Black and Official Market Exchange Rates and Purchasing Power Parity: More Evidence from Non-Linear STAR Tests

Mohsen Bahmani-Oskooee[a], Ali M. Kutan[b] and Su Zhou[c]

ABSTRACT

A group of studies have shown that in less developed countries, purchasing power parity (PPP) theory is supported more often when the black market exchange rates rather than official rates are used in the testing procedure. They have all relied upon linear ADF test applied either to the residuals of a cointegrating vector or to real exchange rates. In this paper we use a non-linear ADF test and show that when non-linearity is incorporated in the testing procedure, the non-linear tests support PPP more often than the linear test regardless of whether we use official or black market exchange rate. Besides, for the post Bretton-Woods period, PPP receives almost equal support using either the black market exchange rates or the official rates.

JEL Classification: F31

Key Words: PPP; Black Market Exchange Rate; Non-linear Test.

a. The Center for Research on International Economics and the Department of Economics, The University of Wisconsin-Milwaukee, Milwaukee, WI 53201. e-mail: bahmani@uwm.edu
b. Department of Economics, Southern Illinois University, Edwardsville, IL 62026-1102.
c. Department of Economics, University of Texas at San Antonio, TX 78249-0633.

I. Introduction

The purchasing power parity (PPP) theory is an important building block of international macroeconomic models. Long run PPP implies a mean-reverting (stationary) process for real exchange rate. PPP has been tested by either studying the long-run linkages between nominal exchange rates and relative prices or by testing whether the real exchange rates are stationary or not. Despite many studies, no consensus has been reached on the validity of PPP in the literature.[1] Besides its well known theoretical reasons, studying whether PPP holds well is significant for other key reasons. First, if PPP holds, then the effects of a shock to the real exchange rates would be only temporary, suggesting that real exchange shocks have no detrimental effects on trade flows at least in the long run. Second, if PPP holds within a region, for example, for the CFA zone in Africa, this would imply price level convergence across the member states, suggesting minimal real exchange rate risk. The latter issue is critical not only for policymakers but also for asset pricing and portfolio management considerations (Koedijk *et al.*, 2004).

A common feature of most of these studies is their reliance upon the standard Augmented Dickey-Fuller (ADF) test in which the null hypothesis of non-stationarity or unit root is tested against a linear stationarity. However, recent studies have shown that the mean reverting process of real exchange rates may follow a non-linear path. For example, Kapetanios, Shin and Snell (2003, KSS hereafter), applying a new test that is based on a nonlinear smooth transition autoregressive (ESTAR) procedure in which the null is still unit root but the alternative is non-linear stationarity in a time series variable, show that evidence for PPP is stronger when KSS test

[1] Early studies that tested for stationarity of the real exchange rates or other formulation of PPP mostly rejected it. Examples include Taylor (1988), Carbae and Ouliaris (1988, 1991), McNown and Wallace (1989), Layton and Stark (1990), Kim (1990), Bahmani-Oskooee and Rhee (1992), and Bahmani-Oskooee (1995). Example of those who have supported PPP includes Bahmani-Oskooee and Barry (1997), Lothian and Taylor (1996), and Bahmani-Oskooee (1998). For a review article see, Rogoff (1996) and Lucio (2005).

is used than the standard ADF test. This finding has received further empirical support in the literature.[2] The empirical evidence has been supported by theoretical arguments as well. For example, some models argued that non-linearity in real exchange rates might be caused by transactions costs in international arbitrage, which create a band of no arbitrage for the real exchange rate.[3] It is also argued that official intervention in the foreign exchange market may impart non-linearity into the adjustment of the nominal exchange rate and, with stickiness in prices in the short run, into the adjustment of the real exchange rate as well (Sarno and Taylor, 2001, and Taylor, 2003). We expect a higher degree of nonlinearity in the official real exchange rates of less developed countries (LDCs) than those of developed countries due to higher level of foreign exchange market intervention in the former.

A common feature of the available empirical studies above is that the majority of them have relied upon the official exchange rates in testing PPP. However, using the official rates for countries with significant black or parallel market activities may significantly bias the inferences regarding the validity of PPP as the black market or parallel exchange rates serve as a better proxy for floating exchange rates. Therefore, a few studies have relied on black market or parallel exchange rates in testing PPP, especially in less LDCs. These studies report that PPP is supported more often when the black market exchange rate is used in the testing procedure than the official rate.[4] Despite this, an important shortcoming of this literature has been that these studies do not apply non-linear tests in investigating the validity of PPP based on the black

[2] See, among others, Sarno (2000), Taylor and Sarno (2001), Liew et al. (2004), Chortareas and Kapetanios (2004), Sarno *et al*. (2004), and Bahmani-Oskooee *et al.* (2006).

[3] For such a model, see Michael *et al*. (1997).

[4] They include Culbertson (1975), Edwards (1989), Phillips (1988), Bahmani-Oskooee (1993), El-Sakka and McNaab (1994), Baghestani (1997), Sanchez-Fung (1999), Luintel (2000), Kouretas and Zarangas (2001), Nagayasu (2002) and Bahmani-Oskooee and Goswami (2005). Bahmani-Oskooee and Goswami (2005) provide a review of the literature.

market or parallel exchange rates. Relatively higher transaction costs in international arbitrage in the developing countries would make these countries' real exchange rates in illegal markets more vulnerable to nonlinearity shocks than those of the advanced market economies.

In this paper we fill this gap in the literature. Not only do we test PPP by using both the official as well as the black market exchange rates, but we also employ both the standard linear ADF test and the non-linear KSS test to determine whether the mean-reverting properties of the real black market exchange rates is on a non-linear but stationary path. Given frequent official interventions and higher transactions in international arbitrage, it is more likely that the real exchange rates in LDCs exhibit nonlinear effects. To our best knowledge, this study provides the most comprehensive evidence on the validity of PPP as far as black market exchange rates are concerned. To this end, we introduce the KSS test in Section II. The empirical results based on 25 LDCs are reported in Section III with a conclusion in Section IV.

II. The KSS Test[5]

Let the time-series variable in question for which we plan to apply unit root tests be defined as *RER* (real exchange rate). The standard ADF test under which we test the null of unit root against the alternative of linear stationarity is formulated by (1):

$$\Delta RER_t = \delta RER_{t-1} + \sum_{k=1}^{n} \rho_k \Delta RER_{t-k} + \varepsilon_t \qquad (1)$$

The relatively new test introduced by Kapetanios, Shin and Snell (2003) still assumes the null to be the unit root, but the alternative is non-linear stationary smooth transition

[5] This section closely follows Bahmani-Oskooee *et al*. (2006).

autoregressive (STAR) process. It is based on the following exponential smooth transition autoregressive (ESTAR) specification:

$$\Delta RER_t = \lambda RER_{t-1}[1-\exp(-\theta RER_{t-1}^2] + \mu_t \qquad (2)$$

Where μ_t is an error term with usual properties. In this specification, the null of unit root, i.e., $\theta = 0$ is tested against the alternative of $\theta > 0$. Kapetanios *et al.* (2003) show that it is not feasible to directly test the null against the alternative because λ in (2) is not identifiable under the null. To remedy the situation, they use a first-order Taylor series approximation and reparameterize (2) to obtain the following specification:

$$\Delta RER_t = \phi RER_{t-1}^3 + \omega_t \qquad (3)$$

Like standard ADF test, to make the residuals in (3) white noise, they further augment (3) by a few lags of the dependent variable as in (4):

$$\Delta RER_t = \phi RER_{t-1}^3 + \sum_{k=1}^{n} \rho_k \Delta RER_{t-k} + \omega_t \qquad (4)$$

As can be seen, non-linearity is reflected by raising the lagged level of *RER* to power three rather than one, as in the standard ADF test. In (4) the null of unit root, i.e., $\phi = 0$ is tested against the alternative of $\phi < 0$ by familiar *t* ratio obtained for ϕ. However, the *t* ratio of the new test has a new distribution for which the critical values are tabulated by Kapetanios *et al.* (2003). Since this *t* ratio is for a non-linear model as outlined by (4), we shall denote it by t_{NL}.

In this study, we apply both the ADF and KSS tests to the real black market exchange rates as well as the real official exchange rates to test for the stationarity of the these rates. In our

testing, the number of augmentations n for either the ADF tests or the KSS tests is selected using the general-to-specific procedure of Hall (1994) and Ng and Perron (1995). The maximum number of n was set to be 24, mostly because of the data being monthly, and insignificant augmentation terms were excluded.

3. Data and the Results

Monthly data of the price indices and the official bilateral exchange rates against the U.S. dollar come from the International Financial Statistics of the IMF. The monthly black market exchange rates, however, come from Reinhart and Rogoff (2004) all for 25 less developed countries (LDCs).[6] The sample period for most of the countries runs from the beginning of 1957 to the end of 1998. No black market rate data are available beyond 1998.[7]

The bilateral real exchange rates (RERs) relative to the U.S. dollar are constructed by

$$RER_i = s_i - p_i + p_{us} \qquad (5)$$

where s_i is number of units of country i's currency per U.S. dollar, p_i and p_{us} are consumer price indices (CPI) of country i and the U.S., respectively. The exceptions are Brazil, Korea, and Thailand, whose monthly CPI data were not available for the whole sample period. Therefore, the producer price indices (PPI) of these countries and the U.S. are employed for getting p_i and p_{us} in (5) for these three countries, respectively. All these variables are in the logarithmic form.

[6] See Table 1 for a list of countries.

[7] Due to lack of some observations, the study period for Dominican Republic, El Salvador, Morocco, and Venezuela were restricted to 1960:03 - 1998:12, 1961:1 - 1998:12, 1959:1 - 1998:12, and 1960:11 - 1998:12, respectively.

Both the ADF and KSS tests are applied to the real exchange rates constructed using the black market exchange rates and the official exchange rates, RER_B and RER_O, respectively. Table 1 reports the results.

Table 1 goes here

There are two panels in Table 1. One panel reports the results for RER_B and the other panel for RER_O. In each panel, four statistics are reported. The test statistic of the standard ADF that includes a constant in regression (1) is denoted by t_{ADF1}, and the one that includes both a constant and a time trend in regression (1) is denoted by t_{ADF2}. The non-linear KSS test statistics based on regression (4) are denoted by t_{NL1} for de-meaned data and t_{NL2} for de-trended data. Although a significant statistic is identified by * at the 10% level, by ** at the 5% level, and *** at the 1% level, for ease of exposure we will concentrate on 10% level of significance.

Consider first the results the real official exchange rate, RER_O. Based on the non-linear KSS test results we gather that KSS tests reject the null of non-stationarity which implies support for PPP in 19 countries, at least by one of the two tests (i.e., by t_{NL1} or t_{NL2}). However, the standard linear tests (t_{ADF1} or t_{ADF2}) reject the null only in ten countries. Thus non-linear KSS test support PPP more often than the standard linear ADF test which is in line with previous literature. However, when we shift to the results for real black market rate (RER_B), number of countries for which PPP is validated decreases from 19 to 14 when the KSS tests are considered and from ten to eight when the standard ADF tests are considered. This contradicts the past literature. The fact that standard ADF tests do not provide relatively more support for PPP when the real black market exchange rate is considered, could be due to long span of monthly data used in this study compared to relatively short span of quarterly or mostly annual data in previous studies. However, most importance and significant finding is that when non-linearity is incorporated into

the testing procedure, the non-linear tests provide more support for PPP in the results for real official exchange rate as compared to the real black market rate. This contradictory outcome in the paper compared to previous studies indicates the weakness in previous research that failed to incorporate non-linearity in mean reverting properties of the official rates. Such a finding may reflect the high level of foreign exchange market interventions in LDCs.

Since the study period combines data from the Bretton Woods as well as the post Bretton Woods eras, we thought of engaging in some sensitivity analysis by breaking up the sample period. While the results for the first period (starting from the beginning of the sample period till February 1973) are reported in Table 2, those for the latter period (from March 1973 to December 1998) are reported in Table 3.

Tables 2 and 3 go here

The results in Table 2 reveal that by relying at least on one of the standard ADF tests, PPP is supported in 10 countries when the black market real exchange rate is used in testing PPP. However, the same tests support PPP only in five countries for the official real exchange rate. Thus, using the data of relatively fixed-exchange rates of the Bretton-Woods era, our findings that PPP receives more support when the black market exchange rate is used is in line with previous literature. This would be expected because of more flexibility in the black market exchange rates as compared to fixed official rates during that period. Indeed, during the period, black market exchange rates are said to be good proxies for floating rates. However, when we shift to KSS tests and use at least one of the non-linear tests, there is no significant difference in the number of countries for which PPP is supported. More precisely, PPP is supported in 11 countries when the black market exchange rate is used and in 9 countries when the official rate is used. Thus, it appears that incorporating non-linearity in the adjustment path of official real

exchange rates provide support for PPP in only slightly smaller number of cases ~~as~~ than the black market exchange rates. Non-linearity in the official rates could also arise from structural breaks due to official devaluation, besides frequent official interventions. This argument is further supported when we consider the results for the post Bretton-Woods era during which official exchange rates have enjoyed more flexibility. From Table 3 we gather that at least one of the ADF statistics supports PPP in four countries when RER_B is used and in three countries when RER_O is used. As for the KSS non-linear tests, at least one of the two statistics support PPP in 14 countries in the results for either the black market or official real exchange rate. Thus, regardless of whether we use the real black market exchange rate or the official rate, incorporating non-linear adjustment in adjustment path of either rate provide more evidence in support of PPP.

IV. Summary and conclusion

Testing for stationarity of real exchange rates is one way of testing the well-known theory of ~~the~~ purchasing power parity theory (PPP). A large body of the literature includes studies that have used different unit root testing procedures and have arrived at different conclusions. These studies have relied upon the official exchange rates in testing PPP. There exists another body of the literature on PPP which includes several studies that have used black market exchange rates in testing PPP. A common theme of this body is that since black market exchange rates act as proxies for floating rates, they support PPP more often than the official rates. Like the former group, however, this group has employed unit-root testing procedures that have unit root as their null hypothesis and a linear stationary adjustment as their alternative hypothesis.

Recently Kapetanios *et al.* (2003) introduced a new test which incorporates non-linearity in the mean reverting process of a time-series variable. When this test was applied to real official

exchange rates, it provided support for PPP in majority of countries as compared to the standard linear ADF test. We wonder the finding by the previous research that standard ADF test based on real black market exchange rate supports PPP more often than the one based on real official rate is due to ignoring the possibility of non-linear adjustment in real rates. Non-linearity in adjustment path may arise due to intervention in the official foreign exchange markets which depending on the extent of intervention, it could introduce structural instability.

In this paper we use monthly black market as well as official exchange rates from 25 less developed countries to test PPP. The sample period begins with 1957 and ends at 1998, the last year for which the black market exchange rates are available. We test PPP by using standard linear ADF test as well as Kapetanios *et al.*'s (2003) non-linear ADF test. The results could be summarized by saying that: First, the standard linear ADF test provided support for PPP in almost the same number of countries regardless of whether the real black market or real official exchange rate was used. Such outcome which contradicts previous research could be due to long span of monthly observations used in this paper as compared to relatively short span of quarterly or annual data used by previous studies. Second, when the non-linear ADF test was used, it provided somewhat more support for PPP when official exchange rates were used (19 cases) as compared to the results obtained for the real black market exchange rate (14 cases). Thus, it appears that incorporating non-linearity in the testing procedure which may account for intervention in the official foreign exchange markets reverses the findings by previous research.

Third, since the study period includes observations from pre and post Bretton-Woods era, we tested the theory by using data from each period. The results from the first period (i.e. fixed exchange rate period) upheld the previous research only when the linear ADF test was used. The non-linear ADF test supported PPP in similar number of countries when either black market rate

or official rate was used. The results signify the importance of non-linear adjustment in real official exchange rates which may account for devaluations during the fixed exchange-rate period. Our results support the recent arguments that official interventions in the foreign exchange market may impart non-linearity into the adjustment of the nominal exchange rate and, with sticky prices in the short run, into the adjustment of the real exchange rate as well (Sarno and Taylor, 2001, and Taylor, 2003). However, during the post Bretton-Woods period when official exchange rates are adjustments are dominated by the market forces, they come closer to the black market exchange rates, which imply that PPP should get almost the same support regardless of the exchange rate used. Although the results from the post Bretton-period supported the above conjecture, still the non-linear ADF test provided support for PPP in much more cases than the linear test, regardless of whether the black market or the official rate was used.

In sum, concentrating on the post Bretton-Woods era, due to relatively more flexibility in the nominal exchange rates of less developed countries and due to currency unification in some countries, PPP receives equal support whether we test by using the black market exchange rates or the official rates. However, it is supported more frequently (using either rate) when the non-linear ADF test is employed in the testing procedure as compared to linear ADF test.

References

Baghestani, H. 1997. “Purchasing power parity in the presence of foreign exchange black Market: The case of India.” *Applied Economics*, 29, 1147-54.

Bahmani-Oskooee, M. 1993. “Black market exchange rates versus official exchange rates in testing purchasing power parity: An Examination of Iranian Rial.” *Applied Economics*, 25, 465-72.

Bahmani-Oskooee, Mohsen, 1995. "Real effective exchange rates and the purchasing power parity: Experiences of 19 industrial countries", *Economic Notes*, 24, pp. 239-250.

Bahmani-Oskooee, Mohsen, 1998. “Do exchange rates follow a random walk process in Middle Eastern countries?” *Economics Letters*, 58, pp. 339-344.

Bahmani-Oskooee, Mohsen and Hyun-Jae Rhee, 1992. "Testing for long-run purchasing power parity: An examination of Korean Won," *International Economic Journal*, 6, pp. 93-103.

Bahmani-Oskooee, M. and M. Barry, 1997. “The purchasing power parity and the Russian Ruble”, *Comparative Economic Studies*, 39, pp. 82-94.

Bahmani-Oskooee, M. and G.G. Goswami, 2005. “Black market exchange rates and purchasing power parity in emerging economies”, *Emerging Markets Finance and Trade,* 41, pp. 37-52.

Bahmani-Oskooee, Mohsen, Kutan, Ali and Zhou, Su, 2006. “Testing PPP in the non-linear STAR framework”, *Economics Letters*, forthcoming.

Chortareas, G and Kapetanios, G., 2004. The Yen real exchange rate may be stationary after all: Evidence from non-linear unit-root tests. *Oxford Bulletin of Economics and Statistics,* 66, pp. 113-131.

Corbae, Dean and Sam Ouliaris, 1988. "Cointegration and tests of purchasing power parity," *The Review of Economics and Statistics*, 70, pp. 508-511.

Corbae, Dean and Sam Ouliaris, 1991. “ A test of long run purchasing power parity allowing for structural breaks,” *The Economic Record,* 67, pp. 26-33.

Culbertson, W. P. 1975. “Purchasing power parity and black market exchange rates.” *Economic Inquiry*, 13, pp. 287-96.

Edwards, S. 1989. *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries*, The MIT Press, Cambridge, pp. 87-127.

El-Sakka, M. I. T. and McNabb, R. 1994. “Cointegration and efficiency of the black market for foreign exchange: A PPP test for Egypt.” *Economic Notes*, 23, pp. 473-80.

Kapetanios, G., Shin, Y., Snell, A., 2003. Testing for a unit root in the nonlinear STAR framework, *Journal of Econometrics*, 112, pp. 359-379.

Kim, Yoonbai, 1990. "Purchasing power parity in the long run: A cointegration approach," *Journal of Money, Credit and Banking*, 22, pp. 491-403.

Koedijk, Kees G., Tims, Ben, van Dijk, Mathijs A., 2004. Purchasing power parity and the euro area. *Journal of International Money and Finance* 23, pp. 1081-1107.

Kouretas, G. P. and Zarangas, L. P. 2001. Long-Run purchasing power parity and structural change: The official and parallel foreign exchange markets for dollars in Greece. *International Economic Journal*, 15, pp. 109-28.

Layton, Allan P. and Jonathan P. Stark, 1990. Co-integration as an empirical test of Purchasing Power Parity. *Journal of Macroeconomics*, 12, pp. 125-136.

Liew, Venus Khim-sen , Ahmad Zubaidi, Baharumshah and Terence Tai-leung ,Chong. 2004. Are Asian real exchange rates stationary? *Economic Letters,* 83, pp. 313-316.

Lothian, J. R. and Taylor, M. P. 1996. Real exchange rate behavior: The recent float from the perspective of the past two centuries. *Journal of Political Economy*, 104, pp. 488-510.

Luintel, K. B. 2000. Real exchange rate behavior: Evidence from black markets. *Journal of Applied Econometrics*, 15, pp. 161-185.

McNown, R. and Wallace, M. S., 1989. National price Levels, purchasing power parity and cointegration: A test of four high inflation economies. *Journal of International Money and Finance*, 8, pp. 533-45.

Michael, P., Nobay, A.R., Peel, D.A., 1997. Transaction costs and nonlinear adjustment in real exchange rates: An empirical investigation. *Journal of Political Economy* 105(4), pp. 862–879.

Nagayasu, J. 2000. "Long run real exchange rate movements in Africa: Parallel market and official rates." *African Economic Journal*, 2, pp. 1-14.

Phillip, R. J. 1988. "War news and black market exchange rate deviations from purchasing power parity: Wartime South Vietnam." *Journal of International Economics*, 25, pp. 373-78.

Reinhart, C.M. and K.S. Rogoff, 2004. "The modern history of exchange rate arrangements: A reinterpretation", *Quarterly Journal of Economics,* Vol. CXIX, pp. 1-48.

Rogoff, K. 1996. "The purchasing power parity puzzle." *Journal of Economic Literature*, 34, pp. 647-68.

Sanchez-Fung J. R. 1999. "Efficiency of the black market for foreign exchange and PPP: The case of the Dominican Republic." *Applied Economic Letters*, 6, pp. 173-76.

Sarno, Lucio, 2000. Real exchange rate behavior in the Middle East: A re-examination. *Economics Letters,* 66, pp. 127-36.

Sarno, Lucio, 2005. Viewpoint: Towards a solution to the puzzles in exchange rate economics: where do we stand? *Canadian Journal of Economics* 38(3), pp. 673-708.

Sarno, Lucio and Taylor, M.P., 2001. Official intervention in the foreign exchange market: Is it effective and, if so, how does it work? *Journal of Economic Literature,* 39, pp. 839-68.

Sarno, Lucio, Taylor, Mark P. and Chowdhury, Ibrahim, 2004. Nonlinear dynamics in deviations from the law of one price: a broad-based empirical study. *Journal of International Money and Finance* 23, pp. 1–25.

Taylor, M. P., 1988. An empirical examination of long-run purchasing power parity using cointegration Technique, *Applied Economics,* 20, pp. 1369-81.

Taylor, M.P., Peel, D.A. and Sarno, L., 2001. Nonlinear mean-reversion in real exchange rates: Toward a solution to the purchasing power parity puzzles. *International Economics Review* 42, pp. 1015–1042.

Taylor, M. P., 2003. Purchasing power parity. *Review of International Economics,* 11, pp. 436-52.

Table 1: Unit root test results for the full sample period

		RER_B				RER_O			
Country	Sample period	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}
Argentina	57:01 - 98:12	-2.70*	-7.20***	-2.93	-7.85***	-2.66*	-4.40***	-3.23*	-4.65***
Bolivia	57:01 - 98:12	-3.49***	-6.84***	-3.61**	-6.90***	-2.07	-14.64***	-2.10	-14.62***
Brazil	57:01 - 98:12	-1.34	-2.73*	-1.58	-3.52**	-1.74	-1.63	-2.22	-2.79
Chile	57:01 - 98:12	-2.09	-4.65***	-2.38	-4.34***	-1.05	-8.21***	-2.12	-17.33***
Colombia	57:01 - 98:12	-1.69	-1.67	-2.14	-2.11	-1.52	-1.58	-1.99	-1.79
Costa Rica	57:01 - 98:12	-1.93	-5.11***	-2.57	-5.54***	-1.17	-3.36**	-1.92	-5.33***
Dominican Rep.	60:03 - 98:12	-1.58	-1.44	-2.10	-1.80	-2.32	-4.32***	-3.10	-7.81***
Ecuador	57:01 - 98:12	-1.77	-1.70	-2.11	-1.64	-1.41	-2.14	-2.06	-2.99
Egypt	57:01 - 98:12	-1.83	-3.58***	-2.25	-3.71**	-3.04**	-3.63***	-3.30*	-3.38*
El Salvador	61:01 - 98:12	-0.63	-2.99**	-1.42	-5.10***	-0.75	-1.64	-3.34*	-6.64***
India	57:01 - 98:12	-1.64	-1.45	-2.90	-3.12	-0.05	-1.24	-2.61	-3.88**
Israel	57:01 - 98:12	-2.70*	-3.17**	-2.70	-3.20*	-3.05**	-3.13**	-3.05	-3.68**
Korea	57:01 - 98:12	-3.39**	1.90	-3.59**	-2.21	-3.83***	-3.32**	-4.01***	-3.43**
Malaysia	57:01 - 98:12	-0.36	-3.13**	-1.68	-5.41***	-0.44	-5.46***	-1.82	-9.63***
Mexico	57:01 - 98:12	-3.04**	-4.84***	-3.24*	-5.11***	-3.74***	-4.07***	-3.96***	-4.29***
Morocco	59:01 - 98:12	-1.66	-2.77*	-2.21	-2.62	-2.12	-3.00**	-2.12	-2.53
Pakistan	57:01 - 98:12	-0.97	-0.13	-3.06	-3.04	-0.54	-0.69	-3.28*	-4.67***
Paraguay	57:01 - 98:12	-1.80	-2.49	-2.18	-2.56	-1.14	-0.56	-1.51	-0.77
Peru	57:01 - 98:12	-1.08	-1.97	-1.55	-2.66	-1.41	-2.81*	-2.05	-2.05
Philippines	57:01 - 98:12	-2.20	-5.52***	-2.45	-5.36***	-3.02**	-2.55	-3.27*	-3.59**
South Africa	57:01 - 98:12	-1.82	-3.96***	-2.85	-5.25***	-1.07	-4.24***	-2.16	-4.47***
Sri Lanka	57:01 - 98:12	-2.72*	-2.30	-2.47	-2.20	-0.97	-0.62	-0.79	-1.39
Thailand	57:01 - 98:12	-3.14**	-4.06***	-3.01	-3.81**	-3.97***	-7.93***	-3.92**	-7.73***
Uruguay	57:01 - 98:12	-2.60*	-1.94	-2.83	-2.24	-3.51***	-5.85***	-3.63**	-5.85***
Venezuela	60:11 - 98:12	-1.74	-1.98	-1.64	-2.02	-2.47	-2.40	-2.77	-2.63

Notes: RER_B and RER_O are the real exchange rates constructed using the black market exchange rates and the official exchange rates, respectively. t_{ADF1} and t_{ADF2} are the standard ADF test statistics for the null of nonstationarity of the variable in the study without and with a time trend, respectively, in the model for testing. t_{NL1} and t_{NL2} are the KSS test statistics for the de-meaned and the de-trended data, respectively. The 10%, 5% and 1% asymptotic critical values are -2.57, -2.86 and -3.43 for t_{ADF1} respectively, and are -3.12, -3.41 and -3.96 for t_{ADF2} respectively. Those for t_{NL1} are -2.66, -2.93 and -3.48, respectively, and for t_{NL2} are -3.13, -3.40 and -3.93, respectively, taken from Kapetanios et al. (2003, p. 364). *, ** and *** denote rejection of the null hypothesis at the 10%, 5% and 1% significance levels, respectively.

Table 2: Unit root test results for the Bretton-Woods period

	RER_B				RER_O			
Country	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}
Argentina	-2.93**	-3.44**	-2.27	-2.44	-1.09	1.24	-2.15	-1.29
Bolivia	-0.38	-1.08	-0.58	-1.86	-1.87	-1.64	1.08	-0.38
Brazil	-2.06	-2.93**	-2.23	-3.03	-2.66*	-4.21***	-2.98	-2.91
Chile	0.47	-1.24	-1.15	-1.81	-0.89	-1.75	-1.67	-4.75***
Colombia	-2.51	-2.19	-4.02***	-2.41	-1.49	-1.39	-2.83	-3.49**
Costa Rica	-1.07	-1.58	-4.41***	-3.08	-1.98	-2.03	-2.26	-3.05
Dominican Republic	-2.89**	-3.86***	-2.95	-3.76**	-1.90	-2.22	-1.90	-2.29
Ecuador	-2.33	-2.70*	-2.31	-2.17	-1.55	-0.88	-2.15	-2.71
Egypt	-0.99	-0.80	-2.73	-1.83	-2.26	-1.98	-2.47	-1.79
El Salvador	-1.50	-2.22	-3.20*	-2.81	0.31	0.59	-2.63	-1.78
India	-2.83*	-2.98**	-4.24***	-3.38*	-1.99	-3.50***	-2.59	-3.55**
Israel	-1.83	-2.03	-2.35	-2.30	-1.56	-3.16**	-2.76	-4.38***
Korea	-2.54	-0.99	-2.67	-0.99	-2.32	-1.52	-2.66	-2.29
Malaysia	-2.18	-2.30	-2.66	-2.16	-1.53	-1.51	-2.54	-1.48
Mexico	-1.65	-0.76	-1.80	-2.76	-1.64	-0.72	-1.81	-2.76
Morocco	-3.16**	-2.98**	-3.46**	-3.46**	-3.38**	-2.67*	-3.28*	-2.54
Pakistan	-0.57	-1.61	-1.92	-1.91	-2.02	-1.62	-2.06	-1.66
Paraguay	-2.75	-1.83	-3.21*	-3.18*	-2.77*	-2.41	-2.66	-2.44
Peru	-1.61	-2.99**	-1.43	-2.97	-2.00	-3.27**	-1.63	-2.75
Philippines	-0.83	-0.92	-1.46	-1.80	-1.78	-2.06	-2.59	-2.03
South Africa	-2.42	-3.61***	-2.50	-2.94	-1.89	-1.44	-1.89	-1.60
Sri Lanka	-1.91	-1.69	-2.13	-1.93	-0.18	0.42	-1.85	-2.39
Thailand	-2.16	-2.29	-3.03	-3.27*	-2.83*	-3.42**	-3.32*	-4.04***
Uruguay	-2.73*	-2.76	-2.93	-3.09	-4.03***	-4.08***	-4.01***	-4.69***
Venezuela	-2.56*	-3.20**	-1.65	-2.51	-2.48	-2.44	-2.38	-3.63**

Table 3: Unit root test results for the post-Bretton-Woods period

	RER_B				RER_O			
Country	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}	t_{ADF1}	t_{NL1}	t_{ADF2}	t_{NL2}
Argentina	-2.01	-6.39***	-2.20	-5.98***	-2.48	-4.00***	-2.66	-3.89**
Bolivia	-2.70*	-5.35***	-2.71	-5.22***	-1.23	-10.99***	-2.23	-10.83***
Brazil	-0.81	-2.28	-1.79	-3.83**	-0.78	-2.59	-1.90	-3.69**
Chile	-1.43	-1.68	-1.54	-2.08	-1.31	-1.79	-1.06	-2.02
Colombia	-1.44	-1.55	-1.66	-2.05	-1.51	-1.21	-1.89	-2.08
Costa Rica	-2.19	-4.55***	-2.07	-4.86***	-1.91	-3.61***	-1.67	-4.40***
Dominican Republic	-2.14	-3.04**	-2.12	-3.14*	-2.06	-4.78***	-2.76	-5.79***
Ecuador	-1.49	-1.38	-1.31	-1.91	-1.13	-1.91	-1.68	-2.86
Egypt	-0.82	-1.26	-1.15	-3.38*	-2.44	-2.88*	-2.57	-2.78
El Salvador	-0.82	-3.16**	-2.13	-4.06***	-1.09	-1.90	-4.59***	-6.45***
India	-1.62	-2.05	-3.68**	-2.82	-1.34	-2.21	-2.10	-2.93
Israel	-1.55	-1.63	-2.38	-1.14	-1.94	-1.24	-2.17	-2.30
Korea	-3.03**	-2.21	-3.26*	-2.50	-2.35	-5.69***	-3.05	-6.09***
Malaysia	-0.67	-2.06	-2.44	-5.02***	-0.91	-5.62***	-3.05	-10.14***
Mexico	-2.65*	-4.06***	-2.59	-3.88**	-2.90**	-3.06**	-2.88	-2.97
Morocco	-2.28	-2.95**	-2.30	-2.97	-1.95	-2.43	-2.65	-2.22
Pakistan	-0.41	0.11	-3.01	-3.89**	-0.64	-1.39	-1.88	-1.67
Paraguay	-1.40	-1.99	-1.39	-2.12	-0.73	-0.23	-1.72	-0.63
Peru	-0.86	-1.87	-1.61	-2.18	-1.01	-1.96	-2.33	-2.16
Philippines	-1.63	-5.60***	-1.69	-5.38***	-2.08	-5.09***	-2.56	-4.47***
South Africa	-2.08	-3.50***	-2.26	-3.61**	-1.36	-3.54***	-1.87	-3.22*
Sri Lanka	-2.34	-2.22	-2.30	-2.47	-4.00***	-3.02**	-2.99	-2.89
Thailand	-1.88	-2.67*	-2.32	-3.99***	-1.95	-7.85***	-2.07	-8.41***
Uruguay	-2.13	-2.43	-2.16	-2.24	-1.84	-2.35	-1.92	-2.50
Venezuela	-1.64	-1.87	-1.26	-1.57	-2.05	-1.88	-2.20	-1.67