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UNIT ROOT TESTING IN WEEKLY PANELS OF TIME SERIES; IS IT APPLICABLE?

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ABSTRACT

Testing for seasonal unit roots essentially means investigating the degree of reversion of seasonal cycles to time constant equilibrium patterns. We consider the problem of testing for seasonal unit roots in weekly panel data. To do this, we generalize the monthly CHEGY test to the weekly case. The problem is that test statistics fail to converge to their expected limiting distributions. All methods are applied to an empirical data obtained from tourism department in Nigeria. Tests currently available suffer from a combination of two serious shortcomings, size distortions and low power against credible alternatives.

KEYWORDS: Parametric and Non-Parametric Test, Unit Roots, Panel Data, Tourism, Statistics Univariate

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1.0. INTRODUCTION

Testing for stationarity in panel data models is also per se a matter of interest and it can be more directly motivated. It seems fairly instinctive that, within the general class of models where heterogeneity is restricted to an individual fixed effect, the times series behavior of an individual variable should often be well approximated either as an autoregressive process with a small positive coefficient and large fixed effects or as an autoregressive process with a near-unit root and negligible individual fixed effects.

Panel data refers to data sets consisting of multiple observations on each sampling unit. This could be generated by pooling time-series observations across a variety of cross-sectional units including countries, states, regions, firms, or randomly sampled individuals or households.

1.1. Problem Statement

The seasonally integrated models of the econometrics of non-stationary unit root process are extremely different from the econometrics of stationary processes. In general, the usual hypothesis testing gives misleading result when applied to non-stationary data. The problem is that test statistics fail to converge to their expected limiting distributions. Testing for seasonal unit roots essentially means investigating the degree of reversion of seasonal cycles to time constant equilibrium patterns. In all unit-root tests on economic time series of limited length, discriminatory power is notoriously low. Repeated observations on series with comparable properties, as they are given in panel data, may serve convenient in increasing that power.

2.1. LITERATURE REVIEW

In recent years the econometrics literature has proposed a number of tests for unit roots in panel data. The tests are; CMLE (conditional maximum likelihood estimation) and is the most restrictive in terms of the assumptions necessary for validity. Then comes the HT (Harris-Tzavalis) test, which is based on bias-adjusted least squares dummy variable (LSDV) or within estimation and therefore allows non-normality but not heteroskedasticity and a version of CMLE suggested by Kruiniger (1999b) which allows for heteroskedasticity across units and time separately and is slightly more general than H-T. The next test, which we will label OLS, allows for heteroskedasticity and non-normality, and takes a very different approach by viewing the panel data regression as a system of T year regressions. It is based on the fact that ordinary least squares is a consistent estimator for the model with a lagged dependent variable and no fixed effects.

In all unit-root tests on economic time series of limited length, discriminatory power is notoriously low. Repeated observations on series with comparable properties, as they are given in panel data, may serve convenient in increasing that power. Compared to the sizeable literature on panel unit roots, tests on seasonal roots in panels have hitherto drawn much less attention. We just mention the contributions of Otero et al. (2005, 2007) as well as of Ucar and Guler (2007) and of Dreger and Reimers (2004).

Most of this research focuses on the case of quarterly data. In this paper, we consider the weekly case.

The panel literature tends to describe unit-root tests under the assumption of homogeneity and independence in the cross-section dimension as the ‘first-generation’ tests and tests that admit heterogeneity and static cross-section correlation as ‘second-generation’ tests (see Hlouskova and Wagner, 2006). In this sense, the above authors already focus on second-generation tests, as seasonal unit roots have drawn little attention in the age of the first generation. In the following, we will adopt the CHEGY test by Otero et al. (2007) and we will contrast it with a nonparametric test that follows the univariate RURS test introduced by Kunst (2009) as a seasonal generalization of the RUR (‘record unit-root’) test by Aparicio et al. (2006). Due to its construction, the RURS panel test is unlikely to be much affected by heterogeneity and cross-section correlation.

2.2. The Testing Procedures

Consider a panel of N real-valued time series variables that are available at a weekly frequency for t=1…,T. Denote the typical element as X_{jt} for j=1……..N and t=1,…., T. the testing problem is to determine whether the autoregressive operator ϕ_j in $\phi_j(B)X_{jt} = \varepsilon_{jt}$ with notation $\phi_j(z) = \sum_{k=0}^{pj} \phi_{k,j} z^k$ ad B denoting the lag operator contain roots at the location $\exp(ik\pi/52)$ for k=0,….52. Such autoregressive representations of order pj are assumed to exist in the sense that error processes ε_{jt} are white noise for all j .

2.2.1. The Weekly CHEGY Test

The CHEGY or cross-sectionally augmented HEGY test was introduced by Otero et al (2007) who take up a plan developed by Peasaran (2007). The tests procedure follow those describe by Peasaran, Otera and Kunst. Panel unit-root tests are known to be sensitive to cross-section heterogeneity. In order to tackle this feature, different methods and corrections to existing methods have been suggested in the literature. The simple idea of the CHEGY test is to add cross-section averages of the Y – variables. Then the weekly regression case reads:

$$\Delta_{52} X_{jt} = \alpha' Y^{-}_{j,t} + \beta''(\Delta_{52} X_{j,t-1} \ldots\ldots\ldots \Delta_{52} X_{j,t-p})' + \dot{\alpha} \overline{Y}^{-}_{t\ \ t} + \bar{\dot{\beta}}'(\Delta_{52} \overline{X}_{t} \ldots\ldots. \Delta_{52} \overline{X}_{t-p}) + \varepsilon_{jt} \qquad 1$$

with the with the noteworthy restriction that the lag order with regard to the averages is identical to the one for the individual regressors $\Delta_{52} X$ and the simultaneous regressor is given as $\Delta_{52} \overline{X}_{t}$

2.2.2. The Weekly RURS Test

The RURS test is robust against seasonal deterministic cycles, and it is also invariant to heterogeneity across j or to non-diagonal $\sum$. As long as dependence in the cross-section dimension does not invalidate laws of large numbers, an average of the N RURS statistics will, under the unit-root null at the considered frequency, converge to the first moment of the RURS null distribution as N → ∞. Of course, for small N it makes sense to study the null distribution of

$$\bar{J}_{*k} = N^{-1} \sum_{j=1}^{N} J^{(j)}_{*k} \qquad 2$$

where J^{j}_{*k} denotes the RURS statistic at frequency k for individual series j. The left-sided test based on the average RURS statistic J^{j}_{*k} will be called the RURS-p test in the following. Some simulated quantiles for the RURS-p test are provided in the lower panels of Table 2. Note that empirical means are identical but that the distribution is much more concentrated than for the univariate RURS statistics. This concentration becomes sharper as N increases.

3. AN EMPIRICAL EXAMPLE

Data used are getting directly from the Department of Tourism database. It covers the time range from February 2001 to December 2012. Quantities are quite Heterogeneous, as are the sizes and population of the size of the regions in the country. viz: Freedom Park, Lagos, Mambilla Plateau, Taraba state, Matsinga waterfalls, Cross River Park, Yangari game Reserve, Obudu mountain resort, Gashaka-ganyi park and Nekede Zoo.

Table 1: CHEGY Statistics for Individual Series in the Panel

Tourism Area/	p	t_0	F_1	F_2	F_3	F_4	F_5	t_6
South West	7.00	-1.64	0.55	6.37	16.80*	27.49*	36.21*	-8.65*
South-south	2.00	-1.76	1.51	5.80	9.20*	11.62*	39.77*	-8.02*
South-south	3.00	-1.35	0.61	5.77	10.91*	14.82*	24.14*	-5.33*
North-east	5.00	-3.04	2.73	3.90	5.25	11.30*	33.15*	-6.53*
North-central	1.00	-1.13	3.11	6.18	7.69*	7.12*	32.14*	-6.69*
North-west	2.00	-2.35	3.27	5.12	7.02*	21.37*	35.85*	-6.77*
CHEGY		-2.40	5.78	6.958	7.87*	9.39*	8.21*	-2.08

Note: Asterisks denote significance at 5%

3.1. The CHEGY Test

The panel test indicates unit-root seasonality for frequencies $\pi/2$ to $5\pi/6$ to be significant especially for the region like North-central and South-west. The F-statistics are provided in the bottom row of the table above, this rendered all CHEGY statistics to be relevant.

3.2. The RURS Tests

Table 2 gives RURS statistics at all frequencies for all the six regions. The null of a seasonal unit root is rejected at the frequencies $\pi/6$ and π for most cases otherwise the data support the null. At the remaining frequencies, most extreme are found than would be typical for unit-root processes, which indicates an expansion of seasonal cycles beyond the random-walk rate.

Table 2: RURS Statistics for All States

Tourism Area/	0	$\pi/6$	$\pi/3$	$\pi/2$	$2\pi/3$	$5\pi/6$	π
South West	3.555	3.021	1.744	3.581	3.693	3.868	2.709
South-south	3.191	3.135	1.788	2.322	3.293	3.672	1.631
South-south	3.279	4.022	1.478	2.744	3.693	3.191	1.542
North-east	3.315	2.940	1.525	2.911	3.513	2.223	1.434
North-central	3.047	2.007	1.810	2.693	3.621	2.851	1.291
North-west	2.653	2.679	1.306	2.688	3.298	2.330	1.398
RURS-p	3.525	2.497	1.537	2.887	3.321	2.847	1.750

4.1. Testing Seasonal Unit Roots in Weekly Tourism Production Data in Nigeria

The autoregressive model is of the form

$$\Delta_{52} X_t = \alpha'(X_{t-1}.......X_{t-52})' + \gamma(\Delta_{52} X_{t-1},........\Delta_{52} X_{t-p})' + \sum_{j=1}^{52} \sigma_j D_{jt} + \lambda l + \varepsilon_t \qquad 3$$

are fitted to the eight observed series with the lag order p and the covariance matrix of the individual error term is estimated by maximum likelihood. These parameters $\hat{\alpha}, \hat{\gamma}, \hat{\sigma}$ and $\hat{\lambda}$ are then used to estimate the model, with errors drawn from an eight-variate $N(0, \hat{\Sigma})$ distribution. 5,000 replications of this parametric bootstrap alternative design are generated and all statistics are recorded.

Table 1 demonstrates the local power of the CHEGY procedure according to the experimental design developed above. The simulation design corresponds to a point in the generalized design because it is partially unstable and represent the alternative of the test, and the column headed $\tau = 1$ shows that the rejection rate is 100% at all frequencies higher than $\pi/6$, while the test does not reject at all at the annual frequency $\pi/3$ and achieves around 50% rejection at the $\pi/2$ zero frequency

Thus, the local-power simulation corroborates the findings for the sample at $\tau = 1$ but it helps to make it more accurate. A first explanation is that the nonparametric tests, by construction, process less information than the parametric rivals and thus have less power. This explanation, however, only suffices for the behavior at the frequency $\pi/2$, where the difference in power is merely quantitative.

At the intermediate frequencies, however, the difference is qualitative. The record-counting tests interpret the typical nature change in a role model seasonal time series as being composed of a pattern-reverting deformation at backbone frequencies at $\pi/3$ and $\pi/6$ and persistent unit root cycles at the annual and various intermediate frequencies, where the CHEGY-type tests are more prone to see a significant amount of pattern reversion.

DISCUSSIONS

We present a generalization of seasonal unit-root tests to weekly panels, and we illustrate the properties on an empirical data set on Nigerian tourism data. The data set permits us to inspect the size and power properties of a parametric and a nonparametric test procedure in a realistic simulation design.

CONCLUSIONS

Overall, the picture drawn from our investigation is not very encouraging. Tests currently obtainable suffer from a combination of two serious shortcomings, as already noted, namely (1) size distortions in the most practically important cases and (2) in situations where the size is adequate, low power against credible alternatives.

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