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5.2.2. Математические, статистические и инструментальные методы в экономике (физико-математические науки, экономические науки)

КОНТРОЛЛИНГ ЭКОНОМИКО-МАТЕМАТИЧЕСКИХ МЕТОДОВ

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Контроллинг как междисциплинарное научное направление посвящен современным технологиям управления в социально-экономической области. Управленческие решения принимают на основе анализа совокупности пяти групп факторов - социальных, политических, экологических, экономических и политических. При подготовке и принятии управленческих решений применяют различные интеллектуальные инструменты (методы). Контроллинг экономико-математических методов – это разработка процедур управления соответствием поставленным задачам используемых и вновь создаваемых (внедряемых) методов. В статье дан краткий обзор развития контроллинга экономико-математических методов за последние 15 лет. Рассмотрены такие его разделы, как контроллинг рисков, инфляции, качества, научной деятельности, статистических методов, инвестиций. Полагаем, что анализ, оценку и управление рисками целесообразно проводить единообразно для различных конкретных областей. Выделяем личные, производственные, коммерческие, финансовые, глобальные риски. Разработана обобщенная аддитивно-мультипликативная модель оценки рисков на основе нечетких и интервальных исходных данных. Под инфляцией понимаем рост цен. Для получения обоснованных выводов в области экономики и управления необходимо перейти к сопоставимым ценам. Контроллинг качества посвящен требованиям к методам управления качеством промышленной продукции, к процедурам статистического приемочного контроля и статистического регулирования технологических процессов. Работы по наукометрии и науковедению, посвященные требованиям к методам оценки результативности деятельности исследователей и научных

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5.2.2. Mathematical, statistical and instrumental methods of economics (physical and mathematical sciences, economic sciences)

CONTROLLING OF ECONOMIC AND MATHEMATICAL METHODS

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Controlling as an interdisciplinary scientific direction is devoted to modern management technologies in the socio-economic field. Management decisions are made on the basis of an analysis of the totality of five groups of factors - social, political, environmental, economic and political. When preparing and making managerial decisions, various intellectual tools (methods) are used. Controlling of economic and mathematical methods is the development of procedures for managing the compliance with the tasks set for used and newly created (implemented) methods. The article gives a brief overview of the development of controlling economic and mathematical methods over the past 15 years. Its sections such as controlling risks, inflation, quality, scientific activity, statistical methods, investments are considered. We believe that the analysis, assessment and risk management should be carried out uniformly for various specific areas. We single out personal, industrial, commercial, financial, global risks. A generalized additive-multiplicative risk assessment model based on fuzzy and interval initial data has been developed. By inflation we mean the rise in prices. To obtain reasonable conclusions in the field of economics and management, it is necessary to move to comparable prices. Quality Controlling is devoted to the requirements for methods of quality management of industrial products, for the procedures of statistical acceptance control and statistical regulation of technological processes. Works on scientometrics and science of science devoted to the requirements for methods for evaluating the performance of researchers and research teams, led to the creation of controlling scientific activity. Two sections of controlling economic and mathematical methods that are currently actively developing are controlling statistical methods and controlling investments. The modern fashion on neural networks leads to the fact that the optimal methods and algorithms of applied statistics that solve the same

коллективов, привели к созданию контроллинга научной деятельности. Два активно развивающихся в настоящее время раздела контроллинга экономико-математических методов - контроллинг статистических методов и контроллинг инвестиций. Современная мода на нейросети приводит к тому, что решающие те же задачи оптимальные методы и алгоритмы прикладной статистики не используются. Так, в базовой задаче диагностики следует принимать решение на основе непараметрических оценок плотностей вероятностей, полученных для каждого из двух классов по соответствующим обучающим выборкам Ни один нейросетевой метод не может дать лучшего результата. Необходимо дальнейшее развитие предложенных идей и подходов

Ключевые слова: КОНТРОЛЛИНГ, ЭКОНОМИКА, УПРАВЛЕНИЕ, МАТЕМАТИКА, МЕТОДЫ, РИСК, ИНФЛЯЦИЯ, КАЧЕСТВО, НАУЧНАЯ ДЕЯТЕЛЬНОСТЬ, СТАТИСТИЧЕСКИЕ МЕТОДЫ, ИНВЕСТИЦИИ

problems are not used. So, in the basic problem of diagnostics, a decision should be made on the basis of non-parametric estimates of the probability densities obtained for each of the two classes on the corresponding training samples. No neural network method can give a better result. It is necessary to further develop the proposed ideas and approaches

Keywords: CONTROLING, ECONOMY, MANAGEMENT, MATHEMATICS, METHODS, RISK, INFLATION, QUALITY, SCIENTIFIC ACTIVITY, STATISTICAL METHODS, INVESTMENT

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Introduction

Controlling as an interdisciplinary scientific direction is devoted to modern management technologies in the socio-economic field, i.e. modern management technologies. As is well known to every head of an organization or region (manager, manager), managerial decisions are made on the basis of an analysis of a combination of five groups of factors - social, political, environmental, economic and political [1|1][1]. Therefore, it must be stated that economics is a part of management, since it covers only a part of the factors that a manager needs to take into account in his work. This statement is also confirmed by the author's own experience as the head of a number of organizations.

In our country, the term "controlling" began to be used at the end of the twentieth century. Gradually, a community of specialists emerged. An important

[1] Here and below, the notation of the form [N|1] means a reference to the publication [N], given in the article [1] of the list of references.

milestone in the development of controlling in our country is the creation in 2001 of a professional organization - the Association of Controllers. To date, controlling is a developed area of scientific and practical work with a complex internal structure. This area can be looked at from different angles, respectively, there are many different definitions of the concept of "controlling". We will proceed from the definition of S.G. Falko [2|1], according to which controlling is "a perspective-oriented and fact-based system of information, analytical and methodological support for management in the process of planning, monitoring, analyzing and making managerial decisions".

2. Controlling of organizational-economic (economic-mathematical) methods as an independent direction in controlling

There are many different directions (areas) in modern controlling [7|1]. In articles [8|1], [9|1], we started developing another of them - controlling organizational and economic methods (see also [10|1]). Controlling within this area is the development of procedures for managing compliance with the tasks set for used and newly created (implemented) organizational and economic methods. With this formulation, we are far away from the original concept of controlling, which is primarily related to the financial aspects of the organization (enterprise), management accounting, in general, from the problems of managing an economic unit, we go beyond the boundaries of economic sciences.

The justification for the expediency of such an expansion of the subject of controlling organizational and economic methods is that in many areas of scientific activity there is a need to manage the compliance of the methods used with the tasks set. For example, in applied statistics, rules are needed to check the adequacy of the calculation methods used in the real situation. The development of such rules is carried out by the controlling of statistical methods [10|1], [11|1], the results of which are applicable in the analysis of statistical data in any field.

Several terminological remarks need to be made. Different terms are often used to refer to the same entities. We discussed some reasons for this in the article [12|1]. As an example, let's point out the evolution of the titles of a series of our three textbooks "Non-numeric statistics", "Expert estimates", "Statistical methods of data analysis". Initially, on the Internet resource of our Scientific-research laboratory "Economic and mathematical methods in controlling" BMSTU[2], this series was called "High Statistical Technologies". Then these textbooks were released under the serial name "Organizational and economic modeling" ([13|1], [14|1], [15|1]). When republished in 2022, the series changed its name to "Artificial Intelligence" ([16|1], [17|1], [18|1]). We believe that the subject under consideration is part of the scientific direction "Economic and mathematical methods", according to the name of our laboratory, and also corresponds to the scientific specialty "Mathematical, statistical and instrumental methods in economics". For further discussion of terminological problems, we refer to the already mentioned article [12|1].

It should be noted that in our publications we consider organizational and economic methods as mathematical methods of research (in accordance with the direction of the eponymous section of the journal "Industrial Laboratory. Diagnostics of Materials"). In particular, this is why we replaced the title of our textbook series "Organizational and Economic Methods" with "Artificial Intelligence" when reprinting in 2022.

This paper provides a brief overview of the development of controlling economic and mathematical methods over the 15 years that have passed since the publication of the article [8|1]. Due to the limited volume of the article, we confine ourselves to references to our works.

[2]http://ibm.bmstu.ru/nil/biblio.html

3. On the scientific results obtained in the framework of controlling economic and mathematical methods

Such sections of controlling economic and mathematical methods as controlling risks, controlling inflation, controlling quality, controlling scientific activity, controlling statistical methods and controlling investments are considered (a variety of areas and tools of controlling is presented in [19|1]).

The main ideas of the general theory of risk are formulated in article [20|1]. We believe that the analysis, assessment and risk management should be carried out uniformly for various specific areas. We single out personal, industrial, commercial (due to relationships with suppliers, consumers, competitors, authorities, banks, organizations, electricity and utilities providers, etc.), financial (caused by changes in legislation, inflation, determined by stock and currency rates), global risks. The article [21|1] is devoted to the variety of risks.

Analysis of the current state *risk controlling* carried out in [22|1]. The article [23|1] is devoted to risk controlling tools. These are the requirements for such tools. One of the recent developments is a generalized additive-multiplicative risk assessment model based on fuzzy and interval input data [24|1], 25|1]. Note that the term "fuzzy logic" is quite often used instead of the terms "fuzzy theory" or "fuzzy set theory", which is not adequate, since logic (the science of thinking) is only one of the areas of application of fuzzy theory. Therefore, we use the term "fuzzy set theory" (or "fuzzy theory"). It is useful to note that the term "fuzzy" is translated into Russian in different ways: fuzzy, vague, blurry, foggy, fluffy.

Risk controlling as a scientific, practical and educational discipline is considered in [26|1]. Master students of the department "Economics and organization of production" of the Bauman Moscow State Technical University. the discipline "Risk Controlling" is taught.

By inflation we mean the rise in prices. As a result of inflation, the purchasing power of the currency decreases. As a result, in order to obtain reasonable conclusions in the field of economics and management, it is necessary to switch to comparable prices. A detailed analysis of the problems of measuring inflation is given in [27|1]. Inflation risks occupy an important place among financial risks. In controlling the dynamics of consumer prices and the cost of living (*controlling inflation*) we are talking about the requirements for organizational and economic methods in this area [28|1]. The tools developed by us for the analysis and use of inflation indices are included in the training courses taught in the disciplines "Applied Statistics" and "Econometrics" at the Bauman Moscow State Technical University, they are constantly used in the final qualifying theses of bachelors.

In the group of production risks, one of the main ones is the risk of defectiveness. It's about product quality. Accordingly, the management of this risk is called quality management. *Quality Controlling* is devoted to the requirements for methods of managing the quality of industrial products, for the procedures of statistical acceptance control and statistical regulation of technological processes [29|1].

In the practical application of controlling, one of the important questions is whether the detected deviation of the plan from the fact of managerial intervention in the business process or whether this deviation can be considered insignificant, not requiring management decisions. Note that the methods for detecting significant deviations of the fact from the plan can be used not only in solving problems of economics and management, but also, for example, to ensure the safety of aircraft flights ([30|1], [31|1]). We are talking not only about methods based on the use of Shewhart's control charts and cumulative sums, but also on recent works based on nonparametric mathematical statistics (see, for example, [32|1]).

Science and scientific services are a populous branch of the national economy. According to the Russian Science Citation Index, the number of Russian researchers who have published at least one scientific paper over the past 5 years is 646,885 (as of May 10, 2023). Science-based methods of managing this industry are needed *controlling science* (controlling scientific activity [33|1], [34|1], [35|1]), which is one of the modern approaches in scientometrics [36|1]. This area also includes work on controlling personnel at enterprises such as "Scientific Research Institute" of the rocket and space industry [37|1]. Research on the science of science and the problems of managing scientific activity is actively continuing at the present stage (see, for example, [38|1]).

In connection with the topic under consideration, it seems appropriate to mention works on promising mathematical and instrumental methods of controlling [39|1], on organizational-economic, mathematical and software control, innovation and management [40|1], on organizational-economic (i.e. economic-mathematical) tools in controlling [41|1].

Econometrics is one of the most practically important areas of economic and mathematical methods (along with the theory and practice of optimization). Modern econometric methods are effective intellectual tools for an engineer, manager, and economist [42|1]. The most fundamental new ideas of the national scientific school 21st century works ([43|1], [44|1]) are devoted to econometrics. In accordance with these ideas, various versions of training courses in the discipline "Econometrics" have been developed ([45|1], [46|1]). Articles [47|1], [48|1] are devoted to the consideration of the problems of applying econometric methods in solving controlling problems.

Two actively developing sections of controlling economic and mathematical methods

These include *Controlling of statistical methods* and controlling investments. Significant progress in these areas was made in 2022-2023. Let's look at them briefly.

Statistical methods and, above all, applied statistics are the most important part of organizational and economic methods. Therefore, it is necessary to develop the controlling of statistical methods. In the article [10|1], in relation to the controlling of statistical methods, a change in the paradigms of applied statistics is considered - changes in the foundations of the generally accepted model of actions in this area. The modern paradigm is based on non-parametric and non-numerical statistics ([49|1], [50|1]). In contrast to parametric mathematical statistics of the first third of the 20th century, sample elements with numerical values are assumed to have an arbitrary continuous distribution function. To date, the statistics of non-numerical data has become the central area of applied statistics, allowing a uniform approach to the analysis of statistical data of an arbitrary nature ([13|1], [16|1], [51|1]).

In accordance with the general approach of controlling economic and mathematical methods, it is necessary to develop a system of requirements for statistical models and methods when they are created, applied and taught, including when they are described in scientific publications and other scientific and technical documentation (for example, in reports on scientific and technical research papers), as well as in educational materials. We will give several examples of such requirements for statistical methods. First of all, a probabilistic-statistical model of data generation should be presented and justified. Since almost all distributions of real data are non-normal, in accordance with the modern paradigm of applied statistics, preference should be given to non-parametric formulations. According to the classical theory of testing statistical hypotheses, not only the null hypothesis, but also the alternative one should be indicated, only then it is possible to discuss the power of the criterion. It is necessary to study the stability of the conclusions obtained

on the basis of the economic-mathematical model, relative to the permissible changes in the initial data and the prerequisites of this model. In such a study, an approach based on the general stability scheme considered in monograph [52|1] is useful.

From the standpoint of controlling statistical methods, we will briefly discuss neural network methods. As you know, they are understood as a variety of mathematical methods (and algorithms and software products created on their basis), built by analogy with the ideas about the operation of networks of nerve cells of living beings. Prototypes of such methods were built in the middle of the last century. An attempt was made to express with the help of mathematical and software tools the mechanisms of thought processes occurring in the human brain. The founders of neural network methods tried to model these processes. It is quite natural that they proceeded from the knowledge of the mid-twentieth century. about the properties of thought processes. It is now well known that, as one would expect, the human brain works differently than the enthusiasts - the builders of the first neural networks - assumed.

If we look at what tasks modern neural network methods are used to solve, then we have to state that these methods are usually used to build classification rules (namely, algorithms for diagnostics, discrimination, pattern recognition with a teacher). At the same time, training samples are used as initial data, the elements of which are known, to which classes they belong.

To solve these problems, numerous diagnostic algorithms developed in the post-war years are used, not only neural networks. It has been proved that it is advisable to compare such algorithms based on such an indicator of the quality of the algorithm as predictive power ([53|1], [56|1]). The following statement is very important for our discussion: it has been established that neural network methods in many cases do not provide optimal solutions.

As an example that substantiates this assertion, consider the basic problem of diagnostics: a decision should be made as to which of the two classes a newly

appeared object should be assigned to. The decision is made based on the fact that there are training samples for each of the two classes. Based on the Neumann-Pearson lemma from the theory of testing statistical hypotheses, it has been established that a decision should be made based on nonparametric estimates of probability densities obtained for each of the two classes on the corresponding training samples (a detailed derivation of this statement is given in [16|1], [57|1] and other publications) . This method is optimal for large volumes of training samples (it is asymptotically optimal). No neural network method can give a better result. Maybe, any neural network method is also asymptotically optimal. However, to date, no such neural network method has been presented in a variety of scientific publications.

We have to state that the modern fashion on neural networks leads to the fact that the optimal methods and algorithms of applied statistics that solve the same problems are not used. They are simply forgotten, their place in the arsenal of intellectual tools used by specialists has been taken by neural networks. As shown in [12|1], one (and perhaps the main) reason for such forgetfulness is the information barrier, due to the limited capacity of the human brain to perceive, comprehend and apply information. This sad circumstance obviously reduces the effectiveness of technological solutions developed in the field of artificial intelligence.

There is no need to explain the importance of using adequate methods for assessing the economic efficiency of investment projects. *Investment Controlling* dedicated to comparing such methods, identifying areas of their reasonable application. The scientific results obtained in this section of controlling economic and mathematical methods are reflected in the articles [58|1], [59|1].

Conclusion

In the field of controlling economic-mathematical methods over the past 15 years, a number of scientific results have been obtained relating to various areas of development and application of such methods. The corresponding publications are scattered among various journals and monographs, and that is why this summary of the results obtained in this area is, in our opinion, of interest to scientific and practical workers in the field of controlling. Obviously, further development of the proposed ideas and approaches is necessary. Currently, research in the area of controlling under consideration is actively continuing, deepening, capturing more and more new areas.

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