

# Preface

As early as the mid-eighteenth century, mathematicians discovered a way to use models involving complex variables. Since then, work with complex variables has been progressing, with the theory of complex variables emerging as a branch of mathematics. Nowadays this theory is widely implemented in all of the natural sciences as work with complex variables makes it possible to describe adequately more complicated processes than do real variables. Economics as an object of scientific research and cognition is no less complicated than the natural sciences, which is why complex variables may be applied in economics to give a more precise description of the processes involved and to build even more complicated models than those that can be built using real variables. Complex variables are sometimes used in certain branches of economic and mathematical simulation, but this study considers application of models of economic and mathematical simulation exclusively in the form of models of complex variables.

Models and mathematical methods of working with complex variables are considered in the study not as some alternative to real-variable models and methods but as an instrument complementing and expanding the existing arsenal of economic and mathematical modeling. It is of principal importance that complex economics provides the economist with a new instrument of research, and the more flexible the instrument, the more diverse the tasks that can be solved by the researcher

The first chapter of this work presents basic principles of complex economics and certain data from the theory of functions of complex variables that are necessary for an understanding of further actions in the formation of complex economic theory.

Very often, understanding a certain meaning of mathematical operations requires graphic methods of describing these operations. Since in the study in question complex economics involves functions of complex variables, it is necessary to know the characteristics of these functions including their graphical

representation. This task is solved in the second and third chapters of the study, which consider conformal mappings of basic functions of complex variables. These chapters do not simply state the respective branches of the theory of functions of a complex variable encountered in various textbooks. Textbooks on the theory of functions of a complex variable, in the section devoted to conformal mappings, do not consider, for instance, exponential complex functions with a complex coefficient; the need for such treatment has not existed. Textbooks consider exceptional conformal mappings of this exponential complex function with real exponent. For the purposes of complex economics, there is a need to use complex exponents not only for exponential functions.

The fourth chapter presents an instrument of practical application in complex economics – complex econometrics. The chapter provides only the basic principles of complex econometrics because it is practically impossible for a group of scientists working in this field to develop or adapt to complex econometrics all the branches of real-variable econometrics. Moreover, it is simply impossible to present the entire scientific discipline of econometrics in one chapter. Here we will substantiate and adapt to complex economics the basic sections of correlation and regression analysis of mathematical statistics – calculation of complex coefficients of pair correlation, least-squares method for evaluating coefficients of complex models, method of construction of confidence limits for obtained statistical estimates, and new coefficients showing the adequacy of econometric constructions. The results obtained are sufficient for solving subsequent tasks of complex economics and developing complex econometrics. The ideas of statistical characteristics of complex random variables currently in use in mathematical statistics has led to a deadlock. This can be seen in calculations of complex coefficients of pair correlation – the obtained contradictory results that follow from standard situations testify to their erroneous character. This made it necessary to devise other principles of statistics of complex random variables that underlie new and consistent conclusions and recommendations.

The fifth chapter contains the results of an investigation of one of the simplest types of economic models of complex variables – production functions of complex arguments, where actual production results depend on a complex argument, that is, production resources represented in the form of a complex variable. These functions possess some very important properties applicable in the successful solution of certain economic tasks. Here, we also demonstrate one remarkable feature of complex argument models – the sustainability of their assessments under multicollinearity.

Chapter 6 discusses production complex variable functions, more complicated models than complex argument ones. Here, the complex production result is represented in the form of dependence on a complex resource. Since functional relationships between two complex variables may have various forms, this chapter considers the basic ones.

The seventh chapter uses a case that has been insufficiently explored in the mathematics of complex variables; the existing theory operates with only one complex variable and is therefore called the theory of functions of a complex variable. Chapter 7 involves multifactor complex models, i.e., models of several complex variables. The development of the theory of functions of several complex variables in mathematics finds very little application in economics. This is why in the sixth chapter we state for the first time the principles and approaches of the theory of multifactor functions of complex variables. This was necessitated by our wish to build complex production functions that are more applicable to real economic processes, and that could be done only by increasing the explanation factors used in complex economic models. This chapter presents the properties and characteristics of simple multifactor complex models. The variety of possible applications of the models and methods of complex economics is not limited only to production function models. However, production functions provide a good example for seeing the advantages and disadvantages of complex models. In Chaps. 5 and 6 this is done by comparing such models with basic models of production functions with real variables.

Another good example that demonstrates the advantages of complex variable models is their application in the analysis of stock markets. Chapter 8 shows how to use complex indices of economic conditions and how to use the properties of complex numbers to obtain phase portraits of stock markets that could allow us to reveal laws that remain hidden with the use of real variables. The materials of Chap. 9 aim at showing other ways of developing complex economics than those specified in previous chapters.

In this study we make reference to the literature used in the form of footnotes. At the end of the study we give a complete list of all the publications by those scientists working on the formation of complex economics. If necessary, the reader may refer to these sources. The large volume of scientific results provided by this study could not have been obtained without the support of the Russian Foundation of Fundamental Research. The grants allocated by the foundation on a competitive basis from 2006 till 2010 rendered invaluable financial and moral assistance.

The main ideas, hypotheses, and materials stated in this study belong to the author; however, these hypotheses would never have become a well-balanced theory without the active involvement of a group of scientists, chief among whom was Dr. Ivan S. Svetunkov. This collaboration laid the foundations of complex economics on which basis many other scientific results were obtained. We are extremely grateful to Prof. G.V. Savinov who reviewed my first works, written in cooperation with I.S. Svetunkov, and later formulated a number of interesting proposals published in various articles. A very important contribution in the creation of various sections of complex economics was made by Dr. T.V. Koretskaya, E.V. Sirotina, and A.F. Chanysheva. Their work and the results obtained by them are discussed in the corresponding sections of the book. Some partial conclusions, recommendations, and new scientific results obtained by other young scientists are stated in various parts of the book.

Insofar as the materials presented in this study are new and this is the first time they have been systematized in this way and used for the proposed scientific purposes, the author understands that some points may be subject to debate or contain inaccuracies. It is every scientist's mission, having obtained a new scientific result, to encourage comprehensive scientific discussion and get to the truth. This is why any constructive criticism of the study is welcome. Comments and remarks may be mailed directly via [www.sergey.svetunkov.ru](http://www.sergey.svetunkov.ru).

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