Logic and probabilistic calculus of Ryabinin and management of risk and efficiency in economics

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Abstract

We state the theoretical fundamentals and describe applications of the logic and probabilistic (LP) approach to management of risk and efficiency in banks, economical and social systems, which consider as structure-complex with L-connections, random events and probabilities. In statistical data base we introduce finite sets for values of parameters. It allows us to get knowledge base and risk model in the form of the L-equations system. We describe also risk LP-models, methods of identification, analysis and LP-management of economical systems on criterions of risk and efficiency.

Keywords: risk, efficiency, economics, bank, system, data base, knowledge base, logic, probability, model, identification, analysis, management.

In book by I. A. Ryabinin "Reliability, vitality and safety. Stories of different years" [1] is stated the history of creation of the logic and probabilistic calculus (LP-calculus) for investigation of problems reliability, vitality and safety in technical systems. LP-calculus of Ryabinin attracted attention of scientists, which are occupied with estimation and analysis of risk in economics. During more than ten years we executed researches and developments, which allowed to create a new efficient information technology and software for management of risk and efficiency in banks, economic and social systems on the base of LP-calculus. Economic, social and organizational systems are structurally complex. They have a great quantity of elements and connections as well as random changes of parameters. In engineering yet in big companies only 3-4 experts are occupied with reliability and safety. In economics the number of companies is bigger on 2-3 order and each manager and economist is occupied with analysis and management by criterions of risk and efficiency. In economics the area of applications of risk LP-models is practically infinite. At present there is no other mathematical adequate approach to assessment, analysis and management of risk and efficiency in banks and economics. The becoming of a new LP-approach to management of risk and efficiency in economics is occurred no easily.

1 Basic axiomatics of LP-calculus

In second edition of the book [2] I. A. Ryabinin leaded the new chapter "Phenomenon of logic and probabilistic calculus" and Appendix 4 with documents on contribution of outstanding scientists Dg. Bool, S.G. Bernstein and V. I. Glivenko in bases of LP-calculus.

Axiomatics of Bool's logic. English scientist Dg. Bool leaded the calculus of propositions truth, or Boolean algebra (1840). This work created the start of the new scientific discipline - mathematical logic.

Axiomatics of Bernstein's events. Russian scientist S. N. Bernstein *extended* axiomatics of Bool's logic on axiomatics of the event (1917). He proposed the totality of axioms for describing of concepts of the event and leaded probabilities of events.

Axiomatics of Kolmogorov's probability. Russian scientist A.N. Kolmogorov proposed axiomatics of the probability (1929), which is the most well-known in at present. He leaded the normalized Bool's algebra of measurable subsets of segment 0, 1.

Axiomatics of Glivenko's sets. Russian scientist V. I. Glivenko fulfilled the analysis and generalizations of axiomatics of logic, event and probability. He showed, that in this case there is not necessity to formulate the special axiomatics for concepts of event and probability, because we can use the ready axiomatics of the set and measure.

Axiomatics of Ryabinin's LP-calculus is formulated on the base of axiomatics of logic, event, probability and set for problems of reliability and safety of structure-complex technical systems and included the following additional axioms:

1. Elements of system have only two levels of values (0 and 1).
2. Elements of systems are connected by L-connections AND, OR, NOT and can be cycles.
3. LP-model of system reliability or safety is built on real scheme of functioning of the system in the form of the shortest paths of successful operation or in the form of minimal cuts of refusals.
4. Weights, significances and contributions of individual elements of the system and their groups are determined by analytical calculations on the LP-model of reliability and safety of the system.

2 Data base and knowledge base in problems of risk and efficiency

We changed in Ryabinin's LP-calculus only the axiom 1 to decide the problems of management of risk and efficiency in banks, economical and social systems: system elements can have the finite set of states (for example until 10-50 in tasks of credit risk and portfolio of security) [3; 4; 5]. Every state of element we consider as grade-event and logical variable. The system can be no two different states, but in the number of different states, equaled product numbers of states of system elements. The risk and efficiency LP-model must explain statistical data of functioning system. It is necessary to decide the task of identification for determination of probabilities of grades-events of system elements on statistical data. Thus, the state of the system is described by parameters that may be quantitative and qualitative and have different dimensions. These random parameters are converted into L-variables connected by logic operations AND, OR, NOT. The efficiency parameter of the system states and the parameters effecting on the efficiency parameter are distinguished among the parameters. Risk and efficiency of the system are considered not separately but as a whole (if there is not efficiency then there is not risk). The efficiency parameter has allowable value. The probability that the efficiency parameter will be less than the allowable value is risk. Statistical data of the system states are presented as a tabular data base (DB), in the columns of the table there are values of parameters. For each parameter that describes the system states the finite set of values or the group of incompatible events (GIE) is introduced thus continuous distributions of random parameters are replaced by discrete sets. On the finite sets of parameter values, logic variables, grades-events and parameters events are introduced. The tabular DB is presented as a new table of the system states where grades-events are in the cells of the table and thus we have a tabular knowledge base (KB). The system has the finite number of states that equals multiplication of the grade numbers for each parameter. Different states of the system are logically orthogonal and their probabilities may be added. It allows replacing an astronomical number of different states with restricted number in statistics. The grade-event in GIE has three probabilities that define appearance and non-success of the system states. The mentioned probabilities and their mean values are connected with the Byes formula. In a lot of risk problems the effecting parameters are considered as independent ones. It is explained by the fact that in real management problems specialists consider only the main parameters due to complexity of the systems and reduce the number of them to the minimum. In statistical tabular KB of states of the complex system with the finite set of parameter values two types of events with their logical and probabilistic functions are considered: 1) appearance of the state; 2) non-success of the state. For events of appearance and non-success of the system states the system of L-equations are written in the tabular KB, they are considered as logical KB or the systems of L-expressions. The system of L-equations of the system non-success may be converted by methods of orthogonalization into the system of non-success P-equations that is used for receiving knowledge of probabilities of events-grades and risk of the system states. For social and economic systems we propose unification of the risk model, the tabular DB, the logical KB and algorithmic iterative method of the problem decision in information technology of LP-management of risk and efficiency.

3 Classes of LP-models of risk and efficiency of systems

Sets of all applications in economics and corresponding risk LP-models are divided to three classes [3; 5]:

- LP-efficiency (the choice of the optimal security portfolio, commodity circulation of restaurant and shops, bribes and corruption and etc.);
- LP-classification (credits, banks, rates, states of system and etc.);
- LP-modeling (risk of a Euro fall, risk of non-electing of president, risk of economical crisis in the country, risk of non-success of management of company and etc.).

These classes have peculiarities in the problem definition and methods of risk assessment and analysis. The LP-modeling (class of models of Ryabinin) is used for construction of risk LP-models of LP-classification and LP-efficiency. The transition from L-model of LP-efficiency class to LP-model of LP-classification class is possible for the targets of the system risk and efficiency analysis as well as from the model of LP-modeling class to that of LP-classification class. Risk P-model unlike the scoring methods is non-linear and structurally complex function. Risk LP-model is always possible to write as a perfect disjunction normal form (PDNF), the fullest and bulky one in writing and calculus. In particular cases the compact risk LP-models are constructed or those with the restricted number of events or as the shortest ways of functioning or using risk scenario. Risk LP-model may be a complex one with joining of particular risk models by AND, OR, NOT operations. Risk LP-model may be a dynamic one with changing probabilities of events in time function or with the use as the time itself parameter or with re-training the model on the new data of monitoring.

4 Identification of risk P-model on statistical data

Identification of non-success risk P-model on statistical data allows defining the probability of non-success for grades-events and allowable risk [4; 5]. As a criterion of identification an integer target function is used: the number of correctly identified good and bad states of the system should be the maximum one. The probabilities of events-grades are defined with accuracy up to 6-7 decimal sign. Identification is an inverse optimization problem to be solved by algorithmic iterative methods of random search or gradients using Byes formula. Recognition asymmetry of good and bad states of the system should be assigned by the choice of the number of good states for the risk LP-model, and the mean risks of the system states should be given on statistical data. LP-models should be specified equal in order that the probabilities of grades-events would have the real meaning. The formulae for the algorithmic iterative identification provide decision taking at a great number of the system states, parameters and grades in parameters and at any L-complexity of the risk model. The quality of the risk LP-model is defined by the following criteria: identification accuracy and stability, transparency of risk assessment and analysis, reduction of the time of the credit application considering.

5 LP-analysis of risk and efficiency in systems

LP-analysis of the system risk and efficiency is carried out on the risk P-model. It consists in definition of contributions of effecting parameters and their grades into risk and efficiency of the system. Combinative and statistical methods of analyses and LP-analysis of the system risk and efficiency are considered. Statistical method of analysis is the simplest one as per computation. LP-analysis has the greatest possibilities for the detailed system risk and efficiency analysis. Combinative analysis makes clear the essence of the process of identification (optimization). Structural significance depends on the place of the element in the risk graph-model. Probabilistic significance takes into account both the place and the value of probability for the system element. The dangerous system elements and their combinations are disclosed by the change of the system risk when they are excluded.

6 LP-management of the risk and efficiency

Operative management of the system risk and efficiency is accomplished by the results of the risk and efficiency analysis in the following succession: assessment of contributions of grades-events and parameters-events, the choice of the most significant contributions, distributions of resources for the change of probabilities of the most significant grades-events and parameters-events. Strategic management of the system development on criteria of risk and efficiency is the management of movement along the chosen trajectory and correction when declining from it. The features of management of the system risk for operation and evolution tests are stated too.

7 Computers and Software in the problems of risk LP-management

The advanced computers should be used since risk LP-models identification and the system risk and efficiency analysis are of extreme computational complexity. Special software is necessary for LP-models of each class: LP-efficiency, LP-classification and LP-modeling. Special logical software is developed for models of classes LP-classification and LP-efficiency (the author is E. Solojentsev) and for class LP-modeling (the author is A. Mozhaev).

8 Applications and advantages of risk and efficiency LP-management

Scenarios of non-success, L- and P-models of risk and efficiency, methods of identification and analysis of risk on statistical data are developed for the applications presented in table [3; 4; 5]. LP-models of risk showed in applications the whole number of advantages in accuracy, stability and transparency of assessment and analysis both the system states risk and the entire system as a whole. The advantages of LP-management of the credits, for instance, are the following:

- twice greater accuracy in classification of good and bad credits,
- seven times greater stability in classification of credits,
- absolute transparency in assessment and analysis of credit risks,
- reduction of time of the credit application considering,
- decision of the new problems of risk analysis and management.

Table 1: Areas of applications of LP-management of risk and efficiency.

	Areas of applications	**Characteristics of applications**
1	Risk of credits of natural and juridical persons	Demonstrational calculation of risk on real data of four banks. Five laboratory works on PC
2	Risk of security portfolio	Risk management of real portfolio. Five laboratory works on PC
3	Risk and efficiency of economical system	Management of risk and efficiency of real restaurant (shop)
4	Non-success risk of company and its management	Researches of management non-success risk of company "Transas". Fifty themes of laboratory works on PC
5	Risk of bribes and corruption	Model researches of risk of bribes in the office, and risk of fraud of official
6	Risk of bribes in service	Real researches of bribes risk in kindergarten on the waiting time of excepting in line
7	Risk of non-success of system development	Real researches on management of non-success risk of system development
8	Risk and efficiency of social and economic processes	Model researches on analysis of risk and efficiency

Let us remind Rudolf Kalman [2], who wrote that the problem "data model explaining data" should be considered as a main one for any field of science. Note that he means not the approximation of the data by the model but the explanation of the data that cannot be done by a hundred of scoring methods and the methods based on neuron networks. Actually the logic scenario of non-success is formulated as follows: non-success of the credit occurs due to any one parameter-event or any two parameters-events-or ... all parameters-events. As per this scenario the risk L-model and of risk P-model is easily written. We have nothing similar in scoring methods. Risk LP-models may be developed for all aspects of the activities of a bank, company or an office. For a bank, for instance, there are the following risk LP-models: assessment and analysis of credit risks of natural and juridical persons, risk of investments, operational risks, complex model of the bank risk, operative management of risks, strategic management of the bank development on criteria of risk and efficiency, assessment of the bribes risk at evaluation of the guaranty

value, of the size and the time of credits, analysis of risk and efficiency of the bank functioning, the crises prediction, risk assessment of the bank management non-success, risk assessment of the bank functioning quality loss.

Conclusion

The LP-approach and accurate mathematical methods are used for construction and identification of risk LP-models for assessment, analysis and management of risk and efficiency in banks and economics. We suppose that the developed LP-models and software will be called for though it will require some time and efforts of economists, financiers, managers and mathematics so that LP-approach to management of risk and efficiency in banks, economic and social systems would accomplish a revolutionary outbreak in economics and financial market. There are the following difficulties in introduction of the developed methods and software:

- the publications on LP-management of risk and efficiency are practically not known to economists, financiers and managers;
- such disciplines as LP-calculus, logic, discrete mathematics and combination theory are not included into education programs of universities and colleges;
- the Russian market is "seized" in the "evil 90-ies
- by the Western expensive, non-transparent and of low quality information technologies, models and software.

The further development of risk LP-management may be as follows:

- construction and research of complex and dynamic LP-models of risk;
- development and use of LP-models of risk for various applications;
- developing Software and special computers with acceptable cost for all classes of risk LP-models for training students of universities;
- the expertise and certification of risk LP-models and efficiency and the appropriate software.

The LP-approach to management of risk in banks, economic and social systems is identified as a paradigm - acknowledged scientific achievements that in the course of time may give to the society the model of the problems setting and deciding. It is expedient to create scientific centers and scientific cities not only on the problems of recently appeared nanotechnologies, but on those of constructing efficient information technologies and software for management of risk and efficiency in everyday economics of many thousands companies, banks and enterprises, the existing problems of greater priority. The expected economic effect is not less than from introduction of nanotechnologies. If we do not arrange the productive management of risk and efficiency in economics, so resources on these nanotechnologies go off sand as before.

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