

The Application of VaR Model in Open Fund Risk Management

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Abstract. In modern society, facing a wide range of investment risks, the VaR model, as one of the most advanced risk management theories in the world, has been adopted by fund managers as a simple and scientifically effective risk management method. This article discusses the necessity of risk management for stock investment portfolio assets managed by fund managers, and elaborates on the efficiency and applicability of VaR model in stock investment portfolio risk management.

Keywords: VaR Model; Open-end Fund; Risk Management.

1. Introduction

Since the birth of Hua'an Innovation Fund in September 2001, China's open-end fund has a history of nearly 20 years. Unlike traditional forms of wealth management such as direct investment in the stock market, open-ended funds have shown strong comprehensive management capabilities in long-term practice, and their variety scale has also been continuously expanding, becoming an extremely important part of China's financial market. With the continuous deepening of open-end funds as institutional investors in the stock market, the risk management of open-end funds' stock investment portfolio has gradually become one of the important issues for financial regulatory agencies and fund parties, especially fund management companies, to conduct in-depth research.

Huang Jianmiao tested the stationarity, normality, autocorrelation, and heteroscedasticity of logarithmic returns of various stock indices. A GARCH (1,1) model was established for the S&P 500 index, and Va R was calculated; For the Nasdaq Composite Index, Va R was calculated using the GARCH (1,2) model. Using a posterior method, it is demonstrated that using the GARCH (1,1) model to calculate Va R can effectively measure the risk of the S&P 500 index at confidence levels of 90% and 95%, respectively; Using the GARCH (1,2) model to calculate VaR can effectively measure the risk of the Nasdaq Composite Index at confidence levels of 90% and 95%.[1] Wang Yiduo, Hu Guangqi, and Wang Qingqing selected 15 listed banks in China, weighted by assets, and used weekly stock returns from 2013 to 2017 to regress with the weekly returns of the Shanghai and Shenzhen 300 Index to calculate the overall industry's β The coefficient is then divided into three categories: state-owned banks, joint-stock banks, and urban commercial banks, and each category is calculated separately β Coefficient, analyze its impact on the beta coefficient of the entire industry, and finally provide suggestions. [2] Liu Lingling conducted empirical analysis using Excel and EVIEWS to verify that the stock price of Wantong Expressway conforms to the price patterns of general stocks. Based on this, she used historical simulation, Monte Carlo simulation, and parameter method to calculate the VaR of Wantong Expressway. [3] On the basis of summarizing the research on various aspects of index funds by domestic and foreign scholars, Guo Rong sorted out index funds from relevant theories, defined them from a conceptual perspective, and conducted a context analysis and current research on their history and development. [4]. Fund managers holding stock investment portfolios mean they face various types of risks, including policy risk, liquidity risk, market risk, etc. Traditional financial risk management theories require fund managers to accurately control each type of risk, which is extremely unfavorable for their risk management. In contrast, the VaR model covers various risks of stock investment portfolios during its application, and through quantitative forms, simply and clearly points out the maximum loss that may occur in stock investment portfolios within a certain holding period, greatly improving the effectiveness and operability of risk management. In addition, the VaR model measures not only the risk of a single asset, but also the risk of an investment

portfolio formed by matching multiple assets. This makes the VaR model highly applicable for the risk management of stock investment portfolios of open-ended funds.

2. Open End Funds and Their Risk Management

2.1 Introduction to Open-ended Funds

The full name of open-end fund is open-end securities investment fund, which refers to a form of securities investment fund that does not specify the overall size of the fund and can be sold or redeemed to investors based on their application. In this operating mode, the size of open-ended funds is closely related to their subscription and redemption of fund shares: for fund companies, investors' purchase of fund shares will enable the fund to have more controllable funds, replenish fund assets, and expand the fund size accordingly; On the contrary, fund redemption behavior will lead to a decrease in the controllable funds of the fund, a reduction in fund assets, and a corresponding reduction in fund size; Driven by share redemption, the size of open-ended funds fluctuates daily. It is worth mentioning that at present, China implements a single contractual fund system, and there is no corporate fund. Therefore, currently, fund initiators in China can only establish contractual open-ended funds.

In the financial market, open-ended funds are positioned as a medium to long-term investment tool, especially suitable for individuals or institutions with large amounts of funds and long investment periods, because the transaction costs of open-ended funds are relatively high, and the frequent short-term operation of entering and exiting is not ideal for investing in open-ended funds. As a medium to long-term investment tool, the investment appreciation brought by open-ended funds mainly comes from the performance improvement brought about by the better management level of fund managers, rather than market fluctuations. This is also one of the reasons why fund managers need to focus on investment risk management.

2.2 The Current Development Status and Market Position of Open-ended Funds.

Open-end funds have developed rapidly in China since 2000, and have long become the mainstream of the fund industry in the international fund market. The reason for this is that compared to closed-end funds, open-end funds have incomparable advantages: (1) The subscription and redemption prices of open-end funds are relatively clear, determined by the net value of the fund unit and related fees, and are not affected by market supply and demand. However, the subscription and redemption prices of closed-end funds are directly determined by market supply and demand, and there are often premiums or discounts. In extreme cases, the fluctuation in subscription and redemption prices can be significant, the returns of investors therefore have significant uncertainty; (2) Open end funds implement a "T+1" unit net value disclosure mechanism, with timely information feedback and disclosure of quarterly, semi-annual, and annual reports. The fund's operation is clear and transparent, while closed end funds have relatively low information disclosure requirements. The frequency of net value disclosure is at least once a week, and the degree of information disclosure is relatively insufficient; (3) The income of open-end fund managers mainly comes from fund management fees drawn in proportion to the unit net asset value. The higher the unit net asset value, the higher the income of fund managers, which directly has a positive incentive effect on fund managers, prompting them to carefully manage and strive to improve fund performance, achieving a win-win situation for investors and managers. Closed end fund managers only calculate income based on the size of the fund, Not linked to fund performance and unable to be accountable to investors; (4) For investors, open-end funds are "open to buy and open to sell", with convenient and flexible subscription and redemption, and good liquidity protection. However, closed end funds can only be traded in the secondary market during their lifespan, with poor liquidity protection. It is possible that fund shares cannot be bought or sold due to a mismatch between supply and demand. With the development of the fund industry, the advantages of open-ended funds will also help them further enter the financial market, compete with traditional securities products on the same platform, and

occupy a more important position in the investment and wealth management field. Do not number your paper: All manuscripts must be in English, also the table and figure texts, otherwise we cannot publish your paper. Please keep a second copy of your manuscript in your office. When receiving the paper, we assume that the corresponding authors grant us the copyright to use the paper for the book or journal in question. Should authors use tables or figures from other Publications, they must ask the corresponding publishers to grant them the right to publish this material in their paper. Use italic for emphasizing a word or phrase. Do not use boldface typing or capital letters except for section headings (cf. remarks on section headings, below).

2.3 Risk Management of Stock Investment Portfolio in Open-end Funds.

In today's fiercely competitive market, the market risk preference of open-end fund managers is gradually increasing. They tend to hold a certain stock portfolio reasonably, which can achieve higher investment profits, improve fund performance, and also improve the investment structure of the fund. As of the end of the third quarter of 2019, the average stock position of 2435 open-end active partial equity funds (common stock type+partial stock mixed type+flexible allocation type) in China's domestic public offering market, which is close to half of the total number of open-end funds, is 71.91%, which is significantly high overall. Among them, common stock type funds account for 88.31%, partial stock mixed type funds account for 81.81%, and flexible allocation funds account for 62.44%. However, the development of China's stock market is not yet sound, and market trends are difficult to control. Stock investment behavior has significant risk exposure. In this context, scientific and effective risk management of its stock investment portfolio has become the primary task of fund managers when investing in the stock market.

Stock assets are greatly influenced by market factors and the frequency of stock price fluctuations is high. Therefore, open-end fund managers often face market risk when holding stock investment portfolios, which is also an important management object in their stock investment portfolio risk management. For market risk, the classic theory of finance advocates hedging through derivatives, but in practical operations, market risk is generally not possible to be reduced to zero due to unsatisfactory real conditions. At the same time, the establishment characteristics of open-ended funds themselves mean that they face significant liquidity risks when holding stock investment portfolios. The open redemption mechanism causes investors to have unstable redemption requirements for fund units, which requires fund managers of open-ended funds to pay special attention to the liquidity of funds during the fund operation process. Holding too little liquid assets may cause the fund to be unable to redeem normally, leading to a crisis of trust and even bankruptcy. Holding too much liquid assets can also reduce the amount of profitable assets that can be invested in the stock market. Contrary to the profit objectives of the fund, the liquidity risk management of open-ended funds should strive to expand the scale of profitable assets while ensuring sufficient liquidity assets. In addition to the above two, the risk management of the stock investment portfolio of open-ended funds also includes many other types of risks. Adopting corresponding different management methods for each type of risk will undoubtedly make the risk management process very complex. Therefore, in practical operation, fund management companies need to adopt a set of simple, feasible, and scientifically effective risk management methods, and VaR theory precisely fits this demand, it has a high degree of use both domestically and internationally, covering a wide range, and has strong applicability for the risk management process of open-ended fund managers investing in the stock market.

3. Overview of VaR Model L

3.1 The Definition and Development History of VaR Model.

VaR (Value at Risk) model is also called value at risk model or Value at risk model in China. Based on Philippe Jorion's definition, VaR can be expressed as "the maximum expected loss caused by holding assets for a certain period of time at a certain confidence level under normal market

conditions". Taking the open-end fund investment in the stock market as an example, under normal market fluctuations, assuming that a certain open-end fund manager holds a stock investment portfolio with a market risk VaR value of 3.4 million yuan in the future day, and a confidence level of 99%, it indicates that the probability of the maximum loss of the stock investment portfolio held by the fund manager due to operating the fund in the future day due to stock price fluctuations exceeding 3.4 million yuan is 1%.

From the above definition, it can be seen that the determination of VaR value is related to the confidence level c and holding period Δt is closely related, and these two parameters must be determined before establishing the model. The confidence level represents the probability of non-extreme loss events occurring, reflecting investors' subjective risk preferences. If the confidence level is too low, it will lead to an excessively high "extreme probability", thereby reducing the reference ability of VaR measurement results. If the confidence level is too high, it will reduce the amount of extreme data in the sample, thereby reducing the accuracy of VaR measurement results; The holding period represents the time span over which a single sample data is generated. When selecting the holding period, it needs to be comprehensively considered along with the entire time range of data selection. The two together determine the size of the sample data, and the sample data size is the direct reason that affects the effectiveness of VaR model measurement results.

The VaR model first appeared in the research report "Practice and Rules for Derivatives" by the G-30 group in 1993 and was promoted accordingly. In the same year, the Basel Accord recognized analytical tools based on the VaR model. The following year, J.P. Morgan Group launched the Risk Metrics information system for calculating value at risk, which was widely adopted by many financial institutions, in 1996, the Basel Supplementary Agreement officially released the internal model method based on VaR model for determining market risk capital, which established the position of VaR model in the financial industry. At present, the VaR model has developed into a relatively mature financial risk measurement tool. Some large foreign financial institutions have publicly disclosed the VaR value of their assets as an important content in their regularly published accounting statements. With the development of China's financial industry, the VaR model has gradually been applied to risk management and other fields by major financial institutions.

3.2 The Definition and Development History of VaR Model.

From the definition, it can be seen that VaR is actually an estimate of the difference between the expected value and the minimum value of an asset within a given confidence interval and holding period. Therefore, assuming that ω is the ending value of the asset, ω^* The minimum closing value of assets at confidence level c , $E(\omega)$ If it is the expected value of the asset, VaR is expressed as:

$$\text{VaR} = E(\omega) - \omega^* \quad (1)$$

Assuming that ω_0 is the value of the asset at the beginning of the holding period, R is the return on the asset for a given holding period, and R^* is the lowest return on the asset at the confidence level c ,

$$\omega = \omega_0 (1+R) \quad (2)$$

$$\omega^* = \omega_0 (1+R^*) \quad (3)$$

According to the basic properties of mathematical expectations, substitute equations (2) and (3) into equation (1), as follows:

$$\begin{aligned} \text{VaR} &= E[\omega_0 (1+R)] - \omega_0 (1+R^*) \\ &= E(\omega_0) + E(\omega_0 R) - \omega_0 - \omega_0 R^* \\ &= \omega_0 + \omega_0 E(R) - \omega_0 - \omega_0 R^* \end{aligned}$$

$$= \omega_0 [E(R) - R^*] \quad (4)$$

Equations (1) and (4) are the generalized models of VaR. In particular, if the return on assets series follows normal distribution, let its mean $E(R)$ be μ , The standard deviation is σ , It can be seen from the nature of normal distribution that under the confidence level c , the maximum possible deviation of the yield data from the mean in unit time is $\mu - \alpha \sigma$, among α Is the inverse value of the cumulative distribution function of $1-c$ under the standard normal distribution, namely:

$$R^* = \mu - \alpha \sigma \quad (5)$$

Replace (5) and $E(R) = \mu$ Substituting (4), we can get the VaR model under normal distribution in unit time:

$$\text{VaR} = \omega_0 [\mu - (\mu - \alpha \sigma)] = \omega_0 \alpha \sigma \quad (6)$$

3.3 Calculation method of VaR

According to whether the distribution of asset returns is known or assumed, VaR calculation methods can usually be divided into non parametric methods, parametric methods, and semi parametric methods. Non parametric methods do not need to satisfy the assumption of asset return distribution, and can effectively handle common non ideal situations in the real market (such as asymmetric distribution of stock returns); The parameter method requires asset returns to follow a certain type of distribution, and the VaR value is determined by estimating the model parameters accordingly; The semi parametric method is based on extreme value theory and is particularly suitable for extreme phenomena in the market. Among the above methods, the historical simulation method, Monte Carlo simulation method, and variance covariance method in parametric methods are commonly used.

3.3.1 Historical Simulation Method

The historical simulation method assumes that the future return distribution of an asset is similar to its historical return distribution, and assumes that the future return changes of the asset will be completely consistent with the past. Under this assumption, the historical simulation method uses the historical data of asset returns to simulate the future risk return of assets, and then estimates the VaR value within the corresponding confidence interval through the quantile. In general, the application steps of historical simulation method mainly include: (1) confirming the target object, collecting historical data of the target object, and determining the sample data size N and confidence level c ; (2) Arrange the sample data in descending order; (3) Calculate quantile $= N \times (1-c)$, VaR value is the value corresponding to quantile in sorting.

3.3.2. Monte Carlo Simulation Method

The Monte Carlo simulation method assumes that the asset return is a certain stochastic process, and uses the method of random generation to simulate and sort out a large number of assets returns that may occur in the future, which is used as the estimation of the distribution of future asset returns, and then combines with the quantile to obtain the VaR estimates of the corresponding quantiles of different confidence levels. Monte Carlo simulation method and historical simulation method have significant similarities, both of which simulate the future distribution of asset returns through specific methods to estimate VaR values. The operating steps of both methods are also relatively similar, but Monte Carlo simulation method is based on the random assumption of asset returns, which is different from historical simulation method based on real historical data.

3.3.3 Variance Covariance Method

The variance covariance method assumes that the asset return follows normal distribution, estimates the parameters using the real historical data of the asset, and then calculates the VaR value.

Taking a stock investment portfolio as an example, the calculation steps of the variance covariance method generally include: (1) estimating the variance, standard deviation, and covariance of individual stock returns through historical data, and then calculating the portfolio standard deviation σ_p ; (2) Obtain the standard normal sampling quantile corresponding to the given confidence level; (3) Apply the normalization model of VaR to obtain the VaR value.

Compared with the above three methods, the variance covariance method is obviously more computationally efficient and has a clearer process. However, due to the fact that normal assumptions are difficult to satisfy in real financial markets, and the phenomenon of "peak thick tail" is very common, its description of extreme situations in the market is clearly insufficient. However, the non-parametric historical simulation method and Monte Carlo simulation method require lower assumptions, it can effectively handle the significant fluctuations caused by fat tails and asymmetric phenomena. Among them, the historical simulation method is easy to operate and will help investors greatly improve their risk management efficiency in today's financial investment environment with fast and frequent information updates. For investment processes with large investment amounts, it can particularly demonstrate the value improvement brought by easy operation. However, when using it, it is necessary to ensure that the sample has a sufficient data volume, Otherwise, the calculation results may deviate from reality, while also taking into account the lag effect on VaR calculation results due to the large amount of data; The Monte Carlo simulation method has high accuracy in calculation results, but its operational complexity far exceeds that of historical simulation method, and it requires high data validity.

3.3.4 Advantages and Disadvantages of VaR Model

As one of the widely used financial risk management tools internationally, the VaR model has its unique advantages: (1) The VaR model's measurement of financial risk is based on statistical principles, with strong scientificity and logicity. Compared with other measurement tools, it also shows obvious simplicity in quantitative calculation; (2) The VaR model can be used to measure various risks, providing a relatively unified standard for the field of risk management. From the perspective of market regulation, it also points out new directions for information disclosure, and the degree of market transparency has been increased VaR is a typical "pre-event indicator" that estimates the future changes in assets, greatly increasing the predictability and effectiveness of financial risk prevention and control compared to post event management.

Although the VaR model has unique advantages, it still has inevitable shortcomings: (1) In theory, the VaR model has two basic prerequisites - normal and efficient market conditions and ideal distribution of asset return data. However, the development of China's financial market is not yet mature and is easily influenced by investor sentiment and policies. Extreme events occur frequently and have a large impact range, which does not meet the efficient market premise, And the actual market data is also difficult to achieve an ideal distribution state due to the potential impact of extreme events; (2) Statistical constraints make VaR models have high requirements for data. Only when the research data is objective and effective enough, independent of subjective factors, can its measurement results have sufficient credibility, which is almost impossible to meet in real life. Therefore, when using the VaR model for risk management, it should be combined with other risk management methods, complementary and collaborative analysis, in order to maximize the role of the VaR model and improve the effectiveness of risk management. seen from the nature of normal distribution that under the confidence level c , the maximum possibility from the nature of normal distribution.

4. Summary

For fund managers, the application of VaR model in risk management of their stock investment portfolio has greatly improved the effectiveness of risk quantification and risk prevention and control. From the perspective of open-end fund operation, fund managers use effective methods such as VaR models to carry out good risk management, which is beneficial for their investment operation, making

the fund's performance growth stable, driving the fund's reputation and investor confidence. As a result, the fund will receive greater capital investment, further increasing the fund's share, and helping the fund stand out in homogeneous competition. The growth of fund size also means that the fund will invest more funds into the securities market, which not only promotes the healthy development of the fund industry in China, but also injects new impetus into China's financial market.

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