An Introduction to Mathematics for Economics

An Introduction to Mathematics for Economics introduces quantitative methods to students of economics and finance in a succinct and accessible style. The introductory nature of this textbook means a background in economics is not essential, as it aims to help students appreciate that learning mathematics is relevant to their overall understanding of the subject. Economic and financial applications are explained in detail before students learn how mathematics can be used, enabling students to learn how to put mathematics into practice. Starting with a revision of basic mathematical principles the second half of the book introduces calculus, emphasising economic applications throughout. Appendices on matrix algebra and difference/differential equations are included for the benefit of more advanced students. Other features, including worked examples and exercises, help to underpin the readers' knowledge and learning. Akihito Asano has drawn upon his own extensive teaching experience to create an unintimidating yet rigorous textbook.

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An Introduction to **Mathematics for Economics**

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Preface

This book is based on lecture notes I wrote for a first-year compulsory quantitative methods course in the Australian National University (ANU) over a period of seven years. Before I started teaching the course in 2002, an encyclopaedic textbook on introductory quantitative methods that had limited focus on economics was used. However, teaching mathematics out of such a textbook to my students seemed ineffective because many of them disliked studying mathematics unless they saw practical applications. Accordingly, as an economist, I looked for other textbooks in mathematical economics. Many good textbooks were available, but they were too advanced for an introductory course, in terms of both mathematics and economics. Although they contained many applications to economics, they usually assumed that students have learnt some introductory economics. These applications are not straightforward for first-year students with little, if any, background in economics. I decided to write my own lecture notes given this unsatisfactory situation.

Scope

The material in the main text ranges from a revision of high-school mathematics to applications of calculus (single-variate, multivariate and integral) to economics and finance. For example: linear and quadratic functions are introduced in the context of demand and supply analysis; geometric sequences, exponential and logarithmic functions are introduced in the context of finance; single-variate calculus is explained in the course of solving a firm's profit maximisation problem; a consumer's utility maximisation is used to motivate introducing multivariate calculus; and integral calculus is explained in the context of calculating the deadweight loss of taxation. The material can be taught in 13–15 weeks (39–45 hours). To give some flexibility, matrix algebra and an introduction to difference/differential equations are covered in appendices.

Features, approach and style

One of the distinctive features of this book is that, where possible, mathematical techniques are introduced in the context of introductory economics. Many students tend to dislike learning mathematics for its own sake, but this feature allows them to realise that learning introductory mathematics is inevitable in studying economics. The book is self-contained since no knowledge in economics or finance is assumed. Economic and financial applications are explained in detail before students learn how mathematics can be used. For example, in Chapter 4, various notions related to a competitive firm's problem (from microeconomics principles) are explained. Then, motivated by this problem, differential calculus is introduced. Of course the primary objective of the book is for students to learn mathematical techniques, so economic ideas are not explained as comprehensively as in other textbooks on introductory economics.

My notes were originally written as a self-contained workbook on maths applications. The material in the workbook was not presented in an encyclopaedic way – because I wanted to have something I could follow exactly – and was written in a conversational style to make my students feel as if they were studying in my lectures. A typical encyclopaedic quantitative methods textbook covers everything at length. It also means that such a textbook tends to contain a lot of unnecessary detail, which I think is not a desirable feature for an introductory textbook. The spirit of the workbook was 'maths is used to examine economics and finance', and this textbook adopts the same philosophy and the conversational style. I have tried to focus on mathematical ideas that are relevant to our applications in economics and finance, and have tried to remove as much unnecessary detail as possible.

I hope instructors find my approach useful in teaching an introductory quantitative methods course and, where necessary, can provide their students with some details that might be missing from this book – in terms of both economics and mathematics – in their lectures, which I am sure will be appreciated.

Target audience

The book is aimed at first-year economics/finance students – with some high-school maths but little (or even no) background in economics or finance – who are required to take a quantitative methods (calculus) course in their degrees. Any other undergraduate student and/or an MBA student who has no economics background, but who is required to take a quantitative course in economics/finance in their degrees will also find the book useful. Although almost no knowledge of economics and finance is required, it is assumed that students have a knowledge of high-school mathematics up to single-variate calculus.

Calculator policy, etc.

The use of a calculator is strongly discouraged. Arithmetic required in this book is not complicated enough to warrant the use of a calculator. Students who routinely use a calculator – and have difficulty in their arithmetic – should try gradually restraining themselves from relying on it. You won't be able to have a good sense of numbers if you keep relying on a calculator. Moreover, we use numbers everyday when we discuss economics and finance, and it helps a lot to have good arithmetic in understanding what other people are discussing.

Some might argue that a scientific calculator is necessary because sometimes a solution may involve expressions such as $\sqrt{\ }$, log, etc. I have come across many students who are used to – with the help of a scientific calculator – providing an approximate solution to these expressions. I have also seen many students who tend to round numbers to two decimal places even when solutions are in fractions, e.g. instead of writing $\frac{1}{30}$, many tend to write 0.03. On many occasions, from a practical point of view, providing an approximate solution is permissible and could be better than providing an exact solution. For example, if your boss asks you to provide him/her with a forecast of the economic growth rate of a country for the next year, he/she is probably looking for an answer such as '2.83 per cent (or even 2.8 per cent)' rather than '$2\sqrt{2}$ per cent'. The rounding error in this case will be considered trivial to your boss as well as to most people. And indeed, it is handy to have a calculator in this case because it will tell you that $2\sqrt{2} \approx 2.828\,427$ (or even more accurately). But what about rounding top 100-metre sprinters' best records to zero decimal places (in seconds)? It is not practical because too many athletes will be tied at 10 seconds and you won't be able to tell the sprinter with the fastest record. On the other hand, you would round top marathon runners' best records because rounding them to zero decimal places would be enough to rank them quite accurately. Using an approximate solution is therefore considered practical and permissible depending on the context, and at times a scientific calculator may be useful in getting the approximate solution.

However, there is a clear distinction between being practical and being precise, and the latter aspect is more important when you study mathematics. In mathematics we tend to carefully connect many dots to get to a solution. If every one of the dots is connected imprecisely, the solution you arrive at might be quite different to the exact one (the difference may still be trivial depending on the context, but that's not the point here). To be a good user of mathematics, it is important to conduct operations accurately and obtain the exact solution at each of the required steps. In fact, in many cases, you will find that only an exact solution exists. For example, when you end up with $\frac{a}{b}$, where a and b are real numbers, there is no way that you can write it in decimals and round it to a particular number of decimal places! For expressions such as $2\sqrt{2}$, $\frac{1}{30}$ and $\log_e 2$, it is possible to provide approximate solutions, but leave them as they are. As far as learning mathematics is concerned, what we care about most is whether you can actually get the exact solution by following the correct steps. For this reason, you will not need to have a scientific calculator (or even a simple calculator) to study this book.

Acknowledgements

I am indebted to many people who have been involved in the process of making this book a reality. As mentioned in the Preface, this book grew out of the lecture notes that I wrote for the quantitative methods course in the ANU. I wrote my own notes because I couldn't find a suitable textbook. In spirit, I essentially followed in the same footsteps of my former colleagues, Ben Smith, Matt Benge and Rod Tyers, who were teaching a first-year macroeconomics course in rotation at that time. They were dissatisfied with existing textbooks in introductory macroeconomics and decided to write their own lecture notes, which were also known as the *brick* (Ben eventually published his brick as a textbook). I read the brick for the first time when I tutored that course for Rod (in 1998 when I was doing my Ph.D.) and was so surprised how systematically and succinctly their material was put together. I would not have thought of writing my own notes without seeing their teaching, so I would like to thank them for showing me their dedication to teaching good economics.

I'd like to express my gratitude to the many students who took my course and used my notes for giving me positive and encouraging feedback as well as some constructive criticism. Teaching that course was a great learning experience for me as an instructor and it was a privilege to have been able to teach such excellent groups of students. My thanks also go to all the tutors – particularly Shane Evans who provided me with valuable assistance as Head Tutor of the course for several years – for their feedback, support and encouragement.

Many people have helped me turn the lecture notes into this book. I'd like to thank my former colleague at the ANU, Chris Jones, for suggesting that I should publish my lecture notes as a book and for introducing Andrew Schuller to me. I am grateful to Andrew for opening up an opportunity for me to discuss this book project with Chris Harrison, Publishing Director of Social Sciences at the Cambridge University Press. I'd like to thank Chris and his editorial and production team for their professional work and continuous support. I'd also like to thank many anonymous reviewers – and again Chris Jones who acted as a non-anonymous reviewer – for providing me with helpful comments and useful suggestions on earlier drafts. Special thanks are due to Rina Miyahara for proof-reading the final manuscript. Of course, I take full responsibility for any remaining errors.