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Testing for PPP in Australia: Evidence from unit root test against nonlinear trend stationarity alternatives

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Abstract

The aim of this paper is to analyse the empirical fulfilment of the PPP in Australia (1977-2004). Previous research focuses on the presence of structural breaks and fails to find any support to the PPP (Darne and Hoarau, 2008, Henry and Olekalns, 2002). In contrast, we find that the PPP hypothesis holds once we account for a more general specification of the Nonlinear Deterministic components based on a Chebishev polynomials approximation.

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1 Introduction

The empirical fulfilment of Purchasing Power Parity (PPP) has probably been one of the most controversial topics in international economics during the last decades. Many authors have contributed to the literature, using different countries, time periods and econometric techniques. However, the results have been in many occasions contradictory

The importance of the analysis of PPP is, at least, twofold. First, many macroeconomic momentary models are based on the PPP assumption. Second, the real exchange rate can be considered a measure of economic integration and external competitiveness (Wei and Parsley, 1995) and its understanding can be helpful in order to design exchange rate policies.

In short, the PPP theory establishes that the Real Exchange Rate (RER) between two currencies has to be equal to 1, that is, the purchasing power of both currencies must be equal. It is well known within the literature that if PPP holds, does it only in the long run. This implies that shocks affecting the currencies affect only the dynamics, converging in the long run towards an equilibrium. Therefore, testing for the empirical validity of PPP is closely related to testing for unit roots in the RER (Meese and Rogoff 1988; Mark, 1990; Ardeni and Lubian, 1991; Huizinga, 1987, among others). However, it has been argued that traditional unit root tests might suffer from power problems when the deterministic components are not properly specified (Perron and Phillips, 1987; and West, 1988, among others). Therefore, the existence of structural changes in the series may bias the results of the traditional unit root tests in favour of the null hypothesis, incorrectly rejecting the PPP hypothesis.

In order to overcome this issue, several authors have applied unit root tests with structural changes (see for instance Camarero, Cuestas and Ordóñez, 2006, among others), finding in general results more favorable to the PPP hypothesis. Following this approach, a recent paper by Darné and Hoarau (2008) analyses whether PPP holds in Australia. These authors apply the Perron and Rodríguez (2003) unit root tests with structural changes, obtaining a structural change in 1985, coinciding with the currency crisis suffered by the Australian dollar. Their results, however, point to the rejection of the null hypothesis of unit root. Likewise, Henry and Olekalns (2002) also reject the PPP hypothesis in the Autralian RER, using the Zivot and Andrews (1992) and Perron (1997) unit root tests with breaks.

Bearing in mind that an incorrect specification of the deterministic components may bias the results towards the integrated process hypothesis (Perron and Phillips, 1987; and West, 1988), and in order to complement Darné and Hoarau (2008), in the present paper we apply a unit root test procedure with a more general specification for structural changes, i.e. nonlinear deterministic trends (Bierens, 1997). Bierens (1997) propose several tests for the unit root hypothesis against the alternative of nonlinear trend stationarity, where the nonlinear trend is approximated by Chebishev polynomials. Contrary to the previous literature, our findings point to different results: the PPP holds in Australia for the analysed period, for the same data set than Darné and Hoarau (2008).

In the next section we summarise the Bierens (1997) technique and the results of applying this technique. The last section concludes.

2 Nonlinear unit root tests and results

In this section we test for the order of integration of the Real Exchange Rate of Australia. The data used in the present paper correspond to the RER computed by the Reserve Bank of Australia[1] from January 1977 to April 2004, the same time series than Darné and Hoarau (2008).

Since time series are most usually modelled by linear equations, unit root tests can be biased by the presence of nonlinearities in the deterministic component. It is standard practice to introduce structural breaks and additive outliers, form of nonlinearities can be eliminated by some transformation of the variables. The identification of structural breaks and outliers is also in-

[1] Available at http://www.rba.gov.au/Statistics/real_exchange_rate_indices.xls.

formative since provides a direct interpretation. They can be contrasted with significant events to give an intuitive interpretation. An alternative approach is to introduce a more general approximation to the nonlinear deterministic component. The approximation would also capture these kind of structural breaks with a smoother functional form. It is in this direction than this paper makes a contribution to the previous literature.

In order to test for the PPP hypothesis we apply the Bierens (1997) unit root test approach. This procedure accounts for the general case of nonlinear deterministic trend when testing for unit roots, by extending the ADF test introducing orthogonal Chebishev polynomials. Thus, the ADF equation becomes

$$\Delta x_t = \alpha x_{t-1} + \sum_{j=1}^{p} \phi_j \Delta x_{t-j} + \theta^T P_{t,n}^{(m)} + \varepsilon_t \qquad (2.1)$$

where $P_{t,n}^{(m)}$ are the Chebishev polynomials and m is the order of the polynomials. The null hypothesis is formulated such that α and the last m components of θ are not significant. In this paper we apply the $\hat{t}(m)$ test that is a t-test on the significance of the coefficient α. In addition, and in order to check the robustness of the previous results I also apply the $\hat{A}(m) = \frac{n\hat{\alpha}}{|1-\sum_{i=1}^{p}\hat{\phi}_i|}$ test, that is an alternative test for the same hypothesis. The distinction between linear or nonlinear trend stationarity depends upon the side of the rejection. Whereas right side rejection (a p-value > 0.90) implies stationarity around a nonlinear deterministic trend, left side rejection (a p-value < 0.10) does not allow us to distinguish between mean stationarity or stationarity around a deterministic trend (see Table 1).

The results are displayed in Table 2. These p-values are based on Monte Carlo simulations based on 5,000 replications of a Gaussian $AR(m)$ process for Δx_t. The parameters and error variances are equal to the estimated $AR(m)$ null model, where the lag length for the ADF regression has been selected by the AIC and the initial values have been taken from the actual series. The results, for m=6[2], point to the rejection of the null hypothesis of unit root in favour of the alternative of stationarity around a nonlinear trend. Therefore, our results are complementary to those obtained by Darné and Hoarau (2008) and do not contradict these authors' findings. Darné and Hoarau (2008) assume the existence of a unique structural break in the Australian RER, what is economically sensible. However, a nonlinear deterministic trend appears to be a better approximation for the deterministic components of this country RER. This hypothesis, therefore, does not agree with the Balassa-Samuelson effect. Instead, the results here reported are in line with Lothian and Taylor (2000) findings.

Finally, we explore whether structural breaks can explain for most of the nonlinearity. In order to check for the importance of structural breaks as

[2] We have selected the order of m that yields more evidence against the null hypothesis.

the main source of the nonlinearity, we also perform the Bierens (1997) test over the variable, previously transformed to account for a structural break in the intercept and trend [3]. If structural breaks are important to explain the nonlinearity, we expect to reject the null hypothesis of unit root for the transformed variable with a low Chebishev polynomial order (i.e. m close to zero). The new results show the transformed variable is stationary around a nonlinear trend for m equal to 5, which is very close to our initial results. This suggests the structural break is not able to capture the true nature of the nonlinerarity. Therefore, the Chebishev polynomial appears to approximate the nonlinear deterministic component better than a single structural break[4].

3 Conclusion

Previous literature (Darne and Hoarau, 2008, Henry and Olekalns, 2002) test the empirical validity of PPP in Australia applying unit root tests with structural changes. Their results point to the rejection of the PPP hypothesis. Complementary to these results, and after generalising the case of structural break to a nonlinear deterministic trend, we obtain that the RER is nonlinear trend stationary for the same sample than Darne and Hoarau (2008).

[3]Preliminary examination of the data reveals the most likely structural break occurs in 1985:1

[4]Hegwood and Papell (1998) refers to the case of stationary real exchange rate with structural changes as Quasi-PPP.

This suggests that it is worth considering alternative forms for approximating the deterministic trends than structural breaks in the coefficients of a linear equation when testing for PPP.

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Table 1: Alternative hypotheses

Test	Left-side rejection	Right-side rejection
$\hat{t}(m)$	MS, LTS or NLTS	NLTS
$\hat{A}(m)$	MS, LTS or NLTS	NLTS

Note: MS= mean stationarity, LTS= linear trend stationarity, NLTS= nonlinear trend stationarity.

Table 2: Bierens (1997) nonlinear unit root test results

$\hat{A}(m)$	$\hat{t}(m)$
0.95	0.90

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