



Contemporary Theoretical Models of Portfolio Risk

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Abstract. Portfolio theory has been widely studied by scholars all over the world since its inception. The analysis and diversification of portfolio risk based on theoretical analysis as well as calculation has been the main research object of many financiers and scientists; the modern portfolio theory they created also takes into full consideration the psychology and thinking of investors. In this paper, based on the analyses and researches of eight papers, the advantages, disadvantages, opportunities and applications of three main principal portfolio risk theories including MPT theory, VaR theory and Expansion financing theory were discussed in this literature review. The results demonstrates that in order to adapt to market changes and the increasing prevalence of investments, portfolio risk theories are needed to keep up with the times and thus help investors to gain more returns. The paper might provide some useful information on the portfolio risk theory and some aids for judgments on investment risk diversification.

Keywords: Portfolio · Expected return · Risk diversification · APT theory · VaR · Expansion Financing theory

1 Introduction

In recent years, financial markets have become increasingly volatile with various black swan events [1]. Economic and financial globalization, technological innovation, deregulation and financial innovation, etc., all of which have greatly increased the degree of correlation, complexity, uncertainty and volatility of financial markets and instruments, resulting in increased financial market risks and complex structural components [2], which are difficult to measure and analyze. Under this kind of background, this paper briefly summarizes the current mainstream risk assessment models in financial academia. In this paper, there are 9 paper is referred, the MPT models is introduced and the risk balance is mainly disused. For the VaR models which is a current major risk analysis method is introduced at the second part, and there are two calculation approaches is referred. At the final part of this paper, a expansion finance method is used to as a case for risk management of portfolio investment. In addition, the advantage

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and disadvantage to each analysis methods are referred in order to illustrate the difference and comparison between these analysis methods. This paper mainly describes and summarizes different risk analysis methods from two aspects: the mathematical point of view and the theoretical point of view. Financial market risks continue to accumulate and become increasingly complex. For accurate measurement, it has become a major subject and task of financial practice, academia and regulatory authorities.

2 Literature Review

2.1 MPT Theory

IN the long history, stock portfolio theory has been developed and accumulated over a long period of time, making it very rich in content. The stock portfolio theory gives a strong help to the pre-investment analysis of enterprises or investors. In 1952, Markowitz first introduced Modern Portfolio Theory (MPT), which laid the foundation of portfolio theory. This theory is the cornerstone of other contemporary portfolio derivative theoretical models and marks the beginning of the theory of portfolio risk. Markowitz considered the reasons why investors did not directly choose the stocks with the greatest intrinsic value, and eventually learned that not only did value need to be considered, but that risk also greatly influenced the decisions made by investors. Markowitz was the first scholar of his time to consider both stock value and risk.

Markowitz created the mean-variance model and the main ideas about portfolio theory. This model, in which the expected return of a stock investment is measured by the expected rate of return and the investment risk is measured by the variance of the return; this model demonstrates the advantages and benefits of diversification. In his article ‘Portfolio Selection’, Markowitz makes three main points about investors: (1) investors are rational people who choose and adjust their portfolios according to the mean and variance (when faced with two stocks with the same expected return, choose the one with less risk; when faced with the same value of risk (2) the systematic risk “beta” of a single asset is determined by the degree of contribution of the asset to the risk of an efficient portfolio; (3) the unsystematic risk of a single asset can be diversified by a portfolio (diversification is risk diversification) [3]. The risk reduction approach in Markowitz’s theory is achieved by analyzing the covariance and correlation coefficients of different stocks.

There are several factors contains in the MPT Theory that needed to be explained in order to get further understanding. To begin with, investors need to be clear about the impact of correlation coefficients on portfolio risk. The correlation coefficient is a representation of the number of correlations that reflect the degree of co-movement between two random variables. For a portfolio, the correlation coefficient reflects the extent to which the expected returns of each two securities in a group move in the same direction or in the opposite direction from each other. Besides, the Portfolio Frontier is also an important concept. For each level of return, there is a portfolio that offers the lowest possible risk; and corresponding to each level of risk, there is also a portfolio that offers the highest possible return. If risk is the horizontal axis and expected return is the vertical axis, the relationship between risk and return of a portfolio will be shown as a curve, the effective frontier. All risk-return portfolios that fall on this curve are the

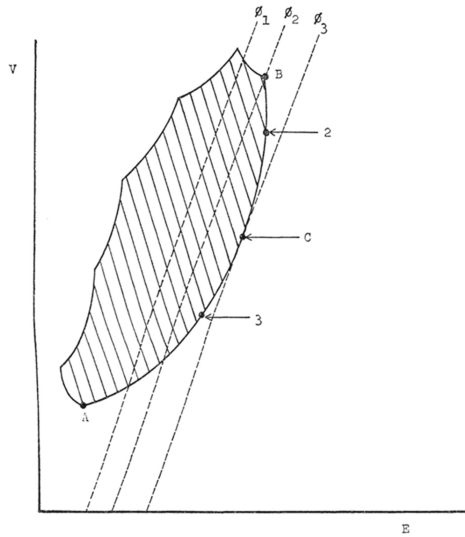


Fig. 1. Asimplified model for portfolio analysis made by William Sharpe [5]. Quoted content from William F. Sharpe (William F. Sharpe, *Management Science*, 9(2), 277–293, 1963, permitted by William F. Sharpe, <https://www.docin.com/p-37901816.html>)

maximum returns that can be obtained for a given risk or minimum risk. Lastly, the standard deviation is used to measure the risk or fluctuations of an asset. It is used to determine how far an asset moves (in terms of value) over time. Assets with a wider range of volatility are riskier.

Markowitz's MPT theory is more widely used in the case of a broad range of companies choosing to invest in stocks, because its diversification can help to reduce risk significantly: when faced with a situation where the business model and market trends are opposite, such as the difference between East and West, a diversified and broad portfolio can help to increase returns and reduce the overall risk of the portfolio. Thus, MPT theory plays an important guiding role in diversifying investment risk. However, there are still significant shortcomings in its practical application. First, the parameters in MPT theory are difficult to define and calculate, thus creating more difficulties for investors. The model also requires the trend of security returns to be normally distributed in order to calculate investment risk based on the variance; in reality, the distribution of security returns does not always satisfy this condition. In addition to this, the quantitative treatment of MPT theory is a purely linear relationship. In reality, risk is caused by multiple causes and the linear relationship between them often cannot be accurately quantified [4]. William Sharpe, in his paper *A Simplified Model for Portfolio Analysis* published in 1963, mentioned that he was inspired by Markowitz and created a theory to solve the above problem. His theory is that a portfolio is efficient if no other portfolio gives higher expected returns and the same variance of returns [4, 5]. This simplified model improves the efficiency and accuracy of risk analysis; it also reduces the computational effort and portfolio risk. Currently, this theory is widely used in various investment decisions (Fig. 1).

2.2 VaR Theory

Over a long period of history, MPT theory has been developed and accumulated as a main stream method for investors, but the disadvantage of it is obvious. In this case, VaR was proposed as an approach that analysis risk by a more compressive aspect. By comparison, it refers more considering market factors that might impact the situation of the market.

VaR is the value at risk, referring to the maximum expected loss of an asset or combination at a given confidence level and a certain holding period. In the formula, it can be illustrated as this form: $\text{prob}(\Delta p > \text{VaR}) = 1 - \alpha$. In this formula, Δp represents the loss of assets or portfolio during the holding period and α represents the given confidence level (confidence). For instance: to assume that a corporation has a confidence level with value of 95% per day to 9.6 million dollars. In this case, it is illustrated that the there is a 5% chance that the company will lose \$9.6 million in one day, or no more than five days in 100 days to hit \$9.6 million. For the calculating process, there are two major approaches: historical simulation and Monte Carlo methods.

The basic principle of the historical simulation is to find the maximum loss value at a given confidence level from actual historical data. For the market factor model, the method of historical simulation is used - the change of the market factor observed in a given historical period is used to represent the future change of the market factor; in the estimation model, the historical simulation method uses the full value estimation method, that is, the position is reweighted according to the future price level of the market factor. The new estimate calculates the value change (profit and loss) of the position; finally, the profit and loss of the portfolio is sorted from the smallest to the largest to obtain the profit and loss distribution, and VaR is obtained by the quantile of the given confidence. For example, for 1000 possible profit and loss situations, the quantile corresponding to the 95% confidence level is the 50th largest loss value of the combination, which is VaR.

To compare to the Monte Carlo method, the basic principle of Monte Carlo method and historical simulation are basically same but the difference is that the data that are used to do the Monte Carlo method is not purely historical data which means the change of the market factor is not come from the observed historical data. It is obtained by the random simulation [6]. The basic idea is to repeat the stochastic process of simulating financial variables, so that the simulated value includes most of the possible situations, so that the overall distribution of the combined value can be obtained through the simulation, so as to obtain VaR.

Comparing the two types of the calculating methods, the historical simulation method is a non-parametric, full-value estimation method, which can effectively deal with nonlinear and large fluctuations in the market. However, because it directly relies on historical data, when the historical data is not representative, the estimated result will be the same as the previous one. The actual risk will have a large deviation. But the Monte Carlo simulation method is a non-parametric, full-value estimation method, which is flexible in application, does not require distribution assumptions, and can handle nonlinear and non-normal problems, but has a large amount of computation and low computational efficiency [6]. In summary, the historical simulation can be easier to calculate but the data that are used to analysis will be complex, while for the Monte Carlo simulation

method, the calculation can be hard to handle but the data that are used for analysis will be easy to collect.

2.3 Expansion Financing Theory

Expansion financing is a very basic and common portfolio approach in the financial industry. For example, increase internal growth revenue by launching new product lines not only attracts more customers, but also the benefits of external growth can be realized by executing mergers and acquisitions. The equity portfolio targets for loans and different shares are also included. When people want to expand market or funds, they need to consider existing resources and fixed assets, which means to do a good job of the risks and benefits of investment growth, and only when people really have funds can you achieve growth and expansion of the market. Expansion financing can take many different forms, such as using your own capital gains or loans from friends and family, and reaching out to equity investors to help the operation expand financing [7]. By far the most popular is the SBA loan program, which means financing continued expansion through loans to selected businesses. It's called the 7(A) loan program. The 7(A) loan program is by far the SBA's most popular loan program and is used for lease improvement and asset or capital purchases for which 20% or more of the equity must be personally secured. In the financial field, we know that no matter what investment or loan, there are pros and cons and risks. When looking at the standard deviation mentioned in investments, it is closely related to investment risk [8]. First, for standard deviation, it's basically a way of measuring the difference between a set of data that represents volatility. In finance, use it to calculate the degree of volatility in certain investments, to help investors approximate the historical performance of the investment terms, so think about the degree of risk of volatility, using the mathematical method of standard deviation to quantify the risk. When you look at the average return on project investment, it will revolve around a trend. During 2019 and 2021, for example, due to the outbreak of the stock market declines and unstable, average annual total returns of 12%, but due to the epidemic control and gradually improve, average annualized standard deviation is 20%, it is 3 years, this is most of the given point average returns, shows the difference between the actual returns. When more people choose to expand financing and take out loans, more people will consider more risks of different nature brought by this loan. For example, the most common credit risk is credit risk. When financial difficulties occur, as far as know, the credit rating of long-term Canadian government bonds is AAA, so the possible credit risk is low. This means that the credit risk of different bonds can be evaluated by credit rating.

Since risk is difficult to measure, the bell curve model of finance is used here. The idea is that it's a way to measure performance, to calculate all the information in front of this normal curve analysis system [9]. The bell curve is called a bell curve and it can be contained in the average and center of the observed curve because the data is located on the left and right, so the bell curve follows symmetry and standard deviation not only is predictable, but also for investment risk analysis can help show patterns and peaks. So a bell curve model, based on the results of this model for any given thing should change 67% of the time and fall within one mean standard deviation, based on the notion that the data stands out about 95% of the time fall within two standard deviations, So you

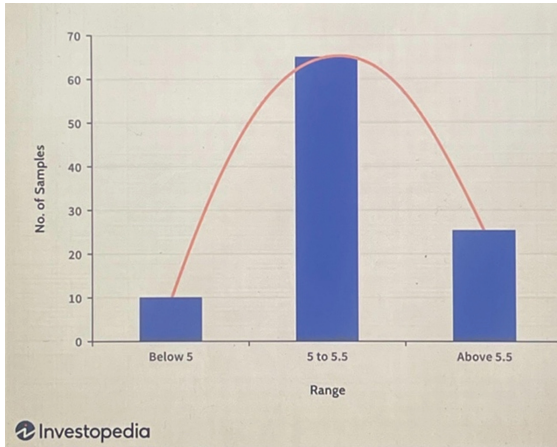


Fig. 2. Risk degrees of investments [10]. Quoted content from S. Seth (S. Seth, Risk Management, 2022, permitted by Sabrina Jiang, <https://www.investopedia.com/articles/investing/100714/using-normal-distribution-formula-optimize-your-portfolio.asp>)

can clearly judge, because the standard deviation and the degree of risk of the outbreak of the stock, assuming a return of 12% plus or minus 20% standard deviation 67% of the time, you can also think of 95% of the time as increasing or decreasing 27% of the remaining two standard deviations, and then determine the value of risk based on the standard deviation, and then analyze and identify the investment [10]. This chart shows the investigation in different months or years based on the data analyzed. Investors can calculate the risk degree of investment in different months or years based on the data analyzed in these tables (Fig. 2).

3 Conclusion

In this paper, risk models of portfolio were summarized based on current published articles on the risk of different types of investment. It is concluded that there are different ways for investments, and also there are different risks to estimate or judge the pros and cons of the investment projects as well as a series of risk perspectives of currency inflation. Anyone who want to know and understand between risk and return may find that it is not perfect estimated based on whichever method, and there exists for a period of time between the correlation of different or special circumstances, of course, it is also known that if investors want more amount of money, they will have to withstand higher risk degree, on the contrary, If the risk is low, it means less money for conservative risk return. When investment is becoming more and more common, there will be a related risk analysis of investment portfolio problem, in different portfolios of all investment projects, which is closely related to the economic situation as well as theoretical knowledge of investment projects, to derive a conclusion on how to choose appropriate investments and get the corresponding returns under different investment conditions.

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