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Computational Statistics & Data Analysis 50 (2006) 3567–3591
COMPUTATIONAL STATISTICS & DATA ANALYSIS
www.elsevier.com/locate/csda

Testing for random effects in panel data under cross sectional error correlation—A bootstrap approach to the Breusch Pagan test

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Received 9 August 2004; received in revised form 16 August 2005; accepted 17 August 2005
Available online 8 September 2005

Abstract

When testing the pooled regression via the Breusch Pagan test model disturbances are often assumed to be i.i.d. over both the time and the cross section dimension. A bootstrap approach to generate critical values for the Breusch Pagan statistic is provided which is valid under heteroskedasticity and cross sectional correlation as typically formalized in the framework of seemingly unrelated regressions. Moreover, asymptotic results are derived for a finite cross section and infinite time dimension. Finite sample simulations show that ignoring cross sectional correlation may lead to large size distortions in practice. Conditional versions of the test statistic designed to cope with random time effects or spatial error correlation show empirical size distortions in case the source of contemporaneous error correlation is misspecified. Moreover, the bootstrap is robust if contemporaneous error correlation is induced by random time effects or in case of spatial error correlation.

MSC: C12; C33

Keywords: Breusch Pagan test; Random effects model; Wild bootstrap; Contemporaneous error correlation

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doi:10.1016/j.csda.2005.08.003

1. Introduction

The use of cross country data and application of panel data models is recently becoming more and more popular in macroeconometrics. Typical fields where such techniques are employed cover, for instance, tests of the purchasing power parity (PPP) and growth models, or empirical approaches to the development of health care expenditures, R&D spillovers, etc. In this field of empirical research often time series of considerable length are available for a finite number of cross section members, countries, say. Therefore, asymptotic results on the properties of estimators or test statistics mostly derived for panel data with finite or infinite time series but infinite cross section dimension are somewhat at odds with key features of available macropanel data.

Crucial assumptions in theoretical panel data models are homoskedasticity over both the time and cross section dimension and absence of contemporaneous cross sectional correlation. The first assumption of time invariant second-order moments of model disturbances may be subjected to criticism. In econometrics of financial data time dependent variances have attracted a huge theoretical and empirical interest (Engle, 1982; Bollerslev et al., 1992). Similarly, with respect to macroeconometrics, shifts in the variations of disturbances may occur owing to (fiscal or monetary) policy changes, central bank interventions or regime switches.

For applied macroeconometrics the second assumption may also be critized since a set of economies often will have to react to the same shocks hitting the global economy and therefore country specific reactions are likely to be contemporaneously correlated. Controlling for cross sectional error correlation may invalidate conclusions obtained under the unrealistic assumption of shocks hitting isolated economies. For a prominent empirical discussion in this respect the reader may consult the debate on PPP, in which O'Connell (1998) relates empirical support of PPP drawn from panel unit root tests directly to falsely discarding contemporaneous cross sectional error correlation. Recent developments in panel data econometrics explicitly allow for contemporaneous error correlation (Chang, 2002; Chang and Song, 2003; Moon and Perron, 2003). The latter, however, concentrate on the issue of panel unit root testing. With respect to a more basic specification test, the Breusch Pagan statistic testing the pooled regression model, conditional versions have been introduced that allow for contemporaneous correlation induced by random time effects (Baltagi et al., 1992) or spatial error correlation (Baltagi et al., 2003). A characteristic feature of the Breusch Pagan statistic conditional on spatial error correlation is that the underlying error covariance matrix is known up to some scaling constant. Attempts to test the pooled regression in scenarios of contemporaneous error correlation in the vein of seemingly unrelated regressions (SUR; Zellner, 1962) have not been made yet.

In presence of either cross sectional error correlation or heteroskedasticity the asymptotic distribution of common test statistics derived under an i.i.d. assumption will depend on nuisance parameters. Then critical values for such test statistics may be cumbersome to evaluate for a given data set. Under such circumstances bootstrap approaches are in widespread use to obtain critical values for a particular test statistic. It is the purpose of this paper to contribute an approach to test for random effects in panel data models by means of the unconditional Breusch Pagan test which retains its validity in panels with finite cross section dimension, under cross sectional and/or time heteroskedasticity, and