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Using panel data to increase the power of modified unit root tests in the presence of structural breaks

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Abstract

When testing for unit roots using the Dickey–Fuller test, the presence of structural breaks can cause serious size distortions to the test. Previous research has suggested two modified tests, the weighted symmetric and the recursively mean-adjusted test, that has robust size properties even in the presence of a structural break. However, recent findings have shown that the power of the two modified unit root tests is severely decreased in the presence of structural breaks. In this paper, we suggest that time series for several cross-sections can be simultaneously considered to increase the power of the modified unit root tests. We suggest two panel data tests that are easy to calculate and show that these tests have an asymptotically normal distribution. Using Monte Carlo simulations, we also show that the use of the suggested panel data tests contribute to very large increases in the power of the modified tests, although structural breaks are present under the null hypothesis.

Keywords: Unit root test; Panel data; Structural change; Response surface; Monte Carlo simulation

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1. Introduction

The use of unit root tests has become increasingly important for research in applied economics and econometrics. However, it has also been shown that the inferences drawn from the unit root tests should be interpreted with caution if there is the slightest possibility that the assumptions of the tests are violated.

One commonly used unit root test is the Dickey–Fuller test. This test has been shown to exhibit serious size distortions when a structural change occurs under the null hypothesis (see e.g. [1]). To come to terms with this problem, modified tests have been considered as robust alternatives to the Dickey–Fuller test. The robust tests do not suffer from the size distortions of the Dickey–Fuller test when a structural change is present (see [2,3]). Even though the robust tests have been shown to possess attractive size properties when a structural break occurs under the null hypothesis, the power properties was recently found to be poor (see [4]).

In this paper, we suggest an extension to the modified unit root tests. More specifically, we suggest that time series for several cross-sections should be used simultaneously when testing for unit roots. We show that these modified panel data unit root tests have considerably higher power compared to the univariate modified unit root tests. Hence, the panel data test offers an attractive way to obtain a test that is both robust against structural breaks under the null hypothesis *and* have good power characteristics against a stationary alternative hypothesis.

The rest of this paper is organized as follows. In Section 2, we introduce the econometric framework. The different unit root tests are considered in Section 3. The panel data extension of the existing tests is presented in Section 4, while a Monte Carlo simulation is performed in Section 5 to assess the size and power characteristics of the panel data unit root tests. Finally, Section 6 concludes.

2. Econometric framework

The econometric framework utilized in this paper is the first-order autoregressive model given in (1).

$$y_t = (1-\rho)\mu + \rho y_{t-1} + \varepsilon_t. \tag{1}$$

In (1), ε_t is a independently, identically and normally distributed disturbance term with zero mean and variance σ^2, that is $\varepsilon_t \sim N(0,\sigma^2)$. Furthermore, μ denotes a deterministic intercept, while ρ denotes the autoregressive parameter that determines whether or not the process is stationary. With $|\rho| < 1$, the process $\{y_t\}$ is stationary, while the process contains a unit root if $\rho = 1$. Whether