Applications Research of Monte Carlo Simulation in Risk Assessment

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Abstract: The Monte Carlo method was proposed in the 1940s with the invention of electronic computers. Based on the theory of statistical sampling, it makes use of the random numbers, through sampling experiments or random simulations in order to obtain some numerical characteristics of statistics and use them as numerical solutions to be solved. This paper expounds the application steps and model improvement of Monte Carlo simulation method in risk assessment, and gives application examples to provide reference for relevant researchers.

1. Introduction

Risk value is a concept of financial statistics, which measures the expected loss under certain conditions [1]. The evaluation method is extremely complex, which involves market simulation under stochastic conditions, which requires a lot of calculation. Behind these methods is a technique called Monte Carlo simulation. Monte Carlo simulation gives thousands or even millions of random market conditions, and observes the impact of these conditions on the portfolio. Because of its high parallelism, it is very suitable for Monte Carlo simulation. Monte Carlo method, or computer random simulation method, is a calculation method based on random numbers. According to the definition of probability, the probability of an event can be estimated by the frequency of the event in a large number of experiments. When the sample size is large enough, the frequency of the event can be regarded as its probability. Therefore, a large number of random variables affecting the reliability of the structure can be sampled at first, and then the sampled values can be substituted into functional formulas one by one to determine whether the structure is invalid or not. Finally, the failure probability of the structure can be obtained. Monte Carlo method is based on this idea for analysis. According to Bernoulli's theorem of large numbers and the characteristics of normal random variables: structural failure probability, reliability index. From the idea of Monte Carlo method, it can be seen that this method avoids the mathematical difficulties in structural reliability analysis. Whether the state function is non-linear or the random variable is non-normal, as long as the number of simulations is enough, a more accurate failure probability and reliability index can be obtained. Monte Carlo risk assessment model is based on the basic financial model of investment calculation, considering the dynamic change of risk variable factors, the original static value of risk variable is selected dynamically by random sampling, and the financial model that can calculate dynamic economic evaluation index is obtained. Using the risk assessment model, we can simulate and calculate the economic indicators, which can be used to reflect the changing law of the economic indicators and evaluate the law [2].

2. Monte Carlo Simulation and Its Improvement

2.1 General Steps.

Under the quantitative analysis method, it is very important to select a suitable quantitative index. For general project investment, whether the return of project investment can be recovered on time and whether the project can bring profits to the company is a question that the decision makers need to examine, that is, risk. In this case, the future return of this investment and its deviation from expectations are often used as indicators of risk. For an investment project, there are many factors affecting future returns. For example, with the passage of time, the amount of additional investment may change; in industry, with the expansion of production scale, there may be economies of scale or

economies of scale, resulting in a decrease or increase in costs; due to the limitation of the amount of capital, the amount of additional investment will be affected by the return of the project. If the rate of return of the project has reached a certain standard before continuing to invest, otherwise it will withdraw from the market.

The general steps of Monte Carlo method are as follows: 1. Select random variables, that is, the variables most sensitive. 2. Determine the probability distribution of random variables 3. Extract random numbers for each random variable 4. Convert the random numbers into the sampling values of each input variable 5. Compose the sampling values into a set of basic data for project evaluation 6. Calculate an evaluation index value under a random situation based on the basic data 7. Repeat the above process, simulate repeatedly, and get a number of evaluation index values 8. Collate the simulation results. The expected value, variance, standard deviation, probability distribution and cumulative probability distribution of the evaluation index are obtained, and the cumulative probability map is drawn. At the same time, whether the number of simulations meets the predetermined accuracy requirement is checked. According to the above results, the influence of each random variable on project income is analyzed.

According to the probability distribution and the probability distribution map, we can obtain a series of evaluation indicators about the future income of the project, such as the expected value, variance, standard deviation, possible interval of the net present value and probability of the future cash flow [4]. However, according to the overall situation of the company, the company's decision-makers need to consider many other factors comprehensively. Therefore, on the basis of understanding the risk indicators of the project, they can make decisions according to the company's cash flow demand and the company's overall operation. Specifically, first of all, the return on investment needs to be used to compensate for the company's expenditure except cost. Therefore, only requiring the present value of future project income to be positive cannot make the company profitable. Policymakers need to determine a net present value of revenue and expenditure on the basis of understanding the total cost, and then make decisions based on the simulation results. Secondly, for a company, the company may have several projects in operation at the same time, and the decision makers need to consider the balance between all the projects of the whole company. For example, one of the company's other projects needs a cash input at some point in the future, which comes from the recovery of funds from our current research projects. In order to ensure the company's smooth capital chain, it is necessary to understand the situation of project fund recovery.

2.2 Model Improvement.

In project evaluation, there may be multiple risk-sensitive variables that will affect the target variables. Although Monte Carlo method can set multiple risk-sensitive variables, the traditional Monte Carlo method does not consider the relationship between variables, so for some cases, we cannot observe the relationship between risk-sensitive variables. Relevance improvement is to study the relationship between risk-sensitive variables, trying to embedding the relationship between variables into the model, making the model more perfect. The most typical example is the scale effect. Scale effect refers to the relationship between sales volume or output and variable cost per unit. It can be divided into economies of scale, economies of scale and economies of scale. Scale economy means that with the increase of sales volume or output, unit variable cost shows a decreasing trend; similarly, scale inefficiency means that unit cost increases with the increase of sales volume or output. In the software MATLAB, the command rand () can be used to generate a sequence of random numbers with uniform distribution from 0 to 1. However, this random number is generated according to certain algorithms, such as inverse congruence method, multiplicative congruence method, linear congruence method and so on. However, the above methods have some shortcomings, such as high-dimensional inhomogeneity and long-period correlation, which will lead to a series of problems such as slow convergence speed and large fluctuation of simulation results. For the above reasons, the traditional Monte Carlo method often causes "gaps and clusters" phenomenon, which results in inadequate search of sampling space. In order to obtain a more uniform distribution of the sequence, a more uniform distribution of the pseudo-random sequence can be used, and the selected sample

points can be used. Moreover, because the convergence rate of quasi-random sequence is higher than that of pseudo-random sequence, it can achieve relatively high accuracy with fewer samples [5].

3. Application Examples of Monte Carlo Simulation in Risk Assessment

3.1 Application of Monte Carlo Simulation in Risk Assessment of Engineering Cost.

Engineering cost risk refers to the aggregation of uncertain factors affecting the determination and control of engineering cost in various stages of project construction. Generally speaking, project cost risk refers to the cost risk in the life cycle of a project, that is, the difference between the actual results and the total of the expected human, material, machinery and a series of actual costs in the decision-making, scheme design, construction and post-completion stages of the project. The difference of project risk includes the uncertainty of loss and income, and the risk caused by the error between the project value estimated by the valuer and the actual project value caused by these uncertainties. Technical problems and improper management in the construction process, the technical level of construction operators cannot meet the requirements, and the tools used for non-standard operation at high altitude are not delivered in time. A series of risks caused by human, technical, technical organization level, management and actual operation process did not meet the requirements, resulting in adverse impact on the project. Monte Carlo simulation is used in risk assessment of Engineering cost. Random simulation method can be used to approximate the system reliability prediction value of engineering cost. Then time series can be generated many times by implementing the set stochastic process. With the increase of simulation times of engineering cost risk, the main risks are identified step by step. The main steps of Monte Carlo simulation are as follows. For the model Carlo simulation of project cost risk, firstly, the overall goal should be decomposed into departments, stages and even specific people, and the responsibility of each work package should be clearly defined. Target decomposition is the basis for achieving the overall goal. In practice, the data of probability distribution is difficult to obtain. In practice, probability distributions such as uniform distribution, triangular distribution and normal distribution are commonly used probability distributions, which conform to the law of occurrence of general events. After Monte Carlo simulation, the probability of risk can be determined by cumulative frequency distribution, and the possibility of risk value can be judged.

3.2 Application of Monte Carlo Simulation in Risk Assessment of Supply Chain.

As the market demand is random, enterprises in the supply chain must constantly adjust the original planning arrangement according to the demand of the external market. From the demand-driven point of view, it is necessary to adjust the plan according to the demand, but it will bring necessary cost waste, mainly for inventory cost and planning cost. From the perspective of resource reallocation involved in the supply chain system, it will bring a series of difficulties and constraints to the operation of the supply chain system. Poor coordination will create bottlenecks in the supply chain, thus reducing the performance of the supply chain and bringing losses to the whole supply chain. Therefore, for the supply chain, market demand fluctuation is a key risk factor, which may cause the supply chain to fail to achieve the expected objectives, resulting in the waste of supply chain costs, and bring losses to the supply chain. Inventory cost usually consists of three parts: purchase cost, inventory holding cost and shortage cost. As a system, the inventory cost of supply chain refers to the sum of the related inventory costs transferred out of the system due to inventory control activities, which is not the sum of the inventory costs of each node enterprise. Therefore, in the supply chain network given in this paper, the seller's purchase cost of products and the manufacturer's purchase cost of raw materials belong to the internal cost of the supply chain, because the supplier's shortage to the manufacturer and the manufacturer's shortage to the seller are not considered. Taking the risk of market demand fluctuation as an example, this paper describes market demand with stochastic distribution in common use, puts forward the risk probability measurement model and risk loss measurement model of market demand fluctuation, simulates the probability density function and risk loss of risk by Monte Carlo method, and solves the problem of risk

estimation of market fluctuation. The estimation method of supply chain risk factors has strong practical value. Supply Chain Risk Probability Measurement. There are many risk factors in the supply chain. Not every risk factor can be described by the existing probability model. Many risk factors are difficult to determine or even determine the specific probability model because they contain many fuzzy and uncertain factors, which makes it difficult to estimate the risk of the supply chain.

3.3 Application of Monte Carlo Simulation in Risk Assessment of Credit Loan.

Credit risk is a kind of credit risk, and it is also one of the basic risks faced by banks. It has long received extensive attention, and formed a variety of traditional methods of measurement and management. For example, expert method, credit rating method and credit scoring method are widely accepted and used tools to assess credit risk. Traditional credit risk mainly comes from the loan business of commercial banks, so it is also called credit risk. These traditional methods still have their rationality and vitality. However, one of their underlying basic characteristics fails to keep pace with the deepening of financial innovation. In recent years, considerable progress has been made in risk measurement and management techniques and scientific research. The new risk measurement and management methods pay more attention to the establishment of highly technical mathematical models. In short, the value-at-risk method is used to measure the possible or potential losses of a given investment instrument or portfolio under future asset price fluctuations. Under normal market conditions, the worst expected loss in a holding period with a given confidence interval. Since its emergence, it has been mainly used to measure the market risk faced by financial assets, but it has less application in credit risk measurement. Compared with market risk, it is very difficult to measure credit risk. Compared with market risk, the probability distribution of credit risk is obviously not normal and unsystematic. Credit risk observation data are few and difficult to obtain. Therefore, we can use it to simulate the stock price distribution of enterprises with specified dates, and then we can get the market value distribution of enterprise’s assets with specified dates. Boot-trap is a computer-based statistical inference method. It does not need to make any assumptions about the unknown population to obtain the empirical distribution of yield.

4. Conclusion

Monte Carlo simulation method can take into account a variety of risk factors and provide more reliable and practical risk analysis results. With the help of computer technology, Monte Carlo simulation eliminates the complicated process of mathematical director and calculating, and can quickly get the results of risk analysis. It is suggested to strengthen the application of Monte Carlo simulation in risk assessment of various industries.

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