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Editorial

Causality, prediction, and specification analysis: Recent advances and future directions

Halbert L. White, Jr.



It is with great pleasure that we have been honored with the responsibility of editing this very special volume of the *Journal of Econometrics*. The issue collects papers that were invited for a conference to honor Halbert L. White on the occasion of his 60th birthday, held at the University of California, Rady School of Management, San Diego during May 6–7, 2011. Originally, this special conference was meant to honor Hal White's achievements and accomplishments in the field of econometrics, and was attended primarily by over 100 of his co-authors, current, and former students. After the conference, we were all immensely saddened by Hal's passing, and this conference volume took on a much deeper meaning, in that all of the contributors wrote papers that saluted

Hal's immense contributions in areas of both theoretical and applied econometrics.

A companion *Springer New York Festschrift* that gathers other papers from the conference was published in 2012, and is entitled *Recent Advances and Future Directions in Causality, and Specification Analysis* (see [Chen and Swanson \(2012\)](#)).

Halbert L. White was a pioneer in modern econometric theory. He was among the first to develop and make accessible the technical tools for deriving the asymptotic properties of estimators and constructing tests under realistic settings in economics. Hal was also among the first to stress the interplay between stylized facts of the data and theoretical features of the economic models. One

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of his insights is that all models are an approximation to reality, and are thus generally incorrect. Nevertheless, we can learn important things, even from an approximation of reality. Hal's contributions have been fundamental not only to the field of theoretical econometrics, but also to the field of empirical economics.

Hal's career was truly a remarkable one. Not only did he publish more than 140 articles, but many of these were pathbreaking, including for example White (1980), which is entitled *A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity*. This paper has received more citations than any other paper in the field of economics since 1970. Another pathbreaking paper written by Hal is entitled, "Maximum Likelihood Estimation of Misspecified Models" (*Econometrica*, 1982). This paper is also heavily cited. His seminal paper on artificial neural networks (Hornik, Stinchcombe, and White) entitled "Multi-layer Feedforward Networks are Universal Approximators" (*Neural Networks*, 1989) has around 4000 Web of Science citations. Additionally, he has made immeasurable contributions in a wide range of fields, and not just econometrics. These include, for example, machine learning, law and medicine.

It is impossible to list all of Hal's important contributions in this short introduction. However, the reader is referred to Chen and Swanson (2012) for a more extensive discussion of Hal's key contributions, as well as a full bibliography to his work.

We now turn to our discussion of the contributions contained in this volume.

In their paper entitled *A Two-Stage Procedure for Partially Identified Models*, Kaido and White build on the theory of set estimation and inference introduced by Chernozhukov et al. (2007) and introduce a two-stage procedure that enables practitioners to construct set estimators and confidence sets in cases where a sub-vector of parameters can be estimated separately from other parameters in a model. They establish the measurability and consistency of their second-stage set estimator. Moreover, when the first stage parameters are point identified and root-n consistently estimated, they propose a subsampling inference for second stage parameters based on a quasi-likelihood ratio statistic.

Lu and White have contributed their paper entitled *Testing for Separability in Structural Equations* to this Annals issue. The authors provide a statistical test for separability in nonparametric structural equations. The authors first show that under some mild conditions either on the nonparametric structural functional forms or on the dimension of latent variable, the null of nonparametric separability is equivalent to the null of conditional independence. Then, building on the conditional independence test of Huang et al. (2013), the authors propose an easy to construct integrated conditional moment type test that achieves root-n local power. (E.g. see Bierens (1990) and Bierens and Ploberger (1997) and Corradi and Swanson (2002)). Their test, thus, falls within the broad and rich class of tests arising in the consistent specification testing literature. In an empirical application, they show that the marginal effects of education depend on unobservables, suggesting that studies assuming separability are possibly based on misspecified models.

In a second interesting paper on testing for conditional independence entitled *Testing Conditional Independence via Empirical Likelihood*, Su and White propose empirical likelihood ratio tests for the conditional independence of two observed random vectors. This paper adds to the large number of recent papers that introduce tests of conditional independence using a variety of approaches ranging from generalized empirical distribution functions and generalized entropy measures to conditional characteristic function based moment conditions. In this paper, the authors establish that hypotheses stated in terms of an infinite number of conditional moment restrictions can be tested using a smoothed empirical likelihood ratio. The particular test statistic that they propose is

asymptotically standard normal and asymptotically optimal with respect to average local power. Interestingly, the test allows for data dependence, thus not ruling out the use of time series data.

White, Xu and Chalak's paper entitled *Causal Discourse in a Game of Incomplete Information* provides a rigorous framework that is used to propose an interesting definition of cause and effect in economics. Their definition extends the "settable systems" definition of causality of White and Chalak (2009) to "topological settable systems" (TSS), a general causal framework that allows for games and other economic structural models. The TSS framework can accommodate choices belonging to general function spaces, and supports causal discourse in more general games. This paper suggests new ways for economists to discuss important causal relations in complicated environments.

In the paper entitled *Conditional Moment Models Under Semi-Strong Identification*, Antoine and Lavergne first introduce the notion of semi-strong identification of parameters that satisfy a parametric conditional moment restriction. The authors then propose a weighted minimum distance (WMD) procedure that is robust to semi-strong identification and free of smoothing parameters. The resulting WMD estimator is consistent and asymptotically normally distributed. The Wald test statistic is still chi-square distributed under the null and diverges to infinity under fixed alternatives. Simulation studies demonstrate that the WMD procedure performs well under semi-strong identification.

The paper by Chen and Liao entitled *Sieve M Inference on Irregular Parameters* introduces inference procedures for hypothesis testing of possibly irregular functionals that may not be $\sqrt{n}$ estimable. This is important in contexts where conditions for estimability at a $\sqrt{n}$ rate are difficult to analyze, such as when it is impossible to obtain closed form efficiency bounds in complicated semiparametric models. The proposed sieve t statistic for irregular parameters of semi-nonparametric models is predicated on the development of a simple and consistent variance estimator for the plug-in sieve M estimator. The proposed sieve likelihood ratio statistic is very easy to construct and is asymptotically Chi-square distributed. Simulation studies and empirical applications based on the Heckman and Singer (1984) semiparametric duration model round out this paper.

Chen, Ponomareva, and Tamer contribute an interesting paper on mixture models entitled *Likelihood Inference in Some Finite Mixture Models*. This paper draws on the fact that parametric mixture models, although commonly used in applied work, are plagued by a lack of point identification and well as by problems associated with parameters on the boundary. These issues may lead to problematic profiled likelihood ratio inference on parameters of interest in the presence of nuisance parameters, given that different asymptotic limits may arise depending on the precise form of the singularity. The paper first presents different asymptotic limits under various drifting sequences. It then proposes using a parametric bootstrap to carry out the profiled likelihood ratio inference, thereby avoiding the task of analyzing asymptotic limits of suprema over complicated stochastic processes. The proposed procedure yields valid confidence sets for the parameters of interest, regardless as to whether or not the model is identified or the parameter is at the boundary. Simulation and an empirical application are provided.

In their paper entitled *Testing for Structural Stability of Factor Augmented Forecasting Models*, Corradi and Swanson propose a test of the joint hypothesis of structural stability of both factor loadings and factor augmented forecasting model regression coefficients. The test statistic is based on the difference between full sample and rolling sample estimators of the sample covariance of the factors and the variable to be forecasted. They show that the quadratic form of the test statistic has a chi-square distribution under the null and diverges to infinity under the alternative, if either the

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