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THE EFFICIENCY ANALYSIS OF THE MATHEMATICAL MODELING METHODS APPLICATION IN THE ECONOMY

The article analyzes the relevance and effectiveness of the use of mathematical modeling methods in the modern economy. Also, in the article the basic stages of the process of mathematical modeling, classical economic problem that can be solved using this method. The article presents arguments proving the need to use mathematical modeling techniques as an integral part of effective management of the enterprise. It should be noted that a huge impact on the development and application of mathematical methods in the economy was and continues to be provided by the improvement of computing technology. Mathematical modeling also does not stand still, and develops in step with the improvement of personal computers. Yes, it is now possible to use those methods that could previously be described only theoretically or using simpler examples. Thanks to computer technology, the risk of errors in solving tasks is reduced and the time spent on solving them is significantly reduced.

Solving tasks of economic analysis by mathematical methods is possible only when constructing mathematical, that is, real economic relations and dependencies of expressions using mathematical analysis. This calls for the development of mathematical models. Mathematical methods play an important role in economic analysis, as they can provide accurate calculations and full accounting of the influence of factors using short-term forecasting methods and management decision-making at the enterprise. The article highlights the results of research and development in the field of analysis of economic processes and systems based on the use of economic and mathematical methods and tools. The mathematical apparatus of economic research was developed and it was proposed to integrate applied methods and solutions into efficiency improvement tools.

The research presented in the article will be useful to everyone who is interested in the theory of mathematical methods of economics. Some of the presented methods and models can be used directly by practitioners in this field.

Key words: *mathematical modeling, economic analysis, models of economic processes, mathematical programming, mathematical programming stages.*

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АНАЛІЗ ЕФЕКТИВНОСТІ ЗАСТОСУВАННЯ МАТЕМАТИЧНИХ МЕТОДІВ МОДЕЛЮВАННЯ В ЕКОНОМІЦІ

У статті проаналізовано актуальність та ефективність використання методів математичного моделювання в сучасній економіці. Також у роботі розглянуті основні етапи процесу математичного моделювання, класичні економічні завдання, які можна вирішити, використовуючи даний метод. У статті наведено аргументи, які б підтверджували необхідність використання математичних методів моделювання як невід'ємної частини ефективного управління підприємством. Слід зазначити, що величезний вплив на розвиток і застосування математичних методів в економіці надавало і продовжує надавати вдосконалення обчислювальної техніки. Математичне моделювання також не стоїть на місці, а розвивається в ногу з удосконаленням персональних комп'ютерів. Так, тепер можна використовувати ті методи, які раніше можна було описати лише теоретично або на більш простих прикладах. Завдяки комп'ютерним технологіям знижується ризик помилок при розв'язуванні завдань та значно скорочуються витрати часу на їх вирішення.

Вирішення завдань економічного аналізу математичними методами можливе лише при побудові математичних, тобто реальних економічних відносин та залежностей виразів з використанням математичного аналізу. Це викликає необхідність розробки математичних моделей. Математичні методи відіграють важливу роль в економічному аналізі, оскільки вони можуть забезпечити точні розрахунки та повний облік впливу факторів за допомогою короткострокових методів прогнозування та прийняття управлінських рішень на підприємстві. В статті висвітлено результати досліджень та розробок у галузі аналізу економічних процесів та систем на основі використання економіко-математичних методів та інструментів. Розроблено математичний

апарат економічних досліджень та запропоновано інтегрувати прикладні методи та рішення до інструментів підвищення ефективності.

Представлені в статті дослідження будуть корисні для всіх, хто цікавиться теорією математичних методів економіки. Деякі з представлених методів та моделей можуть бути використані безпосередньо практикуючими фахівцями у цій галузі.

Ключові слова: *математичне моделювання, економічний аналіз, моделі економічних процесів, завдання математичного програмування, етапи математичного програмування.*

Formulation of the problem

Mathematical methods can be confidently called one of the most important tools for analyzing the phenomena and processes occurring in the economy. On the basis of mathematical methods, theoretical models are built that make it possible to identify the presence of a relationship between various economic indicators, to predict the behavior of economic entities and the dynamics of economic activity in general. Mathematical modeling can be considered as the modern language of economic theory, which is equally understandable for scientists and economists from all over the world [1].

In economics, mathematical methods are accepted as one of the scientific directions of this branch, which is aimed at research using mathematical models of economic processes and systems.

No less significant is the use of mathematical methods in the field of management, where they are aimed at improving management systems and determining the effectiveness of the management process itself. With the help of mathematical methods, it is possible to significantly reduce the time spent on conducting an economic analysis, while these methods contribute to a more complete account of factors that influence the results of the enterprise, company or holding. Also, a significant advantage of using mathematical methods is the minimization of the risk of erroneous conclusions and the accuracy of calculations. They play an important role in establishing the goals and orientations of the company's development, as they allow you to objectively assess the economic efficiency of the enterprise and determine the most acceptable ways of managing the enterprise.

Specialists in almost all fields today work in conditions of information overload. Therefore, the use of new information technologies, which change not only the processes of creation, transmission, processing of information and decision-making based on it, but also the entire activity of an enterprise, organization or institution, is becoming especially relevant. An integral component in the process of using any information technology is the ability to apply basic knowledge, firstly, in economic mathematics, and secondly, the ability to think logically. Students of higher educational institutions, when studying the disciplines of economic and technical, physical, engineering specialties, according to the curriculum, study the discipline "Economic and mathematical methods". The purpose of this discipline is to familiarize and master modern mathematical methods necessary for solving theoretical and practical problems of economics (elasticity of functions, production functions, limit analysis, etc.); development of skills in mathematical research of applied problems, construction of economic-mathematical models and formation of mathematical knowledge for mastering other disciplines of the mathematical cycle; development of students' ability to independently deepen and expand mathematical knowledge and implement it in the analysis of applied problems. However, an important problem arises – this is the quality of studying the discipline, the level of acquisition and assimilation of basic general knowledge by students. The ability to analyze problems of various nature depends on this.

Analysis of recent research and publications

A large number of works by foreign and domestic scientists are devoted to the issues of economic and mathematical methods, their meaningful essence and scope of application. A researcher or a person who plans to engage in entrepreneurial activity faces the most important task at the first stage of choosing an economic-mathematical method that will provide the most complete and justified results. However, the methods of system analysis and methods that make it possible to determine the space of qualitative characteristics of the studied quantities and take into account manifestations of economic risk are universal. Such methods include methods of multivariate statistical analysis.

Formulation of the goals of the article

It is also worth noting the universality of the possibility of applying mathematical methods of analysis. The reason for this is the universality of the language of mathematics. It is often possible to notice that scientists and researchers talk about the same phenomenon or problem in different ways, take into account its various features and cannot reach a consensus. The solution to this problem can be its translation into a mathematical language, with the help of which general regularities will immediately be revealed and even ready-made solutions obtained earlier in another field of knowledge and for other purposes can be obtained. Formalization of the quantitative and qualitative aspects of the problem is the main prerequisite for using mathematics to solve various problems.

In parallel with the development of economic systems, the mathematical methods themselves are being developed, which will be established in the economy. With so much evidence that new methods inevitably betray the old, it's unbelievable. Most often, in such a situation, interpenetration of methods, incorporation of old theories into new ones, as well as many fluctuations are observed.

The main task of financial mathematics is the construction of behavioral models of economic processes, which in one way or another are related to borrowing funds in one form or another (investment activity, various lending). The goal of optimizing the system is to minimize the risk of providing funds and maximize the investor's profit.

Presenting main material

The study of economic operations is carried out with the help of constructed models of optimal decision-making in conditions of limited resources (models of linear and nonlinear programming, models of network planning, models of inventory management).

The advantages of using mathematical models describing economic processes and systems include the following arguments:

When constructing a mathematical model, connections and parameters that are essential and non-essential for a specific economic system will be determined.

The use of a mathematical model allows you to reveal the relationship between various components of the system, as well as to describe the influence of various parameters on a friend.

Unlike the verbal model, the mathematical model can describe the researched process compactly, using a set of mathematical ratios [2].

The mathematical model can serve as a numerical basis for the analysis of the studied system using a personal computer. With its help, alternative scenarios of system development can be identified.

With the help of a mathematical apparatus, the researcher can obtain new knowledge about the studied system, which is accurate to the same extent as the original model is accurate.

Considering the process of mathematical modeling itself, it is possible to distinguish 4 main stages:

- At the I st stage, the characteristics of the main objects of the models, the processes of their connection are recorded using mathematical terms that reflect the data of the relationship. In other words, the analyzed phenomenon or process is recorded in mathematical language using special signs and symbols.

– II stage of inducing mathematical models of field at the previous mathematical tasks, to which mathematical models are created. The basis of this stage is the solution of a direct task, that is, the selection of theoretical data for the support of the analysis of the model, which is based on the results of the warning of the manifestations that are being developed.

– The third stage of building a mathematical division involves adjusting the obtained model by comparing the results of observations with the theoretical consequences of the model within the accuracy of observations. In the case when the model was fully defined and all its parameters were known to us, the solution of the direct problem can be obtained by determining the deviation of the theoretical consequences from the observations, with the subsequent evaluation of the deviations. If the deviations exceed the accuracy of the observations, then the model cannot be accepted. Often, when building a model, some of its characteristics remain undefined

To draw a conclusion about the correctness of the provisions, which is the basis for studying the model, helps to apply the criterion of practice to evaluate the mathematical model.

– The essence of the IV stage is the next analysis of the model in connection with the accumulation of data on the studied phenomena and modernization of the model.

The appearance of software played a huge role in the development of mathematical modeling. Thanks to computerization, this method took one of the leading places among other research methods. Mathematical modeling is especially important for modern economic science.

The application of this research in economics has found a large area of application. Mathematical modeling makes it possible to compile forecast values of various macroeconomic indicators in view of the impact on them of one or another factor of the world economy.

It is also useful to apply mathematical modeling in microeconomics, in terms of any specific enterprise or organization. Under these conditions, it allows you to analyze the efficiency of any department of the company or the risk of the enterprise as a whole, to make forecast values of the main financial indicators of the enterprise, taking into account possible risks. Mathematical modeling allows you to save business plans for the further work of organizations even in conditions of an unstable economic situation, which is especially important in our time [3].

It is worth considering in more detail those tasks that help to solve mathematical programming in the everyday life of organizations:

Tasks of network planning and management

This type of tasks considers the relationship between the deadlines for the completion of a large complex of operations (works) and the moment of the beginning of all operations of the complex. The tasks of network planning and management are designed to determine the minimum duration of a complex of operations, the optimal ratio of the price and the cost of the work performed or the services provided.

We can see an example of solving this type of problem during the construction of any large object. Any construction company uses mathematical modeling methods for the price and delivery terms of the object under construction.

The task of mass service

These tasks study and analyze the problem of service systems with queues of requests or requests. Their purpose is to determine the performance indicators of systems, their optimal characteristics, for example, in determining the number of service channels, service time, etc.

The most important criteria for the effectiveness of mass service systems are:

– possibility of application service or service delay;

– mathematical expectation of the number of satisfied (delayed) applications for a fixed time;

– mathematical expectation of the number of busy channels;

– mathematical expectation of queue length.

The most important criterion of optimality is:

– average total losses from waiting for requirements, on the one hand, and downtime of service channels, on the other.

In real life, these tasks can be faced with determining the optimal number of company branches in a specific region. Also, using this type of tasks, you can determine the required number of cash registers in a supermarket, or the required number of service counters in a bank.

Inventory management tasks

The purpose of these tasks is to find the optimal values of the stock level (order points) and order sizes. The peculiarity of this task is that with an increase in the volume of stocks, the costs of their storage increase, but, on the other hand, at the same time, losses due to a possible shortage of the stocked goods will be reduced.

This problem is faced by any company that has warehouse facilities in its department, whether it is a food warehouse, a building materials warehouse, a pharmacy warehouse, and others.

Resource allocation tasks

The problem of resource allocation becomes relevant when there is a certain set of works that must be performed in conditions of limited resources. The goal of such tasks is to find the optimal combination of resource allocation between operations.

The issue of resource allocation is relevant at enterprises whose main activity is the production of any product. People can also act as a resource, the so-called human resource.

Equipment repair and replacement tasks

This problem is relevant in connection with the moral and physical wear and tear of the equipment, the need to improve the technical base of the enterprise. The main purpose of tasks of this type is to determine the optimal terms and moments of replacement and equipment, to determine the terms and number of preventive works.

Any enterprise during its work faces such problems: whether it is the replacement of specialized equipment in a production workshop, or the planned replacement of morally obsolete or office equipment that has failed.

The task of making a schedule (calendar planning)

The purpose of these tasks is to determine the optimal sequence of operations (for example, processing parts) of various types of equipment.

Planning and placement tasks

Such tasks are designed to solve problems related to determining the optimal number and location of new objects, taking into account their interaction with existing objects and with each other.

Managers and store owners face such questions in everyday life, and this task may also be related to the placement of specialized equipment.

Route selection tasks or network tasks

Such questions are most often encountered during the study of various tasks in the transport and communication system. The main goal of solving the problem is to determine the most economical routes.

This problem is particularly acute in logistics companies engaged in the transportation of various goods, or in enterprises that own vehicles.

Having considered the above-mentioned tasks that can be solved with the help of mathematical modeling methods, there is no doubt about the necessity and relevance of using these methods. With their help, you can solve most of the problems that arise before the organization in the modern world [4, 5].

It is known that the main functions of the enterprise are reduced to meeting the needs of consumers in certain types of products and services and maximizing profit. The latter is at the same time the goal of the enterprise's economic activity. This goal can only be achieved if there is an optimal combination of innovation policy, economic risk and all production factors that are applied. Therefore, knowledge of the basics of economic mathematics and economic-mathematical methods play a key role in the basis of the considered approaches to entrepreneurial activity. The deeper the level of knowledge of economic and mathematical disciplines of a person engaged in business, the more resistant his business will be to the foreign economic, political and social environment, factors of their influence. The ability to apply economic and mathematical methods (estimation of the current financial situation, forecasting of future activities taking into account the influence of various factors) makes entrepreneurial activity more competitive and sustainable. After all,

modern directions and approaches in modeling the economy, modeling of economic and production systems, econometric models and forecasting methods provide an opportunity to carry out a deep and detailed analysis of the impact of various factors on business activity, to identify actual problems, to carry out a comprehensive analysis of activities, and therefore to adopt an objective management decision. The most important part of entrepreneurial activity is the analysis of the use of capital, which is the process of researching the main performance indicators of the efficiency of its functioning at the enterprise with the aim of identifying reserves for further improvement of this efficiency.

Conclusions

It should be noted that a huge impact on the development and application of mathematical methods in the economy was and continues to be provided by the improvement of computing technology. Mathematical modeling also does not stand still, and develops in step with the improvement of personal computers. Yes, it is now possible to use those methods that could previously be described only theoretically or using simpler examples. Thanks to computer technology, the risk of errors in solving tasks is reduced and the time spent on solving them is significantly reduced.

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