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# A COMPARATIVE STUDY ABOUT ISSUES AND CHALLENGES IN EVALUATING ECONOMETRIC MODELS

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# A Comparative Study about Issues and Challenges in Evaluating Econometric Models

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***Abstract – Econometrics, in its long history, has been and continues to be an important branch not only in general economics (macro and micro), but also in specialized fields in the area of economics, such as financial and spatial economics. This paper surveys some recent developments related to the specification and estimation of econometric models widely used in applied research. Even though we lay emphasis on time series models and their application in financial and spatial econometrics, additional topics, such as limited dependent variable models and simultaneous equation systems, are also reviewed in the paper. However, it should be emphasized that the survey is not unified in the sense that it does not provide an exhaustive review of the development of econometrics through its long history.***

***Standard econometric model selection methods are based on four conceptual errors: parametric vision, the assumption of a true data generating process, evaluation based on fit, and ignoring the impact of model uncertainty on inference+ Instead, econometric model selection methods should be based on a semiparametric vision, models should be viewed as approximations, models should be evaluated based on their purpose, and model uncertainty should be incorporated into inference methods.***

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## INTRODUCTION

The process of econometric analysis departs from the specification of a theoretical relationship. We initially proceed on the optimistic assumption that we can obtain precise measurements on all the variables in a correctly specified model. If the ideal conditions are met at every step, the subsequent analysis will probably be routine. Unfortunately, they rarely are. Some of the difficulties one can expect to encounter are the following:

- The data may be badly measured or may correspond only vaguely to the variables in the model. “The interest rate” is one example.
- Some of the variables may be inherently unmeasurable. “Expectations” are a case in point.
- The theory may make only a rough guess as to the correct functional form, if it makes any at all, and we may be forced to choose from an embarrassingly long menu of possibilities.
- The assumed stochastic properties of the random terms in the model may be demonstrably violated, which may call into question the methods of estimation and inference procedures we have used.
- Some relevant variables may be missing from the model.

The ensuing steps of the analysis consist of coping with these problems and attempting to cull whatever information is likely to be present in such obviously imperfect data. The methodology is that of mathematical statistics and economic theory. The product is an econometric model. Since the works of Ciompa [1910] and Frisch [1933], many investigators in the literature of the field have defined econometrics in different but conceptually equivalent ways. Among these investigators we include: (1) Tintner [1953], who defines econometrics as an important special method for the evaluation of mathematical economic models in numerical terms and for the verification of economic theories; it uses the methods of modern statistics for this purpose. (2) Haavelmo [1944], who defines econometrics as the method of econometric research aiming at a conjunction of economic theory and actual measurements, using the theory and technique of statistical inference as a bridge pier. (3) Samuelson, Koopmans and Stone [1954], who define econometrics as the quantitative analysis of actual economic phenomena based on the concurrent development of theory and observation, related by appropriate methods of inference. (4) Spanos [1986], stating that econometrics is concerned with the systematic study of economic phenomena using observed data. (5) Geweke, Horowitz and Pesaran [2007], who define econometrics as the method aiming to give empirical content to economic relations for testing economic theories, forecasting, decision making, and for ex post decision policy evaluation.

Regardless of which definition is adopted, econometrics can be thought of as being the application of mathematics and statistical methods in the analysis of economic data; that is data involved in an economic model. The economic models (static or dynamic) contain behavioral relations for the endogenous variables which are considered solutions of optimization problems and they may be planned contingent on either observed outcomes or expectations. The solution of these relations gives the economic equilibrium. The static models focused on the study of the effects that changes in the exogenous variables may have on the endogenous variables, ignoring the process of transition between the involved equilibria, which are taken up by the dynamic economic models, such as growth models. Econometric models, on the other hand, using mathematical and statistical tools, aim to put the economic models in an empirical perspective of economic relations. To this end, a distinction is made between theoretical and applied econometrics. Theoretical econometrics deal with issues concerning the statistical properties, that is properties of the estimators, in an economic model. Applied econometrics, on the other hand, focuses on issues concerning the application of econometric methods, that is methods representing applications of standard statistical models, to evaluate economic theories. The basic difference between econometric and statistical models is that in econometrics the economic data are observational rather than being derived from controlled experiments as assumed in statistical models. This distinction led to the development of methods in dealing, among other things, with identification and estimation of simultaneous equation models. Generally speaking, econometrics is classified into two major categories: Classical and Bayesian Econometrics.

Classical econometrics, which reflects the tradition of the Cowles Commission, makes use of the distinction between endogenous and exogenous variables imposing restrictions to achieve identification, and allowing the investigators to make causal inferences in the absence of controlled experiments. The models treated in the classical econometrics depends on the particular interest of the researchers and the complexity of the relationships they represent. Based on the number of the equations involved the models are described as single-equation models, that is models in which the variable of interest to the researcher is expressed as a function of one or more independent variables; and multiple-equation models, that is models consisting of a set of interrelated variables (simultaneous equation models). A further categorization of the models include: (1) stochastic vs. nonstochastic models; (2) qualitative models vs. quantitative models; (3) time-series vs. cross-section model; and (4) pooled data vs. panel data models. Recently, emphasis was laid on the so-called financial econometric models, usually classified as classical, volatility, and regime-switching models.

Special ingredients of classical econometrics include: (1) the correct specification of the model, implying both the selection of the functional form and the choice of the variables which should be included in the model. (2) the choice of the appropriate method of estimation. Depending on the nature of the problem and the available data, methods of estimation include the OLS, the 2SLS, the 3SLS, the method of moments, the generalized method of moments, the SURE and the IV methods. (3) the evaluation of the model in terms of the theoretical, econometric, and statistical criteria.

Bayesian Econometrics differs not only from classical econometrics but also from frequentist econometrics. The basic difference between classical and Bayesian econometrics is that in classical econometrics the researcher works with models, such as regression models, and by using data, estimates, through the application of the appropriate technique, the parameters of the model. Bayesian econometric, on the other hand, uses Bayes's rule to do so. It is based on the subjective view of probability, which argues that uncertainty about anything unknown can be expressed using the rules of probability, and the vector of the coefficients is as a random variable, compared to frequentist econometrics in which the vector of the coefficients is not a random variable.

## MOTIVATIONAL BACKGROUND

The purpose of this special issue was formulated as: Econometrics is often used passively to provide the economist with some parameter estimates in a model which from the outset is assumed to be empirically relevant.

In this sense, econometrics is used to illustrate what we believe is true rather than to find out whether our chosen model needs to be modified or changed altogether.

The econometric analyses of this special issue should take its departure from the latter more critical approach. We would like to encourage submissions of papers addressing questions like whether a specific economic model is empirically relevant in general or, more specifically, in a more specific context, such as in open, closed, deregulated, underdeveloped, mature economies, etc. For example, are models which were useful in the seventies still relevant in the more globalized world of today? If not, can we use the econometric analysis to find out why this is the case and to suggest modifications of the theory model?

We encourage papers that make a significant contribution to the discussion of macroeconomics and reality, for example, by assessing the empirical relevance of in uential papers, or the robustness of policy conclusions to econometric misspecification and the ceteris paribus clause, or by comparing different expectations's schemes, such as the relevance of forward versus backward expectations and of model consistent rational expectations versus imperfect/incomplete knowledge expectations, etc.

One of the great advantages of this journal is that it encourages open discussions and critical debates. In my view, this is something that has been lacking in economics over more recent periods, in which we have seen a streamlining of academic research into the \representative agent with optimizing behavior based on rational expectation\ type of Dynamic Stochastic General Equilibrium (DSGE) models. Interpreted positively, this could suggest that economics as a science has finally converged to a state of profound understanding. This, of course, would be a blessing for the billions of people whose welfare depends on an empirically relevant economic policy. Unfortunately, data describing our economic reality tell a very different story. As the present financial and economic crises has amply exemplified, the need to question and debate present dogmas in Economics seems greater than ever.

With this background, it is a great pleasure to introduce the articles of this special issue, demonstrating scientific curiosity, a critical and constructive view on how to do empirical econometrics, and a willingness to address difficult and relevant problems using adequate econometrics. Many of the papers touch methodological themes that have played a prominent role in my own research: to use a strict econometric methodology based on sound statistical principles; to assess the empirical relevance of inuential theory models; to learn from data how to best modify or change economic theory when needed.

As the guest editor of this issue, I take the opportunity to discuss the individual contributions within the context of the following three methodologically motivated themes: (1) principles for how to bridge economic theory and empirical evidence, (2) how to actively use econometrics to improve economics, and (3) incentives, diversity and debate in economics.

## EVALUATING ECONOMETRIC MODELS : PROBLEMS

As in most scientific disciplines there is in economics a considerable gap between econometric theory and practice. While the actual practice of applied economists is only occasionally up to the "best available" procedures as determined by econometric theorists, it is also true that econometric theory frequently ignores the hard and often most relevant procedural problems faced by applied economists or theorists wishing to test their hypotheses.

The former statement is commonplace, while the latter may be more novel. With respect to the former, the applied economist needs to learn how more recent but, paradoxically, often simpler procedures can be implemented, and what are the potential benefits and costs of such implementation.

Correspondingly, the econometric theorist needs to keep in mind the needs of the applied economist and the economic theorist. Both are interested in effective inference; the theorist wishes to test hypotheses about economic behavior, while the applied economist wishes to weigh the effects of alternative policies. However, difficulties occur for the users of econometric procedures in that frequently the econometric prescriptions are inappropriate for the situation in hand.

Inferences based on normal distributions are of little use where the underlying distributions are clearly not normal. Parametric inference is of little use where the economist's theoretical knowledge is limited to directions of change. Classical and even Bayesian inferential procedures are of little help where samples from a population are limited in size, unique, and nonrepeatable except at very high cost. Procedures for which the results are sensitive to extensive and detailed specifications of the maintained hypothesis are of little use where that knowledge does not exist.

These, then, are the main issues which provided the initial motivation for the Conference on Econometric Methodology held in Ann Arbor in June 1977 and for this book of conference proceedings. While there exists a vast potential for econometric research into specific topics generated by the inferential issues mentioned above, the editors and organizers of the conference decided to concentrate on certain major themes.

The first theme involves the degree of detail and precision with which a model is specified; at the extremes we might characterize the distinction as one between formal and informal models, although a more accurate distinction is between parametric and nonparametric specification. For example, compare the statements "the expected value of quantity demanded decreases with increases in price" (nonparametric) with "the expected value of quantity demanded is given by the function e" where p is real price and y and Yi are unknown but estimable parameters." Recently, more attention has been paid to nonparametric (at least less parameter-specific) models in recognition of the fact that rejecting economic hypotheses couched in terms of a specific model may merely be a rejection of the modeler's detailed parametric specification and not the economic hypothesis of interest.

The second and related theme has to do with the robustness of a model's inferences to errors in the specification of the model. The claim is frequently made that since all models are approximations, then all models are in error. While we need not take such an absolute position, it is clearly farsighted for us to recognize that our models may be in error, at least to a small extent, so that we should seek inferential procedures which are not sensitive to the more likely errors. For example, we may suspect that the disturbances are not normally distributed, though they are symmetrically distributed about zero without very fat tails. A corollary notion is to consider in terms of regression analysis those sets of observations which have the greater relative impact on the inferences. This provides a springboard for a detailed analysis of regression results in looking for evidence of model specification errors.

Often, the sensitivity of a model to errors in its specification can be related to the level of aggregation being used. A more informative approach to this aspect of the problem is to consider the extent to which micro (or individual) behavioral coefficients can be inferred from estimates of coefficients in macro (or group) relationships.

Further, one must not forget the straight forward, but crucially important, procedure of checking one's model for specification errors before attempting to use the statistical results. Specification error analysis is the more important, the more parameter-specific (and hence usually the more sensitive to specification errors) the model is.

This leads to a third theme which involves formal methods for the comparison of models. Econometric models are now and have been for some time sufficiently complex in structure as to require the development of new methods and criteria for choice between alternative models of a specified economic situation.

A fourth theme which has only recently been the subject of intense examination is the appropriate role of time series analytical methods in econometric models. The earlier and overstated dichotomy was between sophisticated, but purely statistical, data analysis with no economic theory content on one side and theoretically specified models analyzed with little attention to the possibility of a complex time series structure in the stochastic elements on the other side. Very recently, attempts have been made to reconcile the conflicts between the time series approach and theoretical modeling.

A fifth and last theme concerns the potential benefits and costs of using experimental data to test economic hypotheses. From one perspective, the development of an experimental methodology and its use in economics can serve as a substitute for further attempts to refine, improve, and expand methods for extracting information from historical data. From another perspective, experimentaldata may enable us to examine behavioral relationships not directly observable from historical data no matter how ingenious the inferential methods.

## THE LINEAR REGRESSION MODEL: AN OVERVIEW

In estimating economic relationships, the most widely used method is the OLS. With this method in applied situations it is usually assumed that the so-called Gauss-Markov assumptions are satisfied. The model and the related assumptions are given below:

$$Y = X\beta + \varepsilon \quad [1]$$

where $Y = \{Y_1, Y_2, ..., Y_N\}'$, $\varepsilon = \{\varepsilon_1, \varepsilon_2, ..., Y_N\}'$, $\beta = \{\beta_1, \beta_2, ..., \beta_k\}'$ and x is an $Nxk$ matrix of the exogenous variables of the model.

Assumptions:

$$E(\varepsilon) = 0 \longrightarrow E(Y) = X\beta \quad [2]$$

$$E(\varepsilon\varepsilon') = \sigma^2 I \quad [3]$$

$$Cov(\varepsilon X) = 0 \quad [4]$$

The first assumption mean that, on average, the regression line should be correct; that is. if the model includes all the significant exogenous variables, both positive and negative, the error terms will average out to zero. The second assumption states that: (1) each distribution of e has the same variance, $a^1$, that is the errors are homoskedastic; and (2) all error terms are pairwise uncorrelated, implying absence of autocorrelation. The third assumption suggests that the matrix X is deterministic and not stochastic. Assumptions [2]-[4], summarized by the Gauss-Markov- Theorem, suggest that the OLS estimator. $\hat{\beta} = (X'X)^{-1}X'Y$ .is the best linear unbiased estimator (BLUE). From an empirical point of view some or all the Gauss-Markov

assumptions may not be satisfied. In such cases, the issues involved include: (1) the identification of the problem in question: and (2) the derivation of alternative estimators satisfied the Gauss-Markov assumptions. We briefly outline these issues below.

Heteroskedasticity. The problem of heteroskedasticity. usually appearing in cross-section models, refers to the fact that the error terms are mutually uncorrelated but the variance of $\varepsilon_i$ is not constant but varies over the range of observations. That is $Var(\varepsilon_i / X) \neq \sigma^2$ =constant. Various test statistics, each 011 its own merit, have been developed in the literature for heteroskedasticity testing. Basic test statistics include the Goldfeld-

Quandt [1965] test: (2) the Spearman [1904] test: (3) the Glesjer test [1969]: (4) the Breusch-Pagan test [1979.1980]: (5) the White test [1980]: and (6) the Bartlett test [1949], Alternative methods have been advanced in the literature to cope with the heteroskedasticity problems, such as the weighted least squares(WLS) method, the generalized 2SLS. and the method of the maximum likelihood function (FIML).

Autocorrelation. The problem of autocorrelation, common in time-series models, violates the assumption that all error terms are pairwise uncorrelated. p=autocorrelation coefficient, p=length of the lagged error. There are various forms of autocorrelation, each of which leads to a different structure of the autocovariance error matrix. Among these forms, the first-order autocorrelation. AR(1), is the most popular in empirical situations.

Multicollinearity. In estimating econometric models it is assumed that cov $(X_i, X_j)=0.$ In such a case, the matrix X'X is not invertable. Thus, the estimation of the model with the OLS does not provide unique values of the coefficients of the model. The presence of multicollinearity in a model casts doubts 011 both the interpretation of the estimates and the correct signs of the coefficients.

Specification Errors. The violation of the Gauss-Markov assumptions in empirical situations can. hi general, be attributed to the misspecification of the model in question. Model misspecification leads to specification errors which are due to: (1) omission of important variables. (2) inclusion of superfluous variables. (3) wrong functional form. (4) wrong specification of the error term, and (5) measurement errors both in the dependent and independent variables in the model[4]. The OLS estimators with: (a) omission of important variables gives biased and inconsistent estimates with large variances and standard errors and (b) inclusion of irrelevant variables, the OLS estimators are unbiased and consistent and the estimated variance is larger than necessary (implying larger confidence intervals than necessary). The OLS estimates are unbiased, consistent and less efficient when the dependent variable is measured with error and biased and inconsistent when the values of the independent variables are measured with errors.

## MODEL UNCERTAINTY

The act of model selection can have unwanted distributional implications. For example, Pötscher (1991) shows that the distributions of estimators and test statistics are dramatically affected by the act of model selection. Ideally, these distortions from standard theory should not be ignored in inference. Unfortunately, incorporating the effect of model selection on inference methods is very challenging, and effective methods have yet to be developed. To illustrate the difficulty of the problem, Leeb and Pötscher (2003a, 2003b) show that no estimator of either the unconditional or conditional distribution of the postmodel-selection estimator can be uniformly consistent. Methods to successfully surmount this obstacle are an important topic for future research.

From another angle, it is possible to argue that model selection itself is a misguided goal. It is quite common to find that confidence intervals from different plausible models are nonintersecting, raising considerable inferential uncertainty. Fundamentally, the uncertainty concerning the choice of model is not reflected in conventional asymptotic and bootstrap confidence intervals.

Although the problem is obvious, the solution is not. One proposal is the method of Bayesian model averaging, which has grown in interest over the past decade. Basically, the relevant models are estimated, and then the posteriors are averaged. See Hoeting, Madigan, Raftery, and Volinsky (1999) for a review. Unfortunately, as with all Bayesian methods, there are many arbitrary decisions regarding priors and unfortunate paradoxes involving parameter transformation, rendering practical use of their methods difficult. In a recent contribution, Hjort and Claeskens (2003) propose a frequentist form of model averaging. This is a welcome addition and should be pursued as a viable supplement to model selection methods.

## USING EMPIRICAL ECONOMETRICS TO IMPROVE ECONOMIC MODELS

The idea of the special issue was to challenge the dominance of the `theory first' over the `reality first' approach broadly interpreted. One could say that reality almost surpassed itself in providing us with a relevant example. That the present financial and economic crisis has demonstrated the empirical failure of `the theory first' approach seems rather obvious. Few professional economist were able to foresee this immensely deep and probably long lasting crisis. Central banks, governments, and the public were mostly taken by complete surprise. Even as the crises unfolded, extant theory models did not provide (much needed) guidance for how to ride out the crises. Policy makers were essentially left to grope in the dark hoping that their costly policy measure would have the intended effect (see Colander et al. 2009).

While painful for much of the world, the fact that DSGE models have a hard time addressing the crisis at all|much less explaining it|may, however, be good news for all kinds of economists who think differently and previously have had a hard time making their voices heard.

Let us assume for a moment that economists, say as a result of the present economic crises, will start looking for a paradigmatic change in their theoretical understanding of the empirical reality. How should it come across? My suggestion is to learn from the data in a systematic and structured way. If one takes macroeconomic data seriously, it comes often as a surprise how informative they are. As already discussed, the biggest hurdle in learning from data is the (almost irresistible) urge to impose too many economic priors on the statistical model, in spite of them being against the information in the data. If the outcome of the empirical testing is that a particular assumption isn't in the data and that the economic conclusions using that assumption are not robust, it is an important signal both to the theorist and to the decision maker. The articles in this issue contain many such important signals.

My interpretation of Colander's argument (that the important distinction between `the technical apparatus' and the `art of economics' seems to have been wiped out in today's use of DSGE modelling) is that these models, though technically impressive, may need a reality check. Because the CVAR model is by construction `bigger' than the theory model(s), it may provide such a check. Such empirical checking should address not just one but several (possibly competing) theoretical hypotheses, but it should also be open to evidence that could generate new hypotheses to be subsequently tested on new data. In this sense, the CVAR can provide a framework within which the DSGE proponents should be able to properly test their theoretical assumptions|bringing those assumptions to the data. The articles of this issue illustrate that such an approach is highly relevant.

## CONCLUSION

The purpose of this paper was not to introduce new materials in econometrics. It was rather directed to bringing up a number of issues, problems, and methods of estimations of econometric models extensively applied in empirical research. Particular attention was paid to time-series models, with the emphasis on financial econometrics.

Specification of spatial econometric models, simultaneous equation systems with empirical applications, and limited dependent variable models were also reviewed in this partial survey.

The articles here illustrate that this view needs be challenged. To start from the idea that we know what the empirical model should tell us and then insist that the reality should behave accordingly is not just a recipe for deep frustration, but also for not learning what we need to know. It can be compared with an archeologist who knows before he has started digging what he will find. The answer to this crisis is, in my view, not to force the theory models onto data, suppressing all signals indicating lack of empirical relevance, but to insist on building models that include these features.

## REFERENCES


- Andrews, D.W.K., Moreira M.J, et.al. (2007), “Performance of Conditional Wald Tests in IV Regression with Weak Instruments”, Journal of Econometrics, 139: 116-132.
- Anselin, L. (2002), “Under the Hood. Issues in the Specification and Interpretation of Spatial Regression Models”, Agricultural Economics, 27(3): 247-267.
- Bell, K.P. and Bocksteael, N.E. (2002), “Applying the Generalized Moments Estimation Approach to Spatial Problems Involving Microlevel Data”, The Review of Economic and Statistics, 82(2): 72-82.
- Colander, D, M. Goldberg, A. Haas, K. Juselius, A. Kirman, T. Lux, B. Sloth (2009). The Financial Crisis and the Systemic Failure of the Economics Profession. Critical Review 21.
- Dijk, D., T. Terasvirta and Phillip H. Frances (2002), “Smooth Transition Autoregressive Models- A Survey of Recent Developments”, Econometric Reviews, 21(1): 1-47.
- Gilbert, C.L. (2006). Professor Hendry's Econometric Methodology. Oxford Bulletin of Economics and Statistics, 48 (3): 283–307.
- Hendry, D.F. and G.E. Mizon (2003). Evaluating Econometric Models by Encompassing the VAR in Phillips, P.C. (ed.) Models, Methods and Applications of Econometrics. Blackwell, Basil.
- Hoeting, J.A., D. Madigan, A.E. Raftery, & C.T. Volinsky ~1999! Bayesian model averaging: A tutorial+ Statistical Science 14, 382– 417.
- Leeb, H. & B.M. Pötscher (2003a) Can One Estimate the Unconditional Distribution of Post-Model- Selection Estimators? Working paper, Department of Statistics, University of Vienna.
- Leeb, H+ & B.M. Pötscher (2003b) Can One Estimate the Conditional Distribution of Post-Model- Selection Estimators? Working paper, Department of Statistics, University of Vienna.

- Pötscher, B.M. (1991) The effect of model selection on inference. Econometric Theory 7, 163–185.

- Ramsey, J. B. Limiting functional forms for market demand curves. Econometrica, 1992, 40(March), 327-341.

- Spanos, A. (2006). Econometrics in Retrospect and Prospect, in New Palgrave Handbook of Econometrics, Vol. 1 eds. T.C. Mills and K. Patterson. MacMillan, London.