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Is The Real Effective Exchange Rate Biased Against the PPP Hypothesis?

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Abstract

We show that the use of the real effective exchange rate to test for purchasing power parity, as in Astorga (2012) and other studies, is subject to a problem that biases tests against finding evidence of PPP. The problem is illustrated using Astorga´s data on six Latin American countries.

We are very grateful to Pablo Astorga for providing the data used in his work.
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1. Introduction

Purchasing power parity (PPP) means that the cost of a market basket of traded goods is the same in different locations when denominated in a common currency. Although a wide variety of linear and nonlinear methods have been employed to test the PPP hypothesis, the general approach of most empirical work is to assess a measure of the real exchange rate for stationarity. If evidence of mean reversion is found most researchers assume that the value to which the real exchange rate reverts is its purchasing power parity level. Two types of real exchange rate measures have been used in such tests; the bilateral real exchange rate (RER) and the real effective exchange rate (REER), a weighted average of bilateral rates. The weights used in construction of the REER are usually trade shares so that the price levels of a country's most important trading partners are more heavily weighted.

The intent of this note is to highlight a serious shortcoming in using the real effective exchange rate in PPP studies. The problem we identify introduces a bias against the purchasing power parity hypothesis into stationarity tests. Our argument is straightforward and reflects a problem well known to econometricians. Nonetheless researchers using the REER are either unaware of the problem or have ignored it.

A partial list of recent works testing the REER for stationarity includes Astorga (2012), Arize (2011), Bahmani-Oskooee, Hegerty, and Kutan (2009), and, Bahmani-Oskooee, Kutan and Zhou (2008). Taylor (2001) is, perhaps, the most widely cited empirical study of PPP. One of Taylor's tests applies unit root tests to a country's real exchange rate relative to a world basket of currencies, yet this measure, an unweighted mean, is beset by the same problems as a real effective exchange rate constructed using trade share weights.

The rest of the article is organized as follows: in Section 2, we formally present our main argument. In Section 3, we illustrate our argument empirically using the same dataset of Astorga (2012). Section 4 concludes the paper.

2. Econometric Issues

The real effective exchange rate is constructed using bilateral real exchange rates. If *N* bilateral real rates are used in the construction of the effective rate, then either each of the *N* real rates must be an *I(0)* process or those real rates that are not *I(0)* must be cointegrated to form an *I(0)* process for the REER to be stationary.

As previously noted, the REER is a weighted average of bilateral real rates.

$$\varepsilon_{jt} = \sum_{i \neq j} \alpha_{ijt}\left(e_{ijt} + p_{it} - p_{jt}\right). \tag{1}$$

Let T be the sample size. Then $p_{jt}, p_{it}, e_{ijt}, \alpha_{ijt}$ for $i, j = 1,2,\dots,N \; and \; t = 1,2,\dots,T$ are, respectively, the period t logarithm of the home country j price index, the price index of country i, the nominal exchange rate, and the trade share of country i relative to total trade of home country j. The nominal exchange rate is expressed as the country j price of a unit of country i currency. Note that the expression in parentheses corresponds to the bilateral real exchange rate between countries i and j in period t.

A lack of evidence for PPP hypothesis is asserted if unit roots tests fail to reject the null hypothesis of nonstationarity of the real effective exchange rate, i.e., when $\varepsilon_{jt} \sim I(1)$.[1] However, it is well known that a sufficient condition for nonstationarity of any composite series is that just one of the component series is integrated of order one (or higher). In other words, even if *N-1* bilateral real rates are stationary and the remaining one is *I(I)*, the weighted sum of all the RER would remain nonstationary; thus purchasing power parity could hold for each of the *N-1* bilateral rates, but the inclusion of a nonstationary series in construction of the REER conceals evidence of the hypothesis.

Alternatively, suppose tests suggest stationarity of the real effective exchange rate, cited as support for PPP. Such evidence may arise if all *N* bilateral rates are stationary in which case it is unclear what is gained by using the composite REER series rather than testing the individual RER. Stationarity of the REER may also occur if at least two of the bilateral rates are nonstationary but cointegrated while the others are I(0). Thus purchasing power parity might not hold for the (nonstationary) bilateral rates but cointegration of the nonstationary component series causes the REER to be stationary. Such a result would be meaningless as a test of the PPP hypothesis.

3. Empirical Illustration

We examine the preliminary evidence against PPP presented by Astorga (2012). The intent of this section is not to search for evidence of PPP, but rather to determine whether the problems identified above causing bias against the PPP hypothesis occur in a recent paper using the REER to test for purchasing power parity. Consequently, no effort is made to account for breaks or other types of nonlinearities.

We proceed in two steps. First, we attempt to reproduce Astorga's findings for the six real effective exchange rates included in his study. He reports that initial unit root tests (ADF and Phillips-Perron) fail to reject the null of nonstationarity of the REER series. Second, the same unit root tests are applied to bilateral real rates used to construct the real effective exchange rates of the six Latin American countries in his dataset.[2] Evidence of the problem identified in this paper would exist if the same tests conducted on the component series show stationarity of at least some of the bilateral real rates.

Astorga (2012) tests for mean reversion of the REER of six Latin American countries; Argentina, Brazil, Chile, Colombia, Mexico and Venezuela; using annual data for 1900-2000. To calculate the REER series for a country he includes the bilateral RERs of the most important trading partners: US, UK, Germany, France, Japan, and one or two Latin American countries. He finds that the null hypothesis of a unit root in the REER series cannot be rejected for any country using the ADF and Phillips-Perron unit-root tests. In most cases de-trending each REER series still leads to failure to reject the null. Astorga interprets the test results as indicating that the series do not revert to a constant mean possibly because of the presence of either a deterministic trend and/or structural shifts in the series. Our first step is to repeat Astorga's initial work by applying the ADF and

[1] Note that testing for PPP using this approach implies a restricted cointegration analysis between prices and nominal exchange rates because the elements of the cointegration vector are preset. Specifically, the coefficient associated with the domestic price index must be minus one, while those associated with the nominal exchange rate and foreign price indexes are equal to one.

[2] We are very grateful to Pablo Astorga for providing the bilateral real rates and the real effective exchange rate series for each of the Latin American countries.

Phillips-Perron unit root tests to his REER data. Allowing for a constant and no trend in the tests, we find that the null hypothesis of a unit root cannot be rejected for any of the six countries at the 5% significance level. Inclusion of a trend in the tests does not alter the nonstationarity conclusions in most cases.[3] These results are the same as reported by Astorga.

In practice, does the bias against stationarity, inherent in the construction of the real effective exchange rate series, affect conclusions one can draw from empirical work regarding the validity of PPP? To answer this query, in our second step we apply the same unit-root tests employed by Astorga to five bilateral RER series for each country relative to the currencies of the US, UK, France, Japan, and Germany. Astorga uses these bilateral rates in constructing the real effective exchange rate measures.[4] Table 1 shows the number of bilateral real exchange rates for which the unit root test rejects the null of nonstationarity at the ten percent level or better. Test equations include an intercept but not a trend.

TABLE 1. NUMBER OF STATIONARY BILATERAL REAL EXCHANGE RATES

Country	*ADF*	*PP*
Argentina	2	2
Brazil	1	1
Chile	1	1
Colombia	0	0
Mexico	1	1
Venezuela	1	1

The number of lags to control for autocorrelation for each UR test was selected using the Bayesian Information Criterion.

Unlike Astorga's findings using the real effective exchange rate, there is evidence of stationarity, hence PPP, in at least one of the bilateral real rates for all countries except Colombia. It is important to mention that our results are not fully comparable with those of Astorga. We selected the number of lags using an information criterion (BIC) while Astorga fixed the number of lags equal to 4 (see Astorga, 2012, p. 1535).[5] Including a trend in the unit root tests increases the number of bilateral real exchange rates for which the null of nonstationarity can be rejected at the ten percent significance level or better. These results suggest that PPP does hold for at least some of the bilateral real rates of these countries and that Astorga´s real effective exchange rates are a mix of stationary and nonstationary series for most of the countries, hence conceal evidence of purchasing power parity. Of course, numerous researchers have used real effective exchange rates in various studies and are subject to the same problem uncovered in Astorga.

[3] In our replication, the null of a unit root in the REER series is rejected only for Brazil in both the ADF and Phillips-Perron tests with trend.

[4] Astorga does not identify the Latin American countries with bilateral rates included in calculation of the REER for the six countries of his study so we omit consideration of these other real exchange rates.

[5] The results vary depending on the approach to select the number of lags in the UR test. For example, when fixing the number of lags to one, the null of unit-root is not rejected for the following bilateral rates: Brazilian real-US dollar, Chilean peso-US dollar, Mexican peso-French franc and Venezuelan bolivar-French franc.

4. Conclusions

As the weighted sum of bilateral real exchange rates, the REER will be a nonstationary series if at least one of the component real exchange rates is nonstationary, assuming no cointegration if there are two or more I(1) or higher series. Some of the underlying component RER may be stationary indicating evidence of PPP in the bilateral real rates, but this evidence will be hidden by a finding of nonstationarity in the real effective exchange rate series. We have illustrated the problem using two standard unit root tests and data from Astorga; but our arguments apply equally to any other tests for mean reversion of the REER such as cointegration methods and panel unit root tests.

The main implication of our findings is that use of the real effective exchange rate to test for PPP makes it very unlikely that evidence of purchasing power parity will be found. Even if a REER is found to be stationary, the result is meaningless for the PPP hypothesis since it is possible that the component series are not stationary but instead the underlying bilateral rates are cointegrated to form stationary series. Given the problems associated with the real effective exchange rate, researchers would be better served testing for PPP using bilateral real rates instead.

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