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APPROACH TO RISK ASSESSMENT IN PROBLEMS OF PLANNING

The paper analyzes the main types of risks and specific methods of risk analysis in planning problems. The approach to analysis and risk modeling in problems planning based on VaR method. The efficiency of parametric and nonparametric methods for evaluating VaR.

Keywords: planning, risk, assessment methods, efficiency.

Introduction

Risks are inherent part in any human activity, and the development of innovative technologies and business areas, the number of available and potential risks is very high. Today, risk management is seen as a key direction of applied management, much attention is paid to risk areas and the main types of risks, finding effective methods of evaluation, control and monitoring, and the establishment of appropriate systems of risk management. Risk analysis in various applied problems is very wide and very fast development research field. The efficiency of solving any problem depends mainly on the correctness and validity of decision-making process at all stages of problem solving and, regardless of the complexity of problems to be solved, which is impossible without risks. Managing of any kind of processes or solving planning problems it is necessary to analyze risks, evaluate its extent, anticipate the consequences of the decision and do not go out from the acceptable limits of risk. Thus, for effectively solving of dynamic planning problems it is necessary to identify risks, anticipate it taking as a goal to reduce it to the lowest possible level.

Problem Definition

The aims of the article are: 1 - consider features of risk analysis methods in dynamic planning problems; 2 - develop an algorithm based on VaR method for modeling risks in planning problems.

Overview of Basic Risk Types and Modern Methods and Models of Risk Analysis

The main cause of risk is the uncertainty of the environment, which is caused by factors such as the lack of complete and accurate information about the environment; limited capacity for perception and processing of information about the process or system; chance of occurrence of adverse events in the course of business, or planning; conscious opposition to the stakeholders, including competitors; conflicts; break of contractual obligations; political decisions that significantly affect the economy, and so on.

The need for risk assessment in solving various problems is persistent. There are two types of risk assessment: "subjective" assessment is the risk assessment, such as "large", "medium", "small", this risk assessment affects subjective decision. [1] The "technical" risk assessment that used in information systems for more detailed estimated risks, such as: economic, insurance, environmental, and others.

In terms of risk sources they are divided into external (endogenous) and internal (exogenous). [1,3]

External risks that are arising in the external environment to the object and does not directly depend on its activity. It is the political, legal, social and general economic risks that arise in the event of worsening economic crisis in the country, political instability, war, prohibition on payments abroad, debt consolidation, embargo, cancellation of import licenses, natural disasters (fires, floods, earthquakes) privatization, nationalization, inadequate regulation and so on.

The main factors that affect the level of external risks are political, technical and economic.

All other factors - demographic, social, geographical - are considered in the light of political and economic factors.

There are file main groups among the external risks:

– Risk of force-majeure - unforeseen circumstances that affect the activity of any enterprise or institution;

– Country risk - the possibility of unfavorable business conditions in political, legal or economic area of the country where the company conducts activities, or institution;

– External - political risk - the probability of changes in international relations and political situation in a country that affect the business, or institution (war, international scandals, closure of borders, etc.);

– Legal risk - the probability of an unfavorable situation related to changes in the legislation of different countries;

– Macroeconomic risk - the probability of adverse changes in conditions in certain markets or the economic situation in general (economic crisis).

Implementation of external risks could jeopardize the continuity of the company or institution. The impact of external risks to the effectiveness of the institution exceptionally high, risk management the most difficult, and often - impossible. Therefore, enterprise or institution shall take into account the possible impact of external risks and assess the probability of extreme circumstances using stress scenarios. Assessing the external risks expert and logical methods of analysis are mainly applied. In the case of critical circumstances urgent measures in the form of an action plan are also developed. This plan should be regularly updated and tested. This plan is an integral part of mechanisms to control the level of riskiness.

The internal risks are arising directly from the relationships with the activities of a particular company or institution. The wider range of clients, partners, relationships, banking services, the more internal risk accompanies its work. Internal risks are better exposed to identification and quantification as external ones.

According to the accepted classification of internal risk distinguish several categories of risks, which are divided into two groups:

The first group include quantifiable risks. Quantifiable risks have a direct relationship between risk and income. The purpose of the process of risk management is their optimization. The second group include risks that can not be quantitatively evaluated, i.e. nonquantifiable risks [1]. Nonquantifiable risks have no direct relationship between risk and bank yields. The goal of management is their minimization. These are risks as legal, strategic, reputation.

The process of identification and risk management in dynamic planning problems, aimed to identify existing risks in the development plan, their assessment, planning and implementation of measures to reduce the impact and elimination of risk factors. The general scheme of the process of identification and risk management is presented on figure 1.

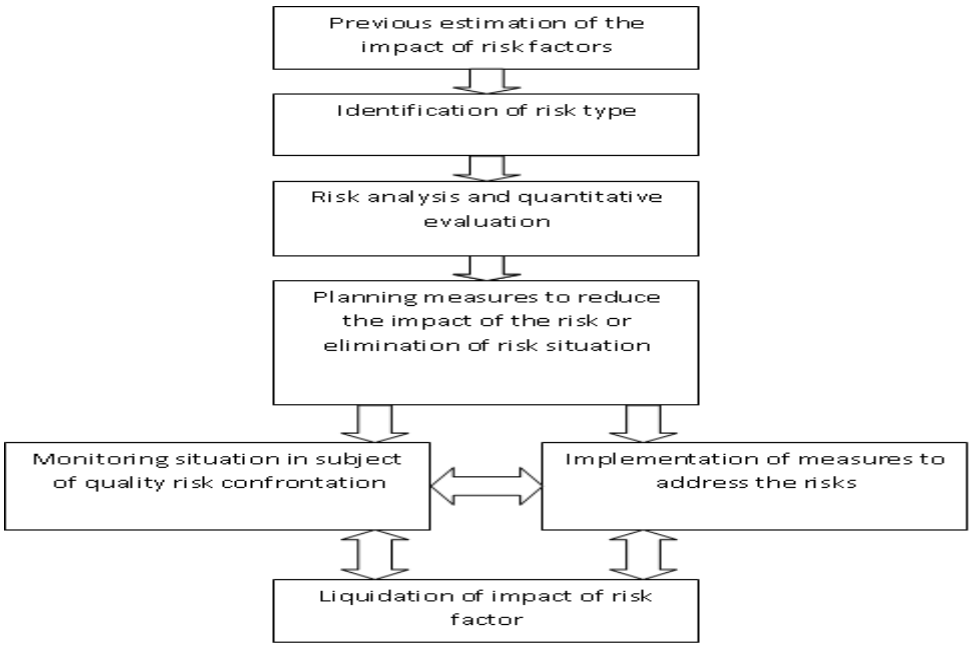

Fig. 1. Process of the identification and risk management

Assessing the external risks logic and expert analysis methods are mainly applied. In the case of critical circumstances urgent measures are also developed. Such a plan should be regularly updated and tested. The internal risks are arising directly in connection with the development of specific stages of the plan. Internal risks are better exposed to identification and quantification as external ones.

Measures of Risk

Assessing the risk magnitude in the dynamic planning problems risk is possible. Two important aspects characterizing the risks: indicators ***volatility*** (the probability or events frequency), and, secondly, ***sensitivity*** criteria to their impacts. Accordingly, we can offer two main categories of risk measurement: sensitivity indicators and probabilistic (statistical) value. [6] The distribution is even more conditional, with taking into account the subjectivity that is an essential feature of risk assessment.

Volatility. In practice, the distribution of performance indicators is usually measured by retrospective, assuming that the observations are identical and independently distributed. If N - number of observations, then the expected yield m can be estimated as simple average $\bar{x}$, and the risk variance - estimation of variance. The square root of the variance of estimates yield - standard deviation - called volatility.

$$\sigma = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}\,. \qquad (1)$$

It measures the magnitude of dispersion of values around the expected performance level [2].

It should be noted that the ***uncertainty of risk*** is characterizing not certain indicators of the distribution, but the distribution. There are distributions, such as Cauchy distribution for which there is no dispersion and approximation by Cauchy distribution of random processes, which are characterized by a finite expectation and finite variance is illegal. [6] Therefore, the choice for the estimation of volatility characteristics of a distribution should be based on features and data distribution problem. As a result, we can conclude that volatility is a characteristic that determines the variability of results from using certain tools. And one example is its standard deviation

The time interval for which the calculated volatility and other parameters can be varied: hours, days, weeks, months, quarters, years. In this regard, there is a problem of aggregation - an expression of volatility and expected performance for different periods.

Considered risk measures characterized by the following shortcomings:

1. Most of them can not be aggregated, (summarized in one parameter of the same type equally to all risk factors). Risk factors can not be aggregated for different tasks.

2. Traditional risk measures compared poorly to monitor risk. Position limits are defined by risk factors or indicators of sensitivity are often ineffective.

This explains the great popularity, which in modern risk management approach with the use of risk assessment is based on the "value at risk» (value at risk - VAR), that effectively cope with the above listed problems.

Index VaR (Value-at-Risk). VAR - is the currency (base currency) assessment of the value which will not exceed the losses during this period with a given probability. [2]

Let a fixed list of open positions. VaR of the portfolio for a given confidence level (1-α) and support positions for a given period t, defined as a value that covers the possible losses of the portfolio holder x at time t with probability (1-α):

$$P(Var \geq x) = 1 - \alpha \qquad (2)$$

As follows from the definition, the value of the VaR of portfolio for a given structure is the largest expected loss, which is caused by price fluctuations in financial markets, which is calculated for:

– A specified period of time in the future (time horizon);

– A given probability of exceeding it (confidence level);
– Assumption about the behavior of the market (method of calculation).

VaR is key that has the following options:

• Expected risk, which can be calculated in absolute terms or as a percentage of the value of the index to a specified date.

• Time horizon that characterized the expected risk value (i.e. the period during which you can implement this tool on the market (close position) without significant losses). In practice, depending on the specific use of VaR such horizons can often be a day, a week, ten days a month.

• Depth settlement period of VaR. This retrospective volume or simulated data is determined based on the score. For example, the phrase "depth calculating of week VaR is 2 years" means that the calculation of loss data were taken for a week for 2 years. [5]

The level of confidence (probability) with which the maximum loss does not exceed the expected calculated risk value is determined by the preferences of risk, in the form of regulatory documents supervisors or corporate practice. For example, the Basel Committee on Banking Supervision recommended trust level - 99%, which is oriented by supervisors, in practice, the most popular trust level - 95%. [6] Thus formula (2) is interpreted as the expected number of VaR risk exceeds the real number x for risk time horizon t with probability α. (α.=0,01;0,05, etc.).

Lets consider approaches to assessing VaR. The evaluation methods are presented on figure 2.

Parametric VaR calculation method means an analytical calculation of the required risk assessment based on statistical models of financial performance of the portfolio.

Almost any parametric method is based on two main components:

– The model dependence of the value of the financial result of changes in portfolio risk factors;
– Volatility model and correlation of risk factors.

Local estimation means linear, or a more complex value approximation function of a financial instrument. [6.7]

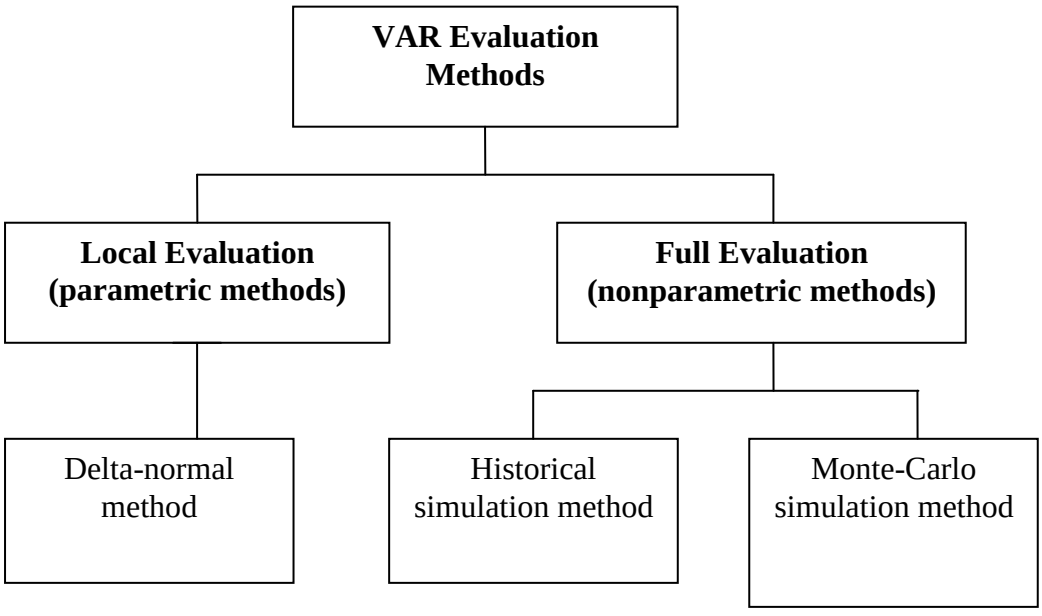

Fig. 2. VaR evaluation methods

There two most widely used nonparametric methods of VaR evaluation:

– Delta-normal VaR;
– Delta-gamma VaR.

On practice most widely used is delta-normal VaR.

Delta-normal method of VaR evaluation provides a VaR estimate in closed form. It is based on the assumption of normal distribution of logarithmic yields risk factors.

$$r_t = \ln(\frac{P_t}{P_{t-1}}) \sim N(\mu, \sigma^2) \quad (3)$$

The assumption of normal distribution of risk factors greatly facilitates finding the value of VaR, as in this case, the distribution of instruments yields that are linear combinations of risk factors will also be normal. This fundamental property will be kept for any portfolio that consists of the tools of linear price characteristics, such as stocks or currencies.

In the case of normally distributed random variable confidence interval (1-α) is always characterized by a single parameter – $k_{1-\alpha}$, quintile that shows the position of the desired value of a random variable (symmetrically in both tails of the distribution) relative to the average ($M[r_t]$), which is expressed in number of standard deviations of portfolio yield (σ_t). Thus, for the values of the confidence interval, which is often used, 95 and 99%, respectively fractile will equal 1.65 and 2.33 standard deviations of portfolio yield.

Advantages and disadvantages if delta-normal method.

Advantages of delta-normal method are:

1. Comparative ease of implementation
2. The relatively small cost of the current data collection
3. Allowable accuracy of the VaR in most cases of practical use in accordance input.

Disadvantages of delta-normal methods are:

1. Low accuracy of the risks evaluation of nonlinear instruments due to a lack of sensitivity of nonlinear measurement instruments to risk factors.

2. Distributions of yields of most financial assets characterized by rejection at the edges of the probability distribution density to the normal distribution. As a result, VaR estimations based on the normal distribution are too high or too low.

3. Ignores the risk of extreme market events that may lead to abnormal loss and not frequent enough to be represented in the recent historical data (based on the estimated correlation and volatility of yields).

Stress testing, which is a form of scenario analysis, takes into account the risk of extreme events. Stress testing - a method of quantitative risk assessment, which determines the value of an inconsistent position, which is determined by factors external shocks - the exchange rate, interest rate and so on. [2] The combination of these values gives an idea of the amount of income or losses can be obtained if events will develop on the specified assumptions.

Nonparametric methods (full evaluation methods).

Nonparametric methods are those methods which estimated functions (for example, the distribution function) are not defined by a finite number of parameters. Full evaluation means that the full evaluation of a financial instrument is held without approximating assumptions [5].

Most widely used nonparametric methods are:

– Historical simulation method;
– Monte-Carlo simulation method.

The essence of both methods is in construction of empirical distribution function of future price changes, and following potential gains and losses.

Historical simulation method.

Historical VaR method of estimation the risk value (VaR) is applied for computing real historical time series of values of a random variable that is analyzed. To calculate VaR you need to build distribution simulated changes in value of an asset or portfolio of assets within previous historical period, depending on changes in one or more risk factors for the same period. The procedure for implementation of the method is as follows:

1) Determine the initial number of indicators - basic values (e.g., prices) in question for all recorded for historic period of the market states;

2) Determine the time interval with which the risk value will be calculated (VaR);

2) Determine the probability (confidence level) with which risk value will be calculated;

3) Consistently calculate changes of basic values and the corresponding change in the value of a single asset or portfolio of assets using the basic values of the corresponding random variable.

4) Value changes calculated on the previous step are arranged in increasing order of formation of the time series changes;

5) According to the chosen probability in the time series changes, starting with the largest negative values singled out as values to the ratio of their number to the total number of values in a time of change was less than 1-α % for the probability α (e.g., less than 1% for 99% probability);

6) The value form the values set that remaining after separation of the data on the previous step, with the lowest index number is the desired value and risk value of VaR. [5]

Advantages of historical simulation method:

- The relative ease of implementation of the method;
- No assumption of normal yields distribution of risk factors or any other stochastic models of price changes on the market, except the one that actually observed in the past (which takes into account the effect of "fat tails" of the distribution;
- A good accuracy of risk assessment nonlinear financial instruments;
- No risk of false use of models to assess the value of the tool;
- Intuitive and easy observation.

Disadvantages of historical simulation method:

- Incorrect results if the sample is obtained on the base period is not representative, including on the number of observations;
- Uses only one trajectory of prices;
- Ignores differences between old and recent observations, while removing the oldest sample values can significantly improve the accuracy of the model;
- Large amount of computations for large diversified portfolios.

Monte-Carlo simulation method.

Monte Carlo or stochastic simulation method based on the simulation of random processes with given characteristics. Unlike the historical simulation, the Monte Carlo method changes are generated in pseudo-random manner according to set parameters of distribution, such as the mathematical expectation μ and volatility σ. Simulation distribution may vary, and the number of scenarios - quite large (up to several tens of thousands). In other method similar to the method of historical simulation.

Main features of assessment methods are presented in table 1.

Table 1. Main features of assessment methods

Method / **Criteria**	Delta-normal	Historical simulation	Monte-Carlo simulation
Evaluation	Local	Full	Full
Considering the historical distribution	As assessment of normal distribution	Similar that were in the past	Full
Consideration of "acceptable" volatility	Possible	No	Yes
The assumption of a normal distribution of returns	Yes	No	No
Estimation of extreme events	Bad	Bad	Possible
Model risk	May be significant	Allowed	High
Retrospective volume	Medium	Very large	Small
Computational complexity	Not high	High	Very high
Observation	Medium	High	Low
Computational power	Low	Medium	High

Conclusions

The VaR measure of risk has a number of advantages and disadvantages. Among its advantages it should be noted the ease of presenting information about risk as only one value of the cost of losses. Among its disadvantages - the lack of information on cases where the probability is low, the lack of information about the distribution of losses and possible ambiguity in assessing damages based on decomposition resources for risk factors. Local evaluation and full evaluation are used to estimate the VaR. The main drawback of local methods of assessment is the assumption of normal distribution of retrospective data with which assessment of risk factors volatility is held. The disadvantages of the full evaluation methods are high demands for accounting facilities in real time and the lack of information about the distribution of losses, when different distributions for a given level of confidence can be observed with the same VaR value. The adequacy of the model for risk assessment in planning should be determined periodically by calculating prediction errors of exposures by the year.

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