Research on VaR Method of Financial Market Risk Analysis

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\textbf{Abstract.} Any business will face some financial risks, it’s not people’s will but no one can ignore its objective existence. However if a business can precisely evaluate the risk analysis and effectively prevent financial risks and control through it, that may bring greater benefit for enterprises. In the past years, more and more enterprises pay attention to their risk analysis and make much effort on maintaining their financial risk management systems. This article outlines the VaR method. VaR (Value at Risk) is a measure of the risk of investments. It estimates how much a set of investments might lose, according to the given normal market conditions, within a set time period such as a day. VaR is typically used by firms and regulators in the financial industry to gauge the amount of possible losses. This article compares the differences between three typical VaR calculation methods. By analyzing their properties, advantages and drawbacks, methods could be implemented in various real situations. The specific situation will find risk control solution effectively. This article gives a detailed introduction of VaR methods, properties and principle and helps enterprises have a clear sight about how to use correct VaR method in a relevant real situation.

\textbf{Introduction}

The traditional ALM (Asset-Liability Management) over relies on the report analysis, lacking of timeliness and it’s too abstract and not intuitive using variance and coefficient $\beta$ to evaluate the financial risk. So G30 came up with the VaR in its report of 1993. Now it has become the mainstream approach in financial circles for evaluating the risk. In financial mathematics and financial risk management, VaR is defined as: for a given portfolio, time horizon, and probability $p$, the $p$ VaR is defined as a threshold loss value, such that the probability that the loss on the portfolio over the given time horizon exceeds this value is $p$ \cite{1}. This assumes mark-to-market pricing, and no trading in the portfolio \cite{2}. This article will give overall comparison and analysis of 3 methods—Historical simulation method, Random sampling and statistical analysis method as well as Monte Carlo simulation method, the definition and methods will also be introduced in the following paragraphs.

\textbf{The Basic Principle, Method, Parameters and Applications of the VaR}

Value at Risk (VaR) is a measure of the investment risks, the maximum loss of investment should not exceed with a confidence level probability over a given risk period. It is a general concept that has broad applications in financial industry in order to measure the market risk of their asset portfolios, and non-financial industry as well. First, it can be used to set risk targets and limitation, then it is useful to capital allocation. In addition, VaR can assess the risks of different investment plans before making decisions.

In general, VaR in risk measurement should be used for understanding the past investment and make strategic decision for future investment and it defines risk as mark-to-market loss on a fixed portfolios among a fixed time. VaR has three parameters includes the time horizon which is the
length of hold time in the portfolio, the confidence level at which plan to make the estimate and an estimate loss which be used to denominate the value. Moreover, there are mainly three measure methods in VaR, including historical simulation method, random sampling and statistical analysis method and Monte Carlo simulation method.

This paragraph illustrates the basic principle of three methods, advantages and disadvantages. It gives a precise insight about these methods. Historical simulation method is an easy and non-theoretical process for predicting values at risk by simulating or constructing the cumulative distribution function of asset over the last a period according to historical resources. This approach cannot assume a particular and complete asset return. In addition, it can reconstruct the asset value of historical profits and loss allocation by repeating this approach. There are two important points when using this historical method. First one is the huge amount of history resources in order to ensure the precise risk value, and the second one is the calculation of last history time that will influence risk value. Once the mark-to-market profits or loss for the last periods have been ensured, the distribution of profits and losses will be determined by loss or profits [2].

Random sampling and statistical analysis method is an approach that selects elements with the same probability from a simple random sample of a given size. The analysis method is sampling the actual data from real samples and when the sample is large enough, it will include “typical” cases and “odd” case at the same time, but the typical case will outweigh the few odd cases. The large random sample gives model a statistical power [5].

Monte Carlo simulation method is a computerized mathematical technique which helps people consider all possible outcomes of decisions and understand the influence of risk. It encompasses any kind of techniques random sampling repeated to obtain solutions. This method is always used in physical and mathematical problems like probability distribution and optimization [4]. Within finance industry, this method is mainly used to model project schedules where simulations for worst-case, best case and most likely duration to determine outcome for the overall project. After using Monte Carlo simulation method, a random value is selected for each task, based on the range of estimate and the resulting outcomes will be introduced and recorded. This process will be repeated and a large amount of results will be analyzed and described the likelihood, probability in the model [2].

The Relationship and Differences Between Historical Simulation Method, Random Sampling and Statistical Analysis Method

According to the market requirements and the properties of different methods, historical simulation method has grown more and more popular in practice because it’s very easy to be applied and very intuitive to be understood. However there are still two obvious disadvantages in it. Firstly, the past historical data is used to provide an estimate for the future. The historical simulation method assumes that the change of the market factors in the future is totally the same with its data in the past and to be independent and identically distributed, the probability density function will not change obviously along with the time. It’s not match with the practical situation in financial market and it is easy for the estimation to be incorrect. When calculate the VaR, the historical simulation method only depends on the static historical data in specific time period and regardless of the dynamic volatility level currently. Considering these disadvantages, Richardson, Boudoukh and Whitelaw, have already came up with a new way, the hybrid method that combines benefits of methods for VaR estimation, to improve this method in 1998 [3] and it really did a big improvement over the competing methods, historical simulation and exponential smoothing after several practical experiments. However, there is one point similar with the historical simulation method, that both methods just depend on the loss value in the past and don’t consider how much the profit factors will affect the VaR. It means simulation cannot present the heavy tailed characteristics of return series. Historical simulation method has the main advantage that it is an easy way that doesn’t need any evaluation of probability law and any distributional assumption, only by using the history of market evaluation over past years to get results, while MC method is a very efficient but time consuming and expensive way because it needs a large number of random sample simulations to evaluate and obtain significant results [3].
The main character of Random sampling and statistical analysis method is making sampling analysis for the actual data while the Monte Carlo simulation method is making sampling analysis and statistics for the data which simulate from the computer and not actual. Even the source of the data for these two methods is different, but people don’t distinguish because of the function is kind of the same. They call them together as Monte Carlo simulation method. For the traditional methods, they need the distribution of Statistics to calculate the critical value while the distribution can’t be gotten clearly actually. That will be not convenient for testing. However the Monte Carlo method can get very accurate critical value even the distribution is not clear. Monte Carlo is more flexible on choosing the statistics and statistically following various distributional assumptions. Meanwhile, it can accurately obtain results when the sample capacity is smaller and instruments are non-linear. Also, a full distribution of potential portfolio will be described not just a specific number. However, Monte Carlo method, there are also some disadvantages for it. Firstly, the result of the random model which is chosen and built and the historical data of estimate parameter have a high incorrect rate, so there will be a risk to make errors and deviations. Secondly, it may need lots of time and take a lot of computational power because of its large calculation quantity. Finally, if the number of segmentation for the risk factors is not enough, the error will be very large [2].

Conclusion

Overall, from the above analysis, this article releases a conclusion that, all these three approaches for estimating VaR need to be effectively utilized according to the real situation and enterprises requirements. The advantages of these methods should be implemented and considered when the manager makes a decision or calculate the risk of investments. In addition, different approaches can also combined together to get a more robust and efficient VaR estimate. Obviously, VaR is an useful tool that not only can deal with the nonlinear problems but also can summarize the risk of the securities portfolio during a risk period, people who make a decision or need control risk should know how to flexibly convert these three methods when they processing. In the future, more things should be took into consider that VaR could also be complemented with other useful tools during the analysis process to optimize analysis result, because VaR only occupied a little piece within the risk management and measurement process. Best methods and best tools will create a great value and profits.

Reference