

## Preface

Application of differential equations to economics is a vast and vibrant area. Concepts and theorems related to differential equations appear everywhere in academic journals and textbooks in economics. One can hardly approach, not to mention digest, the literature of economic analysis without “sufficient” knowledge of differential equations. Nevertheless, the subject of applications of differential equations to economics is not systematically studied. The subject is often treated as a subsidiary part of (textbooks of) mathematical economics. Due to the rapid development of differential equations and wide applications of the theory to economics, there is a need for a systematic treatment of the subject. This book provides a comprehensive study of applications of differential equations to dynamic economics. We not only study analytical methods, but also provide applications of these methods for solving economic problems.

This book is a unique blend of the theory of differential equations and its exciting applications to economics. It is mainly concerned with ordinary differential equations. The book provides not only a comprehensive introduction to applications of theory of linear (and linearized) differential equations to economic analysis, but also studies nonlinear dynamical systems which have been widely applied to economic analysis in recent years. It provides a comprehensive introduction to most important concepts and theorems in differential equations theory in a way that can be understood by anyone who has basic knowledge of calculus and linear algebra. In addition to traditional applications of the theory to economic dynamics, it also contains many

recent developments in different fields of economics. It is mainly concerned with how differential equations can be applied to solve and provide insights into economic dynamics. We emphasize “skills” for application.

The book is divided, according to dimensions of dynamic systems, into three parts. The first part deals with scalar differential equations; the second part studies planar differential equations; and the third part introduces higher-dimensional differential equations. Each part consists of three chapters. The first chapter of each part mainly deals with key concepts and main mathematical results related to linear (linearized) differential equations and their applications to economics. The second chapter mainly studies key concepts and (some of) main mathematical results related to nonlinear differential equations and their applications to economics. For illustration, the first two chapters tend to use simple (simplified) economic systems. The third chapter of each part introduces “complicated” (in terms of the number of variables and relationships among variables) economic models, applying the concepts and theorems from the previous two chapters. Most of the chapters include problems that help the reader from routine exercises through extensions of the models. Except conducting mathematical analysis of the economic models like most standard textbooks on mathematical economics, we use computer simulation to demonstrate motion of economic systems. A large fraction of examples in this book are simulated with Mathematica. Today, more and more researchers and educators are using computer tools to solve – once seemingly impossible to calculate even three decades ago – complicated and tedious problems.

The lively pace of research on differential equations and theoretical and empirical applications of differential equations to economics means that this book cannot cover all the important applications of differential equations to economics, not to mention the current development of differential equations, irrespective of the endeavors to provide a comprehensive study of the subject.

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Gao Xiao, who has been wonderfully supportive of my efforts in writing this book in Beppu City, Japan. She also helped me to draw some of the figures in the book.

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