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Econometric Theory and Practice

Frontiers of Analysis and Applied Research

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Econometric Theory and Practice

This book is a collection of essays written in honor of Professor Peter C. B. Phillips of Yale University by some of his former students. The essays analyze several state-of-the-art issues in econometrics, all of which Professor Phillips has directly influenced through his seminal scholarly contribution and remarkable achievements as a teacher. The essays are organized to cover topics in higher-order asymptotics, deficient instruments, nonstationarity, least absolute deviation (LAD) and quantile regression, and nonstationary panels. These topics span both theoretical and applied approaches and are intended for use by professionals and advanced graduate students.

Dean Corbae is Rex A. and Dorothy B. Sebastian Centennial Professor in Business Administration at the University of Texas at Austin. He is an Associate Editor of the *International Economic Review* as well as *Economic Theory*. Professor Corbae's research interests include applied time series analysis in macroeconomics and international finance.

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Preface

In Praise of a Remarkable Teacher

This volume presents a selection of papers offered to Professor Peter C. B. Phillips by a set of his past students. The collection is somewhat unusual in that it is not offered on the occasion of his reaching a particular venerable age or having decided to retire but rather in recognition of his extraordinary and continuing achievements as a teacher and mentor.

Peter Phillips is universally recognized as one of the great econometricians in the history of our profession. His work on finite sample theory, asymptotic expansions, nonstationary and long-memory time series, and the interface of Bayesian and frequentist methods, to name only a subset of the areas of his scholarship, evidences an extraordinary combination of mathematical analysis of the highest order as well as a level of creativity and insight reflecting that touch of genius apparent in even the most casual interactions with Peter. His more-than-170 published research articles and 30 current working papers attest to a coupling of brilliance with incredible energy.

It is all the more remarkable, then, that Peter has been one of the truly great teachers of aspiring economists. In the last 23 years, he has been a primary advisor to no fewer than 45 graduate students. His students have obtained positions throughout the world and at many of the leading research institutions. Peter's indirect contributions to economics via this college of econometricians would by itself earn him a distinguished place in the annals of scholarship.

Simple numbers cannot describe the reasons so many students have been attracted to Peter as an advisor. One reason is intellectual. Working with Peter has represented, at each stage of his career, an opportunity to participate in an important current research program. In this regard, Peter is well known for his incredible generosity in integrating students into his current research program – usually by making them coauthors. Such an experience can be both exhilarating and occasionally terrifying for a graduate student, for coauthorship with a scholar of Peter's depth demands that one work at one's absolute intellectual peak. Yet this "ordeal by fire" has for many of us remained one of the best memories of our careers, let alone of graduate school. A second

reason is personal. Peter is in every respect an extraordinarily dedicated and caring advisor. He is a champion of all of his students, regardless of ability or success, and any student who works with him knows that it is the beginning of a lifetime commitment. A third reason combines both the scholarly and the personal: Peter embodies that love of discovery that makes the vagaries of academic life worthwhile. Not only is he able to promote that same love of discovery in his students, but he has also instilled in us a deep concern for maintaining the highest intellectual and professional standards. It will come as no surprise that many of Peter's students have themselves been exceptionally active teachers and advisors, reflecting his many gifts.

It is, therefore, with the deepest affection and respect that we present these essays to Peter C. B. Phillips as a reflection of our appreciation. As a one-time student of the classics, Peter will appreciate that it is he we have in mind when we say *magister dixit*.

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Introduction

The thirteen essays: in this volume have been written by the students of Professor Peter C. B. Phillips to recognize, honor, and demonstrate his impact on the practice of econometrics. These writings span parts of Phillips' seminal and enormous research program. His students have continued to work in the areas he helped initiate.

The first section of essays deals with higher-order asymptotics. In "Edgeworth Expansions for the Wald and GMM Statistics for Nonlinear Restrictions," Hansen derives an Edgeworth expansion for the generalized method of moments (GMM) distance statistic for a real-valued, nonlinear restriction on a normal linear regression. He also provides a refinement of the Edgeworth expansion for the Wald statistic derived by Park and Phillips (1988) and shows that the leading coefficient is the same in these two expansions. This establishes that, to the order of approximation of the Edgeworth expansion, the GMM distance statistic has a better approximation to the chi-square distribution than does the Wald statistic. Finally, the essay updates the Monte Carlo simulation of Gregory and Veall (1985) to include both heteroskedasticity-robust covariance matrix estimation and the GMM distance statistic. He finds that if the robust covariance matrix is calculated under the null, the GMM statistic has near-perfect finite sample Type I error in his experiments – even in sample sizes as small as $n = 20$.

In "Moment Selection and Bias Reduction for GMM in Conditionally Heteroskedastic Models," Guido Kuerstiener extends his previous work on GMM estimators for autoregressive moving average (ARMA) models with martingale difference errors to a class with conditionally heteroskedastic innovations. In contrast to standard results for two-stage least squares (TSLS), in which adding more instruments affects the bias of the GMM estimator, the higher-order analysis provided by Kuerstiener reveals that the dimension of the instrument space does not affect the higher-order mean-squared error under a given set of assumptions provided the number of instruments is not too large. Informing the difference is the way he implements the instrumental

variables (IV) estimator; the presence of the parametric component is responsible for the good bias properties.

The second set of essays considers deficient instruments. In "Specification Tests with Instrumental Variables and Rank Deficiency," Yuichi Kitamura studies problems associated with two commonly used misspecification testing procedures in linear models when there is moment matrix rank deficiency. His chapter makes extensive use of invariance properties of orthogonal groups of matrices, which were previously shown by Phillips (1989) to be extremely useful in studying rank deficiency problems.[1] Using these tools, Kitamura is able to study a unified rank deficiency problem allowing him to tie together a "partial identification" problem in which the correlation matrix between the regressors and the instruments satisfies a reduced rank condition as well as the power problem under certain moment conditions in GMM misspecification tests identified by Newey (1985). His theoretical results imply that an applied researcher may find his model passes IV misspecification tests in the partially identified case even when the model is misspecified because the rejection probability of standard tests is below their nominal size asymptotically.

John Chao and Norman Swanson analyze conditions under which various single-equation estimators are asymptotically normal in a simultaneous-equations framework with many weak instruments. In "Asymptotic Normality of Single-Equation Estimators for the Case with a Large Number of Weak Instruments," the authors consider the case in which instrument weakness is such that the rate of growth of the concentration parameter r_n is slower than the rate of growth of the number of instruments K_n but such that $\frac{\sqrt{K_n}}{r_n} \to 0$ as $n \to \infty$. They show how the asymptotic variances of various estimators are different from the case in which r_n is assumed to grow at the same or faster rate than K_n.

Because standard IV estimation techniques are well known to give spuriously small standard errors in the presence of weak instruments, Eric Zivot analyzes the inference problem on individual coefficients in the IV regression model with multiple, endogenous, right-hand-side variables and weak instruments. His essay, "Inference in Weakly Identified Instrumental Variables Regression" extends the previous work of Choi and Phillips (1992) to allow for weak instruments.[2] Zivot evaluates existing techniques for performing inference on individual coefficients using Staiger and Stock's (1997) weak instrument asymptotics and performs extensive finite sample analyses using Monte Carlo simulations. He shows that the only asymptotically valid tests for individual coefficients are based on projections of asymptotically valid tests for

[1] Phillips, P. C. B. (1989) "Partially identified econometric models," *Econometric Theory*, Vol. 5, pp. 181–240.

[2] Choi, I. and P. C. B. Phillips (1992) "Asymptotic and finite sample distribution theory for IV estimators and tests in partially identified structural equations," *Journal of Econometrics*, Vol. 51, pp. 113–50.

all coefficients and that Kleibergen's (2002) concentrated K statistic has quite good size and power behavior relative to other methods.

The third group of essays deals with nonstationarity. In "Extracting Cycles from Nonstationary Data," Dean Corbae and Sam Ouliaris develop a frequency-domain filter to extract the cyclical component of a series that easily handles stochastic and deterministic trends based on earlier work with P. C. B. Phillips (2002).[3] They assess its goodness-of-fit properties relative to the known cyclical component as well as some popular time-domain filters such as the Hodrick–Prescott filter. They apply the filter to U.S. real GDP data and also analyze the cyclical properties of the price level.

In "Nonstationary Nonlinearity: An Outlook for New Opportunities," Joon Park introduces basic tools to deal with nonstationary nonlinearity and uses them to study three different topics associated with data generation, regression analysis, and stochastic volatility. In the first case, Park studies non-linear transformations of random walks, which can generate stationary long memory as well as bounded nonstationarity. An example of such a transformation is policy intervention in the case of target zone exchange rate regimes. In the second case, he considers parametric nonlinear and nonparametric cointegration methods, shows that convergence rates are dramatically reduced in the nonparametric case, and suggests a new two-step, partial parametric approach to estimation and inference. Finally, Park studies a stochastic volatility model in which conditional variance is given by a nonlinear function of a random walk and shows that such models may generate samples with volatility clustering and leptokurticity, which are commonly observed in financial time series.

Jushan Bai and Pierre Perron provide Monte Carlo evidence on the size and power of tests for linear models with multiple structural changes that they developed in earlier papers (1998, 1999), the coverage rates of confidence intervals for break dates, and the relative merits of methods to select the number of breaks in their chapter "Multiple Structural Change Models: A Simulation Analysis." Their simulations cover a wide variety of data-generation processes, and their findings provide a series of suggestions for the applied researcher. Among other things, they show the following: (i) If serial correlation, heterogeneity in the data or errors across segments, or all of these are allowed, trimming the errors will help avoid size problems; (ii) Selecting break points using the Bayesian information criterion (BIC) works well when breaks are present but less so when there is serial correlation; (iii) A strategy for using sequential procedures suggested in their earlier work has good size and power properties; and (iv) Correcting for heterogeneity in the distribution of the data or the errors and for serial correlation improves the power of structural break tests and the accuracy in selecting the number of breaks.

[3] Corbae, D., S. Ouliaris, P. C. B. Phillips (2002) "Band spectral regression with trending data," *Econometrica*, 70, 2002, pp. 1067–1109.

The fourth section provides new developments in LAD and quantile regression. To analyze financial variables that tend to be characterized by distributions having thick tails, Douglas Hodgson studies estimation methods in the presence of possibly non-Gaussian disturbances in cointegrating regressions in his essay "On Efficient, Robust, and Adaptive Estimation in Cointegrated Models." Estimators (robust LAD and M-estimators) that downweight outlying observations in cointegrating regressions were developed earlier by Phillips' (1995), but such estimators were not asymptotically efficient.[4] To handle this, Hodgson explicitly parameterizes short-run dynamics as a general VARMA process and develops an adaptive estimator that allows for thick tails of unknown form in the density, showing it to be asymptotically equivalent to a full-information maximum likelihood (FIML) estimator. Hodgson also considers the implications for estimation when the thick tails are generated by conditional heteroskedacity and conducts a Monte Carlo study to assess alternative estimators' small sample properties.

In "Testing Stationarity Using M-Estimation," Roger Koenker and Zhijie Xiao study a general test of stationarity that has power against a wide range of alternatives based on M-estimators. Their results extend previous unit root tests based on M-estimation with least-squares detrending by such authors as Phillips (1995) to the case in which the detrending itself is based on M-estimation.[5] To obtain distribution free tests, the authors consider a martingale transformation on the partial sum process, which yields consistency. The authors discuss various implementations of the test and compare size and power of the text with conventional stationarity tests in finite samples via a series of Monte Carlos. The authors conclude with an application of their test to macroeconomic variables from the Nelson–Plosser dataset.

In "Consistent Specification Testing for Quantile Regression Models," Yoon-Jae Whang introduces specification tests for linear quantile regression models applicable to cases with dependent observations. The tests he considers are generalizations of the Kolmogorov–Smirnov and Cramer–von Mises tests of goodness of fit, which can be applied to stationary time series as well as cross sections. The tests are consistent against all alternatives to the null hypothesis, powerful against $1/\sqrt{N}$ alternatives, independent of any smoothing parameters, and simple to compute. Although the asymptotic null distributions are case dependent, Whang suggests a simple subsampling procedure to calculate critical values. Monte Carlo experiments show that his test has good finite sample performance relative to those in Zheng (1978).

The fifth topic area develops unit root tests for nonstationary panels with cross-sectional correlation. In "Combination Unit Root Tests for

[4] Phillips, P.C.B. (1995) "Robust nonstationary regression," *Econometric Theory*, 11, pp. 912–51.

[5] Phillips, P.C.B. (1995) "Robust nonstationary regression," *Econometric Theory*, 11, pp. 912–51.

Cross-Sectionally Correlated Panels," In Choi proposes a test statistic that combines p-values from the augmented Dickey–Fuller test applied to each time series whose nonstochastic trend components and cross-sectional correlations are eliminated by GLS-based detrending derived from Elliott, Rothenberg, and Stock (1996) and the conventional cross-sectional demeaning for panel data.[6] These combination tests have a standard, normal, limiting distribution, and Monte Carlo evidence points to good size and power properties. He applies these tests to the real GDP data for a panel of 23 OECD countries and finds evidence for the presence of a unit root.

In "Nonlinear IV Panel Unit Root Tests," Yoosoon Chang shows that if nonlinear transformations of lagged levels by an integrable function are used as instruments, the t-ratio based on the usual IV estimator for the autoregressive coefficient in an augmented Dickey–Fuller-type regression yields asymptotically normal unit root tests for each cross section. More importantly, the nonlinear IV t-ratios from different cross sections are asymptotically independent even when the cross sections are dependent, provided they are not cointegrated.

[6] Elliott, G., T. J. Rothenberg, and J. H. Stock (1996) "Efficient tests for autoregressive time series with a unit root," *Econometrica*, 64, pp. 813–36.

PART ONE

HIGHER-ORDER ASYMPTOTICS