EDITORS' INTRODUCTION

CAUSALITY AND EXOGENEITY IN ECONOMETRICS

Luc Bauwens
CORE and Department of Economics, Université catholique de Louvain
bauwens@core.ucl.ac.be

H. Peter Boswijk
Department of Quantitative Economics, Universiteit van Amsterdam
H.P.Boswijk@uva.nl

and

Jean-Pierre Urbain
Department of Quantitative Economics, Universiteit Maastricht
j.urbain@ke.unimaas.nl

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Corresponding author: Jean-Pierre Urbain, Department of Quantitative Economics, Universiteit Maastricht, P.O.Box 616, 6200 MD Maastricht, The Netherlands. Email:j.urbain@ke.unimaas.nl

This Special Issue of the *Journal of Econometrics* contains a selection of papers presented at the 12^{th} $(EC)^2$ conference on "Causality and Exogeneity in Econometrics" held in Louvain-La-Neuve, Belgium in December 2001.

$(EC)^2$ stands for European Conference of the Econom(etr)ics Community. The $(EC)^2$ conference series was established in 1990. The meetings are small-scale conferences, organized around a particular theme, and taking place over 2 days. An important feature of these conferences is that there are no parallel sessions. Participants contribute in the plenary programme or the poster sessions as presenters of papers and as discussants.

The main purpose of the $(EC)^2$ conferences is to provide a forum where European researchers in Quantitative Economics and Econometrics can meet to discuss the results and progress of their most recent research. In particular, the intention of the $(EC)^2$ conferences is to promote and foster interaction between the junior participants and the senior invited researchers. The participation of younger researchers is encouraged by their presenting papers either in the plenary sessions or through the poster programme. Such poster sessions are scheduled during the main programme to provide an opportunity for younger researchers to describe and discuss their work directly with both senior and junior participants. Overall, 4 invited and 14 contributed papers were presented in the plenary sessions and more than 25 papers in the poster sessions. The meeting was attended by approximately 100 researchers. The Programme Chairs for this meeting were Jean-Pierre Urbain and Peter Boswijk with Luc Bauwens acting as Local Organizer.

The theme of this conference and this Special Issue is "Causality and Exogeneity in Econometrics". The novelty of this 2001 meeting was to bring together econometricians approaching this theme from various backgrounds such as macro-time series but also microeconometrics. This led to exchanges on these fundamental issues from leading researchers working in fields of econometrics that are usually quite separated and that also have accordingly fairly different views on the concepts and meanings of causality and exogeneity. The range of topics covered by the papers presented in both the plenary and poster sessions reflected this broadness. It is important to emphasize that this Special Issue is by no means a proceedings volume. Many more papers were presented during the conference than those that were accepted for publication after a reviewing process. The Editors first of all chose the papers on the basis of the importance of their contribution and the proximity to the theme of the conference. The papers that are collected here have all undergone a rigorous reviewing and revision process. Notice that the ordering of the papers in this Special Issue is made so as to reflect these groupings and their intersection as far as possible.

Economists and econometricians have long been studying the issue of causality and causal laws, i.e., the issue of identifying a causal relation between an outcome and a set of factors that may have determined this outcome. The time-series notion of Granger (-Sims) causality is based on the idea that cause must precede effect, and that a factor cannot cause another variable if it doesn't contribute to the conditional distribution (or expectation) of that variable given the past. This concept has become very influential in time series and macroeconometric modelling. It also plays a role in the concepts of exogeneity developed by Engle *et al.* (1983). An entirely different strand of literature on causal inference and treatment effects originated from the work of Rubin (1974). In this literature, causal effects are usually defined in terms of a comparison between the potential outcomes on the same unit, measured at the same time, but exposed to different treatments. Since only one of these two potential outcomes can be observed, the causal effect is considered essentially as a problem of inference with missing data. This view of causality has been fairly widely adopted in microeconometric studies,

in particular in the studies of social program evaluation, see for example Imbens (2004) where exogeneity assumptions, sometimes known under the heading unconfoundedness or selection on observables, have important implications. Similarities and differences between these concepts are discussed in Florens and Heckman (2003).

Since one of the purposes of the conference was to bring together people working in these different subfields to exchange ideas about these fundamental concepts and on the developments that have occurred during the last ten years, this special issue can be viewed as an update to the issue of the Journal of Econometrics Annals that was published in 1988 around the theme of Causality. The nine papers of this volume are selected to reflect this purpose and this variety of points of view.

Chambers and McCrorie review and discuss developments in econometric modelling that are designed to deal with the problem of spurious Granger causality relationships that can arise from temporal aggregation. The authors point out the distortional effects of using discrete-time models that explicitly depend on the unit of time and outline a remedy of constructing time-invariant discrete-time models via a structural continuous-time model. An application to testing for money-income causality is used to illustrate the importance of incorporating exact temporal aggregation restrictions on the discrete-time data.

Dufour, Pelletier and Renault propose inference methods in the time domain for testing the hypothesis of Granger non-causality at various horizons. This enables the distinction between short-run and long-run causality. The framework is that of VAR models and they propose simple linear methods based on running vector autoregressions at different horizons. Only linear regression or extended regressions techniques are used so that the statistics proposed do not require nonstandard asymptotics even in the presence of unit root nonstationarity. Bootstrap based inference is also considered. The simplicity of the approach should be appealing for empirical researchers.

Building on earlier work by Geweke and Hosoya, *Breitung and Candelon* develop a new testing framework for non-causality in the frequency domain. This enables the researcher to distinguish between causality in the short run and in the long run, and to focus on predictability at, e.g., the business cycle frequency. An important aspect of their procedure is that contrary to earlier work, it allows for cointegration between the time series under investigation. The local power function of the test is derived, showing that the power depends critically on the frequency under consideration. A Monte Carlo experiment reveals that these aymptotic properties are reflected in the finite-sample behaviour of the test. An empirical application to the term structure of interest rates, output and money shows that the yield spread has predictive power for output growth at the short end of the spectrum (2 to 3 quarters), but also at the business cycle frequencies of 2 years or more.

Most of the literature on Granger causality is concerned with processes with a continuous state space. In contrast, *Mosconi and Seri*, analyse causality restrictions in a dynamic discrete-time bivariate probit model. First, the authors discuss conditions for non-causality and simultaneous independence in closed bivariate Markov chains, and they provide a formulation of the model that allows such conditions to be tested as simple parametric restrictions. Next, this analysis is generalized to allow for covariates and higher-order dynamics. Asymptotic properties of likelihood-based inference on causality restrictions are derived . The methods are applied to a panel data model of marital status and the decision to have children, and a survival data example related to the adoption of particular technologies in the Italian metalworking industry.

Particular exogeneity assumptions are often made to ensure optimal properties of simple

estimation/inferential techniques. This is particularly true in dynamic panel data econometrics where research during the last 20 years has largely been devoted to the efficient estimation of dynamic models in the presence of individual-specific components. The contribution of *Bun and Kiviet* focusses on this literature and investigates the finite sample behavior of various estimators in panel data models with individual effects and both a lagged dependent variable regressor and another explanatory variable, allowing for feedback from the lagged dependent variable to the explanatory variable. Asymptotic expansions indicate that the order of magnitude of the bias of method of moments estimators tends to increase with the number of moment conditions exploited. The authors also provide analytical evidence on how the bias of the various estimators depends on the feedbacks and on other model characteristics such as the prominence of individual effects and correlation between observed and unobserved heterogeneity.

Horowitz and Mansky are concerned with 'conservative analysis' of datasets with missing or interval censored data. Their aim is to estimate a functional of the complete data distribution by replacing the joint distribution functions with empirical ones. With missing data and no untestable assumptions on the mechanism creating the missing data, one estimates bounds on the functionals via linear constraints on the complete data distribution imposed by the observed data distribution. Computationally this amounts to solving a nonlinear programming problem with nonlinear objective function and linear constraints. The paper contains an interesting data analysis illustrating the issues.

Issues related to whether data are missing at random or not in dynamic panel data models is also at the heart of the contribution of *Nicoletti*. In her contribution, the author reviews and discusses the estimation and tests procedures for selectivity in panel data. She extends and defines the concepts of missing at random and missing completely at random to the case of dynamic panel data models exploiting the terminology and notation developed in the non-causality and exogeneity literature, most notably in the work of Florens and Mouchart (1985) or Engle *et al.* (1983).

Chernozhukov and Hansen introduce a class of instrumental quantile regression methods for heterogeneous treatment effect models and simultaneous equations models. The main contribution of such methods is that they allow for different effects of a treatment on different parts of the distribution of the dependent variable. An example concerning the returns to schooling shows that the largest gains to additional years of schooling are obtained at the low end of the earnings distribution, and thus illustrates that allowing for such heterogeneity of effects can be empirically very relevant. The authors discuss various computational details of their procedure, and provide a complete asymptotic theory of estimation and inference.

De Luna and Johansson discuss exogeneity of treatments for the estimation of causal parameters. They argue that for consistent estimation of parameters characterizing average treatment effects, the concepts of strong ignorability and weak exogeneity are too restrictive, as they pertain to distributional effects of treatments. The authors propose a new concept called Kullback-Leibler exogeneity, which is not based on counterfactuals, and compare this with the existing notions of exogeneity in some specific models. A distribution-free Chow test is derived and compared to likelihood based alternative tests in a Monte Carlo experiment.

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References

Engle R.F., Hendry D.F., Richard J.-F., 1983, Exogeneity, Econometrica 51, 2, 277-304.

Florens J.P., Heckman J., 2003, Causality and Econometrics, mimeo, University of Chicago.

Florens J.P., Mouchart M., 1985, Conditioning in dynamic models, Journal of Time Series Analysis 52, 1, 157-175.

Imbens G.W., 2004, Nonparametric Estimation of Average Treatment Effects Under Exogeneity: A Review, Review of Eocnomics and Statistics 86, 4-29.

Rubin D.B., 1974, Estimating Causal Effects of Treatments in Randomized and Nonrandomized Studies, Journal of Educational Psychology 66, 688-701.