
Preface

The problem of allocating scarce resources among competing ends is central to economic analysis. Resources are not sufficiently available to produce all of the goods and services to satisfy human wants and therefore choices must be made concerning how resources will be used. Particularly in its “neoclassical” phase, since about 1870 economic analysis tends to presuppose that the economic agents are optimizing. Production units, or firms, maximize profit and households maximize their utility or well-being. In general, there exist a variety of objectives, besides profit maximization, high sales revenue or market share, environmental goals or the different goals followed by economic policy. The scarcity of resources acts as a bottleneck in the furthering of the objectives and represents the opportunity set from which the choices can be made. The problem of optimal allocation of scarce resources can thus be summarized as the optimization of some objective(s) subject to constraints. Constrained optimization, referred to as a mathematical programming model, is useful in economic analysis for providing deeper insights into the behavior of economic agents as well as for preparing of decision support systems for businessmen and policymakers.

This book is intended to offer the reader a systematic exposition of both single- and multiobjective optimization models with the focus on their use for economic analysis. The emphasis is given to the exposition of mathematical optimization as an instrument for qualitative analysis and to a wide range of applications in economics, including efficiency analysis, industrial economics (with focus on regulatory economics), international economics, input–output economics, quantitative economic policy and environmental economics.

Part I of the book is devoted to single-objective optimization and starts with the notion of scarcity and efficiency and with the formulation of different economic problems leading to optimization models (Chapter 1). Kuhn–Tucker conditions as the necessary optimality conditions for the general mathematical programming problem are explored and their application as an instrument of qualitative economic analysis is presented in Chapter 2.

Chapter 3 deals with convex programming and with the economic implications of the convexity property. For an economist, the problem of optimal allocation of scarce resources is immediately related to the pricing problem, referred to in the language of

mathematical programming as the dual problem. Therefore, the basic duality theory is presented with the focus on its economic interpretation.

In Chapter 4, the theory of linear programming as the simplest and most widely spread class of convex programming is developed. The chapter concentrates on the implications of a linearity assumption for economic analysis and the applications of linear programming in economics.

Data envelopment analysis (DEA) as one of the most important recent applications of linear programming in economics is treated in Chapter 5. DEA represents a widely used approach for measuring efficiency and productivity even when dealing with multiple inputs and outputs without the need to assign prespecified weights to either.

Chapter 6 completes the first part of the book with geometric programming as a special class of nonlinear programming focusing on various applications in economics and management science.

In Part II of the book, multiobjective optimization is presented as an instrument of economic analysis providing a deeper insight into the trade-off choices that have to be made with respect to the objectives. Chapter 7 deals with the extension of the Kuhn–Tucker conditions and with the duality theory for multiobjective optimization. Examples from different fields of economics and the analysis of the behavior of a firm facing a bicriteria objective under regulatory constraint demonstrate the possibilities for the application of multiobjective optimization in economic analysis.

As in single-objective optimization, the most developed part of multiobjective optimization is multiobjective linear programming, treated in Chapter 8.

The extension of geometric programming from the first part of the book to problems with multiple objectives is the subject of Chapter 9. A list of references is added to each chapter separately with the aim of providing references for more detailed study and further reading related to particular topics.

Because of the increasing complexity of recent economic problems, the use of mathematical techniques including optimization plays a very important part in economics education and in applied economic research. The book is intended for university economists, graduate and postgraduate students and for quantitative oriented economists in applied research who want to expand the array of mathematical techniques at their disposal. Students of mathematics and operations research interested in economic applications of mathematical programming can also benefit from using this book. As a prerequisite to follow the text, the basics of calculus and linear algebra are needed. Definitions, theorems, and propositions are stated rigorously, but due to the mathematical prerequisite and to emphasize an economic interpretation, most of the proofs are omitted and referred to in the literature.

Following not only the principle of the division of labor by the classical economist Adam Smith, optimization under uncertainty referred to as stochastic programming and questions of choice in dynamic economic models (there are some excellent monographs in this field) are not discussed in the book. These problems and models require essentially higher mathematical background and I aimed to provide a not-too-voluminous text.

A number of students and colleagues have contributed to this book directly or indirectly. The book is an outgrowth of many courses in optimization and mathematical

economics that I have taught at Vienna University of Economics and Business Administration, Vienna University of Technology and Comenius University Bratislava, Slovakia. Inspiring questions that students have raised in my courses have often helped me both to clarify and to deepen my own perception of particular topics. I am indebted to numerous authors and researchers who contributed to the study of mathematical optimization and economics. Relevant literature sources are listed at the end of each chapter.

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