ISSN 2959-6157

Comparative Analysis of the Markowitz Model and the Kraljic Matrix Model in Portfolio Optimization and Procurement Management

Congyang Qian

Oxford International College, Oxford, OX4 1BD, United Kingdom
*Corresponding author: congyang_qian@oxcoll.com

Abstract:

This research studied two important models of portfolio management: the Markowitz model and the Kraljic Matrix Model. The Markowitz model is the basis of modern portfolio theory and is designed to optimise asset allocation by minimising risk while maximising returns. This paper provides a system to build a balanced portfolio by utilising diversity. On the other hand, the Kraljic Matrix Model classifies products based on supply risk and profit impact and provides a strategic tool for purchasing management. This model categorises products into four categories: non-critical, leverage, strategy, and bottleneck to support informed purchasing decisions. Despite its usefulness, the Kraljic matrix has been criticised for not taking into account the supplier's perspective and for not providing guidelines for managing the movement of goods within the matrix. This paper studies the application and limitation of the two models, emphasises the need to adapt to the strategy in the portfolio and procurement management, and adjust according to the market dynamics.

Keywords: Markowitz Model; Kraljic Matrix Model; Portfolio Management; Asset Allocation; Procurement Strategy.

1. Introduction

Every investor wants to allocate their assets in a portfolio as efficiently as possible. Investors must strike a balance between the necessity to minimize risk and the goal of maximizing return on investment. It is commonly acknowledged that risk increases with projected return. Selecting shares that will provide the best return over a specified time is the focus of portfolio management. Due to the possibility of similar company shares behaving similarly and producing comparable risks and returns at similar times, Markowitz demonstrates that a broad diversity of shares will typically offer the largest return with the least degree of risk.

The portfolio is less likely to experience periods of high return if it is diversified. The likelihood of having intervals of high return followed by times of high risk is reduced in a diversified portfolio. It is significant to remember that the average risk of the individual assets is higher than the risk of the entire portfolio, which consists of all the assets together. The portfolio optimization model developed by Markowitz offers a thorough algorithm that minimizes risk and optimizes profit. However, when considering a huge number of assets, this strategy becomes unfeasible. Alternative strategies must therefore be looked for. One way to express the unknowns in a portfolio is through risk. It might refer to the possibility of the share value rising or falling in this situation. Volatility is the traditional metric used to quantify risk. As a measure of how an asset's value fluctuates, volatility can be either positive or negative based on fluctuations in price. Risk is only used negatively in this work. Put another way, "How bad can things get?" refers to what could go wrong and how much could be lost. Risk can be determined in a variety of ways. This paper considers the Value at Risk approach [1].

In this study, compare two portfolio optimisation models, Markowitz Model, and Kraljic Matrix Model, and compare their different effects on portfolio optimisation. The Markowitz model is based on the modern portfolio theory, which emphasises optimising the portfolio through the diversification of assets and maximising the balance between expected return and risk. By calculating the returns and risks of different assets and combining their correlations to build an optimal portfolio, overall returns and reduce risk are increased.

In contrast, the Kraljic Matrix Model comes from the field of supply chain management and is used to evaluate and classify suppliers to optimise procurement strategies. The model helps companies identify key suppliers and de-

velop management strategies by analysing their strategic importance and supply risks. Although the Kraljic Matrix Model is not specifically designed for portfolio building, its classification and risk management methodologies are a useful reference for applications in other fields.
This paper compares the applicability of these two models to portfolio optimisation in a system, evaluates their performance in a real application, and evaluates their strengths, limitations, and applications. It clarifies the scenario and provides a strong basis for reference to investors and decision-makers.

2. Methodology

2.1 Markowitz Model

2.1.1 Definition

Imagine having a portfolio P with n securities, $S1...,Sn$. Each security in this portfolio is given a percentage weight by $x1,...,xn$, to have the total of these weights equal one. Keep in mind that negative weights might suggest a quick selling. (A short sale is when a stock investor borrows a share from a broker, sells it, and hopes that the price will drop, allowing the investor to later purchase the share at a reduced price.) Furthermore, let μ_i represent the security's anticipated return on investment expressed as a percentage. The weighted total of the expected returns of each security in a portfolio is hence its μ_p expected return, which can be found using the equation [2]:

$$\mu_P = \sum_{i=1}^{n} x_i \mu_i \quad (1)$$

2.1.2 Advantages

There is some systematicity in the Markowitz Model. Software is available to assist in figuring out correlations between the various assets in a portfolio. Attain diversification similar to the Markowitz Model by selecting uncorrelated assets. This makes the model's implementation rather systematic with the help of software.
Markowitz efficient frontiers provide a large dimensionality reduction of the lookback covariances and growth of the assets. They are square root second-order polynomials that can be represented by three parameters. With the help of this dimensionality reduction, this paper suggests extending the Markowitz model to take into account the non-stationary behaviour of the return and covariance of the portfolio assets. This eliminates the need for the extremely challenging task of forecasting the complex covariance matrix and asset growth [3].
As was already established, because of the efficient frontier, the Markowitz Model successfully lowers investment risks while perhaps maximizing portfolio profits. Not all assets will probably fit on the efficient frontier. Not many, if any, will be on the efficient frontier. Investors are essentially left with two asset classes as a result of the efficient frontier: high-risk with potentially large rewards and low-risk with correspondingly low returns.
The diversification of uncorrelated assets is predicated on the Markowitz Model. This should lead to lower volatility and, consequently, drawdowns without compromising total returns. Investors can create a balanced portfolio that fits their financial objectives and risk tolerance by using the Markowitz Model, which encourages effective and well-thought-out investing choices. Investors should be mindful of the Markowitz Model's limitations despite these benefits.

2.1.3 Limitations

Because of its heavy reliance on historical data, the Markowitz Model may not be able to accurately forecast future market movements. Investment commercials typically include a disclaimer stating that past performance does not guarantee future outcomes, which is probably seen. Here, the same holds. The fundamental presumptions of the model are based on markets that operate normally.
The model may no longer be applicable in extremely erratic and volatile markets.
Mean-variance portfolio theory is known as MPT. Investment choices in mathematical finance and financial economics are frequently predicated on Markowitz's mean-variance portfolio theory. In the mean-variance framework, the $ex-ante$ mean and standard deviation (μ_p, σ_p) of a given portfolio p of asset returns indicate optimal investment options in a two-dimensional space. Specifically, the investor's decision issue under the MV framework is to select a vector of asset weights so that the portfolio's variance, σ_p^2, is minimised given a desired rate of return on a portfolio of n assets [4]. Returns with a normal distribution are suitable for risk by variance. Using the MPT will not be possible for assets that do not have a normal distribution.
Additionally, a mean-variance framework presumes that investors have assigned all of the assets in their portfolio to a single time period. In actuality, such is rarely the case. The justifications provided emphasize how crucial it is to incorporate Markowitz's paradigm, which Markowitz laid the foundation for behavioural portfolio theory in 1952 while he was creating mean-variance portfolio theory. He released two important works in a row, one in the neoclassical style and the other in the behavioural style [5]. In this situation, investors can find a practical way to accomplish MPT with the assistance of a financial advisor

2.1.4 Application

Chaweewanchon and Chaysiri investigated a novel approach to portfolio selection that makes use of the most current developments in machine learning. The suggested technique incorporates a hybrid model that combines robust stock prediction features obtained from Huber's location estimator with Markowitz's mean-variance (MV) approach. Convolutional neural networks (CNN) and bidirectional long short-term memory (BiLSTM) networks are used in this hybrid model. Using these algorithms to anticipate high-quality stocks for portfolio development and then applying the MV model is the strategy. Testing was conducted using historical data from the SET50 index. The findings indicate that the proposed approach performs better in terms of risk, return, and Sharpe ratio than conventional models, such as the MV model and an equal-weight portfolio model [6].

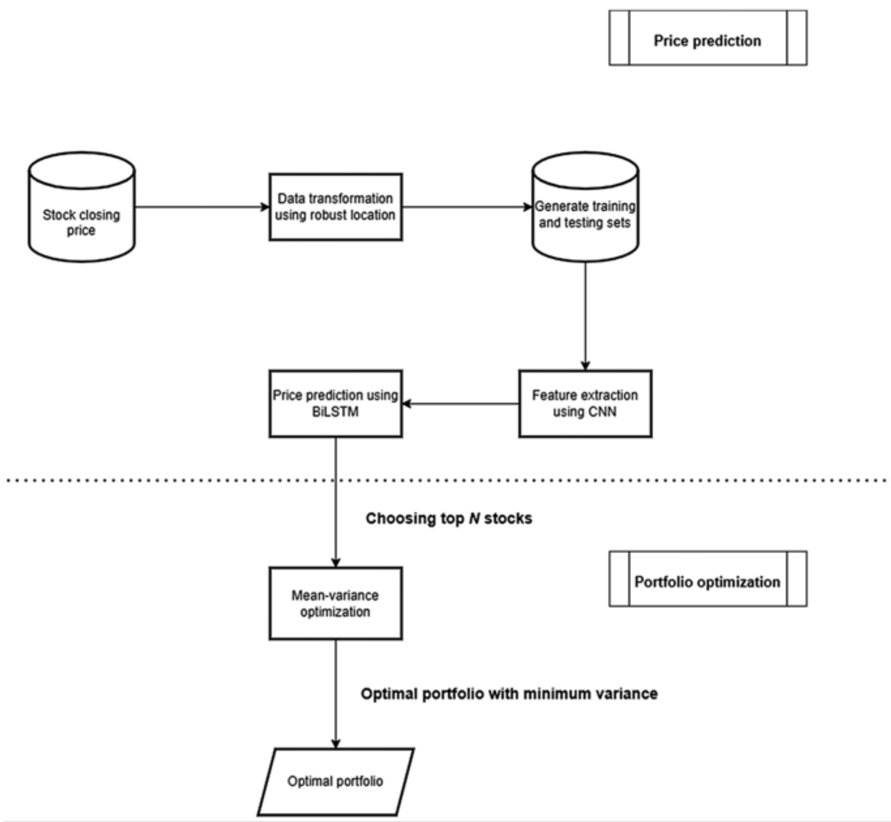

Fig. 1 The scheme of the proposed model [6].

They proposed a hybrid R-CNN-BiLSTM model to improve the accuracy of the prediction. The detailed process of the proposed model is presented in Fig. 1.

The goal of them is to improve portfolio optimization and stock selection by combining machine learning with reliable statistical techniques. In order to increase prediction accuracy, it assesses the predictive performance of three different models: CNN-BiLSTM, BiLSTM, and LSTM using strong statistics. The findings show that BiLSTM outperforms other models in the prediction of financial time-series. Furthermore, the CNN-BiLSTM model performs better when robust characteristics from stock closing prices are included. The study shows that choosing stocks based on expected returns improves portfolio performance; in terms of risk, return, and Sharpe ratio, portfolios built with R-CNN-BiLSTM and other models beat traditional models [7].

2.2 Kraljic Matrix Model

2.2.1 Definition

A portfolio matrix is proposed by Kraljic to classify commodities according to two supply risk and profit effect. In particular, relationship uncertainty and availability drive the supply risk, while the profit effect is linked to the purchase value. The four quadrants of commodities are non-critical, leverage, strategic, and bottleneck, according to the supplier and the Kraljic portfolio matrix. The fundamental idea is to create various purchase kinds that correspond with the characteristics of commodities to take advantage of buying power and maintain supply. "Form partnerships for strategic products; assure supply for bottleneck products; exploit power for leverage products and ensure efficient processing for non-critical products" is a summary of the whole sourcing approach. Numerous research works have aided in the expansion or use of the KPM.

According to some research, the KPM ignores possible shifts in power reliance as well as the interdependencies among products. As a result, a growing body of research proposes additional criteria for categorising goods or supplier-buyer interactions. Several internal and external elements are suggested by Olsen and Ellram as influencing the strategic significance and challenge of purchasing management [8].

2.2.2 Advantages

By classifying goods and services according to risk and profitability, the Kraljic Matrix assists in making more informed purchasing decisions. The matrix has numerous benefits when used. Among the most often used and well-known tools is Kraljic's Matrix. By moving goods and services to other quadrants, Kraljic's Matrix can assist in lowering reliance on particular vendors. The quadrants of Kraljic's Matrix provide a practical way to group purchases according to overall expenditure.

2.1.3 Limitations

The Kraljic matrix has drawbacks and difficulties, including the inability to quantify supply risk and profit impact objectively, the use of subjective criteria, and the disregard for additional elements that might affect the procurement choice. It is also overly static and unsophisticated to adequately represent the fluctuations of the supplier market. Furthermore, applying the matrix accurately and consistently takes a large amount of data and analysis. It may also encounter resistance and skepticism from internal and external stakeholders who may disagree with the implications or outcomes of the matrix.

2.1.4 Application

To classify and position commodities (works and services) in the Kraljic Portfolio Matrix (KPM) on a continuous scale around the supply risk and profit impact—that primarily influence a firm's purchasing strategy—a more objective methodology is proposed in a research study. Different commodities are given performance scores based on supply risk and profit effect attributes using fuzzy multi-attribute scoring. The commodities are positioned in the KPM by the use of a multidimensional scaling technique. The suggested method is attempted to be applied to goods purchased by an Indian state government's Rural Development Department [9].

Using information from the Rural Development Department (RDD) of an Indian state government, the approach for mapping commodities in the KPM is applied. In order to fulfil their regular operational duties and put numerous plans and strategies into action, this RDD purchases a wide range and quantity of goods, labour, and services. Office supplies and scientific equipment are among the products; wall painting and bridge construction are among the works; and transportation and consulting are among the services. The company uses a variety of purchasing techniques, such as competitive bidding, request for quotation, rate contract, open call auction, spot purchase, umbrella agreement, and agreement through discussion, to acquire these commodities [10]. The RDD is using the suggested process to procure 8 works and services.

3 Conclusion

Two common models for portfolio management are the Markowitz model and the Kraljic matrix model. The Markowitz model is primarily used to optimises portfolios and balance risk and return. By diversifying investments, and reduce the overall risk and maximise the return to some extent. However, because the model relies on historical data, it can be disabled in predicting future market behaviour, especially if the market is extremely volatile. The model assumes that the return on investment is a normal distribution, but in practice.

On the other hand, the Kraljic matrix is used for purchasing management that divides products into four quadrants: non-critical, leverage, strategy, and bottleneck products according to the impact of supply risk and profit. The model helps companies adjust their procurement strategies according to the characteristics of their goods to maximise procurement effects while maintaining supply chain stability. However, there are also limitations, such as the supplier's perspective being ignored and a lack of guidance on how products and services work within the matrix.

This paper analyses the merits and demerits of these two models and how they are being used in their respective fields, and uses them as a reference for investors and procurement managers. However, the author also paid attention to the limitations in the actual application of these models, and proposed to adjust and optimise according to the specific situation, so as to achieve the highest effect.

References

[1] Beste A, Leventhal D, Williams J, Lu Q. The Markowitz Model. Selecting an Efficient Investment Portfolio. Lafayette College, Mathematics REU Program, 2002.

[2] Bradshaw N A, Walshaw C, Ierotheou C, Parrott, A. K. A multi-objective evolutionary algorithm for portfolio optimisation. In Proceedings of the Adaptive and Emergent Behaviour and Complex Systems Convention, 2009: 27-32.

[3] Alexander N, Scherer W, Burkett M. Extending the

Markowitz model with dimensionality reduction: Forecasting efficient frontiers. In 2021 Systems and Information Engineering Design Symposium (SIEDS) IEEE, 2021, April:1-6
[4] Markowitz H M, Todd G P. Mean-variance analysis in portfolio choice and capital markets. John Wiley & Sons, 66, 2000.
[5] Shefrin H. The behavioral paradigm shift. Revista de Administração de Empresas, 2015, 55(1): 95-98.
[6] Chaweewanchon A, Chaysiri R. Markowitz mean-variance portfolio optimization with predictive stock selection using machine learning. International Journal of Financial Studies, 2022, 10(3): 64.
[7] Wang W, Li W, Zhang N, Liu K. Portfolio formation with preselection using deep learning from long-term financial data. Expert Systems with Applications, 2020, 143, 113042.
[8] Ye Y. Empirical investigation of Kraljic portfolio matrix. Journal of Supply Chain and Operations Management, 2021, 19(2): 153-177.
[9] Padhi S S, Wagner S M, Aggarwal V. Positioning of commodities using the Kraljic Portfolio Matrix. Journal of Purchasing and Supply Management, 2012, 18(1): 1-8.
[10] Padhi SS, Mohapatra PKJ. Centralized bid evaluation for awarding of construction projects—a case of Indian government. International Journal of Project Management, 2010, 28 (2): 275–284.