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Nonlinear adjustment to purchasing power parity for ASEAN countries

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ABSTRACT

This study applies a simple and powerful nonlinear unit root test, proposed by Sollis (2009), to test the validity of long-run purchasing power parity (PPP) in a sample of ASEAN countries. The empirical results indicate that PPP only holds for three of these ASEAN countries studied, and the adjustment toward PPP is found to be nonlinear and asymmetric.

1. Introduction

Purchasing power parity (hereafter, PPP) is a cornerstone of many theoretical models in international finance. PPP states that the exchange rates between currencies are in equilibrium when the purchasing power is the same for the two countries. This means that the exchange rate between any two countries should equal the ratio of two currencies' price level for a fixed basket of goods and services. The basic idea behind the PPP hypothesis is that since any international goods market arbitrage is traded away over time, we should expect the real exchange rate to return to a constant equilibrium value in the long run. Studies on this issue are critical not only for empirical researchers but also for policymakers. In particular, a non-stationary real exchange rate indicates that there is no long-run relationship between nominal exchange rate and domestic and foreign prices, thereby invalidating the PPP. As such, PPP cannot be used to determine the equilibrium exchange rate. An invalid PPP also disqualifies the monetary approach from exchange rate determination, which requires PPP to hold true.

Empirical evidence on the stationarity of real exchange rates is abundant but inconclusive thus far. For details on previous studies, please refer to the works of Taylor (1995), Rogoff (1996), MacDonald and Taylor (1992), Taylor and Sarno (1998), Sarno and Taylor (2002), Taylor and Taylor (2004), and Lothian and Taylor (2000, 2008), who have provided in-depth information on the theoretical and empirical aspects of PPP and the real exchange rate.

Recently, there has been a growing consensus that the real exchange rate exhibits nonlinearity. Consequently, conventional unit root tests such as the Augmented Dickey–Fuller (ADF) test have low power in detecting the mean reversion of exchange rate. A number of studies have provided empirical evidence on the nonlinear adjustment of exchange rate.[1] However, the finding of nonlinear adjustment does not necessarily imply nonlinear mean reversion (stationarity). As such, stationarity tests based on a nonlinear framework must be applied.

[1] Reasons for the asymmetric adjustment are the presence of transaction costs that inhibit international goods arbitrage and official intervention in the foreign exchange market leading to asymmetric nominal exchange rate movements (see, Taylor, 2004; Taylor and Peel, 2000; Juvenal and Taylor, 2008). Kilian and Taylor (2003) also suggest that nonlinearity may arise from the heterogeneity of opinion in the foreign exchange market concerning the equilibrium level of the nominal exchange rate. As the nominal rate takes on more extreme values, a great degree of consensus develops concerning the appropriate direction of exchange rate moves, and traders act accordingly.

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Table 1
The study periods for eight ASEAN members.

Country	Study periods	Obs.
Cambodia	1994M10–2008M9	168
Indonesia	1980M1–2008M9	345
Laos	1987M12–2008M6	247
Malaysia	1980M1–2008M9	345
Philippines	1980M1–2008M9	345
Singapore	1980M1–2008M9	345
Thailand	1980M1–2008M9	345
Vietnam	1995M1–2008M6	162

The exponential smooth transition autoregressive (ESTAR) time series model has proven to be popular in economics for the analysis of time-series data, such as data on real exchange rates. The presence of transaction costs suggests that while large deviations in real exchange rates from their equilibrium values are corrected by arbitrage, small deviations may not be corrected, and the globally stationary ESTAR model with a unit root central regime is capable of capturing this type of nonlinearity (see for example Baum et al., 2001; Taylor et al., 2001; Sollis, 2009). A number of tests on the unit root hypothesis against stationary ESTAR nonlinearity have recently been proposed (see for example Kapetanios et al., 2003; Park and Shintani, 2005). However, the assumption of symmetric mean reversion (linear or nonlinear) in some empirical applications is too restrictive. One might expect asymmetry in the adjustment of the process toward its equilibrium. For example, in the case of real exchange rates, one might expect asymmetric adjustment if domestic or foreign policymakers behave asymmetrically in response to appreciation and depreciation of the same proportionate amount. Sollis et al. (2002) and Sollis (2009) find evidence suggesting that asymmetric nonlinear mean reversion is an important feature of data on real exchange rates against the U.S. dollar.

This empirical study contributes to this line of research by determining whether PPP holds true in a sample of ASEAN countries and the adjustment process toward its equilibrium is nonlinear in a symmetric or asymmetric way. We test the non-stationarity of real exchange for ASEAN countries using a simple and powerful nonlinear unit root test of Sollis (2009). With this, the current research hopes to fill the existing gap in the literature. To our knowledge, this study is the first, to date, that utilizes asymmetric exponential smooth transition autoregressive (hereafter, AESTAR) unit root test for ASEAN real exchange rates We find that AESTAR unit test strongly rejects the unit root process for three of the ASEAN countries examined, while the traditional unit root tests such as the ADF, PP, and KPSS, lead to no rejection at all. In addition, the adjustment process toward its equilibrium for these three ASEAN countries is nonlinear and asymmetric.

The remainder of this paper is organized as follows. Section 2 presents the data used in our study. Section 3 briefly describes the AESTAR test and our empirical results. Section 4 concludes the paper.

2. Data

As of 2009, there are 10 members within the Association of Southeast Asian Nations (ASEAN). Due to insufficient data for Brunei and Myanmar, our empirical analysis only covers 8 of the ASEAN countries: Cambodia, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam. Table 1 presents the time span for each country and monthly data are employed in this study. All consumer price indexes, CPI (based on 2000 = 100) and nominal exchange rates relative to the U.S. dollar (USD) data are taken from the International Monetary Fund's International Financial Statistics CD-ROM. Each of the consumer price index and real exchange rate series is put into natural logarithms before the econometric analysis.

A summary of the statistics of bilateral real exchange rate is given in Table 2. The Jarque–Bera test results indicate that, except for Indonesia, for all country pairs, the bilateral real exchange rate data sets are approximately non-normal. Fig. 1 plots the real exchange rate series for these 8 country pairs. We find significant upward or downward trend in some real exchange rate series. Most of the series seem to exhibit some nonlinear adjustment patterns.

3. Methodology and empirical results

3.1. AESTAR unit root test (Sollis, 2009)

This paper employs the AESTAR test developed by Sollis (2009) which using an extended version of the ESTAR model. The advantage of this method is that allows for symmetric or asymmetric nonlinear adjustment under the alternative hypothesis to a unit root. As the suggestion of Sollis (2009), the AESTAR model expressed as follows:

$$\Delta y_t = G_t(\gamma_1, y_{t-1})\{S_t(\gamma_2, y_{t-1})\rho_1 + (1 - S_t(\gamma_2, y_{t-1}))\rho_2\}y_{t-1} + \sum_{i=1}^{k} k_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

Furthermore, Sollis et al. (2002), Kapetanios et al. (2003) and Park and Shintani (2005) suggest that do not allow for transitions in the higher order dynamic terms in Eq. (1). The unit root hypothesis can be tested against the alternative hypothesis of globally stationary symmetric or asymmetric ESTAR nonlinearity with a unit root central regime by testing $H_0 : \gamma_1 = 0$ in Eq. (1). Unfortunately, γ_2, ρ_1 and ρ_2 are unidentified under this null, thus conventional methods cannot be used. As the treatment of Kapetanios et al. (2003), using an auxiliary model by taking a first-order Taylor expansion of the exponential function in the

Table 2
Summary statistics: ln(real exchange rate).

	Cambodia	Indonesia	Laos	Malaysia	Philippines	Singapore	Thailand	Vietnam
Mean	8.214	8.517	8.884	1.079	3.642	0.486	3.471	8.888
Median	8.268	8.481	8.911	1.033	3.651	0.504	3.423	8.907
Max.	8.337	9.803	9.592	1.525	3.959	0.644	3.989	9.592
Min.	7.973	7.745	8.524	0.678	3.323	0.249	3.132	8.524
Std. Dev.	0.111	0.406	0.204	0.220	0.174	0.100	0.189	0.187
Skewness	−0.837	−0.017	0.589	0.029	−0.020	−0.606	0.348	0.560
Kurtosis	2.268	2.982	3.254	1.644	2.162	2.481	2.072	3.584
Jarque–Bera	23.355	0.021	11.014	26.481	10.125	25.005	19.333	15.339
Prob.	0.0000	0.9898	0.0041	0.0000	0.0063	0.0000	0.0001	0.0000

Note: ln(real exchange rate) = ln(nominal exchange rate) + ln(foreign price level) − ln(domestic price level); the US serves as the base country.