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A century of purchasing power parity confirmed: The role of nonlinearity

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ABSTRACT

Taylor (2002) claims that Purchasing Power Parity (PPP) has held over the 20th century based on strong evidence of stationary for century-long real exchange rates for 20 countries. Lopez et al. (2005), however, found much weaker evidence of PPP with alternative lag selection methods. We reevaluate Taylor's claim by implementing a recently developed nonlinear unit root test by Park and Shintani (2005). We find strong evidence of nonlinear mean-reversion in real exchange rates that confirms Taylor's claim. We also find a possible misspecification problem in using the ESTAR model that may not be detected with Taylor-approximation based tests.

1. Introduction

Purchasing power parity (PPP) is a simple theory of real exchange rate determination that continues to serve as a key building block for many open economy macro models. Despite its popularity and extensive studies, however, empirical evidence on PPP still remains elusive. Taylor (2002) constructed over a century-long real exchange rates for 20 countries, and implemented an array of unit root tests. Finding very strong evidence for PPP, he concluded that PPP has held over the 20th century. His claim, however, was upset by Lopez et al. (2005) who pointed out that his results were sensitive to the choice of lag selection methods. They reported much weaker evidence of PPP from implementing the same unit root tests for his data with alternative lag selection methods.

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This paper takes a different road and reevaluates Taylor's claim by implementing a new nonlinear unit root test proposed by Park and Shintani (2005). Recent theoretical and empirical studies on real exchange rates have shown the importance of nonlinear adjustment of the real exchange rate toward long-run equilibrium value. Dumas (1992) and Sercu et al. (1995) show how transaction costs in international arbitrage can induce nonlinear adjustment of the real exchange rates toward PPP. Michael et al. (1997) and Obstfeld and Taylor (1997) study nonlinear adjustment process motivated by transaction costs that define a neutral band with profitable commodity arbitrage opportunities at the boundary. It should be noted that a failure to account for such nonlinearity may underlie the difficulties in better understanding real exchange rates dynamics (see, among others, Taylor, 2001).

We also note the low power problem of the conventional linear unit-root tests when the true data generating process is nonlinear mean-reverting process. Pippenger and Goering (1993) find that conventional linear tests perform poorly when the true data generating process is the threshold autoregressive (TAR) model, and are sensitive to the speed of adjustment as well as location of the threshold parameter. Taylor et al. (2001) show with Monte Carlo simulations that the Dicky–Fuller test has low power against exponential smooth transition autoregressive (ESTAR) process. This body of work suggests that nonlinear models can provide an explanation for the poor performance of conventional linear unit-root tests on PPP deviations and why the deviations from the PPP appear to be nonstationary or extremely slowly mean-reverting (see, among others, Crucini and Shintani, 2008).

In this light, we reinvestigate Taylor's (2002) claim by testing the null of unit root for his century-long real exchange rate data against nonlinear alternatives. We consider three types of transition autoregressive process: exponential smooth transition autoregression (ESTAR), band logistic smooth transition autoregression (BLSTAR), and band threshold autoregression (BTAR). For this purpose, we implement the inf-*t* test by Park and Shintani (2005) for Taylor's data extended through 2004. Their test is superior than many previously proposed nonlinear unit root tests in various aspects. The inf-*t* test does not require stationary threshold variables, while other tests such as the one by Caner and Hansen (2001) does. Unlike the test by Kapetanios et al. (2003), the inf-*t* test does not need any Taylor approximation to deal with the so-called "Davies problem." Their test requires much less stringent assumptions on the parameter space compared with more recently proposed tests that include Kapetanios and Shin (2003), Seo (2008), and Bec et al. (2004).

By testing the null of unit root against three types of transition AR models for Taylor's (2002) data, we obtain very strong evidence of PPP. The inf-*t* test rejects a maximum of 14 out of 16 developed countries with standard lag selection procedures. Our results, thus, confirm Taylor's claim. We also report some evidence against the use of ESTAR models due to a potential misspecification problem that may not be detected when one uses Taylor-approximation based tests such as the test by Kapetanios et al. (2003).

The remainder of the paper is organized as follows. Section 2 briefly describes Park and Shintani's (2005) inf-*t* test. In Section 3, we describe the three transition functions we employ in this paper. In Section 4, we provide a brief data description and report some pre-test results. Then, we report our main empirical results. Section 5 concludes.

2. The inf-*t* test

Park and Shintani (2005) consider the transition between the following two regimes: the unit root regime,

$$\Delta q_t = u_t \tag{1}$$

and the stationary regime,

$$\Delta q_t = \lambda q_{t-1} + u_t, \tag{2}$$

where $\lambda < 0$ and u_t is the zero mean sequence of possibly serially correlated errors. The transition function $\pi(q_{t-d}|\theta)$ is defined as a weight on the stationary regime. Then, the stochastic process of q_t can be jointly represented by