THEORETICAL FOUNDATIONS OF FORECASTING ACTIVITIES AND THE NATURE OF MANAGEMENT OF ECONOMIC SYSTEMS

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Abstract: This article presents the theoretical foundations of forecasting activities and the essence of managing economic systems, the introduction of modeling into management, its application in economic calculations, and the most advanced methods of management and modern technical means of management.

Keywords: economic system, management, modeling, economic model.

The term “model” is widely used in various fields of human activity and has many semantic meanings. It comes from the Latin word “modulus” - sample, norm, measurement. In a general sense, a model is a logical or mathematical description of components and functions that reflect the important characteristics of an object or process being modeled as a system or system elements[1]. A model is an object and a system of selected assumptions that replace the original and reflect the most important properties and characteristics of the original for a particular study[2]. The creation of any model includes four stages:

1) formation of a system of economic indicators of the object of modeling;

2) study the activities of the enterprise;

3) formation of knowledge about the object. Knowledge about the model should be adjusted taking into account the characteristics of the activities of the research object.

4) Practical verification of the knowledge obtained with the help of models and their use for the construction of an object for management purposes. The main purpose of an economic model is to ensure that the forecasts obtained with its help correspond to real events. Therefore, the model should be simple enough to allow for expansion and increase the efficiency of its application. An economic model identifies the most important factors, determines the laws of the functioning of the object under study, and abstracts from other factors that, although they have a small impact, can jointly determine the behavior of the model[3].

The widespread use of modeling in economics is one of the main directions of increasing management efficiency. The introduction of modeling into management is inextricably linked with its use in economic calculations and the creation of automated production control systems, which are a combination of the most advanced management methods and modern technical means of management. The use of these tools by appropriately qualified management personnel ensures the adoption and implementation of appropriate management decisions with the necessary efficiency[4], completeness of the necessary information, and minimal labor costs. Modeling is divided into two main classes - material and ideal (Figure 1).

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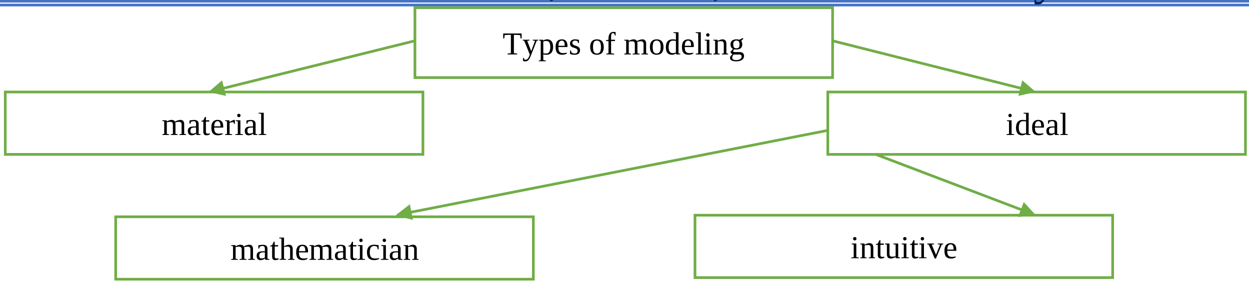

Figure 1 – Types of modeling

In economic research, ideal modeling plays a particularly important role, since the possibilities of conducting full-scale experiments and experiments with physical models are limited. Ideal modeling, in turn, is divided into mathematical and intuitive.

Intuitive models are based on a person's personal experience. Any person making an economic decision is based on one or another informal model that he considers in the economic situation. Decisions made on the basis of this model can often lead to incorrect decisions, since different people can understand the intuitive model differently and give different answers to the same question based on it. On the basis of mathematical (symbolic) models, a more accurate and rigorous description of the models and an explanation of the conclusions drawn from them are created.

Their use does not diminish the role of intuitive modeling. It synthesizes both types of modeling, which are called simulation systems. To characterize the functioning of the economic system, it is necessary to model two levels: production and technological and socio-economic. The first level is production and technological, which includes a description of the production capabilities of the economic systems under study.

In mathematical modeling of the production capabilities of an economic system, it is first divided into separate “elementary” production units. Then it is necessary to characterize the possibilities of exchanging production resources and products between the production and “elementary” production units of each unit. Production capabilities are characterized by various types of production functions, and equilibrium relations play a key role in describing the possibilities of exchange.

The second level is socio-economic processes. They determine how the production capabilities described in the modeling of the production and technological level of the economic system are realized. There are a huge number of options for making decisions and distributing tasks that correspond to the technological constraints that determine the production capabilities of the system. At the level of socio-economic processes, the mechanism for selecting management actions is determined.

However, there are many problems for which it is not necessary to describe the socio-economic level. These are the so-called normative problems, in which it is necessary to show how to determine the management actions in order to achieve the best results in some sense. At the same time, it is necessary to clearly define what the best result means, that is, to form a criterion by which different management actions can be evaluated and compared. The criterion (also called the objective function) is a function of the model variables of the system under study. It is usually assumed that there is a single criterion for choosing a system management.

Management is sought in such a way that the criterion is determined by making the right decision to achieve the best result between the maximum (output, profit, etc.) or minimum (costs) values. Such a control value is found by optimization methods and is called optimal[5]. All economic models can be divided into two classes:

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- models intended to understand the characteristics of real or hypothetical economic systems. The values of the parameters of such models cannot be determined on the basis of empirical data.

- models whose parameters, as a rule, can be estimated on the basis of experimental data. These models can be used for forecasting or decision-making. The second class of models, in turn, is divided into three subclasses:

- firm (enterprise) models - can be used as a basis for making decisions at the level of firms and similar organizations;

- models of a centrally planned economy - a basis for making decisions at the level of a centralized planning body;

- models of a decentralized economy or its individual sectors - can be used for forecasting or as a basis for economic regulation. One of the most important methodological problems in building economic models is which equations to use to describe such models - differential or ordinary-difference.

A differential equation is an equation that contains the derivatives of the desired function and can contain the desired function and an independent variable. In the following, we assume that the independent variable is always real. The independent variable, whose derivative is included in differential equations, is denoted by the letter x or t, since in most cases time plays its role. The unknown function is denoted by y(x).

The variables of a typical economic model should be considered as continuous functions of time, and such a model should be described by a system of differential equations, and the higher the level of the model, the closer it is to reality. In practical economic research, models are usually expressed as a system of ordinary differential equations. This is probably due to the difficulty of estimating the parameters of stochastic differential equation systems from discrete observations of the values of the variables.

However, there are no major obstacles to obtaining such calculations. In addition, the methods developed for estimating the parameters of discrete models can be successfully applied to estimating the parameters of continuous models. It should be noted that the more modern the enterprise management system is, the less discrete it is, and the model can be considered continuous[6]. The most widespread models in the process of optimizing confirmed decisions in economics and management are economic and mathematical models.

Mathematical programming methods are mainly intended for solving conditional optimization problems with several variables. Most often, mathematical programming methods are used to solve problems such as planning the product range and assortment, determining the optimal direction, minimizing production waste, regulating the inventory level, planning production, and so on.

The main task facing the analyst is to formulate an analytical research problem and correctly interpret its solution. Thus, mathematical programming methods are mainly intended for optimizing economic activity, which allows the analyst to assess the level of achievement of the set goal, determine the level of limited resources, competitiveness and scarcity.

A mathematical model of an object (phenomenon, system) is understood as some artificial system that simply reflects the basic laws of the structure and development of a real object in such a way that its study provides information about the state and behavior of the object under study. Mathematical programming methods include deterministic, dynamic and stochastic programming methods (Figure 2).

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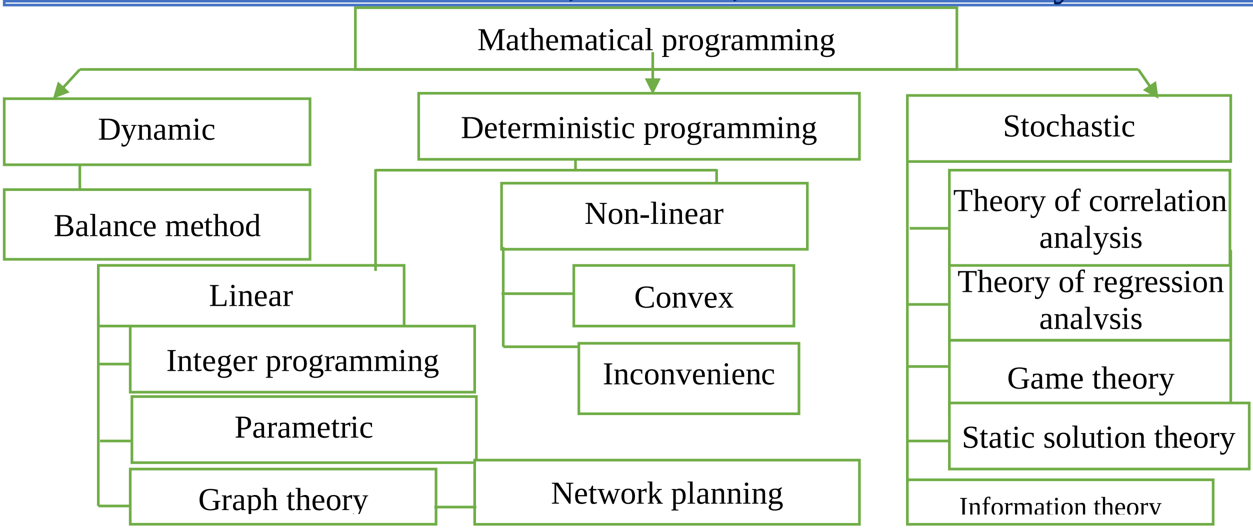

Figure 2. Classification of mathematical programming

A prerequisite for mathematical methods is the construction of an adequate mathematical model for the object under study. Dynamic programming models allow finding an optimal solution in conditions where the final results are affected by the results of the implementation of the solution at the previous stage, and the final results are affected by the results of the implementation of the solution at the previous stage. Statistical and dynamic balance models are widely used in economic and mathematical modeling. The balance method is a comparison of available material, labor and financial resources and their needs.

Such models allow making decisions taking into account the relationships between individual production units and the need for a balance between production and consumption. Decisions using these models are aimed at the balanced development of production. They are used both at the level of inter-sectoral planning, and in planning at the scale of an industry or even a separate enterprise. The balance method is the main tool for analyzing ratios in the economy. Balance models based on accounting balances describe the formed ratios, and their resource part is always equal to the cost part.

Balance models belong to the matrix type of economic and mathematical models, since they are constructed in the form of matrices - tables of numbers with squares. In matrix models, the equilibrium method has a strict mathematical expression. A deterministic mathematical model is an analytical representation of the data, in which for a given set of input data one result can be obtained at the output of the system. Such a model can also reflect a probabilistic system, in which case it is its simplification and is a deterministic system[7]. Deterministic programming is divided into linear and nonlinear programming. Models in which the solution quality indicator and the system variable functions are linear functions are called linear programming models. Such methods are used by analysts to solve many optimization problems, where the functional dependence of the phenomena and processes under study is deterministic. The results obtained allow the analyst to identify and analyze potential opportunities for changing the value of any parameters of the object under study, as well as to identify reserves of unrealized opportunities. Linear programming, in turn, is divided into models.

Integer programming is a mathematical programming model in which the variables in the equations can take only a limited number of discrete values, according to their physical meaning. Parametric programming is a mathematical programming model in which the initial parameters for the variables can vary within certain limits. Models based on mathematical graph theory are also widely used in the optimization of management decisions.

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One of the types of such models is network planning models, which are used both at the stage of optimizing the decisions made, and in organizing their implementation, and controlling their execution, that is, they are cross-sectional models that are used at all stages up to the implementation of the approved management decision. Depending on whether it is possible or impossible to accurately determine the duration of work when compiling the network schedule, network planning models are divided into deterministic and stochastic. Modeling based on graph theory includes solving transport problems in networks and other applications of this theory in economic work[8].

If the efficiency criterion and (or) the system of constraints are given by nonlinear functions, we have nonlinear programming. This method is divided into convex and non-convex. If the specified functions have convex properties, then the resulting problem is a convex programming problem. Convex programming combines three subclasses of extremal problems:

- problems related to the absence of constraints in the form of two-sided constraints on variables and equations;
- quadratic programming problems related to finding the extremum of a quadratic function under linear constraints;
- problems with a general formula, that is, not included in the previous two subclasses. Another category of mathematical programming is related to calculations based on the application of elements of mathematical statistics and probability theory. Stochastic models are systems under study in which the value of one or more variables varies randomly.

Stochastic models include models from the theory of correlation and regression analysis, the theory of variance analysis, statistical test methods, game theory, statistical decision theory, information theory, reliability theory, planning theory, and others. The methods described above are the main tools of economic and mathematical modeling and are actively used by researchers and analysts in the process of assessing various economic processes.

Classical methods of economic and mathematical modeling are being replaced by new methods, in particular, fuzzy logic and artificial intelligence methods. This methodology and mathematical apparatus allow for the formulation and mathematical substantiation of such problems, which provide the ability to adapt economic and mathematical models to changing economic conditions, even in the absence of complete statistical data or when only qualitative indicators are present among the information factors[9].

Models created on the basis of artificial intelligence have proven themselves well in economic analysis and forecasting changes in stock indices, assessing the reliability of borrowers in the financial and credit sector, determining the probability of bankruptcy of an enterprise, studying the activities of industrial and commercial enterprises, analyzing financial and insurance risks, and solving complex problems in the field of economics.

The study of economic processes consists of several stages. The first stage is devoted to the formulation of the problem. The customer (individual or organization) poses a problem to researchers (contractors), uses the results and finances the research. The purpose of the first stage of the study of economic processes is to find among the problems of interest to the client those that can be solved at the current level of development of economic and mathematical methods.

When deciding on the selection of problems to be analyzed using economic and mathematical models, it is first of all necessary to remember that practical research can be carried out only when the performer has at his disposal proven models that are suitable for describing the objects to be modeled. If such models do not exist, then first of all you need to learn how to build models of the objects of interest, which usually requires serious effort and a lot of time. The second stage of research is the construction and specification of a mathematical model of the economic object under study. This stage consists in selecting a suitable model from the entire set of known economic models and selecting the parameters of this model in such a way that they correspond to the object under study.

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The process of selecting model parameter values is called model identification. The parameters of the production functions are selected based on the analysis of technological data and statistical data on economic indicators[10].

The final stage is the study of the created model. The method of analyzing the model to solve the problems formulated at the first stage should consist of selecting and analyzing the most suitable options for the client in advance for the production and technological processes for managing the economic system. The forecasting process based on econometric models includes several stages:

1. Statement of the problem, its theoretical and logical formulation.
2. Analysis of the forecasting object.
3. Selection of a predictive indicator and factors determining its level.
4. Construction of a model that meets the requirements of logical and statistical adequacy.
5. Collection of initial data and filling the conceptual economic model (system of equations) with the necessary empirical (statistical) data.
6. Implementation of the model based on a previously developed algorithm and initial data.
7. Assessment of the quality and reliability of the model parameters and the model itself.
8. Conducting a retrospective analysis based on “background” data.
9. Building a forecast based on the selected model.
10. Assessing the quality and reliability of the forecast.
11. Drawing up an explanatory note based on the forecast and making management decisions based on its results[11]. In general, the entire process of using economic models as a forecasting tool can be divided into two parts:

- building a predictive model that meets the necessary conditions;
- building a forecast based on the built model. The use of economic methods in economic research is associated with solving a number of complex theoretical and methodological problems. Thus, an economic model is any set of equations based on certain assumptions and approximately characterizing the economy as a whole or its individual sectors. The subject of economic research is almost always the construction and analysis of models.

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