# Mathematical Methods and Models in Economic Planning, Management and Budgeting

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Galimkair Mutanov
Al-Farabi Kazakh National University
Almaty, Kazakhstan

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# Preface

A new qualitative stage of the market economy, defined as knowledge economics, differs considerably from the previous stage in terms of nonlinear trends in economic development. Those responsible for reproduction cycle management have to make managerial decisions in conditions of high uncertainty affecting the development of production processes, distribution, exchange, and consumption. It is impossible to estimate the effectiveness of such projects and processes without adequate administrative instruments.

Economic-mathematical modeling is one of the most effective methods for describing complex socio-economic objects and processes in terms of mathematical models in combination with new engineering decisions. Modeling thus becomes part of economics itself. Knowledge economics as a common albeit somewhat abstract category must be expressed in a tangible concrete form. This can be achieved by means of mathematic modeling of its processes as managerial objects.

The present work presents a series of works in the field of scientific and methodological bases of creation of information-analytical systems of management of financial and economic processes and systems in the period from 1995 to 2011 years.

This text reflects the current level of theoretical research and development of the system of mathematical models and methods that can be used to solve real, important economic problems: control of development and operation support at any budget level; quality assessment of economic systems management in terms of energy-entropic approach; and risk management of investment processes.

The proposed mathematical methods and models were tested on the example of Kazakhstan's economy, and developed solutions and models may be used in any level and in any State. In the course of this research were analyzed and developed the ideas of Nobel laureates and leading scientists—V. Leontiev, Prigogine, G. Odum, E. Odum, Harold Kuhn, John Keynes, Christopher Sims, principle of McKinsey matrix and others.

The reader will find presented here a complex of models used to analyze and forecast the flow of budget financial resources. Current calculations and long-term forecasting of budget indicators are the instruments of realization of strategic development plans. Traditional methods of budget program planning are still widely

used; they include planning based on rated standards specified by administrative bodies or by the changing dynamics of previous periods. However, the development of information technologies (IT), the requirements of a market economy, and the high pace of development necessitate new, highly intellectual and precise analytical and planning models.

The semantic and frame-based models suggested in this work create the mathematical basis for automated system control. The author presents here his seminal development of a mathematical budget model which with mathematical exactness reflects properties and conditions at any budget level. Methods and mathematical models for program control of budget resources focused on end results such as correct planning are utilized according to the strategic plan of socio-economic development of the nation or region. Benchmarks are thus created against which to estimate the achievability of set goals under certain limitations in budget funds and budget potential as determined in the process of medium-term planning. This work details an effective method for estimating the stability of program movements determining system decisions, based on construction of Lyapunov's function, allowing planners to estimate the efficiency of budget mechanisms for resource distribution. The principles governing the design of an intellectual system modeling program control of budget resources, and permitting correction of the decision by adjustment of the system of indicators, are outlined.

New knowledge often arises at the intersection of different scientific fields when well-known laws of one science are adapted to and interpreted by the other, opening up a phenomenon for approach from another angle, and the results can be exciting. An example is application of the thermodynamic approach to business system management, through mathematical descriptions focused on a decrease in entropy and increase in productive efficiency. The theoretical approach proposed by the author becomes even more valuable as national theory and practice in Kazakhstan have not previously offered developments in the assessment of business system efficiency based on the energy-entropic method. The universality of the proposed method is based on the fact that all systems of the material world—from wildlife and inanimate nature to technology and production—are arenas of ever-present change in amounts of energy and entropy, and studying this dynamic can give new knowledge of the laws governing the functioning and development of such systems. This research undertakes, therefore, the scientifically based application of the energy-entropic method to assessment of the economic efficiency of any production process.

The work further suggests methods and mathematical models which can be used to analyze currency purchase and sale, to make forecasts, to determine profitable cycles, and to structure decision-making in the foreign exchange market. An information system is developed on the foundation of these methods and is applied to a more detailed analysis of the foreign exchange market, leading to practical recommendations for second-rank banks on correction of exchange rates. A description is provided of the software, hardware, and instrumentation used in the proposed system.

In order to protect the safety of financial investments in conditions of information uncertainty, methods and mathematical models are developed to assess innovation

projects. This is a strategically oriented approach which enables every project to engage the highest available expertise level with application of advanced information technologies. The role of risk-management and qualitative project assessment becomes even more important if the project in question is innovative—and it must be stressed here that innovativeness of development is one of the main priorities of the economic program of our country. A richly complex method of assessment of innovation projects and a graphic model based on such parameters as innovation, competitiveness, and reduced net cost of a project facilitate in-depth assessment of innovation projects on the basis of absolute positioning. The methods and mathematical models presented here can be used by expert commissions of venture funds, development institutes, and other potential investors to meaningfully assess innovation projects.

Investment in the development of economic processes and systems always entails risk. An investment decision that is not adequately reasoned can cause adverse economic consequences for the investor. Making investment decisions becomes even more complicated with the high degree of uncertainty surrounding economic consequences of a given investment. The series of mathematical methods and models proposed here represent an integrated methodology for making investment decisions that aims to reduce risk by more objectively estimating probability of investment consequences, and thereby to equip the investor with a practical instrument for scientifically-based forecasting. A review of a variety of methodological approaches to studying risk reveals that researchers tend to focus their attention on entrepreneurial risk—that is to say, as the object of analysis they consider individual enterprises, and the subjects of their investigations are statistical variations in stochastic probability distributions of all possible losses and damages. Meanwhile, insufficient attention is given to the investigation of principles of functioning and forms of manifestation of nonstatistical risks, their influence on the entrepreneurial activity and interaction with statistical risks. This research suggests a methodological base for creation of an integral expert system supporting coordinated investment decisions that takes into account assessment and control of project risks.

The methods and models developed by the author have been brought to practical realization in the form of software tools. These are reliable instruments to be used in solving problems of business forecasting, assessment, and management of the development of economic processes and systems.

I would like to acknowledge contributions to this book made by my assistants I.G. Kurmashev, A.U. Shintemirova, Zh.D. Mamykova, E.S. Kutuzova, V.P. Kulikova.

It is my hope that this work will be of both theoretical and practical interest to its readers, to the benefit of all.

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