVP model to estimate expected returns, variances, and covariances.

Subjective Views and Market Equilibrium, incorporated in the BL model to adjust for current market conditions and investor insights.

### 2.5.2 Dependent Variable:

Portfolio Performance, measured by returns and risk-adjusted returns (e.g., Sharpe ratio).

### 2.5.3 Moderating Variables:

Market Conditions, volatility, liquidity, and availability of data in the GSE.

Transaction Costs, potential impact on the performance of more active models like the BL model.

**Conceptual framework**

Historical Stock Prices

Portfolio Optimization

MVP Model

BL Model

Market Equilibrium

Subjective Views

Figure 1: Conceptual framework

***Source: Asare N.P & Saforo A.S. Construct 2024***

# CHAPTER THREE

# METHODOLOGY

## 3.1 Introduction

The methodology chapter is essential as it forms the basis for the research, establishing the framework within which the study was executed. By employing appropriate and systematic approaches, it ensures the reliability and validity of the findings. Each element of the methodology is carefully crafted to align with the research objectives and provide a clear approach to addressing the research questions. This chapter aims to comprehensively explain the research methodology used in this study. It outlines the research design, describes the target population, and details the criteria for sample selection. Additionally, it discusses the type of secondary data utilized, the sources from which this data was acquired, and the techniques of analysis employed. Finally, it elucidates the methods used for data analysis.

## 3.2 Research Design

The research design chosen for this study is a quantitative approach, concentrating on the rigorous analysis of financial data from selected stocks of listed companies on the GSE. This design is crucial to offering a comprehensive and empirical understanding of how investment portfolios are constructed and assessing the effectiveness of the MVP and BL models. The quantitative approach facilitates the objective measurement and statistical analysis of financial metrics, resulting in robust and generalizable findings. The quantitative research design entails collecting and analyzing secondary data from the GSE. By utilizing statistical methods, the study aims to identify patterns and compare the effectiveness of the MVP and BL models in portfolio optimization. This ensures that the findings are based on objective and verifiable evidence.

By employing a quantitative research design, this study offers a comprehensive and systematic approach to constructing investment portfolios using stocks from selected institutions on the GSE. The use of empirical data and rigorous statistical methods guarantees that the conclusions are reliable and make a significant contribution to the existing body of knowledge on portfolio optimization using the MVP and BL models.

## 3.3 Population

The population for this study comprises all listed companies on the Ghana Stock Exchange (GSE). This specific population has been selected due to several critical reasons that ensure smooth and comprehensive analysis of the two models. Institutions listed on the GSE are subject to stringent regulations and oversight. This high level of regulation ensures that the financial information provided by these companies is accurate, transparent, and reliable. Investors and researchers can trust this data, making it a solid foundation for financial decision-making and analysis.

Listed companies typically have a high reputation for their performance within their respective industries. These companies are often market leaders or significant players, providing a reliable benchmark for industry standards. Their reputation adds an additional layer of credibility to the financial data, ensuring that the analysis conducted is based on well-established and reputable entities. One of the most crucial factors for selecting listed companies is the availability of their stock price data on a daily basis. This continuous and detailed tracking of stock prices provides a rich dataset for analysis, allowing for precise and timely evaluations of market performance. The accessibility of daily stock price data is essential for conducting thorough and accurate quantitative research, particularly in the context of portfolio optimization using the MVP and BL models.

In summary, the selection of all listed companies on the GSE as the population for this study is driven by the need for reliable, reputable, and readily available financial data. These factors collectively ensure that the findings of the study are robust, credible, and contribute valuable insights into the field of portfolio optimization.

## 3.4 Sample Size and Sampling Technique.

The sample size for this study comprises 10 institutions listed on the Ghana Stock Exchange (GSE) that have successfully met the trading requirements of the exchange. A purposive sampling method, a type of non-probability sampling, has been strategically chosen for this study. This method is ideal for focusing on specific characteristics within the population that are directly relevant to the research objectives. By deliberately targeting these institutions, the study ensures that the sample consists of entities that are most pertinent to the research questions, thereby enhancing the validity and relevance of the findings. This method allows the study to thoroughly analyze the effectiveness and impact of the MVP and BL models on portfolio optimization within the context of the GSE. The purposive sampling technique is well-suited to the study's objectives, ensuring that the selected institutions are highly relevant to the research focus. This approach provides a robust foundation for evaluating the portfolio optimization models under investigation.

## 3.5 Data Source

The primary data source for this study is secondary data obtained from the GSE. This dataset includes key financial metrics such as stock prices, market capitalization of various institutions, and the GSE composite index, covering a period from 2014 to 2024. The selection of this data is pivotal, as it provides a detailed and continuous record of the trading activities and financial performance of the institutions listed on the GSE. The inclusion of a decade's worth of data allows for a comprehensive analysis, offering insights into the long-term trends and fluctuations within the market. This extensive historical data serves as the foundation for evaluating the strategic responses of these institutions, particularly in the context of changing market conditions and regulatory environments.

The study's focus on the impact of the MVP and BL models on investment portfolio optimization necessitates the use of reliable and consistent data. The stock prices and market capitalization figures will be instrumental in calculating key financial ratios and metrics that inform the portfolio construction process. Additionally, the GSE composite index serves as a benchmark in the BL model, enabling the study to assess the relative performance of individual stocks and the overall market. By leveraging this rich dataset, the study aims to derive meaningful insights into how these portfolio optimization models perform in the real-world context of the GSE, ultimately contributing to the broader understanding of investment strategies in frontier markets.

## 3.6 Variable description and Measurement.

### 3.6.1 The Sharpe’s Ratio

This ratio is a measurement for risk-adjusted returns and was developed by William F. Sharpe. There is a risk and return characteristics of the portfolio that will change in a non-linear fashion as the weighting of the component assets change. The Sharpe ratio characterizes how well the return of an asset compensates the investor for the risk taken. The higher the returns mean better investment option. risk premium systematic risk taken. The returns mean better investment option.

= ,

where,

*rp* is the average returns of portfolio *p*,

*R* is the risk-free rate of returns,

*sd* is the standard deviation (risk) of portfolio *p.*

### 3.6.2 Risk and Return

The expected returns of portfolio:

*,*

where,

w denotes the weights of individual assets and the E(ri) denotes the of the expected returns of the instrument.

### 3.6.3 Variance

where

w denotes the vector of portfolio weights and Σ denotes the variance-covariance matrix

### 3.6.4 Risk (standard deviation)

where ρ denotes the risk of the portfolio.

### 3.6.5 Formula for Market-Implied Prior Returns:

The implied equilibrium returns Π in the BL model are typically calculated using the following formula:

Π = δ⋅Σ⋅wm

Π = implied equilibrium returns

δ = market-implied risk aversion

Σ = covariance matrix of asset returns

wm = market capitalization weights

### 3.6.6 Adjusted Expected Returns in the BL model

E[R] = ((τΣ)-1 + PT Ω −1 P)-1 ((τΣ)-1 Π + P T Ω-1 Q)

τ = scalar reflecting the uncertainty in the prior estimate of the mean (often set to a small value)

P = matrix representing the views (each row corresponds to a view)

Ω = diagonal covariance matrix of the errors in the views

Q = vector of view returns

E[R] = adjusted expected returns

# CHAPTER FOUR

# RESULTS AND DISCUSSIONS

## 4.1 Introduction

This chapter provides a detailed examination of the research results and their implications. This chapter is crucial for translating raw data into meaningful insights, addressing the research questions, and evaluating the study's objectives. It is structured into two main sections, results and discussion. In the results section, it presents a clear and objective account of the findings. This includes detailed descriptions of the data, statistical analyses, and visual representations such as tables, charts, and graphs. The discussion is where the results are interpreted in a broader context. Here, the focus shifts to understanding the significance of the findings, exploring their implications, and relating them to existing literature and theoretical frameworks.

Table 1: Descriptive statistics of the various assets.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Assets** | **BOPP** | **CAL** | **CMLT** | **CPC** | **GCB** | **GGBL** | **SIC** | **SOGEGH** | **TOTAL** | **TLW** |
| **Count** | 2526 | 2526 | 2526 | 2526 | 2526 | 2526 | 2526 | 2526 | 2526 | 2526 |
| **mean** | 5.509 | 0.860 | 0.114 | 0.020 | 4.413 | 2.277 | 0.197 | 0.194 | 0.194 | 18.795 |
| **std** | 4.488 | 0.219 | 0.017 | 0.005 | 0.633 | 1.089 | 0.112 | 0.320 | 0.320 | 8.905 |
| **min** | 2.00 | 0.420 | 0.090 | 0.100 | 2.950 | 0.900 | 0.07 | 0.570 | 0.570 | 11.920 |
| **25%** | 2.85 | 0.740 | 0.100 | 0.020 | 3.950 | 1.600 | 0.100 | 0.730 | 0.730 | 11.920 |
| **50%** | 4.10 | 0.840 | 0.110 | 0.020 | 4.413 | 2.050 | 0.150 | 0.840 | 0.840 | 11.940 |
| **75%** | 6.34 | 0.990 | 0.120 | 0.020 | 4.950 | 2.550 | 0.260 | 1.030 | 1.030 | 27.880 |
| **max** | 22.0 | 1.970 | 0.160 | 0.030 | 5.850 | 6.200 | 0.520 | 2.400 | 2.400 | 36.000 |

The descriptive statistics of the various assets reveal notable differences in their distributions, with BOPP showing the highest mean value (5.509) and significant variability (std = 4.488), reflecting the potential risk and return profile associated with this asset, consistent with the Capital Asset Pricing Model (CAPM) theory that emphasizes the trade-off between risk and return (Sharpe, 1964); CAL and CMLT, with lower means of 0.860 and 0.114, respectively, and lower standard deviations, suggest a more stable performance but with potentially lower returns, aligning with Modern Portfolio Theory (Markowitz, 1952) which advocates for diversification to manage risk; CPC exhibits the lowest mean (0.020) and standard deviation (0.005), indicating minimal variability and returns, which might make it attractive for risk-averse investors, as per Behavioral Finance Theory (Tversky & Kahneman, 1979), which suggests that investors' risk tolerance influences their asset choices; GCB and GGBL display moderate means (4.413 and 2.277) and standard deviations (0.633 and 1.089), indicating a balanced approach between risk and return, which is often sought by investors aiming to optimize their portfolios in line with Efficient Market Hypothesis (Fama, 1970); TOTAL and TLW show substantial variability with standard deviations of 1.786 and 8.905, respectively, suggesting that these assets may be subject to significant market fluctuations, highlighting the importance of Risk Management strategies in portfolio construction, as noted in Fabozzi et al. (2007). These statistics underscore the diversity in performance and risk across assets, emphasizing the need for tailored investment strategies.

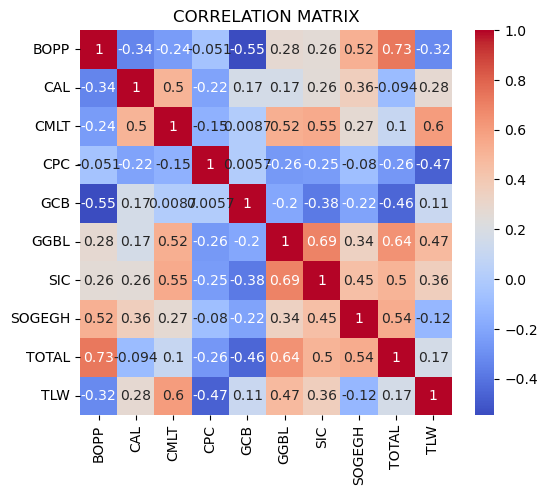
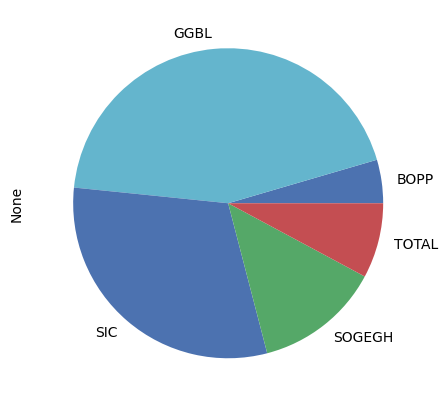
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Figure 2: Graphs on correlation between all the various assets and the optimum portfolio weights developed by the BL model using EfficientFrontier.

Table 2: The correlation matrix of the stocks.

**CORRELATION MATRIX**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **BOPP** | **CAL** | **CMLT** | **CPC** | **GCB** | **GGBL** | **SIC** | **SOGEGH** | **TOTAL** | **TLW** |
| **BOPP** | 1 | -0.335 | -0.244 | -0.051 | -0.566 | 0.281 | 0.259 | 0.521 | 0.729 | -0.322 |
| **CAL** | -0.335 | 1 | 0.504 | -0.219 | 0.178 | 0.169 | 0.255 | 0.357 | -0.094 | 0.279 |
| **CMLT** | -0.244 | 0.504 | 1 | -0.148 | 0.012 | 0.525 | 0.546 | 0.275 | 0.101 | 0.604 |
| **CPC** | -0.051 | -0.219 | -0.148 | 1 | 0.008 | -0.259 | -0.25 | -0.08 | -0.263 | -0.468 |
| **GCB** | -0.566 | 0.178 | 0.012 | 0.008 | 1 | -0.365 | -0.51 | -0.22 | -0.495 | 0.258 |
| **GGBL** | 0.281 | 0.169 | 0.525 | -0.259 | -0.365 | 1 | 0.694 | 0.337 | 0.642 | 0.47 |
| **SIC** | 0.259 | 0.255 | 0.546 | -0.246 | -0.514 | 0.694 | 1 | 0.447 | 0.501 | 0.357 |
| **SOGEGH** | 0.521 | 0.357 | 0.275 | -0.08 | -0.22 | 0.337 | 0.447 | 1 | 0.539 | -0.122 |
| **TOTAL** | 0.729 | -0.094 | 0.101 | -0.263 | -0.495 | 0.642 | 0.501 | 0.539 | 1 | 0.171 |
| **TLW** | -0.322 | 0.279 | 0.604 | -0.468 | 0.258 | 0.47 | 0.357 | -0.122 | 0.171 | 1 |

The correlation matrix of the stocks indicates that BOPP has a moderate negative correlation with CAL (r = -0.335) and GCB (r = -0.566), suggesting that as BOPP increases, these stocks tend to decrease, while BOPP shows a strong positive correlation with TOTAL (r = 0.729), indicating that these two stocks move together; CAL is positively correlated with CMLT (r = 0.504) but negatively correlated with CPC (r = -0.219), reflecting mixed relationships, whereas CMLT has a strong positive correlation with SIC (r = 0.546), implying that they are closely related, but is negatively correlated with CPC (r = -0.148), indicating an inverse relationship; CPC is generally weakly correlated with other stocks, showing a negative relationship with GGBL (r = -0.259) and TLW (r = -0.468); GCB has a moderate negative correlation with SIC (r = -0.514) and TOTAL (r = -0.495), suggesting that as GCB rises, these stocks fall; GGBL and SIC share a strong positive correlation (r = 0.694), indicating that they move together, and SOGEGH shows a positive correlation with TOTAL (r = 0.539) but a negative correlation with TLW (r = -0.122); finally, TLW is strongly positively correlated with CMLT (r = 0.604), reflecting a close relationship, while TOTAL and GGBL also exhibit a strong positive relationship (r = 0.642), highlighting the interconnectedness of these stocks.

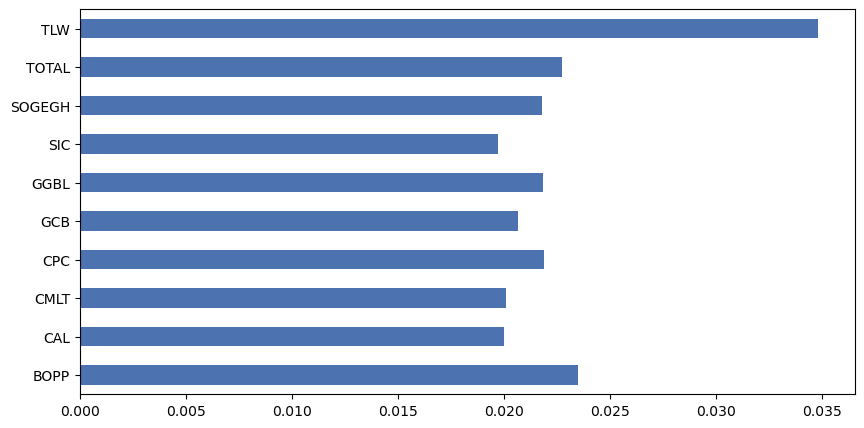


Figure 3: Graph on how much the investor will be compensated per each of the risk the investor will assume as per the BL model.

Table 3: Mean Variance Portfolio and Black Litterman expected returns for each asset.

MVP AND BL EXPECTED REYURNS ON EACH ASSET

|  |  |  |
| --- | --- | --- |
|  | MVP | BL |
| BOPP | -0.036 | 0.069 |
| CAL | 0.152 | -0.046 |
| CMLT | 0.059 | -0.020 |
| CPC | 0.632 | -0.300 |
| GBC | 0.054 | -0.002 |
| GGBL | 0.087 | 0.217 |
| SIC | 0.148 | 0.157 |
| SOGEGH | -0.018 | 0.087 |
| TOTAL | 0.045 | 0.075 |
| TLW | 0.117 | 0.011 |

The comparison of the Mean Variance Portfolio (MVP) and Black-Litterman (BL) expected returns across the assets reveals both alignment and divergence, illustrating the distinct methodologies underlying each model. For example, BOPP and SOGEGH demonstrate substantial differences, with BOPP showing a negative MVP return (-0.036) but a positive BL return (0.069), while SOGEGH has a negative MVP return (-0.018) and a positive BL return (0.087), reflecting how the Black-Litterman model adjusts for market views, potentially capturing investor sentiment that the MVP does not, as highlighted in Cheung's (2010) review of the BL model’s flexibility in integrating subjective opinions.

In contrast, assets like CPC and GCB show drastic shifts between the two models, with CPC having a strong positive MVP return (0.632) but a negative BL return (-0.300), and GCB shifting from a small positive MVP return (0.054) to a nearly neutral BL return (-0.002), which can be explained by the BL model's tendency to recalibrate expectations based on equilibrium conditions and new information, as noted by He & Litterman (1999). On the other hand, assets such as GGBL, SIC, and TOTAL show more consistent positive returns across both models, indicating that for these assets, both the traditional mean-variance optimization and the more complex Black-Litterman adjustments converge, which aligns with Fabozzi et al. (2007)'s argument that in stable market conditions, both models may offer similar insights. Overall, this comparison underscores the importance of considering multiple models in portfolio management to capture a more comprehensive picture of expected returns, particularly in light of the Markowitz (1952) framework's limitations and the BL model's ability to incorporate investor confidence and market dynamics.

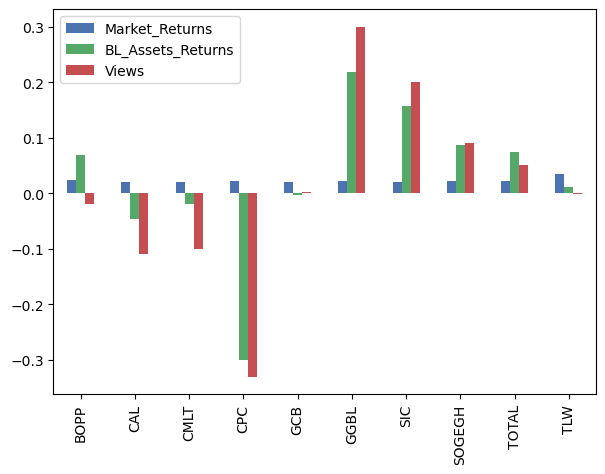


Figure 4: Market Returns, Stock Returns and Views on movement of stocks as per the BL Model.

Table 4: Portfolio results for both BL and MVP models.

**FINAL PORTFOLIO RESULTS FOR BOTH MVP AND BL MODELS**

|  |  |  |
| --- | --- | --- |
|  | **MVP** | **BL** |
| Expected returns | 12.40% | 16.40% |
| Annual volatility | 19.72% | 25.70% |
| Sharpe ratio | 0.63 | 0.56 |

The portfolio results for the Mean Variance Portfolio (MVP) and Black-Litterman (BL) models offer significant insights into the trade-offs between expected returns, risk, and overall portfolio efficiency. The MVP model yields an expected return of 12.40% with an annual volatility of 19.72% and a Sharpe ratio of 0.63, indicating a relatively balanced approach that prioritizes risk-adjusted returns. In contrast, the BL model shows a higher expected return of 16.40% but also comes with greater annual volatility at 25.70%, resulting in a slightly lower Sharpe ratio of 0.56. This suggests that while the BL model may offer higher potential returns, it does so at the cost of increased risk, which is reflected in the reduced risk-adjusted performance.

From a theoretical perspective, the MVP Theory (Markowitz, 1952) is centered around the optimization of portfolios by maximizing expected returns for a given level of risk, or equivalently, minimizing risk for a given level of expected returns. The MVP model's higher Sharpe ratio (0.63) compared to the BL model (0.56) aligns with Markowitz’s framework, which emphasizes creating the most efficient portfolio in terms of risk-adjusted returns. The relatively lower volatility (19.72%) under the MVP model further supports its goal of balancing risk and return efficiently.

On the other hand, the BL Model (Black & Litterman, 1992) incorporates subjective views and market equilibrium into the traditional mean-variance optimization framework. This model’s higher expected return (16.40%) suggests that the integration of market views and investor confidence can lead to more aggressive return predictions. However, the higher volatility (25.70%) and lower Sharpe ratio (0.56) highlight the model's potential trade-offs, particularly when investor views deviate from traditional risk-return dynamics. He & Litterman (1999) note that while the BL model offers flexibility by allowing adjustments based on market sentiment, it can also lead to higher risk, especially when market views are overly optimistic or misaligned with actual market conditions.

In comparing the two theories, MVP Theory is rooted in a more structured and objective approach to portfolio construction, focusing strictly on historical data and the relationship between risk and return. It is often favored for its simplicity and clear decision rules, which is reflected in the higher Sharpe ratio and lower volatility in the MVP model. Conversely, the BL model introduces a layer of subjectivity by incorporating market views, which can provide an edge in capturing future market trends but also introduces additional risk, as seen in the increased volatility and slightly lower Sharpe ratio. The BL model is particularly useful in environments where investor sentiment and market predictions play a significant role, as it allows for adjustments that the traditional MVP model may overlook. Ultimately, the choice between the two models depends on the investor's risk tolerance and confidence in their market views. For risk-averse investors seeking stability, the MVP model may be preferable due to its focus on efficient risk-adjusted returns. However, for those willing to take on more risk in pursuit of higher returns, and who have strong market views, the BL model may offer better opportunities, despite its associated higher volatility.

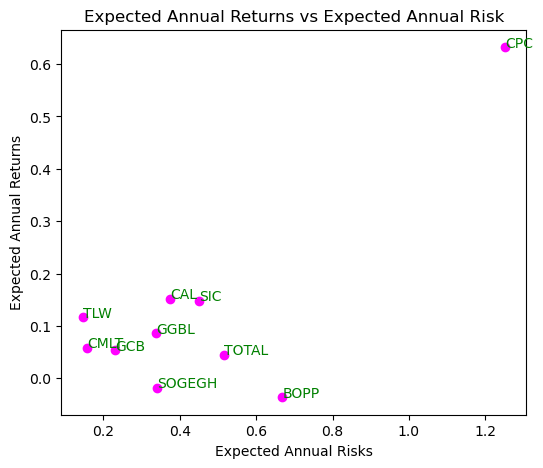


Figure 5: Expected Annual Returns and Expected Annual risk as per MVP Model.

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATION

## 5.1 Introduction

This chapter summarizes the key findings, drawing conclusions based on the research, and providing recommendations for future action or study. This chapter extracts the essential outcomes of the research, highlighting how the objectives were met and addressing the significance of the results. This chapter ties together the entire study, reinforcing its contributions and suggesting pathways for applying its insights in both academic and practical contexts.

## 5.2 Summary of Findings

This research investigated the effectiveness of two widely recognized portfolio optimization models, the Mean-Variance Portfolio (MVP) model and the Black-Litterman (BL) model, using selected stocks from the Ghana Stock Exchange (GSE). The study aimed to assess and compare these models in the context of frontier market to determine which model provides better portfolio optimization in terms of balancing risk and return. The descriptive analysis revealed notable differences across the selected assets, with varying degrees of risk and return profiles. For instance, BOPP exhibited the highest mean return but also the greatest variability, aligning with the Capital Asset Pricing Model (CAPM) theory, which emphasizes the risk-return tradeoff. The correlation matrix highlighted both positive and negative correlations among the assets, suggesting that diversification can effectively reduce unsystematic risk within the portfolio.

When comparing the performance of the MVP and BL models, the study found that the MVP model yielded an expected return of 12.40% with a lower annual volatility of 19.72% and a higher Sharpe ratio of 0.63. This indicates that the MVP model offers a more balanced approach, prioritizing risk-adjusted returns, which is particularly advantageous for risk-averse investors. On the other hand, the BL model provided a higher expected return of 16.40% but with significantly higher volatility (25.70%) and a lower Sharpe ratio (0.56). The higher expected return under the BL model reflects its ability to incorporate subjective market views and investor confidence, but this comes at the cost of increased risk. These findings suggest that the choice of model depends on the investor's risk tolerance and market outlook, with the MVP model being more suitable for stability and the BL model for potentially higher returns but with greater uncertainty.

## 5.3 Conclusion

The comparative analysis between the MVP and BL models demonstrated that both models offer distinct advantages depending on the investor’s risk profile and market perspective. The MVP model, grounded in Modern Portfolio Theory (Markowitz, 1952), proved to be effective in delivering stable, risk-adjusted returns, making it a preferable choice for risk-averse investors who prioritize minimizing volatility. The model's lower annual volatility and higher Sharpe ratio reinforce its suitability for investors seeking a conservative approach to portfolio optimization. Conversely, the BL model, which integrates subjective views with market equilibrium, showed its strength in capturing higher returns, albeit with increased risk. The BL model's flexibility in incorporating investor insights makes it particularly valuable for investors who possess strong market views and are willing to accept higher volatility in pursuit of greater returns. However, this comes with the tradeoff of reduced risk-adjusted performance, as evidenced by the lower Sharpe ratio.

Overall, the study contributes to the theoretical understanding of portfolio optimization in frontier markets like Ghana. It highlights the importance of considering multiple models to capture a more comprehensive picture of expected returns and risks. The findings also underscore the need for investors to align their portfolio optimization strategy with their individual risk tolerance and investment goals.

## 5.4 Recommendations

Based on the findings of this study, several recommendations are proposed for investors and portfolio managers operating within the Ghana Stock Exchange:

* + 1. **Adopt a Hybrid Approach:** Investors should consider combining the strengths of both the MVP and BL models when constructing their portfolios. The MVP model should be prioritized for the core of the portfolio to ensure stability and minimize risk, while the BL model can be applied to a smaller portion of the portfolio to capture higher returns based on market insights.
    2. **Risk Management:** For risk-averse investors, the MVP model is recommended due to its focus on optimizing risk-adjusted returns and minimizing volatility. Investors who prioritize capital preservation should lean towards the MVP model, especially in volatile market conditions.
    3. **Utilize Market Views with Caution:** Investors who are willing to accept higher risk and have strong market views should consider the BL model. However, it is crucial to regularly reassess market views and adjust portfolios accordingly to avoid potential losses due to misaligned predictions.
    4. **Continuous Monitoring and Adjustment:** Given the dynamic nature of emerging markets like the GSE, it is essential for investors to continuously monitor their portfolios and adjust their strategies in response to changing market conditions. Regular rebalancing is necessary to maintain the optimal balance between risk and return.
    5. **Further Research:** Future research should explore the application of the MVP and BL models in other emerging markets to validate their effectiveness across different contexts. Additionally, incorporating alternative data sources such as macroeconomic indicators and investor sentiment could further enhance the robustness of these models.

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# Appendix

