

Research on Financial Risk Based on Extreme Value Theory

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Abstract: By expounding the extreme value theory, the measurement model of financial risk is concluded. Through comparative analysis, it is found that the variance covariance method has strong practicability, and its advantages and characteristics are analyzed. Finally, from the perspective of systemic financial risk and non system financial risk, the paper put forward the prevention and supervision of financial risk.

1. Introduction

The extreme value theory is a mathematical method that specializes in research that occurs only in rare cases and has a great effect on consequences once it occurs. For a few cases where the consequences are rare and particularly serious, special measurement models are needed to handle related financial risks in an accurate and effective way. Foreign financial markets started earlier and developed quite well. The main measurement models of financial risk are the Sharpe Ratio (1996), which is based on Markowitz's portfolio theory. The Model of Low Partial Moments was developed by Markowitz (1952) in a case study that used the model of low partial moments and method of effective rate of return. The Capital Asset Pricing Theory Model is proposed by William Sharp (1964) on the basis of improving the theoretical model of portfolio, which optimizes the portfolio model to make it effective with more realistic meaning. Stephen Ross (1976) extends the Capital Asset Pricing Model and proposed a theoretical model of arbitrage pricing to measure the equilibrium of returns between market risks and return rate. The frequently used model, however, is the VaR model put forward by Baumol (1963), which measures risk level of market fluctuations in accordance with the confidence level of expected revenue. In 2008, F. Gao made minor adjustments to the VaR model and verified the VaR model is of more accuracy through simulation experiments. Our Chinese scholars started the analysis of measurement model of financial risk relatively late. Yang Xuelai (2006), through empirical analysis, found that with the gradual development of China's stock market, the traditional risk assessment model cannot reflect the risk better and the traditional model needs to be improved or build a new risk assessment model. Hou Wailin (2012) used regression modeling to measure the yield indicators of the financial industry, and conducted a good analysis of the volatility of the stock index and the correlation mantissa differences. Hu Juan (2013) conducted a comparative analysis of various risk measurement models and found out with prediction and the combination of different models that the VaR model has a higher accuracy and can accurately reflect the fluctuating market risk.

2. The Extreme Value Theory and Modeling

With the rapid development of economic globalization, there has been unprecedented fierce competition in various financial sectors. Financial institutions also face greater risks including credit risk, operational risk, market risk and liquidity risk. The market risk, the unavoidable one, is the most important within the entire financial system. The operational risk mainly involves the improper connection of various aspects in the internal process operation, as well as the professionalism of the employees. The credit risk and liquidity risk are able to be controlled by the circulation of each transaction. In recent years, with the continuous increase of financial risks in various industries, the method to establish effective precautionary and preventive measures is an important part in the stable structure of financial industry. Extreme value theory can be applied to

better analyze the financial risks by making good use of its own characteristics. VaR is the abbreviation of Value at Risk, which refers to the maximum loss of a financial asset portfolio under the certain level of financial risk namely confidence level P (P represents confidence level, $0 < p < 1$). In order to reflect clearly the logical relationship of the formulas through letters, W_0 is applied to reflect the initial investment amount of the portfolio and R is used to represent the investment rate of return during the holding period. Then the value of the portfolio at the end of the target investment period can be $W = W_0(1 + R)$. If μ represents expectation value, σ represents standard deviation, within the particular confidence level, the minimum value of investment portfolio can be

$$W^* = (1 + R^*) * W_0$$

In accordance to the risk measurement, it can be converted into:

$$VaR = E(W) - W^* = -W_0(R^* - \mu)$$

In general, the most common form can be obtained from the probability distribution of the portfolio value $f(w)$ when the VaR is at a given confidence level P. Given the confidence level p, the probability distribution can be obtained from the future probability distribution of the portfolio value. The form of confidence level P is as follows:

$$1 - p = \int_{-\infty}^{w^*} f(w) dw = P(w \leq w^*)$$

In this formula, the changes of various factors are as follows: (1) the level of confidence P is usually at random, and in order to ensure the reliability of the financial system, the Basel Commission selects a confidence level of 99%. Companies can set their own confidence intervals according to their own circumstances. Many large multinational corporations adopt a level of 99.5%, in order to obtain a higher level of trust. In addition, the error term, constant, etc. are also important factors that affect the level of confidence. (2) The index that reflects the length of holding time can be identified with t. As time goes on, the stability of the volatility is better, so to exclude the influence caused by the particular difference, we generally choose a quarter or half a year as a time quantum to measure the fluctuations of financial risk. (3) The distribution characteristics of the yield is the income density distribution of an investment asset or portfolio in a given holding time period. Because the yield is affected by various factors such as season, industry and time, using a fixed model to measure the risk of return rate of the financial sector does not give good results. Therefore, the parameter method and covariance method are usually adopted in the actual operation. First, suppose that the yield follows a normal distribution, and then use the tail-end difference method to carry out the back-squeeze calculation and finally get the rate of return. However, after the verification of the scholars, it is found that the return rate of financial assets in many industries does not follow the normal distribution, and because of the phenomenon of less peak data but more tail data, scholars then improved normal distribution a lot, which led to good results.

The calculation method of VaR mainly includes the historical simulation method, the variance-covariance method and the Monte Carlo simulation method. The historical simulation method assumes that the future return of the asset portfolio is consistent with the current return, it's a simple method of evaluating the future return based on the existing return. It's a simple one, but due to the impact of the financial environment, the future earnings are changing, so the historical simulation method is not qualified enough. In spite of its complex and detailed accounting steps, Monte Carlo simulation is rarely adopted in practical business due to its strict requirement of authenticity and reliability of the samples as well as high cost. While integrated risk-return method is applied to assess overall portfolio risk in Variance - Covariance method, which means assessing every risk factor and taking into account its share in the total risks. Assuming that there are n kinds of assets in the portfolio and the number of assets i is C_i , then the daily return generated by the assets i is

$$\sigma_p = \sum_{i=1}^n c_i \sigma_i$$

According to the statistic of the return produced by each variable, the formula of VaR is as follows:

$$\sigma_p = \sqrt{\sum_{i=1}^n \sum_{j=1}^n p_{ij} c_i c_j \sigma_i \sigma_j}$$

Variance - covariance method is performed on a simple matrix, which is applied to deal with large numbers of assets more swiftly and conveniently. However, the variance-covariance method is particularly computationally intensive based on the fact that many financial assets have fat-tailed income distributions, leading to underestimations of risk. The VaR model can better evaluate the corporate performance, bring more benefits to managers and investors, provide more accurate data in the prevention and prediction of financial risks, and bring more comprehensive information in communication, which will help managers with an overall control of financial-related risks to avoid risks and obtain higher returns.

3. The Prevention and Supervision of Financial Risks

From a macro perspective, the financial risks include the systematic risk and the non-systematic risk. The systemic risk is the inevitable public risk that the entire financial system faces. While the non-systematic risk is the risk that every financial enterprise will suffer due to its own business, staff quality, operation process, internal control and other factors, mainly including credit risk and operational risk. Managers should analyze and judge various financial risks from a combination of internal and external perspectives to avoid and guard against financial risks in a reasonable and effective manner.

In the course of preventing and supervising systematic financial risks, the manager only pays attention to the partial financial risk events instead of overall ones, focusing on the stability and risk of the single financial market system, which leads to neglects of the whole financial system risks. Second, in the regulatory scope, the overall linkages with the macroeconomy are lack of consideration and less attention is paid to the overall financial markets, structures and instruments. The spread of systemic financial risks is mainly generated and rapidly expanding throughout the financial system.

In addition, in terms of regulatory measures, relying solely on the original risk measurement model is not sufficient to analyze the ever-changing financial risks in the existing economic environment, the existing model needs to be improved or a new risk measurement model needs to be built, not only to pay attention to the efficient assessment of systemic risk, and more importantly, the prediction, analysis and response of risks. The original pursuit of stable economic growth and the stabilization of the financial system, are less appropriate and require greater caution in today's volatile financial market environment and face the potential risks and their impact, and pay more attention to the systemic risk caused by the macro-risk to the entire financial system.

In the process of preventing and supervising non-systematic financial risks, firstly, managers evaluate their own internal structure and personnel quality, formulate effective internal control and performance appraisal system, establish a standardized appraisal system, and conduct regular appraisal of employees in various positions, to see whether the quality of their own staff and the existing job requirements corresponding to the ability to work in order to avoid the existence of the lack of staff quality of business impact. In addition, employee's professional ethics and collective honor evaluation is also an important factor for managers to guard against credit risks and operational risks.

Because financial enterprises are all in the financial system, the financial enterprises are in a state of mutual convergence. The financial risks of any enterprise may affect the related enterprises in information and business transmission, thus causing the domino effect, resulting in a serial

reflection of non-systematic financial risks.

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