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Editorial

Editors' Introduction

Special issue in Honor of Jean-Marie Dufour on Identification, Inference, and Causality

This annals issue celebrates the remarkable career of Jean-Marie Dufour by collecting 22 papers on identification, inference, and causality. It grew out of the CIREQ conference in honor of Jean-Marie Dufour organized by Marine Carrasco and Victoria Zinde-Walsh and held in Montreal, Canada, on May 7–8, 2016 where much work was inspired by his contributions.

Jean-Marie has had a long and productive career. He received a Ph.D. in economics from the University of Chicago in 1979. From 1979 to 2007, he was professor at the Université de Montréal before moving across town to McGill University in 2007 where he holds the William Dow Chair in Political Economy. He has published more than 140 articles in scientific journals and has supervised more than 36 Ph.D. students.

Jean-Marie reads widely in a variety of fields: economics and statistics, but also philosophy, formal logic and mathematics. This knowledge deepens the approach in his papers and informs many interesting discussions and exchanges with colleagues and students. He can often surprise one with a reference to Aristotle or to some lesser-known historical event. In statistics and econometrics Jean-Marie makes important contributions to the field of causality, exact finite sample inference methods, and weak identification. He is always delighted to bring to light deep features such as the invariant characteristics of some of his finite sample tests, identification robustness, and the exactness of confidence sets. He continues in his efforts to extract the most value in situations where the information is far from complete. Besides his theoretical contributions, Jean-Marie makes important contributions to the fields of dynamic macroeconomic modelling, structural macroeconomics and finance, inflation, the pricing of financial assets, taxation and investment, and export financing. Jean-Marie is always very generous with his time for colleagues and students. We are grateful to him and are happy to prepare this annals issue in his honour.

The twenty-two articles of this issue are divided into five broad areas: (i) unidentified or partially-identified models, (ii) exact and simulation inference, (iii) asymptotic inference, (iv) high dimension, and (v) financial econometrics.

(i) Unidentified or partially-identified models

One of Jean-Marie's most important works deals with locally almost unidentified parameters and impossible inference (Dufour, 1997) which inspired the development of methods robust to weak identification. The first group of papers considers related issues.

Bertanha and Moreira (2020) study settings in which tests can have power smaller than size and/or confidence regions have nonzero probability of being unbounded. The general framework builds upon and connects many existing theories on impossible inference that rely on the weak and total variation topologies to show models are not distinguishable or nearly unidentified. The paper then demonstrates impossible inference in multiple economic applications of models with discontinuity and time-series models.

Antoine and Renault (2020) consider models defined by a set of moment restrictions that may be subject to weak identification. The strength of identification determines whether the standard asymptotic theory applies. The authors address this by proposing a testing procedure to assess whether the instruments are "too weak". The advantage of the proposed testing procedure is that it applies to subvectors of parameters without assumption of identification for the parameters not being tested. This approach provides a novel insight in the application to cross-country comparison of the elasticity of intertemporal substitution by showing that strong identification for the intercept and weak identification for the slope hold universally in the model.

It is standard practice to rely on orthogonality conditions to identify the parameter of interest in regression models. Kiviet (2020) instead considers bounds which allow nonzero correlations between disturbances and regressors. Asymptotic validity of the suggested alternative form of inference is proved, and its finite sample accuracy is demonstrated by simulation. The practical relevance is illustrated in a few applications borrowed from the literature.

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Lütkepohl et al. (2020) consider inference in heteroskedastic simultaneous equations models where some of the equations have conditionally heteroskedastic errors. Heteroskedasticity is used for identification of structural parameters where possibly only a subset of those is identified. Limit properties are established for the identified parameters and tests for identification are developed. The inference procedure is used to investigate the relation between economic openness and inflation.

Dovonon et al. (2020) focus on inference for second-order locally identified models where standard GMM inference breaks down. The paper compares performance of identification-robust statistics and the conventional Wald and LM statistics, as well as that of the J-statistic for model specification. The properties of the statistics are evaluated for a unit root test in an autoregressive model and for overidentifying restrictions in a conditionally heteroskedastic factor model. While the results are fairly nuanced, they suggest that tests with meaningful power can be conducted in second-order identified models.

Finally, Bontemps and Kumar (2020) consider inference procedures for entry games with complete information where the model is set-identified with the set of predicted choice probabilities given by a convex polytope. Testing whether a parameter is in the identified set is performed via a test of whether the true choice probability vector belongs to the convex set. For discrete explanatory variables a finite number of inequalities result and those are fully characterized. The paper proposes a reduction in the number of moment inequalities and computational simplification for the critical values, thus providing a significant reduction in the overall computational complexity.

(ii) Exact and simulation inference

The next group of papers illustrates other signature contributions of Jean-Marie on finite-sample and simulation inference. Doko Tchatoka and Dufour (2020) revisit Durbin–Wu–Hausman and Revankar–Hartley tests for exogeneity and studies their finite-sample properties in a model where the structural parameters may not be identified and the reduced form may be incompletely specified. Through conditioning and invariance arguments, the distribution is shown to be nuisance-parameter-free. While the distribution is nonstandard, it can be implemented as a Monte Carlo test.

In Khalaf and Saunders (2020), the authors combine the Monte Carlo test (MCT) and the indirect inference estimation (IIE) principles to construct confidence regions for autoregressive panel parameters with valid coverage that applies regardless of mean-stationarity and of autoregressive roots being at (or close to), or far from unity. Location-scale invariance is shown to hold for the proposed test; the MCT involves stages that preserve exchangeability. The advantage of the proposed test is size control for finite N and T; the numerical evaluation confirms performance even with very small sample sizes.

Previous research has shown that inference using difference-in-differences is unreliable when there are few treated clusters, whether it is performed using cluster-robust standard errors or some variant of the wild cluster bootstrap. As an alternative, MacKinnon and Webb (2020) study two randomization inference procedures, one based on estimated coefficients and one based on t statistics. The procedure based on t statistics typically performs better than the procedure based on coefficients (and better than alternatives) under the null hypothesis of no effect, but at the cost of some power loss.

The last two papers in this section study the bootstrap. Davidson and Trokic (2020) extend the fast double bootstrap of Davidson and MacKinnon (2007) to higher orders of iteration. The new methods make computational demands that increase only linearly with the level of iteration, unlike standard procedures whose demands increase exponentially. Simulation experiments indicate that the fast triple bootstrap suffers less size distortion compared to the standard and fast double bootstraps.

Finally, Gonçalves and Perron (2020) consider bootstrap methods for factor-augmented regressions with cross-sectional dependence among idiosyncratic errors. The authors propose the cross-sectional dependent (CSD) bootstrap where bootstrap samples are obtained by taking a random vector and multiplying it by the square root of a consistent estimator of the covariance matrix of the idiosyncratic errors. They show that if the covariance matrix estimator is consistent in the spectral norm, then the CSD bootstrap is consistent, and they verify this condition for the thresholding estimator of Bickel and Levina (2008). An application to forecasting inflation using convenience yields shows the relevance of the method.

(iii) Asymptotic Inference

While Jean-Marie is not an advocate of the use of asymptotic approximations as the basis for statistical inference, it has proven to be a useful way to proceed in complex cases, and the papers in this section exemplify this.

Andrews et al. (2020) provide a set of results that can be used to establish the asymptotic size and the similarity in a uniform sense of confidence sets and tests. The results are particularly useful when the pointwise asymptotic distribution of a test statistic is a discontinuous function of the parameter. Various examples are included, in particular the conditional likelihood ratio test of Moreira (2003) and the grid bootstrap confidence interval of Hansen (1999).

Xu (2020) considers inference based on local estimating equations in the presence of nuisance parameters. Inference is based on a criterion function, and conditions under which the test statistic has a pivotal asymptotic distribution are provided. Nuisance parameters are eliminated either by a Laplace-type plug-in approach or by optimization. The framework allows non-smooth criterion functions and can incorporate bias correction induced by localization, and allows inference robust to the strength of identification.

Komunjer and Zhu (2020) consider the problem of hypothesis testing in linear Gaussian state space models. Two hypotheses are of interest: a simple null and a hypothesis of explicit parameter restrictions. The authors derive the

asymptotic distributions of the corresponding likelihood ratio test statistics and compute the Bartlett adjustments. They apply their analysis to test the validity of the Dynamic Stochastic General Equilibrium (DSGE) models.

Finally, Tuvaandorj (2020) establishes the equivalence between nonparametric regression with discontinuity in mean and a continuous time Gaussian white noise model in the Le Cam sense. Then it provides a lower bound on the minimax convergence rate for estimating the discontinuity size in a derivative of the regression function. Similarly, a correspondence between regression discontinuity with an unknown threshold and a convolution white noise model is established and used to derive the minimax optimal rate for estimating the discontinuity location.

(iv) High dimension

In recent years, we have seen across many fields a rapid increase in the number of applications with large data sets and in models with a large number of parameters, sometimes more numerous than the number of observations available. Econometric research has followed this trend, and the three papers in this section illustrate this evolution.

Galbraith and Zinde-Walsh (2020) consider estimation of a low-dimension parameter of interest in a model with a large dimension (possibly exceeding sample size) of other potential explanatory variables. The proposed estimator uses principal components as auxiliary regressors; its limit properties are established allowing for dependence and heterogeneity as well as increasing dimension of the set of controls; it is shown in the paper how the assumptions compare to those for popular estimators such as LASSO. The estimator has the advantage that it is easily computable and the only choice parameter is the number of principal components. The finite-sample evidence with information criterion used to select the number of components demonstrates stable performance.

Ghysels et al. (2020) propose a simple alternative to the Wald test of nullity of coefficients in a linear regression when the number of regressors is large but finite. The testing procedure consists of estimating many parsimonious regressions where the key regressors are included one at a time. The so-called max test is based on the maximum of the individual squared estimators, and its properties are studied under the null and alternative hypotheses. The max test is then applied to testing Granger causality in a mixed-frequency model.

Finally, Amengual et al. (2020) use regularization methods to propose specification tests for parametric distributions based on the (possibly) complex-valued characteristic function. The test is analogous to the overidentifying restrictions test based on a continuum of moments. Tikhonov regularization is used to stabilize the inverse of the covariance operator. The asymptotic distribution of the test is derived for a fixed and vanishing regularization parameter. Its local power is studied and compared to that of existing tests.

(v) Financial econometrics

The last set of papers discusses various issues in financial econometrics, including rank-based methods close to Jean-Marie's heart.

Kim and Meddahi (2020) analyse the properties of a regression of some variance measure on its past, a method often used to forecast integrated variance, when variance may have heavy tails. The authors show that when the second moment of spot variance is unbounded, the slope of this autoregression converges to a random variable as the sample size diverges. As an alternative, for diffusion variance models with affine drift, the authors propose an instrumental variable estimator that is a consistent estimator of the drift parameters as long as the variance process has a finite first moment regardless of the existence of the second moment. For example, for the GARCH diffusion model, an IV estimator where the instrument is the sign of the centred lagged value of the variable of interest provides consistent estimation.

Gourieroux et al. (2020) discuss linear rational expectation models. While there is a single linear stationary equilibrium, the paper demonstrates the existence of a multiplicity of stationary nonlinear solutions which can display speculative bubbles or volatility-induced mean reversion. Standard econometric tools designed for linear models may be misleading for these nonlinear solutions. The paper discusses appropriate approaches to identification, impulse responses, and estimation.

Hallin and La Vecchia (2020) propose rank-based estimators (R-estimators) for models with a nonnegative variable (such as the duration between trades) as an alternative to QMLE using the exponential density. The authors show that these estimators are root-n consistent and achieve semiparametric efficiency. Numerical results illustrate that R-estimators based on the exponential reference density outperform the QMLE under a large class of actual innovation densities, such as the Weibull or Burr densities.

Finally, Gungor and Luger (2020) develop a simulation-based procedure to test for stock return predictability with multiple predictors. The process governing the regressors is left unspecified, and the test procedure remains valid in the presence of non-normalities and GARCH-type effects. Using this new procedure, the authors find some evidence of predictability during the period 1948–2014, driven entirely by the term spread. This empirical evidence, however, is much weaker over subsamples.

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