Estimating Macroeconomic Models: A Likelihood Approach

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This paper shows how particle filtering facilitates likelihood-based inference in dynamic macroeconomic models. The economies can be non-linear and/or non-normal. We describe how to use the output from the particle filter to estimate the structural parameters of the model, those characterizing preferences and technology, and to compare different economies. Both tasks can be implemented from either a classical or a Bayesian perspective. We illustrate the technique by estimating a business cycle model with investment-specific technological change, preference shocks, and stochastic volatility.

1. INTRODUCTION

This paper shows how particle filtering facilitates likelihood-based inference in dynamic equilibrium models. The economies can be non-linear and/or non-normal. We describe how to use the particle filter to estimate the structural parameters of the model, those characterizing preferences and technology, and to compare different economies. Both tasks can be implemented from either a classical or a Bayesian perspective. We illustrate the technique by estimating a business cycle model with investment-specific technological change, preference shocks, and stochastic volatility. We highlight three results. First, there is strong evidence of stochastic volatility on U.S. aggregate data. Second, two periods of low and falling aggregate volatility, from the late 1950's to the late 1960's and from the mid 1980's to today, were interrupted by a period of high and rising aggregate volatility from the late 1960's to the early 1980's. Third, variations in the volatility of preferences and investment-specific technological shocks account for most of the variation in the volatility of output growth over the last 50 years.

Likelihood-based inference is a useful tool to take dynamic equilibrium models to the data (An and Schorfheide, 2007). However, most dynamic equilibrium models do not imply a likelihood function that can be evaluated analytically or numerically. To circumvent this problem, the literature has used the approximated likelihood derived from a linearized version of the model, instead of the exact likelihood. But linearization depends on the accurate approximation of the solution of the model by a linear relation and on the shocks to the economy being distributed normally. Both assumptions are problematic.

First, the impact of linearization is grimmer than it appears. Fernández-Villaverde, Rubio-Ramírez and Santos (2006) prove that second-order approximation errors in the solution of the model have first-order effects on the likelihood function. Moreover, the error in the approximated likelihood gets compounded with the size of the sample. Period by period, small errors in the policy function accumulate at the same rate at which the sample size grows. Therefore,

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   The Oxford Handbook of Applied Nonparametric and Semiparametric Econometrics and Statistics Jeffrey Racine,Liangjun Su,Aman Ullah,2014-04 This volume edited by Jeffrey Racine Liangjun Su and Aman Ullah contains the latest research on nonparametric and semiparametric econometrics and statistics Chapters by leading international econometricians and statisticians highlight the interface between econometrics and statistical methods for nonparametric and semiparametric procedures   *Nonparametric Econometric Methods* Qi Li,Jeffrey Scott Racine,2009-12-04 Contains a selection of papers presented initially at the 7th Annual Advances in Econometrics Conference held on the LSU campus in Baton Rouge Louisiana during November 14 16 2008 This work is suitable for those who wish to familiarize themselves with nonparametric methodology   **Nonlinear Modeling of Economic and Financial Time-Series** Fredj Jawadi,William A. Barnett,2010-12-17 Presents researches in linear and nonlinear modelling of economic and financial time series This book provides a comprehensive understanding of financial and economic dynamics in various aspects using modern financial econometric methods It also presents and discusses research findings and their implications   *Applied Nonparametric Econometrics* Daniel J. Henderson,Christopher F. Parmeter,2015-01-12 The majority of empirical research in economics ignores the potential benefits of nonparametric methods while the majority of advances in nonparametric theory ignore the problems faced in applied econometrics This book helps bridge this gap between applied economists and theoretical nonparametric econometricians It discusses in depth and in terms that someone with only one year of graduate econometrics can understand basic to advanced nonparametric methods The analysis starts with density estimation and motivates the procedures through methods that should be familiar to the reader It then moves on to kernel regression estimation with discrete data and advanced methods such as estimation with panel data and instrumental variables models The book pays close attention to the issues that arise with programming computing speed and application In each chapter the methods discussed are applied to actual data paying attention to presentation of results and potential pitfalls   **Handbook of Empirical Economics and Finance** Aman Ullah,David E. A. Giles,2016-04-19 Handbook of Empirical Economics and Finance explores the latest developments in the analysis and modeling of economic and financial data Well recognized econometric experts discuss the rapidly growing research in economics and finance and offer insight on the future direction of these fields Focusing on micro models the first group of chapters describes the statistical issues involved in the analysis of econometric models with cross sectional data often arising in microeconomics The book then illustrates time series models that are extensively used in empirical macroeconomics and finance The last set of chapters explores the types of panel data and spatial models that are becoming increasingly significant in analyzing complex economic behavior and policy evaluations This handbook brings together both background material and new methodological and applied results that are extremely important to the current and future frontiers in empirical economics and finance It emphasizes inferential issues that

transpire in the analysis of cross sectional time series and panel data based empirical models in economics finance and related disciplines   **Semiparametric and Nonparametric Econometrics** Aman Ullah,2012-12-06 Over the last three decades much research in empirical and theoretical economics has been carried on under various assumptions For example a parametric functional form of the regression model the heteroskedasticity and the autocorrelation is always as sumed usually linear Also the errors are assumed to follow certain parametric distri butions often normal A disadvantage of parametric econometrics based on these assumptions is that it may not be robust to the slight data inconsistency with the particular parametric specification Indeed any misspecification in the functional form may lead to erroneous conclusions In view of these problems recently there has been significant interest in the semiparametric nonparametric approaches to econometrics The semiparametric approach considers econometric models where one component has a parametric and the other which is unknown a nonparametric specification Manski 1984 and Horowitz and Neumann 1987 among others The purely non parametric approach on the other hand does not specify any component of the model a priori The main ingredient of this approach is the data based estimation of the unknown joint density due to Rosenblatt 1956 Since then especially in the last decade a vast amount of literature has appeared on nonparametric estimation in statistics journals However this literature is mostly highly technical and this may partly be the reason why very little is known about it in econometrics although see Bierens 1987 and Ullah 1988   **Handbook of Econometrics** Zvi Griliches,Michael D. Intriligator,Robert Engle,Dan McFadden,1983 The Handbook is a definitive reference source and teaching aid for econometricians It examines models estimation theory data analysis and field applications in econometrics   **The Routledge Handbook of Agricultural Economics** Gail Cramer,Krishna Paudel,Andrew Schmitz,2018-07-17 This Handbook offers an up to date collection of research on agricultural economics Drawing together scholarship from experts at the top of their profession and from around the world this collection provides new insights into the area of agricultural economics The Routledge Handbook of Agricultural Economics explores a broad variety of topics including welfare economics econometrics agribusiness and consumer economics This wide range reflects the way in which agricultural economics encompasses a large sector of any economy and the chapters present both an introduction to the subjects as well as the methodology statistical background and operations research techniques needed to solve practical economic problems In addition food economics is given a special focus in the Handbook due to the recent emphasis on health and feeding the world population a quality diet Furthermore through examining these diverse topics the authors seek to provide some indication of the direction of research in these areas and where future research endeavors may be productive Acting as a comprehensive up to date and definitive work of reference this Handbook will be of use to researchers faculty and graduate students looking to deepen their understanding of agricultural economics agribusiness and applied economics and the interrelationship of those areas   **Generalized Latent Variable Modeling** Anders Skrondal,Sophia Rabe-Hesketh,2004-05-11 This book unifies and extends latent variable models

including multilevel or generalized linear mixed models longitudinal or panel models item response or factor models latent class or finite mixture models and structural equation models Following a gentle introduction to latent variable modeling the authors clearly explain and contrast a wi **Economic Theory, Dynamics and Markets** Takashi Negishi,Rama V. Ramachandran,Kazuo Mino,2012-12-06 Economic Theory Dynamics and Markets The collection of essays in honor of Ryuzo Sato written by his colleagues and students covers the many fields of economic theory and policy to which he has contributed The first section pays tribute to his contributions to mathematical economics and economic theory Ryuzo Sato is known for his work in growth theory and technical progress and the second section has a number of papers on macroeconomics and dynamics The third section has a number of papers on financial markets and their functioning in Japan and the United States The next section examines various aspects of the economics of firms and industry Ryuzo Sato has been very involved in analyzing the economic and business relations between Japan and the United States and the last section is devoted to comparative analysis of economic systems *Parallel Population and Parallel Human* Peijun Ye,Fei-Yue Wang,2023-06-06 Parallel Population and Parallel Human Proposes a new paradigm to investigate an individual s cognitive deliberation in dynamic human machine interactions Today intelligent machines enable people to interact remotely with friends family romantic partners colleagues competitors organizations and others Virtual reality VR augmented reality AR artificial intelligence AI mobile social media and other technologies have been driving these interactions to an unprecedented level As the complexity in system control and management with human participants increases engineers are facing challenges that arise from the uncertainty of operators or users Parallel Population and Parallel Human A Cyber Physical Social Approach presents systemic solutions for modeling analysis computation and management of individuals cognition and decision making in human participated systems such as the MetaVerse With a virtual real behavioral approach that seeks to actively prescribe user behavior through cognitive and dynamic learning the authors present a parallel population human model for optimal prescriptive control and management of complex systems that leverages recent advances in artificial intelligence Throughout the book the authors address basic theory and methodology for modeling describe various implementation techniques highlight potential acceleration technologies discuss application cases from different fields and more In addition the text Considers how an individual s behavior is formed and how to prescribe their behavioral modes Describes agent based computation for complex social systems based on a synthetic population from realistic individual groups Proposes a universal algorithm applicable to a wide range of social organization types Extends traditional cognitive modeling by utilizing a dynamic approach to investigate cognitive deliberation in highly time variant tasks Presents a new method that can be used for both large scale social systems and real time human machine interactions without extensive experiments for modeling Parallel Population and Parallel Human A Cyber Physical Social Approach is a must read for researchers engineers scientists professionals and graduate students who work on systems engineering human machine interaction cognitive computing and

artificial intelligence   *The New Palgrave Dictionary of Economics* ,2016-05-18 The award winning The New Palgrave Dictionary of Economics 2nd edition is now available as a dynamic online resource Consisting of over 1 900 articles written by leading figures in the field including Nobel prize winners this is the definitive scholarly reference work for a new generation of economists Regularly updated This product is a subscription based product   *The International Handbook on Non-Market Environmental Valuation* Jeff Bennett,2011-01-01 Non market environmental valuation NMEV is undergoing a period of increased growth in both application and development as a result of increasing recognition of the role of economics in environmental policy issues Against this backdrop The International Handbook on Non Market Environmental Valuation brings together world leaders in the field to advance the development and application of NMEV as a tool for policymaking The expert contributors provide insights into the state of the art across the spectrum of both revealed and stated preference methods and highlight new directions being taken A sequence of topical applications demonstrate various techniques and illustrate what can be achieved using NMEV deliberately diverse case studies are drawn from Europe North America Asia and Australia with valuation targets ranging across use and non use values of the environment A number of reviews of cutting edge issues are also presented This outstanding resource will enable those interested in environmental valuation from theoretical practical or policy perspectives to bring themselves to the forefront of developments and practice As such this Handbook will prove invaluable to a wide ranging audience encompassing academics researchers students practitioners and consultants involved in environmental economics and NMEV   *The Refinement of Econometric Estimation and Test Procedures* Garry D. A. Phillips,Elias Tzavalis,2007-02-01 The small sample properties of estimators and tests are frequently too complex to be useful or are unknown Much econometric theory is therefore developed for very large or asymptotic samples where it is assumed that the behaviour of estimators and tests will adequately represent their properties in small samples Refined asymptotic methods adopt an intermediate position by providing improved approximations to small sample behaviour using asymptotic expansions Dedicated to the memory of Michael Magdalinos whose work is a major contribution to this area this book contains chapters directly concerned with refined asymptotic methods In addition there are chapters focusing on new asymptotic results the exploration through simulation of the small sample behaviour of estimators and tests in panel data models and improvements in methodology With contributions from leading econometricians this collection will be essential reading for researchers and graduate students concerned with the use of asymptotic methods in econometric analysis   **Essays in Honor of Joon Y. Park** Yoosoon Chang,Sokbae Lee,J. Isaac Miller,2023-04-24 Volumes 45a and 45b of Advances in Econometrics honor Professor Joon Y Park who has made numerous and substantive contributions to the field of econometrics over a career spanning four decades since the 1980s and counting   **Short-lived Shocks with Long-lived Impacts?** Michael Lokshin,Martin Ravallion,2000 In theory it is possible that a vulnerable household will never recover from a sufficiently large but short lived shock to its income which could explain the persistent poverty that has emerged in many

transition economies But this study for Hungary shows that in general households bounce back from transient shocks although not rapidly   *Handbook of Econometrics* J.J. Heckman,Edward Leamer,2001-11-22 The Handbook is a definitive reference source and teaching aid for econometricians It examines models estimation theory data analysis and field applications in econometrics Comprehensive surveys written by experts discuss recent developments at a level suitable for professional use by economists econometricians statisticians and in advanced graduate econometrics courses For more information on the Handbooks in Economics series please see our home page on http www elsevier nl locate hes

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Complex and Chaotic Nonlinear Dynamics Thierry Vialar,2009-04-26 Complex dynamics constitute a growing and increasingly important area as they offer a strong potential to explain and formalize natural physical financial and economic phenomena This book pursues the ambitious goal to bring together an extensive body of knowledge regarding complex dynamics from various academic disciplines Beyond its focus on economics and finance including for instance the evolution of macroeconomic growth models towards nonlinear structures as well as signal processing applications to stock markets fundamental parts of the book are devoted to the use of nonlinear dynamics in mathematics statistics signal theory and processing Numerous examples and applications almost 700 illustrations and numerical simulations based on the use of Matlab make the book an essential reference for researchers and students from many different disciplines who are interested in the nonlinear field An appendix recapitulates the basic mathematical concepts required to use the book

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