

A new class of efficient and unbiased two-step shrinkage estimators: method and application

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ABSTRACT

This paper introduces a new class of efficient and unbiased two-step shrinkage estimators for a linear regression model in the presence of multicollinearity. We derive the proposed estimators' mean square error and define the necessary and sufficient conditions for superiority over the existing estimators. In addition, we develop an algorithm for selecting the shrinkage parameters for the proposed estimators. The comparison of the new estimators versus the traditional ordinary least squares, ridge regression, Liu, and the two-parameter estimators is done by a matrix mean square error criterion. The Monte Carlo simulation results show the superiority of the proposed estimators under certain conditions. In the presence of high but imperfect multicollinearity, the two-step shrinkage estimators' performance is relatively better. Finally, two real-world chemical data are analyzed to demonstrate the advantages and the empirical relevance of our newly proposed estimators. It is shown that the standard errors and the estimated mean square error decrease substantially for the proposed estimator. Hence, the precision of the estimated parameters is increased, which of course is one of the main objectives of the practitioners.

ARTICLE HISTORY

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KEYWORDS

Unbiased estimator; Monte Carlo simulations; multicollinearity; two-parameter estimator; ridge regression; chemical structures

1. Introduction

To describe the problem, we consider the following classical linear regression model (LRM):

$$Y = X\beta + \varepsilon, \quad (1)$$

where Y is a $(n \times 1)$ vector of observations on the response variable, X is a $(n \times p)$ full ranked design matrix consisting of the explanatory variables, β is a $(p \times 1)$ column vector of unknown regression coefficients and ε is a $(n \times 1)$ vector of random errors assumed to be normally distributed with $E(\varepsilon) = 0$ and $E(\varepsilon\varepsilon^T) = \sigma^2 I_n$ where I_n is a $(n \times n)$ identity matrix. The ordinary least square estimator (OLSE) of the unknown parameter vector β is:

$$\hat{\beta}_{OLS} = (X^T X)^{-1} X^T Y. \quad (2)$$

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Jicheng Xie



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When are Two Step Estimators Efficient? Michael McAleer, C. R. McKenzie, 1991

The Econometric Analysis of Time Series Andrew C. Harvey, 1990 The Econometric Analysis of Time Series focuses on the statistical aspects of model building with an emphasis on providing an understanding of the main ideas and concepts in econometrics rather than presenting a series of rigorous proofs

Efficiency and Productivity Analysis Artem Prokhorov, 2024-02-28 This book is an easy to understand guide to modeling productivity and efficiency using modern statistical tools It introduces readers to the fundamentals of stochastic frontier analysis SFA and gradually takes them to the forefront of academic research in this area examining the latest concepts and methods related to the use of copulas in SFA Following a comprehensive review of classic methodology Professor Artem Prokhorov covers topics in panel data modeling in endogeneity in SFA in joint modeling of technical and allocative inefficiency and in optimal and robust prediction of inefficiency scores This is done using copulas to capture various kinds of statistical dependence that have been previously ignored when modeling production The classic and advanced topics are illustrated using practical examples and codes written in modern programming languages As an important example the book spells out the case where both the values of output and the ratio of inputs used in production are optimized simultaneously Such simultaneity if ignored leads to biased estimates of productivity and returns to scale and may understate inefficiency The book offers a useful reference for those interested in the newest robust methods of business analytics in the area of productivity and efficiency with implications for strategy budgeting resourcing and benchmarking of firms industries and production units more generally

Applied Adaptive Statistical Methods Thomas W. O'Gorman, 2004-01-01 Adaptive statistical tests developed over the last 30 years are often more powerful than traditional tests of significance but have not been widely used To date discussions of adaptive statistical methods have been scattered across the literature and generally do not include the computer programs necessary to make these adaptive methods a practical alternative to traditional statistical methods Until recently there has also not been a general approach to tests of significance and confidence intervals that could easily be applied in practice Modern adaptive methods are more general than earlier methods and sufficient software has been developed to make adaptive tests easy to use for many real world problems

Applied Adaptive Statistical Methods Tests of Significance and Confidence Intervals introduces many of the practical adaptive statistical methods developed over the last 10 years and provides a comprehensive approach to tests of significance and confidence intervals It shows how to make confidence intervals shorter and how to make tests of significance more powerful by using the data itself to select the most appropriate procedure

The Econometrics of Multi-dimensional Panels Laszlo Matyas, 2024-02-01 This book presents the econometric foundations and applications of multi dimensional panels including modern methods of big data analysis In light of the big data revolution and the emergence of higher dimensional panel data sets it provides new results to synthesize existing knowledge on the field The first

theoretical part of the volume is providing the econometric foundations to deal with these new high dimensional panel data sets It not only synthesizes our current knowledge but mostly presents new research results The second empirical part of the book provides insight into the most relevant applications in this area These chapters are a mixture of surveys and new results always focusing on the econometric problems and feasible solutions This second extended and revised edition provides an update of all existent chapters to reflect on new developments in the area as well as several new chapters on topics such as machine learning nonparametric models networks and multi dimensional panels in health economics The book serves as a standard reference work a textbook for graduate students in economics and a source of background material for professionals conducting empirical studies

Encyclopedia of Measurement and Statistics Neil J. Salkind, 2006-10-13 The study of measurement and statistics can be less than inviting However in fields as varying as education politics and health care assessment and the use of measurement and statistics have become integral parts of almost every activity undertaken These activities require the organization of ideas the generation of hypotheses the collection of data and the interpretation illustration and analysis of data No matter where educated people look this critical analysis is more important than ever in an age where information and lots of it is readily available The ideas and tools contained in the *Encyclopedia of Measurement and Statistics* are approachable and can be invaluable for understanding a very technical world and the increasing flow of information Although there are references that cover statistics and assessment in depth none provides as comprehensive a resource in as focused and accessible a manner as the three volumes of this *Encyclopedia* Through approximately 500 contributions experts provide an overview and an explanation of the major topics in these two areas

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Unit Roots, Cointegration, and Structural Change G. S. Maddala, In-Moo Kim, 1998 Time series analysis has undergone many changes

in recent years with the advent of unit roots and cointegration Maddala and Kim present a comprehensive review of these important developments and examine structural change The volume provides an analysis of unit root tests problems with unit root testing estimation of cointegration systems cointegration tests and econometric estimation with integrated regressors The authors also present the Bayesian approach to these problems and bootstrap methods for small sample inference The chapters on structural change discuss the problems of unit root tests and cointegration under structural change outliers and robust methods the Markov switching model and Harvey's structural time series model Unit Roots Cointegration and Structural Change is a major contribution to Themes in Modern Econometrics of interest both to specialists and graduate and upper undergraduate students

Measurement Error and Latent Variables in Econometrics T. Wansbeek, E. Meijer, 2000-12-08 The book first discusses in depth various aspects of the well known inconsistency that arises when explanatory variables in a linear regression model are measured with error Despite this inconsistency the region where the true regression coefficients lies can sometimes be characterized in a useful way especially when bounds are known on the measurement error variance but also when such information is absent Wage discrimination with imperfect productivity measurement is discussed as an important special case Next it is shown that the inconsistency is not accidental but fundamental Due to an identification problem no consistent estimators may exist at all Additional information is desirable This information can be of various types One type is exact prior knowledge about functions of the parameters This leads to the CALS estimator Another major type is in the form of instrumental variables Many aspects of this are discussed including heteroskedasticity combination of data from different sources construction of instruments from the available data and the LIML estimator which is especially relevant when the instruments are weak The scope is then widened to an embedding of the regression equation with measurement error in a multiple equations setting leading to the exploratory factor analysis EFA model This marks the step from measurement error to latent variables Estimation of the EFA model leads to an eigenvalue problem A variety of models is reviewed that involve eigenvalue problems as their common characteristic EFA is extended to confirmatory factor analysis CFA by including restrictions on the parameters of the factor analysis model and next by relating the factors to background variables These models are all structural equation models SEMs a very general and important class of models with the LISREL model as its best known representation encompassing almost all linear equation systems with latent variables Estimation of SEMs can be viewed as an application of the generalized method of moments GMM GMM in general and for SEM in particular is discussed at great length including the generality of GMM optimal weighting conditional moments continuous updating simulation estimation the link with the method of maximum likelihood and in particular testing and model evaluation for GMM The discussion concludes with nonlinear models The emphasis is on polynomial models and models that are nonlinear due to a filter on the dependent variables like discrete choice models or models with ordered categorical variables

Migration, local off-farm employment, and agricultural

production efficiency Yang, Jin,Wang, Hui,Jin, Songqing,Chen, Kevin,Riedinger, Jeffrey,Chao, Peng,2014-04-04 This paper studies the effect of local off farm employment and migration on rural households technical efficiency of crop production using a five year panel dataset from more than 2 000 households in five Chinese provinces While there is not much debate about the positive contribution of migration and local off farm employment to China s economy there is an increasing concern about the potential negative effects of moving labor away from agriculture on China s future food security This is a critical issue as maintaining self sufficiency in grain production will be critical for China to feed its huge population in the future Several papers have studied the impact of migration on production and yield with mixed results But the impact of migration on technical efficiency is rarely studied Methodologically we incorporate the correlated random effects approach into the standard stochastic production frontier model to control for unobservable that are correlated with migration and off farm employment decisions and technical efficiency The most consistent result that emerged from our econometric analysis is that neither migration nor local off farm employment has a negative effect on the technical efficiency of grain production which does not support the widespread notion that vast scale labor migration could negatively affect China s future food security

Theoretical and Applied Econometrics Phoebus J. Dhrymes,1995 This selection of Professor Dhrymes s major papers combines important contributions to econometric theory with a series of well thought out skilfully executed empirical studies The theoretical papers focus on such issues as the general linear model simultaneous equations models distributed lags and ancillary topics Most of these papers originated with problems encountered in empirical research The applied studies deal with production function and productivity topics demand for labour arbitrage pricing theory demand for housing and related issues Featuring careful exposition of key techniques combined with relevant theory and illustrations of possible applications this book will be welcomed by academic and professional economists concerned with the use of econometric techniques and their underlying theory

Asymptotic Efficiency of the Maximum Likelihood Estimator Sol Kaufman,1965 **The American Economic Review** ,2005-03 Includes annual List of doctoral dissertations in political economy in progress in American universities and colleges and the Hand book of the American Economic Association Efficiency Arithmetic Charles Ernest Chadsey,James Hamblin Smith,1917 Designed for pupils of the fifth and sixth grades this textbook combines fundamental operations decimal and fraction drills with common life applications **Studies in Econometric Theory** Takeshi Amemiya,1994 Takeshi Amemiya has made a significant contribution to econometric theory over the past 30 years This volume brings together 34 of his key articles and papers on areas such as limited dependent variables non linear simultaneous equations models time series analysis and error components models Many of the articles reprinted in this volume are indispensable references for researchers in the relevant fields The specially written preface outlines the influences and motivations behind Professor Amemiya s work **Studies in Econometric Theory** presents in a single volume the most significant work of one of the most important influential econometricians of our time Time-varying Risk Premia and

the Efficiency of the New Zealand Foreign Exchange Market Dimitris Margaritis,1991 *Topics in Generalized Method of Moments Estimation with Application to Panel Data with Measurement Error* Zhiguo Xiao,2008 Econometrics Course Materials ,1981 *Guide to Improving Efficiency of Combustion Systems* Albert Thumann,1988 *Laggards in Our Schools* Leonard Porter Ayres,1909 **Current Index to Statistics, Applications, Methods and Theory** ,1997 The Current Index to Statistics CIS is a bibliographic index of publications in statistics probability and related fields

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