

Article

Asymptotic Theory for Cointegration Analysis When the Cointegration Rank Is Deficient

David H. Bernstein ¹ and Bent Nielsen ^{2,*} ¹ Department of Economics, University of Miami, Coral Gables, FL 33146, USA; dbernstein@bus.miami.edu² Department of Economics & Nuffield College & Programme on Economic Modelling, University of Oxford, Oxford OX1 1NF, UK

* Correspondence: bent.nielsen@nuffield.ox.ac.uk

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Abstract: We consider cointegration tests in the situation where the cointegration rank is deficient. This situation is of interest in finite sample analysis and in relation to recent work on identification robust cointegration inference. We derive asymptotic theory for tests for cointegration rank and for hypotheses on the cointegrating vectors. The limiting distributions are tabulated. An application to US treasury yields series is given.

Keywords: cointegration; rank deficiency; weak identification

JEL Classification: C32

1. Introduction

Determination of the cointegration rank is an important part of analyzing the cointegrated vector autoregressive model in the framework of Johansen (1988, 1991, 1995), Johansen and Juselius (1990), and Juselius (2006). We consider the rank deficient case where the cointegration rank of the data generating process is smaller than the rank used in the statistical analysis. In that case, the data generating process has more unit roots than the number of unit roots imposed in the statistical analysis and the usual asymptotic theory fails. We provide asymptotic theory for cointegration rank tests and tests on cointegration vectors along with simulated tables of the asymptotic distributions.

Cointegration analysis is conducted in three steps. First, the specification of the model is checked. Second, the rank is determined using a sequential procedure using Dickey-Fuller type distributions. Third, the cointegrating vectors are estimated and restrictions can be tested using standard inference. Asymptotic theory shows that estimated rank is consistent in the sense that the probability that the estimated rank is not equal to the true rank equals the size of tests, whereas the probability that the estimated rank is too small vanishes, see Johansen (1992, 1995) and Paruolo (2001). Hence, the rank deficiency problem does not arise in the asymptotic analysis.

In practice, rank deficiency matters in two ways. The asymptotic theory often suffers from considerable finite sample distortion. Further, if an investigator wants to focus on the inference on the cointegrating relations then problems can arise if the rank is taken as known when in fact it is deficient. These problems mirror those of instrumental variable estimation with weak instruments, see Mavroeidis et al. (2014).

When conducting inference on the cointegrating vector under near rank deficiency the parameters are weakly identified. At the extreme when testing on the cointegrating vector in the case of a deficient rank the model is mis-specified. This problem arises in cointegration as well as in instrumental variable estimation. In both cases maximum likelihood is conducted using reduced rank regression. The weak identification problem has attracted considerable attention in the instrumental variable literature, see for instance Mavroeidis et al. (2014). Khalaf and Urga (2014) discussed the weak

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Hans-Martin Krolzig



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Asymptotic Theory for Cointegration Analysis when the Cointegration Rank is Deficient David Bernstein, Bent Nielsen, 2014 **Markov-Switching Vector Autoregressions** Hans-Martin Krolzig, 2013-06-29 This book contributes to recent developments on the statistical analysis of multiple time series in the presence of regime shifts Markov switching models have become popular for modelling non linearities and regime shifts mainly in univariate economic time series This study is intended to provide a systematic and operational approach to the econometric modelling of dynamic systems subject to shifts in regime based on the Markov switching vector autoregressive model The study presents a comprehensive analysis of the theoretical properties of Markov switching vector autoregressive processes and the related statistical methods The statistical concepts are illustrated with applications to empirical business cycle research This monograph is a revised version of my dissertation which has been accepted by the Economics Department of the Humboldt University of Berlin in 1996 It consists mainly of unpublished material which has been presented during the last years at conferences and in seminars The major parts of this study were written while I was supported by the Deutsche Forschungsgemeinschaft DFG Berliner Graduiertenkolleg Angewandte Mikroökonomik and Sonderforschungsbereich 373 at the Free University and Humboldt University of Berlin Work was finally completed in the project The Econometrics of Macroeconomic Forecasting founded by the Economic and Social Research Council ESRC at the Institute of Economics and Statistics University of Oxford It is a pleasure to record my thanks to these institutions for their support of my research embodied in this study

Likelihood-Based Inference in Cointegrated Vector Autoregressive Models Søren Johansen, 1995-12-28 This book gives a detailed mathematical and statistical analysis of the cointegrated vector autoregressive model This model had gained popularity because it can at the same time capture the short run dynamic properties as well as the long run equilibrium behaviour of many non stationary time series It also allows relevant economic questions to be formulated in a consistent statistical framework Part I of the book is planned so that it can be used by those who want to apply the methods without going into too much detail about the probability theory The main emphasis is on the derivation of estimators and test statistics through a consistent use of the Gaussian likelihood function It is shown that many different models can be formulated within the framework of the autoregressive model and the interpretation of these models is discussed in detail In particular models involving restrictions on the cointegration vectors and the adjustment coefficients are discussed as well as the role of the constant and linear drift In Part II the asymptotic theory is given the slightly more general framework of stationary linear processes with i.i.d innovations Some useful mathematical tools are collected in Appendix A and a brief summary of weak convergence is given in Appendix B The book is intended to give a relatively self contained presentation for graduate students and researchers with a good knowledge of multivariate regression analysis and likelihood methods The asymptotic theory requires some familiarity with the theory of weak convergence of stochastic processes The theory is

treated in detail with the purpose of giving the reader a working knowledge of the techniques involved Many exercises are provided The theoretical analysis is illustrated with the empirical analysis of two sets of economic data The theory has been developed in close contract with the application and the methods have been implemented in the computer package CATS in RATS as a result of a collaboration with Katarina Juselius and Henrik Hansen

Uncertainty Modeling in Knowledge Engineering and Decision Making, 2012 FLINS originally an acronym for Fuzzy Logic and Intelligent Technologies in Nuclear Science is now extended to Computational Intelligence for applied research The contributions to the 10th of FLINS conference cover state of the art research development and technology for computational intelligence systems both from the foundations and the applications points of view Sample Chapter s Foreword 55 KB Evaluation of Manufacturing Technology of Photovoltaic Cells 124 KB Contents Decision Making and Decision Support Systems Uncertainty Modeling Foundations of Computational Intelligence Statistics Data Analysis and Data Mining Intelligent Information Processing Productivity and Reliability Applied Research Readership Graduate students researchers and academics in artificial intelligence machine learning information management decision sciences databases information sciences and fuzzy logic

New Introduction to Multiple Time Series Analysis Helmut Lütkepohl, 2007-07-26 This is the new and totally revised edition of Lütkepohl s classic 1991 work It provides a detailed introduction to the main steps of analyzing multiple time series model specification estimation model checking and for using the models for economic analysis and forecasting The book now includes new chapters on cointegration analysis structural vector autoregressions cointegrated VARMA processes and multivariate ARCH models The book bridges the gap to the difficult technical literature on the topic It is accessible to graduate students in business and economics In addition multiple time series courses in other fields such as statistics and engineering may be based on it

Time-Series-Based Econometrics Michio Hatanaka, 1996-01-25 In the last decade time series econometrics has made extraordinary developments on unit roots and cointegration However this progress has taken divergent directions and has been subjected to criticism from outside the field In this book Professor Hatanaka surveys the field examines those portions that are useful for macroeconomics and responds to the criticism His survey of the literature covers not only econometric methods but also the application of these methods to macroeconomic studies The most vigorous criticism has been that unit roots do not exist in macroeconomic variables and thus that cointegration analysis is irrelevant to macroeconomics The judgement of this book is that unit roots are present in macroeconomic variables when we consider periods of 20 to 40 years but that the critics may be right when periods of 100 years are considered Fortunately most of the time series data used for macroeconomic studies cover fall within the shorter time span Among the numerous methods for unit roots and cointegration those useful from macroeconomic studies are examined and explained in detail without overburdening the reader with unnecessary mathematics Other less applicable methods are discussed briefly and their weaknesses are exposed Hatanaka has rigorously based his judgements about usefulness on whether the inference is

appropriate for the length of the data sets available and also on whether a proper inference can be made on the sort of propositions that macroeconomists wish to test This book highlights the relations between cointegration and economic theories and presents cointegrated regression as a revolution in econometric methods Its analysis is of relevance to academic and professional or applied econometricians Step by step explanations of concepts and techniques make the book a self contained text for graduate students *Handbook of Financial Time Series* Torben Gustav Andersen, Richard A.

Davis, Jens-Peter Kreiß, Thomas V. Mikosch, 2009-04-21 The Handbook of Financial Time Series gives an up to date overview of the field and covers all relevant topics both from a statistical and an econometrical point of view There are many fine contributions and a preamble by Nobel Prize winner Robert F Engle Political Analysis Walter R. Mebane, 1999 Discusses some of the latest developments in political methodology Cointegration, Causality, and Forecasting Halbert White, Robert F. Engle, Clive William John Granger, 1999 The book is a collection of essays in honour of Clive Granger The chapters are by some of the world leading econometricians all of whom have collaborated with or studied with or both Clive Granger Central themes of Grangers work are reflected in the book with attention to tests for unit roots and cointegration tests of misspecification forecasting models and forecast evaluation non linear and non parametric econometric techniques and overall a careful blend of practical empirical work and strong theory The book shows the scope of Granger s research and the range of the profession that has been influenced by his work Complex Systems in Finance and Econometrics Robert A. Meyers, 2010-11-03 Finance Econometrics and System Dynamics presents an overview of the concepts and tools for analyzing complex systems in a wide range of fields The text integrates complexity with deterministic equations and concepts from real world examples and appeals to a broad audience *The Econometric Analysis of Non-Stationary Spatial Panel Data* Michael Beenstock, Daniel Felsenstein, 2019-03-27 This monograph deals with spatially dependent nonstationary time series in a way accessible to both time series econometricians wanting to understand spatial econometrics and spatial econometricians lacking a grounding in time series analysis After charting key concepts in both time series and spatial econometrics the book discusses how the spatial connectivity matrix can be estimated using spatial panel data instead of assuming it to be exogenously fixed This is followed by a discussion of spatial nonstationarity in spatial cross section data and a full exposition of non stationarity in both single and multi equation contexts including the estimation and simulation of spatial vector autoregression VAR models and spatial error correction ECM models The book reviews the literature on panel unit root tests and panel cointegration tests for spatially independent data and for data that are strongly spatially dependent It provides for the first time critical values for panel unit root tests and panel cointegration tests when the spatial panel data are weakly or spatially dependent The volume concludes with a discussion of incorporating strong and weak spatial dependence in non stationary panel data models All discussions are accompanied by empirical testing based on a spatial panel data of house prices in Israel **Applied Time Series Econometrics** Helmut Lütkepohl, Markus Krätzig, 2004-08-02 Time series

econometrics is a rapidly evolving field. Particularly the cointegration revolution has had a substantial impact on applied analysis. Hence no textbook has managed to cover the full range of methods in current use and explain how to proceed in applied domains. This gap in the literature motivates the present volume. The methods are sketched out reminding the reader of the ideas underlying them and giving sufficient background for empirical work. The treatment can also be used as a textbook for a course on applied time series econometrics. Topics include unit root and cointegration analysis, structural vector autoregressions, conditional heteroskedasticity and nonlinear and nonparametric time series models. Crucial to empirical work is the software that is available for analysis. New methodology is typically only gradually incorporated into existing software packages. Therefore a flexible Java interface has been created allowing readers to replicate the applications and conduct their own analyses.

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.

Time Series and Panel Data Econometrics M. Hashem Pesaran, 2015
 The book describes and illustrates many advances that have taken place in a number of areas in theoretical and applied econometrics over the past four decades.

Handbook of Computational Statistics James E. Gentle, Wolfgang Karl Härdle, Yuichi Mori, 2012-07-06
 The *Handbook of Computational Statistics: Concepts and Methods* second edition is a revision of the first edition published in 2004 and contains additional comments and updated information on the existing chapters as well as three new chapters addressing recent work in the field of computational statistics. This new edition is divided into 4 parts in the same way as the first edition. It begins with *How Computational Statistics became the backbone of modern data science*. Ch 1 an overview of the field of Computational Statistics how it emerged as a separate discipline and how its own development mirrored that of hardware and software including a discussion of current active research. The second part Chs 2-15 presents several topics in the supporting field of statistical computing. Emphasis is placed on the need for fast and accurate numerical algorithms and some of the basic methodologies for transformation, database handling, high dimensional data and graphics treatment are discussed. The third part Chs 16-33 focuses on statistical methodology. Special attention is given to smoothing, iterative procedures, simulation and visualization of multivariate data. Lastly a set of selected applications Chs 34-38 like Bioinformatics, Medical Imaging, Finance, Econometrics and Network Intrusion Detection highlight the usefulness of computational statistics in real world applications.

COMPSTAT Jelke G. Bethlehem, Peter G.M. van der Heijden, 2012-12-06
 This Volume contains the Keynote, Invited and Full Contributed papers presented at COMPSTAT 2000. A companion volume Jansen Bethlehem 2000 contains papers describing the Short Communications and Posters. COMPSTAT is a one week conference held every two years under the auspices of the International Association of Statistical Computing, a section of the International Statistical Institute. COMPSTAT 2000 is jointly organised by the Department of Methodology and Statistics of the Faculty of Social Sciences of Utrecht.

University and Statistics Netherlands It is taking place from 21-25 August 2000 at Utrecht University Previous COMPSTATs from 1974-1998 were in Vienna Berlin Leiden Edinburgh Toulouse Prague Rome Copenhagen Dubrovnik Neuchatel Vienna Barcelona and Bristol The conference is the main European forum for developments at the interface between statistics and computing This was encapsulated as follows on the COMPSTAT 2000 homepage <http://neon.vb.cbs.nl/irsml/compstat> Statistical computing provides the link between statistical theory and applied statistics As at previous COMPSTATs the scientific programme will range over all aspects of this link from the development and implementation of new statistical ideas through to user experiences and software evaluation The programme should appeal to anyone working in statistics and using computers whether in universities industrial companies research institutes or as software developers At COMPSTAT 2000 there is a special interest in the interplay with official statistics This is evident from papers in the area of computerised data collection survey methodology treatment of missing data and the like

Stochastic Processes and Calculus Uwe Hassler, 2015-12-12 This textbook gives a comprehensive introduction to stochastic processes and calculus in the fields of finance and economics more specifically mathematical finance and time series econometrics Over the past decades stochastic calculus and processes have gained great importance because they play a decisive role in the modeling of financial markets and as a basis for modern time series econometrics Mathematical theory is applied to solve stochastic differential equations and to derive limiting results for statistical inference on nonstationary processes This introduction is elementary and rigorous at the same time On the one hand it gives a basic and illustrative presentation of the relevant topics without using many technical derivations On the other hand many of the procedures are presented at a technically advanced level for a thorough understanding they are to be proven In order to meet both requirements jointly the present book is equipped with a lot of challenging problems at the end of each chapter as well as with the corresponding detailed solutions Thus the virtual text augmented with more than 60 basic examples and 40 illustrative figures is rather easy to read while a part of the technical arguments is transferred to the exercise problems and their solutions

Time Series with Long Memory Peter M. Robinson, 2003 Long memory processes constitute a broad class of models for stationary and nonstationary time series data in economics finance and other fields Their key feature is persistence with high correlation between events that are remote in time A single memory parameter economically indexes this persistence as part of a rich parametric or nonparametric structure for the process Unit root processes can be covered along with processes that are stationary but with stronger persistence than autoregressive moving averages these latter being included in a broader class which describes both short memory and negative memory Long memory processes have in recent years attracted considerable interest from both theoretical and empirical researchers in time series and econometrics This book of readings collects articles on a variety of topics in long memory time series including modelling and statistical inference for stationary processes stochastic volatility models nonstationary processes and regression and fractional cointegration models Some of the articles are highly

theoretical others contain a mix of theory and methods and an effort has been made to include empirical applications of the main approaches covered A review article introduces the other articles but also attempts a broader survey traces the history of the subject and includes a bibliography

Multivariate Modelling of Non-Stationary Economic Time Series John Hunter, Simon P. Burke, Alessandra Canepa, 2017-05-08 This book examines conventional time series in the context of stationary data prior to a discussion of cointegration with a focus on multivariate models The authors provide a detailed and extensive study of impulse responses and forecasting in the stationary and non stationary context considering small sample correction volatility and the impact of different orders of integration Models with expectations are considered along with alternate methods such as Singular Spectrum Analysis SSA the Kalman Filter and Structural Time Series all in relation to cointegration Using single equations methods to develop topics and as examples of the notion of cointegration Burke Hunter and Canepa provide direction and guidance to the now vast literature facing students and graduate economists

Granger's Representation Theorem and Multicointegration Tom Engsted, Søren Johansen, 1997

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