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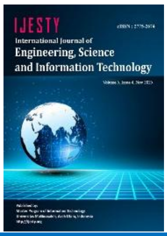

An Empirical Investigation of Portfolio Optimisation Using the Markowitz Model

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Abstract

In finance, portfolio optimisation involves an essential concept that requires determining the ideal combination of assets to optimise returns by lowering the return risk. The concept of efficient portfolios, which aims to attain the maximum return for a given level of risk or the minimum risk for a given level of return, was initially suggested by Markowitz's model. Considering an emphasis on the Shanghai Stock Exchange (SSE), this research explores portfolio optimisation using Markowitz's Portfolio Theory about the Chinese stock market. The objective is to identify the optimal stock portfolio from a selection of various companies listed on the SSE for the 2020-2024 periods, balancing risk and expected return. A purposive sampling method is used to select various stocks based on their historical performance, with stocks screened through a two-level process: first by correlation coefficients, and by their coefficient of variation to assess risk-return trade-offs. Weekly return rates of selected stocks from the SSE over four years are used for the analysis. Using the mean-variance optimisation approach, the ideal weights for each stock in the portfolio are determined using the expected return effect. The results show that the optimized portfolio, consisting of various stocks (Industrial and Commercial Bank of China (ICBC), GD Power Development Co., Ltd, Beiqi Foton Motor Co., Ltd., Shanghai Automotive Industry Corporation (SAIC Motor), China Life Insurance Company (LIC)), performs more effectively with the return in trading days. The portfolio includes companies with diversified sectors, ensuring a balanced risk and return profile.

Keywords: *Markowitz Portfolio Theory, Shanghai Stock Exchange, Stock Portfolio Optimisation, Chinese Stock Market, Risk-Return.*

1. Introduction

The process of distributing resources among a specified number of assets is known as portfolio selection. Various financial assets, including stocks, bonds, commodities, and other instruments, can be acquired into a portfolio. A portfolio is frequently possessed by investors and could be managed by a manager or financial expert. When creating or constructing a portfolio, it is important to consider the investor's expectations and maintain the sensitivity to risk, or capacity to control volatility, in the portfolio. By determining the optimal distribution of a group of stocks with risk and return preferences, the portfolio optimisation concern is established [1]. The subject of optimum portfolio allocation that centred on maximising expected returns while minimising risk is considered a traditional applied finance task. Portfolio optimisation has gained prominence among financial professionals and researchers with Markowitz's groundbreaking model that defined return and risk in the mean-variance approach [2] [3]. The allocation of the investment portion is continuously modified to maximise expressed return and risk acceptance. The concept of portfolios is widely used and established in portfolio management [4]. In recent years, stock investigation has grown significantly and received interest from a wide range of users. The COVID-19 epidemic has impact on investment activities, requiring investors to modify and rearrange their ideal portfolios when the stock market changes during the epidemic, and investors need to maintain balance [5] [6]. Determining the assets' ideal weight by raising the anticipated return and lowering the associated risk is the highlight of portfolio optimisation. The initial concept of portfolios presents a solution to the balance between maximising expected returns and avoiding risk [7] [8]. The real estate sector, which plays a significant role in its economic activity, was considered crucial for maintaining financial stability throughout the financial crisis. Changes in real estate prices directly impact several financial indicators that contribute to a significant factor in financial system formation that has a direct connection with market developments [9]. The investment plan, risk tolerance, and liability use influence the portfolio's development. In a circumstance of unpredictability, Markowitz created a framework for determining portfolio allocations and developed the modern financial concepts.

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Investors can efficiently manage risk by using portfolio construction to describe a collection of assets in terms of returns, considering variations in portfolio returns and expected profits [10]. Stock market portfolio is a popular activity for professionals, non-professionals, and research networks, and it is considered for the possibilities for a continuous return. The entire population selects the stocks based on the businesses' prominent returns and incentives without having extensive knowledge of the risk considerations [11]. Determining the most effective asset allocation to achieve the investment desires is the primary concern of portfolio allocation. A varied and beneficial portfolio can be generated by the prevalent investment approach [12] [13]. There are unclear inquiries in the financial industry concerning the way investors establish portfolios and determine asset values. When making investment decisions, choosing the ideal securities and managing the assets are essential measures to consider for an efficient portfolio along with the highest possible returns related to the risk levels [14]. The objective of this research: Examining the Markowitz model of mean-variance model efficacy in optimizing portfolios of stock in the Chinese financial market, particularly with the Shanghai Stock Exchange (SSE) from 2020 to 2024, is the objective of this research. Through a two-stage screening procedure, asset weight calculations that balance risk and return, and stock selection based on past performance, it intends to create an ideal portfolio. According to return and risk efficiency, it is assessed that the optimal portfolio outperforms the stock market benchmark.

2. Literature Review

The advantages of diversifying a Euro-based stock portfolio using volatility derivatives and Markov-Switching models were examined [15]. The performance of three hypothetical investors that had varying trade costs and made investments in VSTOXX derivatives and three-month notes during times of difficulty or extreme distress, or in ESTOXX50 during times of composure, was generated. Results indicated that the short-term benefits of diversification maintenance and the two-asset portfolio maintenance, the existence of trading expenses greatly improved the stock portfolio for longer periods. Considering that the stochastic process of volatility has a rapid mean-reverting process and it is one of the limitations of volatility derivatives.

Developing an ideal portfolio with many cryptocurrencies and no traditional assets utilising a modern theoretical portfolio was the main objective [16]. Yahoo Finance provided the majority of the past information on the regular adjacent price of cryptocurrencies. Correlation research showed that all the virtual currencies, except for Tether, were moderately correlated. The research established the beneficial consequences for investors. Furthermore, information on the risk characteristics of cryptocurrency markets needs to be obtained by regulators.

Investors could effectively control the risk by using portfolio design to categorise a portfolio as a measure of returns by considering variations in portfolio returns and expected profits, as was suggested [17]. The suggested method's efficacy was demonstrated by applying it to publicly available data sets that were utilised in multiple analyses for a wide range of portfolio selection techniques. Results from the suggested hybrid approach showed that the relationship requirement of portfolio optimisation was more significant compared to results from existing methods. Comparisons could be considered with performance metrics that were not provided in the research.

Based on the anticipated price, the research [18] focused on maximising the stock portfolio of businesses that have been listed on the Tehran Stock Exchange. Technical analysis-based trading rule optimisation was one of the several changing techniques that constitute the basis of the research. A drop in transaction risk and an increase in stock portfolio return were found to occur when company shares were changed. Additionally, the risk was raised and the stock portfolio returned partially when two alternatives were used at the same time.

Robustness in the traditional mean-variance optimisation model by the pair of alterations in the mean-variance approach was examined [19]. Moderate behavioural scores of stocks determined the portfolios with a greater relationship, according to the results of the copula behavioural mean-variance (CBMV) and behavioural mean-variance (BMV) examinations. The BMV approach exhibited a reverse performance in the Forex market, while the CBMV was consistent. In the Forex market, the BMV model was lacking alignment.

An integrated Markowitz and Data Envelopment Analysis (DEA) model for supporting investors to select the optimal portfolio for the highest possible return was provided [20]. An analysis of 50 active companies on the Tehran Stock Exchange utilising the Non-Dominated Sorting Genetic Algorithm was used to demonstrate the model's efficacy by comparing performance. Internal performance and all of the Markowitz model's limitations were provided. The research was limited by the suggested Markowitz DEA model enhanced portfolio returns, and it significantly raised the risk while excluding the wider effects of external market variables.

The most efficient portfolio technique was identified [21] by utilising an expected utility optimisation from the last stage of assets that evaluated property values using a random approach that included a variety of economic conditions. Analysing the impact of big investors on the property market was the purpose. The findings demonstrated that the balance of the economy, maintenance costs, rental revenue, interest rates, and the investment tendency of significant investors in property were determined by the investment methods, and the state of the economy further influenced the consequences.

A thorough analysis of more than 140 publications that have addressed the portfolio optimisation concern using swarm intelligence and evolutionary algorithms was performed [22]. Depending on whether the portfolio optimisation issue was limited or unconstrained, the materials were divided into two categories: single-objective and multi-objective. The different models of portfolios that were implemented, along with the limitations, standards, and characteristics, were covered completely. The research lacks focus on dynamic portfolio optimisation, predictive pricing, and a deeper examination of multi-objective methods.

A dynamic neural network influenced by using machine learning (ML) was created [23]. A theoretical examination of the constructed neural network's convergence was presented. Results from experiments with actual stock market data showed the suggested model's efficacy. The cost function that represented all risks and benefits has been reduced by 123.6% using the suggested model. The suggested dynamic neural network determined a specific optimum solution for the improvement, but it could not guarantee that the solution identified the global optimum.

Markowitz mean-variance portfolios utilising sample mean and covariance with inaccuracy, extreme weights, and high sensitivity to parameter changes were examined [24]. In comparison with shrinkage-based and limited portfolios, the assessment achieved fewer changes by developing a computationally efficient predictor with the Gaussian features and demonstrating its efficacy in stock markets. The estimations of samples for means and the covariance resulted in inadequate performance. Table 1 explores the relevant research.

Table 1. Relevant Research on Portfolio Optimisation in the Stock Market

Reference	Objective and Methods	Results	Benefits	Limitations
De la Torre-Torres et al., [11]	Diversifying a Euro-based stock portfolio using volatility derivatives and Markov-Switching models was examined.	The short-term benefits of diversification were maintained while an investor maintained the two-asset portfolio.	The existence of trading expenses greatly improved the stock portfolio's performance for longer periods.	Considering that the stochastic process of volatility has a rapid mean-reverting process and it is one of the limitations of volatility derivatives.
Mazanec [12]	Developing an ideal portfolio with many cryptocurrencies with Yahoo Finance information.	Correlation research showed that all the virtual currencies were moderately correlated.	Provides beneficial consequences for investors.	Information on the risk characteristics of cryptocurrency markets needs to be obtained by regulators.
Yaman & Dalkılıç [13]	The Portfolio Optimisation Model was presented to solve the Cardinality Constraint.	The relationship requirement of portfolio optimisation was more significant compared to the results from existing methods.	The efficiency of the suggested method was utilised in a wide range of portfolio selection techniques.	Performance metrics were not provided in the research.
Mazraeh et al., [14]	Maximising the stock portfolio of businesses with technical analysis-based trading rule optimisation was used in the research.	A drop in transaction risk and an increase in stock portfolio return were found to occur when company shares were changed.	The suggested method was utilised to provide stock prices.	The risk was raised, and the stock portfolio returned partially when two alternatives were used at the same time.
Mba et al., [15]	The robustness of the traditional mean-variance optimisation model was examined.	Stocks with lower behavioural scores performed significantly with the portfolios of higher interpersonal scores.	The CBMV maintain consistency in the Forex market, whereas the BMV approach showed a reverse tendency.	The BMV model was lacking alignment in the Forex market.
Rasoulzadeh et al., [16]	The research suggested the Markowitz DEA model for providing the highest possible return of an optimal portfolio.	Obtained and compared with present techniques, demonstrating the efficacy of the suggested model.	Internal performance, returns of intuitionistic fuzzy numbers, and all of the Markowitz model's limitations were determined.	A modest rise in portfolio returns significantly increased the risk in the portfolio.
Yilmaz et al., [17]	The most effective portfolio approach by using an expected utility optimisation from the final stage of wealth was determined.	The investment tendency of significant investors in property is determined by the investment methods.	Investors receive assistance in optimising their financial position through portfolio optimisation.	The impacts of large investors having various financial assumptions, along with credit limits, were not determined in the research.
Erwin & Engelbrecht [18]	A thorough analysis of the portfolio optimisation using swarm intelligence and evolutionary algorithms was conducted.	The analysis and discussion demonstrated the significant characteristics for portfolio optimisation.	The different portfolio models were employed, with the constraints and characteristics were covered in detail.	The research lacks focus on dynamic portfolio optimisation and predictive pricing.
Cao & Li [19]	A new dynamic neural network for portfolio optimisation was explored.	The cost function is reduced by 123.6% by the suggested method.	The suggested dynamic neural network could determine a specific optimum solution for the improvement.	The suggested method could not protect the identified solution as the global optimum.
Petukhina et al., [20]	Markowitz's mean-variance portfolios that utilise mean and covariance were explored to resolve the issues in portfolio optimisation.	The fewer changes by a computationally efficient predictor with the Gaussian features demonstrate its efficacy in stock markets.	The method significantly lowered the trading volume as indicated by turnover, which resulted in an improved risk adjustment for net returns.	The research emphasised attention to sample estimation for means and covariance resulted in inadequate performance outside the sample caused by estimation mistakes.

3. Methods

This section provides the process of portfolio optimisation by employing the Markowitz framework in the Chinese stock market with a focus on SSE. Stocks are selected through a two-step process that involves purposive sampling. Initially, stocks are filtered according to correlation coefficients that enhance diversity, and then the risk and return balance is evaluated using the coefficients of variation. The covariance matrix, mean, standard deviation (SD), variance, and expected return are computed to determine weekly returns. After the optimised portfolio utilising the Markowitz mean-variance framework, in the constraint of a fully invested portfolio and without shorting stocks.

3.1. Data Collection

A balance between risk and expected returns with an optimal stock portfolio from a range of SSE-listed companies during the years 2020–2024 is observed in the research. The research gathers a total of 5 stocks from 5 various companies: Industrial and Commercial Bank of China (ICBC), GD Power Development Co., Ltd., Beiqi Foton Motor Co., Ltd., Shanghai Automotive Industry Corporation (SAIC Motor), China Life Insurance Company (LFC). Each company consists of various sectors and the sectors including energy, manufacturing, automotive, financial services, and insurance.
The obtained companies were provided with individual IDs like A, B, C, D and E. Table 2 represents the IDs and sectors of the obtained companies.

Table 2. ID and Sectors of the Obtained Companies

Name of the Company	ID	Sectors
ICBC	A	Financial Services
GD Power Development Co., Ltd	B	Energy
Beiqi Foton Motor Co., Ltd	C	Manufacturing
SAIC Motor	D	Automotive
China LIC	E	Insurance

3.2. Markowitz's Portfolio Theory

Portfolio optimisation is the basic concept in finance that determines the ideal combination of assets to optimise returns while lowering risk. The Markowitz model provided effective portfolios intended to achieve the highest return for a specified level of risk or the lowest risk for a specified level of return. The mean-variance model and the risk-balance optimisation framework model are two of the theory's primary components. The initial one represents the investment value and risk of securities using an expected return rate and variance, while the second one derives the risk-balance optimisation framework of the securities portfolio. Building a portfolio of securities using the effective risk-balance optimisation approach provides benefits for investors. According to the basic idea created by Markowitz's portfolio concept, investors desire to select the portfolio having the greatest return at an established level of volatility or the fundamental portfolio with the least risk at a specified level of return.

3.2.1. Mean-Variance Framework

The optimal weights for every stock in portfolios based on anticipated return rates were determined through the mean-variance optimisation technique, allowing investors to evaluate the volatility that assesses the risks in the portfolio. The following Equations (1-2) are based on Markowitz's portfolio theory.

$$Max \sum_{j=1}^{n} \frac{z_j O_j - O_e}{\sigma_j} \quad (1)$$

$$\sum_{j=1}^{n} z_j = 1, z_j \geq 0, j = 1, \cdots, n \quad (2)$$

The variable $O_j$as the initial return stock, O_eAs the final return of stocks, the variance of every stock is represented by σ_j and jIs the stock? The weight vector is denoted by z_j. Utilising the following Equation (3), the ideal portfolio of high-risk assets has been determined. The high-risk asset considers the individual investor and calculates the value that could be invested in risky assets, along with the invested risk-free securities, based on the level of risk resistance.

$$b^* = \frac{F(O_q) - O_e}{X\sigma_q^2} \; b \quad (3)$$

Where b^*Denotes the percentage of the portfolio allocated to risky assets, and matrix multiplication is denoted by $F(O_q)$ and ADenotes the investor's tendency toward risk coefficient level; a positive number larger than zero can be considered equivalent to one.

3.2.2. Mean-Variance Framework

According to the risk-balance technique, a portfolio can increase its score and become more resistant to stock market losses by changing asset allocations to represent an equivalent degree of risk. Given a portfolio $z \in On$ and the return covariance matrix Σ, The volatility of the portfolio is as follows (Equation (4)).

$$\sigma(z) = \sqrt{z^S} \sum z \quad (4)$$

The definition of the j^{th} risk contribution (Rc) of assets to overall risk $(\sigma(z))$Is presented in Equation (5).

$$Rc_j = z_j \frac{\partial \sigma}{\partial z_j} = \frac{z_j(\sum z)j}{\sqrt{z^S \sum z}} \quad (5)$$

The risk balance by distributing the weights such that every stock provides the same level of risk is the model's primary intention. The equal risk portfolio (ERP) equalises portfolio weights (Equation (6)).

$$Rc_j = \sigma(z)/n \quad (6)$$

The intention is to lessen the differences between z_j and $\sum z_j$To attain a balance in the risk contributions. The variable zAn be reduced by Equation (7).

$$\sum_{j,i=1}^{n} \left(z_j\left(\sum z_j\right) - z_j\left(\sum z_j\right)^2\right) - E(z) \quad (7)$$

Where $z$is the constraint in the arbitrary convex set and $E(z)$as an additional function.

3.3. Data Analysis Assessment

Data analysis is useful for predicting market shifts, identifying inadequate assets, and assessing the effectiveness of portfolio optimisation. Employing data to comprehend market patterns, evaluate potential investments, and control risk is known as data analysis in the stock market and portfolio optimisation. The data assists investors in building portfolios that support the stock market investment desires and generating accurate decisions on the allocation of assets. The research employed two data analysis techniques, such as the correlation coefficient and the coefficient of variation, to perform the stock market's portfolio optimisation. The evaluation of risk in portfolio securities, stock ID correlation, covariance and the effective performance of the mean variance model with five portfolios is provided.

Correlation coefficient: The investor needs to estimate the correlation coefficients between the returns of different assets to effectively select stocks that are not considered to diminish simultaneously, according to the existing portfolio optimisation theory.

Coefficient of variation: It is defined as the ratio of the SD in the dataset to the expected mean value. Investors utilise this method to determine whether the anticipated return on investment balances the possibility of volatility, or the risk of loss in the stock investment.

$$Coefficient\ of\ Variation = \frac{SD}{Mean} \quad (8)$$

4. Results and Discussions

This section provides the performance evaluation of portfolio optimisation by employing data analysis techniques, like the correlation coefficient and the coefficient of variation in the stock market. The demonstration shows the evaluation outcomes of data analysis techniques with the obtained stock IDs.

4.1. Risk Assessment

A portion of the efficient risk is displayed using the five portfolios in Table 3. The assessment demonstrates that the risk rises in combination with the optimised portfolio's predicted return rates when the rate of risk increase and the rate of return increase (Figure 1).

Table 3. Expected Returns in The Risk of Portfolios

Expected Returns	Risk of Security Portfolios				
	1	2	3	4	5
	0.4000	0.4050	0.4080	0.4100	0.4150

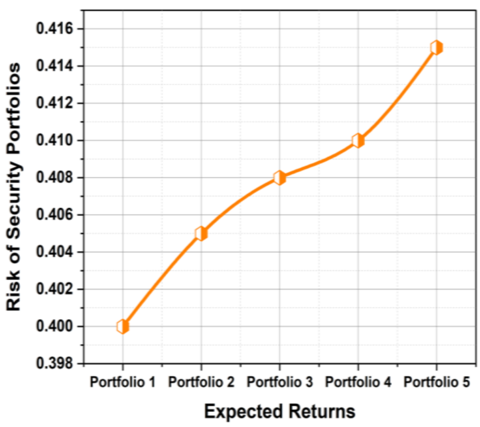

Fig. 1. Evaluation of Efficient Risk with Five Portfolios

The relationship between security portfolio risk and expected returns showed that as expected returns increase, portfolio risk also increases. The results show the optimal portfolio evolves with changing risk and return levels by showing five portfolios, which indicates a distinct stock composition.

4.2. Evaluation of Correlation Coefficient

The relationship between the portfolio's returns on stocks has been evaluated using the correlation coefficient. Through correlation analysis, it is determined that stocks transfer in connection with one another. Low-correlation stocks are selected to increase diversified portfolios, reduce returns and enhance the portfolio's risk-return profile. Investment correlation analysis is the statistical measurement of the shift of two securities with one another. This measure is essential for investors required to create diverse portfolios, as it indicates which assets can balance the high risk associated with other stocks. This assessment utilises the stock IDs (A, B, C, D, and E) for the correlation performance (Figure 2), and Table 4 demonstrates the numerical outcomes of the correlation coefficient.

Table 4. Mathematical Results of Correlation Coefficient with Stock IDs

Stock IDs	A	B	C	D	E
BoldA	**1.00**	0.45	0.30	0.55	0.65
B	0.45	**1.00**	0.40	0.60	0.50
C	0.30	0.40	**1.00**	0.70	0.55
D	0.55	0.60	0.70	**1.00**	0.60
E	0.65	0.50	0.55	0.60	**1.00**

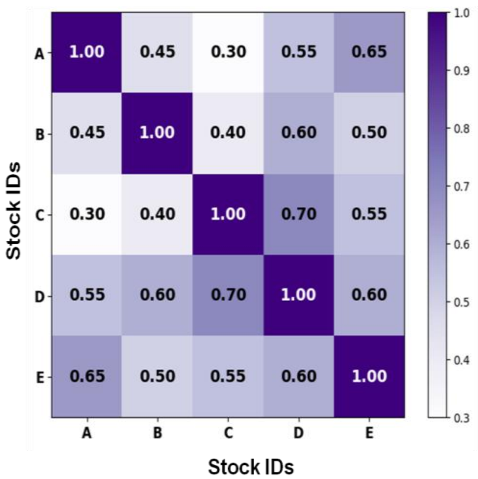

Fig. 2. Outcomes of Correlation Coefficients with the Stock IDs

A stock's correlation with itself is represented by a value of 1.00 Different stocks' correlation coefficients are represented by other values. The correlation coefficients range from -1 to 1. The weekly returns of the stocks are employed to calculate accurate correlation. Whereas 1 denotes positive correlation, -1 indicates a negative correlation and 0Denotes absence of correlation.

4.3. Estimation of the Coefficient of Variations

Each stock's risk-return efficiency is evaluated using the coefficient of variation. The method calculates a stock's relative risk, or volatility, based on its predicted return. The research provides that the identified stocks have an optimal risk-return ratio, maximising the portfolio's performance with risk by assessing the coefficient of variation. An evaluation of coefficient variations is performed by employing the performance matrices like mean, SD, and coefficient of variance for the stock IDs like A, B, C, D, and E. Following the computation of the weekly average return rate and its mean, SD, and coefficient of variation for the five stocks, Table 5 displays the changed results based on the coefficient of variation. The five stocks with IDs (A, B, C, D, and E) perform better in terms of risk-return balance determined by the lower and positive coefficients of variation. Figure 3 depicts the coefficient of variation with mean and SD values. Figure 4 displays the variance results.

Table 5. Evaluation Outcomes in Coefficient of Variation with Weekly Return Stocks

Stock IDs	Mean	SD	Coefficient of Variation
$\boldsymbol{BoldA}$	0.02	0.05	2.50
$\boldsymbol{B}$	0.015	0.04	2.67
$\boldsymbol{C}$	0.03	0.06	2.00
$\boldsymbol{D}$	0.025	0.05	2.00
$\boldsymbol{E}$	0.018	0.04	2.22

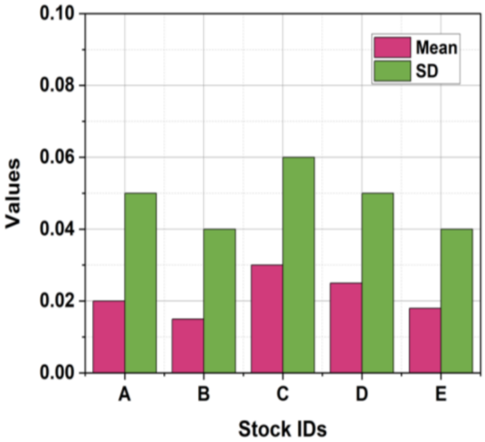

Fig. 3. Mean and SD Outcomes in Coefficient of Variations

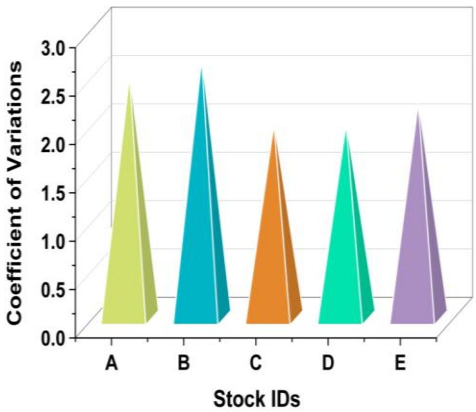

Fig. 4. Outcomes of Variations

The coefficient of variations presented in the analysis provides the significant outcomes in portfolio optimisation for all five stocks, with a mean ($A - 0.02,\ B - 0.015,\ C - 0.03,\ D - 0.025\ and\ E - 0.018$), $SD\ (A - 0.05,\ B - 0.04,\ C - 0.06,\ D - 0.05\ and\ E - 0.04)$ and coefficient of variation ($A - 2.50, B - 2.67, C - 2.00, D - 2.00\ and\ E - 2.22$). Except in cases when the mean is significantly larger, the coefficient of variation typically increases with the SD. A low coefficient of variation indicates that the stock portfolio is considered highly risk-efficient when it has a high mean and a low SD. Stocks with a high mean maintain a larger standard deviation, which raises the coefficient of variation. If the return is high and the volatility is high, the coefficient of variation cannot be considered low. To maintain the profit, stocks with lower returns have a lower SD, which could contribute to a lower coefficient of variation (lower risk-return).

4.4. Performance of Mean-Variance Model

Through the utilisation of the mean-variance optimisation approach, the ideal weights for each stock in the portfolio are determined using the expected return in the context of portfolio optimisation. Five portfolios are selected for the performance in risk assessment (Table 6).

Table 6. Optimal Weight Evaluation with Five Portfolios

Stock Weights	$Portfolio\ 1$	$Portfolio\ 2$	$Portfolio\ 3$	$Portfolio\ 4$	$Portfolio\ 5$
$CapA$	18.5%	22.3%	25.4%	10.2%	5.60%
B	10.1%	8.00%	6.50%	0.00%	63.9%
C	45.8%	48.5%	51.2%	77.4%	92.8%
D	8.40%	3.20%	32.1%	45.2%	0.00%
E	17.2%	18.00%	17.9%	12.40%	1.60%

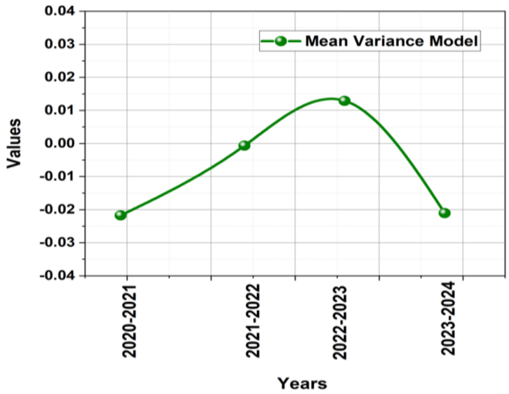

Fig. 5. Performance of Mean-Variance in Portfolio Optimisation with Markowitz Model

The consistent improvement in expected return rates serves as an indication for the process, and the model improves its allocations; the weights in the portfolio change in favour of more ideal stock market securities. Additionally, the results indicate that the model performs an effective task of optimising the portfolio to generate higher profits, and it is examined by the stock C portfolios (1 has 45.8%, 2 has 48.5%, 3 has 51.2%, 4 has 77.4% and 5 has 92.8%).

Figure 5 examines the mean variance model's return rate for the portfolio for the period of 2020 – 2024, and it is higher. The results suggest that the stock portfolio developed using the screening evaluation technique (mean-variance model) is long-term profitable.

In portfolio optimisation by utilising the Markowitz model, the Mean-Variance Model's performance varies from $2020\ to\ 2024$. The greatest value indicates an improvement in portfolio efficiency that occurred in $2022-2023$. The performance consequently reduces in 2023–2024, which indicates a reduction in the efficacy of optimisation.

4.5. Discussion

The research examined the portfolio optimisation through the Markowitz model with a performance analysis in the Chinese stock market and risk-return constraints. The inability to maintain global optimal solutions, lack of dynamic portfolio optimisation, inadequate sample estimation, inadequate performance measures, and the absence of a thorough focus on risk factors or market conditions constitute certain limitations in the existing methods. The existing limitations were resolved by the Markowitz model for stock market portfolio optimisation determined in this research. Using the Markowitz Mean-Variance Model, the results show that various portfolio optimisation approaches, such as correlation analysis (1.00) and coefficient of variation, could be implemented. Stocks with positive risk-return ratios and lower correlations were selected to optimise portfolios for higher returns with minimised risk. The findings of the correlation coefficient validation with five stocks have a minor and positive coefficient of variation. The correlation coefficient of the five stocks that were selected is frequently low, as shown in the correlation coefficient analysis, which is similar to the idea of distributing the risk of non-system in the initial stage of selecting stocks. These five stocks are consequently a component of the stock portfolio. A coefficient of variation assessment identifies stocks with lower volatility, whereas the significant improvement in stock C's weights across portfolios suggests its strong performance. The Markowitz model effectively improves portfolio performance and provides increased profitability through beneficial risk control in stock returns.

5. Conclusion

The Markowitz model, employed to maximise return for a given level of risk or to minimise risk for a given level of return, introduced the concept of idea of efficient portfolios. Research examined portfolio optimisation in the Chinese stock exchanges, focused on the SSE particularly, using Markowitz's Portfolio Theory. The research determined an ideal stock portfolio from a variety of SSE-listed businesses for the 2020–2024 durations while balancing risk and expected return represented the task. Using a purposive selection technique, the different stocks were chosen based on historical performance. The stocks were initially evaluated using correlation coefficients, followed by the coefficient of variation to evaluate risk-return constraints. During four years, the analysis used the weekly return rates of certain selected SSE stocks. The mean-variance optimisation technique was utilised to ascertain the optimal weights for every stock in the portfolio by leveraging a specific expected return. The optimised portfolio consists of a variety of stocks for the majority of the effective trading periods, including China LIC, SAIC Motor, Beiqi Foton Motor Co., Ltd., GD Power Development Co., Ltd., and ICBC, which performed more effectively in terms of return. Businesses from a variety of industries were included in the portfolio, maintaining a risk and return profile by effectively balancing. The research demonstrated the effectiveness of Markowitz's methodology in optimising investment portfolios in the circumstances of the stock market.

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