POINT-OPTIMAL INSTRUMENTS AND GENERALIZED ANDERSON-RUBIN PROCEDURES FOR NONLINEAR MODELS

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Abstract

In this paper, we develop finite-sample inference procedures for nonlinear regressions and structural models. We propose simple exact tests based on linear regressions (auxiliary linear regressions) which may be inverted to obtain confidence sets for the vector of unknown parameters. This class of tests generalizes the procedure proposed by Anderson and Rubin (1949) for linear structural models and the method of Hartley (1964) for hypothesis testing and confidence set construction in nonlinear regressions. Under the null hypothesis, the test statistics follow standard central Fisher distributions when the errors are i.i.d. Gaussian. By construction, the procedures are robust to the presence of weak or excluded instruments. We also study the problem of building optimal instruments for testing purposes in this context. The optimal instruments are those that maximize the power of the proposed test. This can be contrasted with "optimal instruments" as typically defined in the econometric literature, which refers to the minimization of the asymptotic variance of an estimator. The optimal instruments depend on the alternative hypothesis, yielding point-optimal instruments. As the matrix of optimal instruments is unknown in general, we propose a split-sample technique to approximate optimal instruments while retaining a finite-sample validity result. The exact distribution of the test is derived under the assumptions of independence and normality of the disturbances, but the tests remain valid asymptotically under weaker assumptions similar to those usually assumed to derive asymptotic distributions. Finally, a simulation study demonstrating the advantages of the proposed procedure is presented.

Key words: nonlinear model; simultaneous equations; structural model; instrumental variable; weak instrument; weak identification; simultaneous inference; projection; split-sample; Anderson-Rubin test; artificial regressions; point-optimal instruments; split-sample technique; exact inference; asymptotic theory.