A Concise Introduction to **Econometrics**

AN INTUITIVE GUIDE

Philip Hans Franses

CAMBRIDGE

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CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge CB2 1RP, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
The Edinburgh Building, Cambridge, CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
477 Williamstown Road, Port Melbourne, VIC 3207, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain
Dock House, The Waterfront, Cape Town 8001, South Africa

http://www.cambridge.org

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First published 2002

Printed in the United Kingdom at the University Press, Cambridge

Typefaces Meridien 10.5/16 pt and Stone Sans *System* LaTeX 2_ε [TB]

A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication data

Franses, Philip Hans, 1963–
A concise introduction to econometrics : an intuitive guide/Philip Hans Franses.
p. cm.
Includes bibliographical references and index.
ISBN 0 521 81769 2 – ISBN 0 521 52090 8 (pb.)
1. Econometrics. 2. Econometrics – Case studies. I. Title.
HB139 .F722 2002
330'.01'5195 – dc21 2002067380

ISBN 0 521 81769 2 hardback
ISBN 0 521 52090 8 paperback

Preface

This book is targeted at two distinct audiences. The first audience concerns novices in econometrics who consider taking an econometrics course in an advanced undergraduate or a graduate program. For them, this book aims to be an introduction to the field, and hopefully such that they do indeed take such courses. It should be stressed, though, that this is not a condescending book – that is, it is not something like "econometrics for dummies." On the contrary, the reader is taken seriously and hence some effort is required. The second audience consists of colleagues who teach these courses. It is my belief that many econometrics courses, by zooming in on theory and less on practice, are missing the most important aspect of econometrics, which is that it truly is a very practical discipline.

Therefore, central to this book are practical questions in various economic disciplines such as macroeconomics, finance, and marketing, which might be answered by using econometric tools. After a brief discussion of a few basic tools, I review various aspects of econometric modeling.

Along these lines, I also discuss matters which are typically skipped in currently available textbooks, but which are very relevant when one aims to apply econometric methods in practice. Next, several case studies should provide some intuition of what econometricians do when they face practical questions. Important concepts are shown in *italic* type; examples of practical questions which econometricians aim to answer will be shown in **bold** type.

This book might be used prior to any textbook on econometrics. It can, however, never replace one of these, as the discussion in this book is deliberately very sketchy. Also, at times this book has a somewhat polemic style, and this is done on purpose. In fact, this is the "personal twist" in this book. Therefore, the book should not be seen as the ultimate treatment of the topic, but merely as a (hopefully) joyful read before one takes or gives econometrics classes. Hence, the book can be viewed as a very lengthy introductory chapter.

Finally, as a way of examining whether a reader has appreciated the content of this book, one might think about the following exercise. Take a newspaper or a news magazine and look for articles on economic issues. In many articles are reports on decisions which have been made, forecasts that have been generated, and questions that have been answered. Take one of these articles, and then ask whether these decisions, forecasts, and answers could have been based on the outcomes of an econometric model. What kind of data could one have used? What could the model

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have looked like? Would one have great confidence in these outcomes, and how does this extend to the reported decisions, forecasts, and answers?

I wish to thank Clive Granger and Ashwin Rattan at Cambridge University Press, for encouragement and helpful comments. Also, many thanks are due to Martijn de Jong, Dick van Dijk, and in particular Christiaan Heij for their very constructive remarks. Further comments or suggestions are always welcome. The address for correspondence is Econometric Institute, Erasmus University Rotterdam, P.O. Box 1738, NL-3000 DR Rotterdam, The Netherlands, email: franses@few.eur.nl

PHILIP HANS FRANSES
Rotterdam

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— ✝ CHAPTER ONE ✝ —

Introduction

In this chapter I provide an introductory discussion of what econometrics is and what econometricians do. Next, I consider a more detailed motivation for writing this book. Finally, I give an outline of the other chapters of the book.

What is econometrics?

Econometric techniques are usually developed and employed for answering practical questions. As the first five letters of the word "econometrics" indicate, these questions tend to deal with economic issues, although applications to other disciplines are widespread. The economic issues can concern macroeconomics, international economics, and microeconomics, but also finance, marketing, and accounting. The questions usually aim at a better understanding of an actually observed phenomenon and sometimes also at providing forecasts for future situations. Often it is hoped that these insights can be used to modify current policies or to

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put forward new strategies. For example, one may wonder about the causes of economic crises, and if these are identified, one can think of trying to reduce the effects of crises in the future. Or, it may be interesting to know what motivates people to donate to charity, and use this in order to better address prospective donors. One can also try to understand how stock markets go up – and, particularly, how they go down – in order to adjust investment decisions.

The whole range of econometric methods is usually simply called "econometrics," and this will also be done in this book. And anyone who either invents new econometric techniques, or applies old or new techniques, is called an "econometrician." One might also think of an econometrician as being a statistician who investigates the properties particular to economic data. Econometrics can be divided into *econometric theory* and *applied econometrics*. Econometric theory usually involves the development of new methods and the study of their properties. Applied econometrics concerns the development and application of tools to solve relevant practical questions.

In order to answer practical questions, econometric techniques are applied to actually observed data. These data can concern (1) observations over time, like a country's GDP when measured annually, (2) observations across individuals, like donations to charity, or (3) observations over time and over individuals. Perhaps "individuals" would be better phrased as "individual cases," to indicate that these observations can also concern countries, firms, or households, to

mention just a few. Additionally, when one thinks about observations over time, these can concern seconds, days, or years.

Sometimes the relevant data are easy to access. Financial data concerning, for example, stock markets, can be found in daily newspapers or on the internet. Macroeconomic data on imports, exports, consumption, and income are often available on a monthly basis. In both cases one may need to pay a statistical agency in order to be able to download macroeconomic and financial indicators. Data in marketing are less easy to obtain, and this can be owing to issues of confidentiality. In general, data on individual behavior are not easy and usually are costly to obtain, and often one has to survey individuals oneself.

As one might expect, the type of question that one intends to answer using an econometric method is closely linked to the availability of actual data. When one can obtain purchase behavior of various households, one can try to answer questions about this behavior. If there are almost no data, there is usually not much to say. For example, a question like **"how many households will use this new product within 10 years from now?"** seems rather difficult to answer. And, **"what would the stock market do next year?"** is complicated, too. Of course, one can always come up with an answer, but whether one would have great confidence in this answer is rather doubtful. This touches upon a key aspect of the application of econometric techniques, which is that one aims at answering questions with *some*

degree of confidence. In other words, econometricians do not provide answers like "yes" or "no," but instead one will hear something like "with great confidence we believe that poor countries will not catch up with rich countries within the next 25 years." Usually, the size of "great" in "great confidence" is a choice, although a typical phrase would be something like "with 95 per cent confidence." What that means will become clear in chapter 2 below.

The econometrician uses an *econometric model.* This model usually amounts to one or more equations. In words, these equations can be like "the probability that an individual donates to charity is 0.6 when the same individual donated last time and 0.2 when s/he did not," or "on average, today's stock market return on the Amsterdam Exchange is equal to yesterday's return on the New York Stock Exchange," or "the upward trend in Nigeria's *per capita* GDP is half the size of that of Kenya." Even though these three examples are hypothetical, the verbal expressions come close to the outcomes of actual econometric models.

The key activities of econometricians can now be illustrated. First, an econometrician needs to *translate a practical question* like, for example, **"what can explain today's stock market returns in Amsterdam?"** *into a model.* This usually amounts to thinking about the economic issue at stake, and also about the availability and quality of the data. Fluctuations in the Dow Jones may lead to similar fluctuations in Amsterdam, and this is perhaps not much of a surprise. However, it is by no means certain that this is best

observed for daily data. Indeed, perhaps one should focus only on the first few minutes of a trading day, or perhaps even look at monthly data to get rid of erratic and irrelevant fluctuations, thereby obtaining a better overall picture. In sum, a key activity is to translate a practical question into an econometric model, where this model also somehow matches with the available data. For this translation, econometricians tend to rely on mathematics, as a sort of language. Econometricians are by no means mathematicians, but mathematical tools usually serve to condense notation and simplify certain technical matters. First, it comes in handy to know a little bit about matrix algebra before taking econometrics courses. Note that in this book I will not use any such algebra as I will just stick to simple examples. Second, it is relevant to know some of the basics of calculus, in particular, differential and integral calculus. To become an econometrician, one needs to have some knowledge of these tools.

The second key activity of an econometrician concerns the *match of the model with the data*. In the examples above, one could note numerical statements such as "equal" or "half the size." How does one get these numbers? There are various methods to get them, and these are collected under the header "estimation." More precisely, these numbers are often associated with unknown parameters. The notion "parameter estimation" already indicates that econometricians are never certain about these numbers. However, what econometricians can do is to provide a certain degree of

confidence around these numbers. For example, one could say that **"it is very likely that growth in *per capita* GDP in Nigeria is smaller than that of Kenya"** or that **"it is unlikely that an individual donates to charity again if s/he did last time."** To make such statements, econometricians use statistical techniques.

Finally, a third key activity concerns the *implementation of the model outcomes*. This may mean the construction of *forecasts*. It can also be possible to simulate the properties of the model and thereby examine the effects of various policy rules.

To summarize, econometricians use economic insights and mathematical language to construct their econometric model, and they use statistical techniques to analyze its properties. This combination of three input disciplines ensures that courses in econometrics are not the easiest ones to study.

In this book I try to introduce the essentials of econometrics to novices, keeping the mathematical and statistical level at a minimum, but without being condescending. This book can be used prior to any textbook on econometrics, but it should certainly not replace it! The intention is that this book should be used as introductory and supplementary reading. For textbooks on econometrics, one can choose from Verbeek (2000), Koop (2000), Gujarati (1999), Kennedy (1998), Ramanathan (1997), Johnston and Dinardo (1996), Griffiths, Hill and Judge (1993), and Goldberger (1991) at the introductory level, from Heij *et al.* (2002), Ruud (2000),

Greene (1999), Wooldridge (1999), and Poirier (1995), at the intermediate level, and from White (2000), Davidson and MacKinnon (1993), and Amemiya (1985), at the advanced level. For more specific analysis of time series, one can consider Franses (1998), Hamilton (1994), and Hendry (1995), and for financial econometrics, see Campbell, Lo and MacKinlay (1997).

So, do you have any interest in reading more about econometrics? If you are really a novice, then you can perhaps better skip the next section as this is mainly written for colleagues and more experienced econometricians. The final section is helpful, though, as it provides an outline of subsequent chapters.

Why this book?

Fellow econometricians may now wonder why I decided to write this book in the first place. Well, the motivation was based on my teaching experience at the Econometric Institute of the Erasmus University Rotterdam, where we teach econometrics at undergraduate level. My experience mainly concerns the empirical projects that undergraduate students have to do in their final year before graduation. For these projects, many students work as an intern, for example, with a bank or a consultancy firm, and they are supposed to answer a practical question which the supervising manager may have. Typically, this manager knows that econometricians can handle empirical data, and usually

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