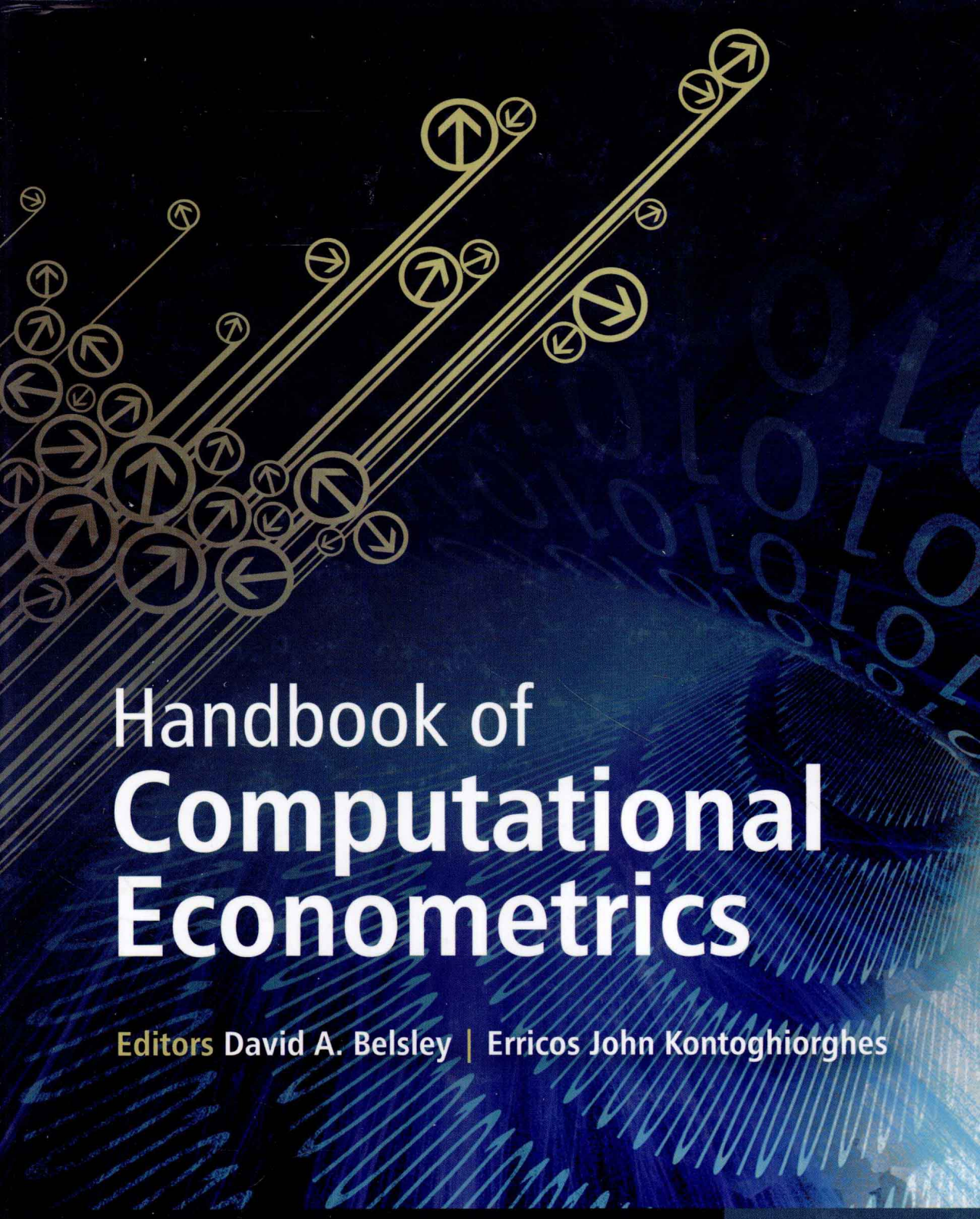

Handbook of Computational Econometrics

Editors David A. Belsley | Erricos John Kontoghiorghes

WILEY

Handbook of Computational Econometrics

Edited by

David A. Belsley

Boston College, USA

Erricos John Kontoghiorghes

University of Cyprus and Queen Mary, University of London, UK

A John Wiley and Sons, Ltd., Publication

This edition first published 2009

Registered office
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, United Kingdom

Library of Congress Cataloging-in-Publication Data

Handbook of computational econometrics / edited by David A. Belsley, Erricos Kontoghiorghes.
p. cm.
Includes bibliographical references and index.
Summary: "Handbook of Computational Econometrics examines the state of the art of computational econometrics and provides exemplary studies dealing with computational issues arising from a wide spectrum of econometric fields including such topics as bootstrapping, the evaluation of econometric software, and algorithms for control, optimization, and estimation. Each topic is fully introduced before proceeding to a more in-depth examination of the relevant methodologies and valuable illustrations. This book: Provides self-contained treatments of issues in computational econometrics with illustrations and invaluable bibliographies. Brings together contributions from leading researchers. Develops the techniques needed to carry out computational econometrics. Features network studies, non-parametric estimation, optimization techniques, Bayesian estimation and inference, testing methods, time-series analysis, linear and nonlinear methods, VAR analysis, bootstrapping developments, signal extraction, software history and evaluation.
This book will appeal to econometricians, financial statisticians, econometric researchers and students of econometrics at both graduate and advanced undergraduate levels"–Provided by publisher.
Summary: "This project's main focus is to provide a handbook on all areas of computing that have a major impact, either directly or indirectly, on econometric techniques and modelling. The book sets out to introduce each topic along with a more in-depth look at methodologies used in computational econometrics, to include use of econometric software and evaluation, bootstrap testing, algorithms for control and optimization and looks at recent computational advances"–Provided by publisher.
ISBN 978-0-470-74385-0
1. Econometrics–Computer programs. 2. Economics–Statistical methods. 3. Econometrics–Data processing. I. Belsley, David A. II. Kontoghiorghes, Erricos John.
HB143.5.H357 2009
330.0285'555–dc22
2009025907

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

ISBN: 978-0-470-74385-0 (H/B)

TypeSet in 10/12pt Times by Laserwords Private Limited, Chennai, India
Printed and bound in Great Britain by CPI Antony Rowe, Chippenham, Wiltshire.

Handbook of Computational Econometrics

To our families

List of Contributors

Alessandra Amendola, DiSES, University of Salerno, 84084 Fisciano (SA), Italy

Christian Francq, EQUIPPE-GREMARS, Université de Lille, BP 60149, 59653 Villeneuve d'Ascq, France

Manfred Gilli, Department of Econometrics, University of Geneva and Swiss Finance Institute, Bd du Pont d'Arve 40, 1211 Geneva 4, Switzerland

Lennart F. Hoogerheide, Center for Operations Research and Econometrics, Université Catholique de Louvain, Voie du Roman Pays 34, 1348 Louvain-la-Neuve, Belgium and Econometric and Tinbergen Institutes, Erasmus University Rotterdam, Burg. Oudlaan 50, 3062 PA Rotterdam, The Netherlands

Helmut Lütkepohl, Economics Department, European University Institute, Villa San Paolo, Via della Piazzuola, 43, I-50133 Firenze, Italy

James G. MacKinnon, Department of Economics, Queen's University, Kingston, Ontario, K7L 3N6, Canada

B. D. McCullough, Department of Economics, LeBow College of Business, Drexel University, Philadelphia, PA 19104, USA

Anna Nagurney, Department of Finance and Operations Management, Isenberg School of Management, University of Massachusetts, Amherst, MA 01003, USA

Panos Parpas, Department of Computing, Imperial College of Science, Technology & Medicine, 180 Queen's Gate, London SW7 2AZ, UK

D. Stephen G. Pollock, Department of Economics, University of Leicester, Leicester LE1 7RH, UK, *and* 12 Gladsmuir Road, London N19 3JX, UK

Charles G. Renfro, Alphametrics Corporation, 11 East Princeton Road, Bala Cynwyd, PA 19004, USA, *and* 601 West 113th Street, #12G New York, NY 10025, USA

Berç Rustem, Department of Computing, Imperial College of Science, Technology & Medicine, 180 Queen's Gate, London SW7 2AZ, UK

Herman K. van Dijk, Econometric and Tinbergen Institutes, Erasmus University Rotterdam, Burg. Oudlaan 50, 3062 PA Rotterdam, The Netherlands

Rutger D. van Oest, Department of Marketing, Tilburg University, Warandelaan 2, 5000 LE Tilburg, The Netherlands

Rand R. Wilcox, Department of Psychology, University of Southern California, Los Angeles, CA 90089-1061, USA

Peter Winker, Faculty of Economics and Business Administration, University of Giessen, Licher Strasse 64, 35394 Giessen, Germany

Preface

This volume comprises eleven chapters dealing with a variety of aspects of computational econometrics. Computational econometrics is a discipline that, to those who do it, is easily understood, but, to the wider field, appears to be difficult to define. Many (most) top-level econometrics journals ignore the subject altogether, and most econometrics textbooks give it short shrift, providing, at best, practically useless treatments. Yet its substance is the very heart and soul of applied econometric practice, the essential means by which most econometric studies take place. The result, as is made clear in several of the chapters in this handbook, is that the computational tools commonly made available to carry out econometric studies can be far from cutting edge, and, worse, quite ill suited for producing the desired results. A major goal of this handbook, then, is to examine the state of the art of computational econometrics and to provide exemplary studies dealing with computational issues arising in a wide spectrum of econometric fields.

Econometrics has, by its very nature, a large statistical component. But econometricians differ from statisticians in at least one important aspect: statisticians are essentially mathematicians dealing with probabilistic phenomena not necessarily related to any specific discipline, whereas econometricians are trained in both statistics *and* the discipline of economics. They bring to the table, therefore, a particular point of view that shapes the kinds of studies they find of interest and the kinds of tools they find appropriate to use and to develop. This has resulted in a discipline with a flavour of its own, a flavour that is inherited by those engaged in the computational aspects of econometrics.

Computational econometrics has several main subfields, all represented in this handbook. These include: the development of computational techniques for carrying out econometrics, such as estimation or numerical methods; studies in which the computer is the central playing field, such as Monte Carlo experiments, genetic algorithms, network studies, or estimation methods like simulated annealing; studies in which the computer does the necessary heavy lifting, such as nonlinear estimation of large-scale systems or massive simulations; and the development of computational environments in which to conduct econometric studies, such as GAMS or Stata. All such potentially diverse studies fall into the rubric of computational econometrics, and that is perhaps the reason the field is so difficult to define. This handbook contains studies in all these categories. All attempt

to provide a self-contained overview of their subject and, where relevant, an accessible technical development along with examples or illustrations. They should be of value to those learning as well as to those well versed in the field.

David A. Belsley
Boston College, USA

Erricos John Kontoghiorghes
University of Cyprus and Queen Mary, University of London, UK

2009

Contents

1

Econometric software

Charles G. Renfro

1.1 Introduction

The production and use of econometric software began at the University of Cambridge in the early 1950s as a consequence of the availability there of the first operative stored-program electronic computer, the EDSAC (Electronic Delay Storage Automatic Calculator). This machine became available for academic research starting in or about 1951 [214, 248, 249]. Among the first to use it were members of the Department of Applied Economics (DAE), some of whom had been invited to Cambridge by the Director, Richard Stone. From the beginning, they employed the EDSAC to produce work that remains well regarded [8, 77, 124, 195]. They also appear to have been the first to describe in print the workaday process of using a stored-program computer [36]. There, Lucy Slater, working with Michael Farrell, wrote the first distinguishable econometric software package, a regression program [14, 224, 225]. However, these economists were not alone in their early adoption of emerging computing technologies, for previously, in 1947, at one of the first gatherings of computer designers, the Symposium on Large-Scale Digital Calculating Machinery, Wassily Leontief [153] had presented some of his then current work on inter-industry relationships to provide an example of a challenging computational problem. He used the existing electromechanical 'Mark I' Automatic Sequence Control Calculator at Harvard, which, although not actually a stored-program electronic computer, can nonetheless be described as the first 'automatic digital computer' [248]. The Mark I also represents IBM's start in a business it was later to dominate.

At the time, worldwide, these machines were the only automatic computing devices generally available for research. Consequently, other computationally inclined

Handbook of Computational Econometrics edited by D. A. Belsley, E. J. Kontoghiorghes