Research on Financial Risk Management Based on VaR

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Abstract: With the continuous development of the financial industry, financial risk management has become increasingly important. Among all financial risks, market risk and credit risk are the two most important. In the past, in the context of relatively stable financial market prices, people pay more attention to the credit risk of financial markets, and almost do not consider the factors of market risk. This paper mainly introduces VaR, a risk quantitative analysis method that has recently been widely recognized by the financial industry. The article includes an introduction to various aspects of VaR, hoping to give a detailed introduction to this important financial statistical method, characterized by a detailed study of risk management for Monte Carlo simulation. Since the VaR method is a specific application of statistics in the financial field, this study also interpolates between finance and statistics.

1. Introduction

In recent years, the rapid development of financial innovation and information technology, as well as the trend of financial liberalization in the world, has made financial market volatility more intense. Due to the need to diversify financial risks, financial derivative instruments have emerged and developed rapidly.

When financial derivatives are increasingly used for speculation rather than for the purpose of maintaining value, the financial derivatives generated by the need to avoid risks are inherently risky. In recent years, the US bankruptcy of the Orange County government, the bankruptcy of the Bank of Bahrain, and the huge transaction losses of Japan's Daiwa Bank have all been related to financial derivatives. Therefore, how to effectively control the market risk of financial markets, especially financial derivatives markets, has become an urgent problem for banks and company managers, investors and financial supervisory authorities. Financial derivatives are a "double-edged sword". It is an important risk aversion tool, but it is often counterproductive in practice. Therefore, how to strengthen the risk supervision of financial derivatives has become a problem worthy of attention.

2. VaR Definition and Calculation

2.1 Definition of VaR

Used to assess and measure the magnitude of market risk and potential maximum value loss that any financial asset or portfolio of securities faces in a given period of time, within normal market conditions and given confidence. For example, if we say that an exposure has a VaR value of $10 million at a 99% confidence level, this means that on average, the actual loss of the exposure exceeds $10 million in 100 trading days. 1 day (that is, 2 to 3 days per year).Mathematically, VaR can be expressed as the quantile of the investment instrument or portfolio's P&L distribution (α -quantile), the expression is as follows:

$$\Pr ob(\Delta P_{\Delta t} \le -VaR) = \alpha$$

$\Delta P_{\Delta t}$ indicates that the combination p is Δt changes in market value during the holding period. The above equation states that the probability that the loss value is equal to or greater than VaR is α, or can be said, in probability α, the loss value is greater than VaR. It can also be said that the specific definition of VaR is: within a certain holding period Δt, a certain confidence level 1- α The biggest loss possible under the portfolio p. Taken together, you can be sure $\Delta P_{\Delta t}$ should be understood as a negative value, that is, the loss suffered, α indicates the probability of its occurrence.

2.2 VaR Calculation

The VaR value is the potential maximum loss amount faced by a financial investment instrument or portfolio within a certain holding period and a certain degree of confidence. For example, Bankers Trust reported in its 1994 annual report that its 1994 daily 99% VaR value averaged $35 million. This shows that the bank can guarantee a 99% probability that the investment portfolio at each specific point in 1994 will not exceed $35 million on average due to changes in market prices over the next 24 hours. By comparing this VaR value with the bank's 1994 annual profit of $615 million and the capital of $4.7 billion, the bank's risk profile can be seen at a glance, showing that the bank's ability to withstand risks is still strong. Its capital adequacy ratio is sufficient to ensure that the bank can cope with the maximum loss that may occur. To calculate the VaR value, first define ω. For an initial investment amount, R is the rate of return for the entire holding period of the set. Then the ending value of the portfolio is ω = ω (1 + R).

Due to the existence of various random factors, the rate of return R can be regarded as a random variable, and its annual mean and variance are set to μ and δ, respectively, and Δt is set as its holding period. Assuming that the annual return of the portfolio is irrelevant, the mean and variance of the portfolio return in Δt years are μΔt and δ, respectively. If the market is assumed to be valid, the daily income Rt of the assets within 10 days is the same and independent of each other, then the 10th return R(10)= $\sum_{t=1}^{10} R_t$ obey normal distribution, mean $\mu_{10} = 10\mu$, variance $\sigma_{10}^2 = 10\sigma^2$.

3. Risk Value Measurement Model

VaR's measurement methods can be basically divided into two categories: the first is the local evaluation method, including the delta-normal evaluation method; the second is the full evaluation method, including the historical simulation method and Monte Carlo simulation method. There are advantages and disadvantages for each measurement method, because different parameter settings and different measurement models under different assumptions will produce different results. Therefore, when measuring VaR, it should not be limited to any measurement method. Appropriate parameters and models should be selected according to its characteristics to estimate the value of risk.

3.1 Delta - Normal Evaluation Method

The method is simple to calculate, but the yield distribution of many financial assets has a thick tail. Because VaR tries to capture the income of the portfolio at the left tail, the tail is very large and troublesome. In this case, the models based on normal distribution will the outlier ratio will be underestimated. In addition, based on the time variation and weight distribution, there are sample variation method, risk matrix method and GARCH estimation method to estimate the delta value.

3.2 Historical Simulation Method

The historical simulation method assumes that the return distribution of the portfolio is independent and identical. The future fluctuations and historical fluctuations of the market factor are exactly the same. The core is to use the data of the return on assets in the past period to estimate the statistical distribution of the return on the assets, and then according to different points. The number

of bits is determined by the corresponding confidence level of VaR. The steps of the historical simulation method are:

(1) Arrange stock returns in the order of small to large;

(2) For the data window width (sample interval length) T, the 5th and 1st quantiles of the sorted stock return rate distribution correspond to 95% VaR and 99% VaR.

The advantage of the historical simulation method is that the method is simple, intuitive and easy to operate. It does not need to make assumptions about the form of the return rate distribution, and can solve problems such as the thick tail or the asymmetry of the return rate distribution, and avoids the parameter estimation or the selection model. The error caused.

Historical simulation methods also have many drawbacks. The specific performance is as follows: First, the distribution of returns is fixed throughout the sample period. If the historical trend is reversed, the VaR value based on the original data will be greatly deviated from the expected maximum loss. Second, HS cannot provide an expected loss that is worse than the minimum rate of return in the observed sample; third, the size of the sample has a large effect on the VaR value, resulting in a larger variance; fourth, the HS cannot be sensitive in extreme situations. Sex test.

4. Monte Carlo Simulation Management

The VaR calculation based on the historical simulation method is based on the historical actual price changes of the market factors to obtain the n possible results of the combined profit and loss, so that the VaR is calculated by the quantile based on the observed profit and loss distribution. The principle of VaR calculation based on Monte Carlo simulation is similar, except that the change of market factor is not from historical observations, but through random number simulation. The basic idea is to repeat the stochastic process of simulating financial variables so that the simulated values include most of the possible cases, so that the overall distribution of the combined values can be obtained by simulation, and on this basis, VaR can be obtained.

VaR calculation based on Monte Carlo simulation can be performed in three steps:

(1) Scenario generation. Select the stochastic process and distribution of market factor changes, and estimate the corresponding parameters: simulate the change path of market factors, and establish the future changes of market factors.

(2) Portfolio valuation. For each scenario of the market factor, use a pricing formula or other method to calculate the value of the combination and its changes.

(3) Estimate VaR. Calculate the specific confidence level based on the simulation results of the combined value change distribution VaR.

The specific steps for calculating VaR using Monte Carlo simulation are as follows:

(1) Select a random model

In the Monte Carlo simulation, first select the stochastic model and distribution that reflects the price change, and estimate the correlation parameter. Geometric Brownian Motion is one of the most commonly used models of stock price changes. It assumes that changes in asset value are irrelevant in time, and its discrete form can be expressed as:

$$\Delta S_{t+1} = S_t(\mu\Delta t + \sigma\varepsilon\sqrt{\Delta t}\,)$$

Since the general Monte Carlo simulation method uses the fluctuation of the standard deviation balance yield under the assumption of normal distribution, σ for the standard deviation of the return on assets, ε to be a random variable subject to the standard normal distribution.

(2) Random simulation of price trends

Corresponding random sequences are generated sequentially according to the stochastic model ε_i (i=1, 2,..., n) and calculate the simulated price from this S_{t+1}, S_{t+2},…, S_{t+n}. Define t as the current time and T as the target time. We will simulate the price of T at time t. $\tau = T - t$ is the time interval of the simulation, in order to be in duration τ generate a series of random variables S_{t+i}, i=1, 2,...n, order $\Delta t = \tau / n$.

In order to simulate the price trend of the random variable s, from the current price S_t departure, in the order of i=1, 2,..., n, according to the random number ε_i find:

$$S_{t+1} = S_t + S_t(\mu\Delta t + \sigma\varepsilon_1\sqrt{\Delta t})$$

$$S_{t+2} = S_{t+1} + S_{t+1}(\mu\Delta t + \sigma\varepsilon_2\sqrt{\Delta t})$$

$$\cdots$$

$$S_{t+n} = S_{t+n-1} + S_{t+n-1}(\mu\Delta t + \sigma\varepsilon_n\sqrt{\Delta t}) = S_T$$

This simulates the future trend of the random variable s ($S_{t+1}, S_{t+2}, ..., S_{t+n}$) and calculate the price at the target time t S_T.

(3) Estimating VaR

Repeat the second step multiple times. The more the number of repetitions (in k), the closer to the true distribution, so that the price of a series of assets at time T can be obtained. $S_T^1, S_T^2, ..., S_T^k$, at a given level of confidence α, VaR is the kth in the k simulation results, and the simulated price is sorted in ascending order. α is a loss of simulated price. For example, simulation is performed 1000 times (k=1000), and when the confidence level is 95% (α=95%), find the lower 5% quantile in the sorted asset price sequence $S_T^{\min 5\%}$ (The last 50th number, 1000*(l-95%)=50), according to the formula:

$$\omega_0 - \omega^* = -\omega_0 R^*$$

A VaR at 95% confidence level can be defined as:

$$VaR = \omega_0 - \omega^* = S_t - S_T^{\min 5\%}$$

The advantage of the Monte Carlo method is that it is not limited by the complexity of financial instrument types, the nonlinearity of financial time series, thick tail, etc. It can handle nonlinear problems well, and the estimation accuracy is good, especially with computer soft. With the rapid development of hardware technology, this method has become the mainstream method for computing VaR. However, this method also has many shortcomings: one is the large amount of calculation. In general, complex portfolios often include financial instruments such as bonds, stocks, forwards, and options in different currencies. The underlying market factors include different currencies, different maturities, exchange rates, stock indexes, etc., making the market the factor becomes a huge set. Even if the number of market factors is relatively small, it is very difficult to perform thousands or even tens of thousands of simulations on the multivariate distribution of market factor vectors. Second, the model selection error. The price fluctuation of financial products is a stochastic process. The price fluctuations of different products are also different. It is difficult to describe with a specific model, so the choice of model will bring certain selection errors.

5. Conclusion

The VaR approach is a powerful analytical tool for institutional investors to make investment decisions. Institutional investors apply the VaR method to measure the risk of investment objects in the investment process, compare the calculated risk with their ability to withstand risks, and determine the investment amount and investment strategy to reduce the blindness of investment. , to minimize the losses caused by investment decisions. At present, in addition to being widely used by financial institutions, the VaR method has also begun to be adopted by some non-financial institutions, such as Siemens and IBM. This paper focuses on the Monte Carlo simulation technology commonly used in financial risk management. Its function is very powerful, and its application is very flexible. It can be used for the simulation of different yield trends and when the yields are subject to different distributions. Monte Carlo simulation technology uses computer simulation to generate a large number of scenarios, which makes it more reliable and comprehensive conclusions when measuring risk than analysis methods. In addition, the Monte Carlo simulation method is a full-value estimation method, which embodies the convexity of nonlinear assets and effectively

solves the difficulties encountered by analytical methods in dealing with nonlinear and non-normal problems.

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