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Identifying stationary series in panels: A Monte Carlo evaluation of sequential panel selection methods

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HIGHLIGHTS

- We investigate the merits of sequential panel selection methods in classifying individual time series into nonstationary and stationary ones.
- A Monte Carlo analysis based on simulating individual unit root asymptotic test statistics and p values is carried out.
- We illustrate the simulation results using Receiver Operating Characteristic (ROC) graphs.
- Sequential panel selection methods may outperform unit root time series tests only under rather special conditions.

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ABSTRACT

Sequential panel selection methods (SPSMS — procedures that sequentially use conventional panel unit root tests to identify $I(0)$ time series in panels) are increasingly used in the empirical literature. We check the reliability of SPSMS by using Monte Carlo simulations based on generating directly the individual asymptotic p values to be combined into the panel unit root tests, in this way isolating the classification abilities of the procedures from the small sample properties of the underlying univariate unit root tests. The simulations consider both independent and cross-dependent individual test statistics. Results suggest that SPSMS may offer advantages over time series tests only under special conditions.

1. Introduction

Panel unit root (UR) tests are powerful tools to check the global null hypothesis that all the N series in a panel are $I(1)$, but are unsuitable to classify individual time series into nonstationary and stationary ones. With this aim, Chortareas and Kapetanios (2009) proposed using a sequential panel selection method (SPSM), based on the following steps:

1. Apply the panel UR test. If the global null is not rejected, do not reject the $I(1)$ hypothesis for all the series in the panel: the procedure stops.
2. If the global null is rejected then remove from the panel the series with the minimum individual Dickey–Fuller (DF) t-statistic: classify the removed series as $I(0)$.
3. Go to 1.

The result is a partition of the panel into two sets of $I(0)$ and $I(1)$ time series.

The procedure was originally conceived using DF tests jointly with Im et al.'s (2003) panel UR test, but different SPSMS can be obtained using different tests. However, the chosen panel test should be able to reject even in the presence of only one $I(0)$ series and should not be based on $N \to \infty$, given that it is applied sequentially over a decreasing number N of series. Furthermore, it should preferably be built by combining individual test statistics or p values, so to be consistent with the selection criterion used to eliminate from the panel one series at each iteration. For these reasons, beside Im et al.'s (2003) test, p value combination tests (Choi, 2001;

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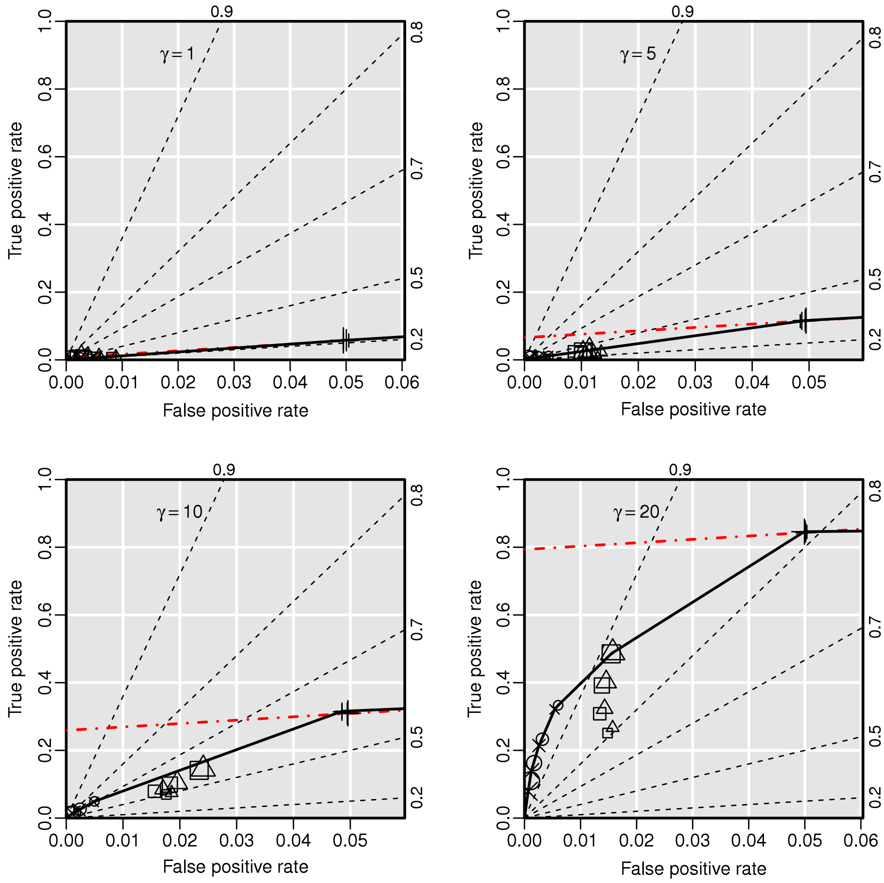

Fig. 1. $\rho = 0$, $N_1/N = 0.2$. Larger symbols correspond to larger panels with $N \in \{10, 20, 40, 80\}$. The dashed lines are precision isometrics. The lowest precision isometric coincides with the random guessing line. The dot-dashed line connects classifiers with the same average recall as the worst case among the standard DF. The broken solid line is the ROC convex hull. □ = C-SPSM; △ = I-SPSM; ◯ = H-SPSM; + = DF; × = Hommel.

Demetrescu et al., 2006) and Hanck's (2013) intersection test are natural candidates to be used within SPSMs. We label the resulting procedures as I-SPSM, C-SPSM, D-SPSM, and H-SPSM, respectively.

In this paper we investigate the performance of SPSMs as classification devices, as compared to standard time series UR tests and to Hommel's (1988) multiple testing procedure.[1] In particular, we intend to study the behaviour of the sequential procedures under the best theoretical conditions, so to obtain simulated upper bounds of the classification ability of these procedures. Other approaches have been recently proposed in the literature to determine the stationarity of individual time series in panels (see, e.g., Ng, 2008; Hanck, 2009; Moon and Perron, 2012; Smeekes, 2015); however, these procedures cannot be strictly labelled as SPSM (in the sense used by Chortareas and Kapetanios, 2009) and cannot be analysed using our simulation method, specifically tailored on Chortareas and Kapetanios (2009).

We complement and extend Chortareas and Kapetanios's (2009) analysis along five directions:

1. we study the performance of the procedure using four different panel UR tests;
2. we use local-to-unit root alternatives;
3. our analysis covers the cases of independent and dependent test statistics;
4. we focus on the classification performance of the procedure in a way that is not influenced by the finite-sample performance of the underlying individual UR tests;
5. we summarize the simulation results using ROC graphs, consistently with the literature on discrete classifiers.

Two by-products of this research may also be of interest to many researchers:

1. we offer a viable way to simulate dependent unit root and near-unit root test statistics and p values;
2. we report a response surface to compute the critical values of the $t\text{-}bar_{NT}$ test for any $N \in [2, 200]$ in this way generalizing Im et al. (2003, Table 2).

2. Monte Carlo design

Since we focus on procedures that use panel UR tests based on p value combinations or on averaged test statistics, rather than simulating the individual time series constituting the panel, we directly simulate the asymptotic ($T \to \infty$) individual DF t statistics and p values under the UR null and under selected local alternatives. The simulated t statistics and p values are then used as the fundamental input to compute the panel UR tests outcomes. In so doing, the classification performance of the different procedures depends only on the procedures' properties, not on the specification and the finite-sample properties of the underlying individual UR tests. For this reason, the simulation outcomes can be interpreted as the best possible results attainable by each procedure: in no practical circumstance the examined procedures can be expected to do better on average than in our simulations.

The series in the panel are assumed to obey

$$y_{i,t} = \varrho_i y_{i,t-1} + \epsilon_{i,t} \quad (1)$$

$$\varrho_i = \exp\left(-\frac{\gamma_i}{T}\right) \approx 1 - \frac{\gamma_i}{T} \quad (2)$$

[1] Hommel's procedure is a closed testing procedure related to Hanck (2013).