The Sri Lankan Rupee and Purchasing Power Parity during the Current Floating Period

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This paper examines the empirical validity of purchasing power parity (PPP) hypothesis in a Sri Lankan context using exchange rates for six foreign currencies during the period January 1986 to November 2000. Both graphical and econometric methods are used in the analysis. Graphical analysis indicates that the spot exchange rates for the currencies except for the Indian rupee follow the respective PPP exchange rates closely during certain time periods only and real exchange rates are non-stationary thus violating a necessary condition for the PPP to hold. The results of econometric methods are also consistent with those of the graphical methods. In addition, the symmetry and proportionality hypotheses implied by the PPP were rejected. These results refute the validity of PPP hypothesis to Sri Lanka. While these results have implications for policy makers, they may be corroborated using other econometric techniques such as cointegration and error-correction models and nonlinear models.

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Introduction

The purchasing power parity (PPP) which is the cornerstone of many of the theoretical models in international finance states that nominal exchange rates tend to adjust to those levels where PPP of currencies remains constant over time. It is an important concept for policy makers in a less developed country like Sri Lanka for at least two reasons (Holmes, 2001a). First, PPP can be used as a model to predict exchange rates and determine whether a particular currency is over/undervalued. Predicting exchange rates and determining whether a currency is over/undervalued is particularly important for less developed countries and those experiencing large differences between domestic and foreign inflation rates. Second, many theories of exchange rate determination use some notion of the PPP in their construction. Therefore, the validity of the PPP is of paramount importance to policy makers in developing countries who base their advice on the PPP (Liu and Burkett, 1995). Empirical evidence on PPP is abundant in relation to developed as well as developing economies using different data sets and methodologies ranging from graphical methods to more advanced techniques such as multiple cointegration and error-correction modelling. However, the results of different empirical studies are not consistent providing mixed evidence.

There are two versions of purchasing power parity hypothesis, namely, absolute and relative versions. Absolute version asserts that the spot exchange rate of a particular currency should be equal to the ratio of domestic price level to the foreign price level. Any deviation of the two from each other indicates over/undervaluation of the currency. On the other hand, the relative version of the PPP indicates that the changes in spot exchange rates adjust to the differences in domestic and foreign inflation rates. Therefore, changes in the spot exchange rates

at any time should be equal to the changes in domestic and foreign inflation rates. Any deviation indicates that the local currency is over/undervalued. However, as Moosa and Bhatti (1997) point out, there is no clear-cut distinction between absolute and relative PPP according to Cassel's writings. They further assert that the large number of empirical literature on the relative version of PPP is due to a misinterpretation of Cassel's writings[1].

To the knowledge of the author, there have been four recent empirical studies on the validity of the PPP to Sri Lanka. However, these studies have focussed either on one exchange rate (Aggarwal et al., 2000, Holmes, 2001a and Holmes, 2001b) or nominal and real effective exchange rates (Weliwita, 1998). The objective of this study is to investigate the validity of the PPP to Sri Lanka using graphical and univariate and multivariate econometric techniques. This study differs from previous studies using Sri Lankan data in two respects: (i) it uses bilateral spot exchange rates for six currencies as opposed to one bilateral exchange rate or nominal/real effective exchange rates used in previous studies and (ii) investigates symmetry and proportionality conditions of the PPP relationship which previous studies have not examined.

The remainder of this paper is organized as follows. Previous empirical studies are reviewed in the second section. Methodology and data used are discussed in the third section. The fourth section discusses the empirical results. The fifth section concludes this paper.

[1] Cassel, the Swedish economist, made the PPP an operational theory of exchange rate determination and was the first to test it empirically although the notion of PPP predated him. See, chapter two of Moosa and Bhatti (1997) for a discussion of misinterpretation of Cassel's writings.

Previous Studies

The origins of the concept of the PPP date back to the fifteenth and sixteenth centuries (Officer, 1982). However, the term PPP itself was coined at the beginning of the last century (Cassel, 1918). The empirical literature on the PPP before the latter half of the 1980s was mainly based on ordinary least squares regression method. With the developments of techniques for testing unit roots and cointegration in the latter part of the 1980s, testing methodologies took a new direction. Recently there have been several methodological advances in time series econometrics such as asymmetric unit root tests, smooth transition autoregression and panel unit root and cointegration tests which have been used to test the empirical validity of the PPP. This section reviews some of the recent studies in the area of PPP that employed these different methodologies.

One strand of empirical literature has used different unit root testing procedures to examine whether the real exchange rates of currencies follow random walks[2]. If the real exchange rate of a particular currency does not follow a random walk[3], the deviations from the long-run PPP are temporary. Therefore, PPP is said to hold for such a series of exchange rates. The presence of a unit root in the real exchange rate for a currency on the other hand indicates that deviations from PPP will persist permanently leading to the failure of the PPP in the long-run.

Whitt (1992) used Sims test to examine the validity of the PPP for five currencies using the US as the base country. Results of the Sims test indicated that all real exchange rates follow random walks refuting the validity of PPP for all the

[2] A random walk is a time series which is non-stationary or which does not follow any predictable pattern. The mean and variance of such a time series are not constant over time and the value of the covariance between two time periods depends on the actual time at which the covariance is computed. See, chapter 21 of Gujarati (1995) for a discussion of this concept.

currencies. Similarly Ahking (1997) using Bayesian unit root tests and Cuddington and Liang (2000) using augmented Dickey-Fuller (ADF) tests and Phillip-Perron (PP) tests rejected the random walk hypothesis respectively for monthly and quarterly Canadian real exchange rates and US dollar-sterling real exchange rate. A study by Maeso-Fernandez (1998), however, using real exchange rates of 19 currencies against the US dollar found stationarity in annual data but not in monthly data thus providing support for the PPP.

A large number of empirical studies have been conducted using cointegration methodologies initially developed by Engle and Granger (1987) and extended to the multivariate case by Johansen (1988) and Johansen and Juselius (1990). If the long-run PPP holds, the spot exchange rate for a currency, domestic price level and foreign price level should be cointegrated or there should be a long-run co-movement among these three variables with one or more cointegrating vectors. Moosa (1994) examined the validity of PPP for Japan, the US and France treating the UK as the foreign country. Using annual data, he found that PPP applies to all the three countries in the long-run. He also examined the symmetry, proportionality and exclusiveness in PPP which had not been examined in most of the previous studies. In a similar study using five bi-lateral Canadian dollar exchange rates Kouretas (1997) reported results in favour of PPP when wholesale price index (WPI) was used but not when consumer price index (CPI) was used. However, these results which were based on the Johansen's method were overturned when the multivariate Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was applied.

[3] When a time series is stationary, the value of its mean and variance are constant over time and the value of covariance between two time periods depends only on the distance or lag between two time periods and not on the actual time at which the covariance is calculated (ibid, p.713)

Wu (1996) examined the validity of PPP to Taiwan exchange rates using consumer prices to proxy the price levels. Using Engle and Granger bi-variate cointegration test, he obtained evidence in support of the PPP. However, Weliwita (1998) found evindence against PPP for six Asian countries including Sri Lanka using both Engle and Granger bi-variate cointegration test and Johansen and Juselius multivariate cointegration test. He used effective exchange rates instead of nominal exchange rates for individual currencies.

PPP during the floating exchange rate regime in the 1920s has been the subject matter of a study by Bleaney (1998). He found that nominal exchange rates of high-inflation currencies tended to move in line with PPP while those of low-inflation currencies tended to under-adjust to relative price movements. He pointed out that this behaviour perhaps reflected the influence of historical nominal exchange rates on market expectations or on the market's belief about the rate at which the currency would be fixed on the return to gold.

Salehizadeh and Taylor (1999) examined the validity of the PPP for 27 countries against the US dollar. They found that PPP holds only for 14 countries. Symmetry and proportionality hypothesis implied by PPP were rejected in all but one case. Further, they found that departures from long-run exchange rate values can last for several years and a priori restrictions imposed on the cointegrating vector can lead to a false rejection of the PPP.

The validity of the PPP to industrial countries was examined by Ramirez and Khan (1999). They found that PPP holds for all countries in the long-run but not in the short-run. Error-correction models estimated suggested that deviations of actual exchange rate from its long-run PPP value were corrected in subsequent periods. Further, they found that high frequency monthly data models did a better

job of tracking the turning points of the actual data than the low-frequency quarterly or annual data.

Papell's (1997) study used panel unit root tests to examine the validity of the long-run PPP to 21 industrial countries during the current float using monthly and quarterly data from January 1973 to September 1994. He found that evidence against the unit root hypothesis is stronger for larger panels than smaller panels, for monthly than quarterly data and when the German mark, rather than the United States dollar is used as the base currency. His results as a whole are consistent with the long-run PPP.

Using quarterly data on bilateral real exchange rates in terms of the Japanese yen Aggarwal *et al*. (2000) investigated the validity of the PPP in two groups of countries: Asian and Western. The ADF test and unit root tests under the presence of breaks in the model specification were used in the empirical analysis. They found evidence supporting the PPP when the presence of several structural breaks of the Japanese yen real exchange rates was taken into account. However, they report weaker evidence for the PPP for the real exchange rates of these countries for the US dollar, the German mark and the Australian dollar.

Holmes (2001a) used a larger sample of thirty developing countries to test the relative version of the PPP. He used a new methodology where he examined the stationarity of the largest principal component based on the deviations from relative PPP against the United States. This technique is more powerful than the widely used Engle-Granger and Johansen-Juselius cointegration methodologies. Holmes found overwhelming evidence supporting the PPP in the sample of countries he studied. Further, he reported that, unlike previous studies, the PPP is not confined only to the high-inflation countries.

In another study Holmes (2001b) used panel unit root tests to investigate the validity of the PPP in the same thirty developing countries. In contrast to the results he obtained using the principal component analysis (Holms, 2001a), he found evidence against the PPP for most less developed countries.

Enders and Dibooglu (2001) focussed on the issue of asymmetric adjustment of PPP. They argue that the low power of standard cointegration tests lead to the rejection of the null of no cointegration which affects the results based on real exchange rates. According to them, this can happen due to two reasons. First, any mean reversion in real exchange rates is very gradual and second, the length of the post-Bretton Woods period sample period is relatively short. In view of the foregoing observations, they use threshold cointegration tests to examine the long-run PPP in six countries. They found that cointegration with threshold adjustment holds for a number of European countries on a bilateral basis. Focussing on France and Germany as base countries, they found that the error-correction model has important nonlinear characteristics in that prices and exchange rate have markedly different adjustment patterns for positive gaps from PPP than negative gaps.

Nagayasu (2002) examined the validity of the long-run PPP in 17 African countries using recently developed panel cointegration tests. He used annual data on parallel exchange rates and consumer prices for a 15-year period from 1980 to 1994 and found evidence in favour of the weak-form of the long-run PPP hypothesis in Africa.

Methodology and Data

The empirical validity of PPP in Sri Lanka is examined using graphical and econometric methods. Two graphical methods of analysis are employed. In the

first method, the validity of PPP is examined by plotting the graphs of spot exchange rates and the PPP exchange rates. If the PPP holds, the lines for the spot exchange rates for each currency should overlap with those for the PPP exchange rates. If there is a gap between the above two lines, spot exchange rates are over/under-valued. The PPP exchange rates are calculated using the following formula:

$$\bar{S}_t = S_0\left(\frac{P_t / P_0}{P_t^* / P_0^*}\right) \tag{1}$$

where $\bar{S}_t$ is the PPP exchange rate for period *t*, S_0 is the spot exchange rate in the base period, P_t is the domestic price level in period *t* , P_0 is the domestic price level in the base period, P_t^* is the foreign price level in period *t*, and P_0^* is the foreign price level in the base period.

In the second graphical method, the validity of the PPP is examined by plotting the graphs of real exchange rates for each currency. If the PPP holds real exchange rates should be stationary. This means that although there are short-run deviations of the real exchanges rates from their mean, in the long-run they tend to revert to the mean. Real exchange rates are calculated using equation (4).

Econometric methods used in this paper consist of two methodologies: (i) estimation of the relationship between spot exchange rate and domestic and foreign price levels using a multivariate regression model and (ii) examining the time series properties of the real exchange rates. In the first method, two versions of the PPP equation, namely restricted and unrestricted, are estimated. The restricted version of the PPP is tested using the following equation.

$$s_t = \alpha_1 + \alpha_2 (p_t - p_t^*) + \varepsilon_t \quad (2)$$

where, α_1 and α_2 are respectively the intercept and the coefficient of the ratio of domestic price level to foreign prices level, s_t is the natural logarithm of the amount of Sri Lankan rupees per unit of foreign currency, p_t and p_t^* are respectively the natural logarithms Sri Lankan price level and the price level of foreign country proxied by consumer price index (CPI) or wholesale price index/ producer price index (WPI/PPI), and ε_t is the independently and identically distributed (IID) or white noise error term[4]. If the absolute purchasing parity holds, constant in equation (2) should be zero, and the coefficient of the log difference between domestic price index and foreign price index should be unity. Therefore, the null hypotheses tested are H_0*:* $\alpha_1=0$ and $\alpha_2=1$. These hypotheses are tested using a Wald *F*-test.

The equation (2) posits a weak version of the PPP that imposes restrictions on the coefficients. The strong version or the unrestricted version of the PPP is tested by estimating the following equation.

$$s_t = \alpha_1 + \alpha_2 p_t + \alpha_3 p_t^* + \varepsilon_t \quad (3)$$

According to the PPP hypothesis, an increase (decrease) in the home (foreign) price levels should be accompanied by an equal rise (fall) in the spot exchange rate. This implies that $\alpha_1 = 0$ and $\alpha_2 = -\alpha_3 = 1$ which is the proportionality

[4] An error which has a zero mean, constant variance and is non-autocorrelated is known as a white noise error term.

hypothesis. Symmetry hypothesis implied by the PPP is that $\alpha_2 = -\alpha_3$ These hypotheses are tested using a Wald *F*-test.

One prediction of the PPP theory is that changes in prices are exactly offset by changes in the spot exchange rates. This means that the real exchange rate for a currency does not vary over time when the PPP holds. In line with this prediction, the PPP can also be tested by calculating the autocorrelation coefficients at various lags of the real exchange rate to examine whether it is stationary. If the deviations from the PPP are not permanent and hence the PPP holds, the autocorrelation coefficients at various lags of the real exchange rate should not be significantly different from zero. The real exchange rate is obtained by adjusting the nominal exchange rate for the inflation in domestic and foreign country as follows.

$$r_t = s_t + p_t^* - p_t \tag{4}$$

where, r_t is the natural logarithm of the real exchange rate, p_t and p_t^* are as defined previously. The autocorrelation coefficient of the real exchange rate is calculated using equation (5) below.

$$\rho(k) = \frac{Cov(r_{it}, r_{it-k})}{Var(r_i)} \tag{5}$$

where $\rho(k)$ is the auto-correlation coefficient at lag *k*, $Cov(r_{it}, r_{it-k})$ is the covariance between a real exchange rate at time *t* and *k* lags before and $Var(r_i)$ is variance of a real exchange rate. According to Bartlett (l946) if a time series is purely random, the sample autocorrelation coefficients are approximately normally

distributed with zero mean and variance $1/\sqrt{n}$, where n is the sample size. The hypothesis tested in this study is that the autocorrelation coefficients of successive monthly real exchange rates of the 6 currencies at lag k (k = 1, 2, …36) are zero. The hypothesis of zero autocorrelation is rejected at the one percent and five percent levels of significance if the calculated autocorrelation coefficient exceeds $\pm 2.58 \times 1/\sqrt{n}$ and $\pm 1.96 \times 1/\sqrt{n}$ respectively.

To test the joint hypothesis that all the autocorrelation coefficients up to lag *m* are simultaneously equal to zero, a variant of the Box-Pierce Q-Statistic introduced by Ljung and Box (1978) known as Ljung-Box (LB) Q-statistic is used. The LB Q- statistic is calculated as follows.

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\rho_k^2}{n-k}\right) \tag{6}$$

where *n* is the number of observations, *m* is number of lags, and ρ_k is auto-correlation coefficient at lag *k*. The LB Q-statistic follows the Chi-Square distribution with *m* degrees of freedom. This statistic has been found to be more powerful than the Box-Pierce Q-Statistic when samples are small.

Data used in the study are the average spot exchange rates expressed in terms of the amount of Sri Lankan rupees per unit of German mark (DM), French franc (FF), UK pound (UKP), Indian rupee (IR), Japanese yen (JY) and US dollar (USD) and the consumer and wholesale price indices for Sri Lanka and German, France, Britain, India, Japan and the USA on a monthly basis from January 1986 to November 2000. Monthly exchange rates were obtained from the Central Bank of Sri Lanka while data on consumer and wholesale/producer price indices with

base year 1995 for each country except for producer price index for France were obtained from international financial statistics CD-ROM. The producer price index for France with base year 1995 was obtained from the DX database.

Empirical Results

Graphical Evidence on PPP

Figure 1. Actual and CPI-based PPP exchange rates

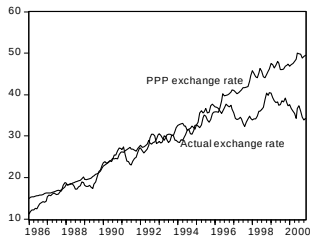

Figure 1a. German mark

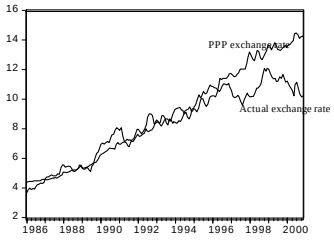

Figure 1b. French franc

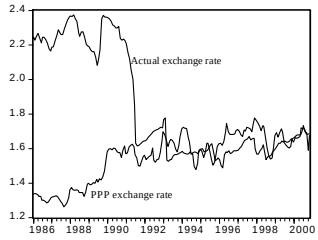

Figure 1c. Indian rupee

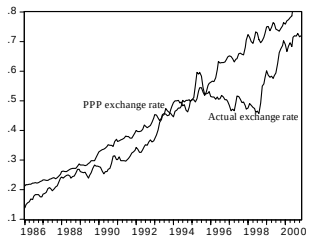

Figure 1d. Japanese yen

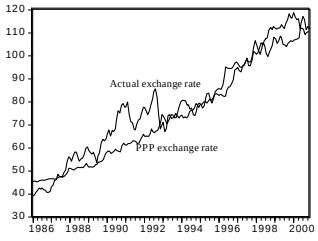

Figure 1e. UK pound

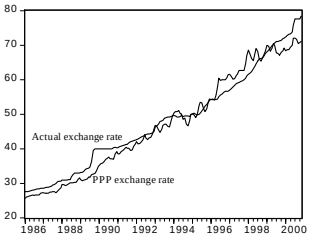

Figure 1f. US dollar

Figure 1 depicts the graphs for the CPI-based PPP exchange rate and the actual exchange rate for each foreign currency. According to the PPP, the spot exchange rate of a particular currency should be equal to the PPP exchange rate. If the line for the actual exchange rate is above or below the line for the PPP exchange rate, the local currency is said to be under- or over-valued and vice versa. According to the graphs, all but in one case (US dollar) the lines for the actual exchange rates move closely with the line for the PPP exchange rate although they do not overlap. However, in some periods they drift apart. This means that the exchange rate of the Sri Lankan rupee does not follow the PPP exchange rates. In relation to the Indian rupee, its actual exchange rate is significantly above the PPP exchange rate till

1991. However, after 1991 the spot and the PPP exchange rates for the Indian rupee move closely.

Figure 2. Actual and WPI-based PPP exchange rates

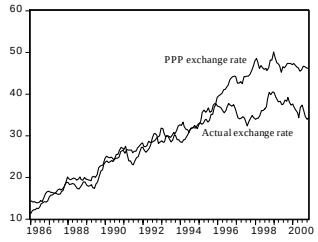

Figure 2a. German mark

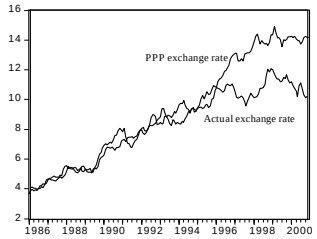

Figure 2b. French franc

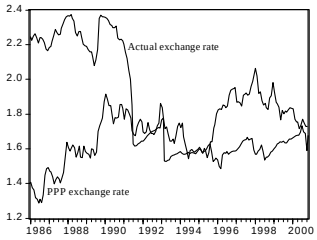

Figure 2c. Indian rupee

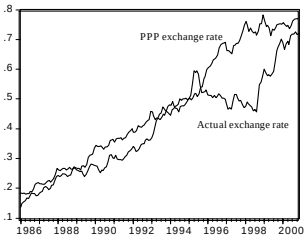

Figure 2d. Japanese yen

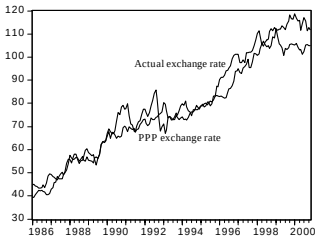

Figure 2e. UK pound

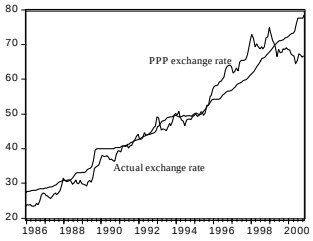

Figure 2f. US dollar

Figure 2 depicts the graphs for actual and PPP exchange rates when the wholesale price index is used to proxy domestic and foreign price levels. As in the case of CPI-based PPP exchange rates, lines for actual exchange rates and those for PPP exchange rates except for the Indian rupee, show upward trends and move close to each other during certain periods of time. The gap between the PPP exchange rate and actual exchange rate is wider for the Indian rupee. These results are consistent with the results obtained when CPI is used to proxy the price levels.

Figure 3. CPI- based real exchange rates

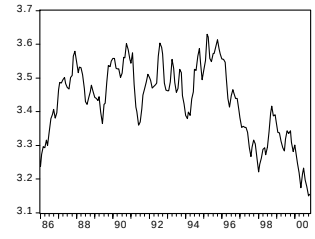

Figure 5a. German mark

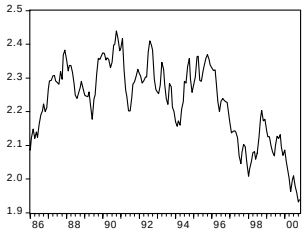

Figure 5b. French franc

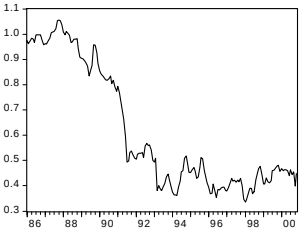

Figure 5c. Indian rupee

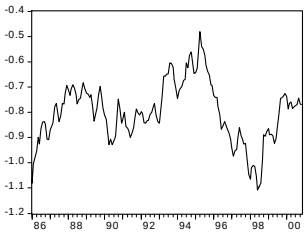

Figure 5d. Japanses yen

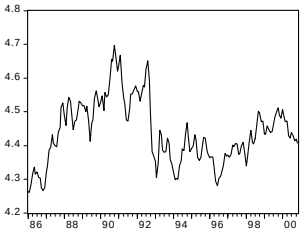

Figure 5e. UK pound

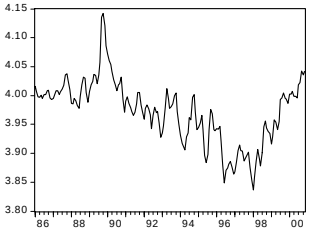

Figure 5f. US dollar

Figure 3 exhibits the graphs of real exchange rates when CPI is used as the proxy for the price levels in the two respective countries. If the PPP holds, the reals exchange rates should be stationary. That means any deviations from the mean of an exchange rate are transitory. However, the graphs for all the real exchange rates indicate that this is not the case.

Figure 4. WPI- based real exchange rates

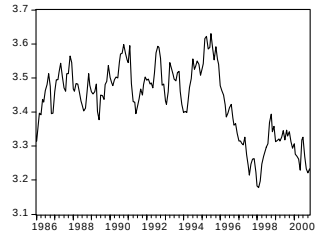

Figure 6a. German mark

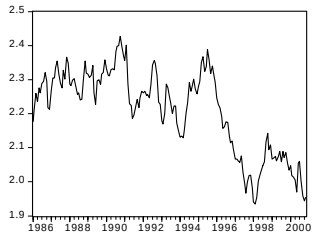

Figure 6b. French franc

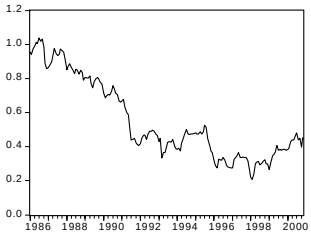

Figure 6c. Indian rupee

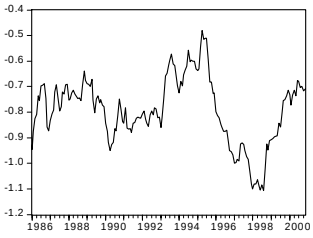

Figure 6d. Japanese yen

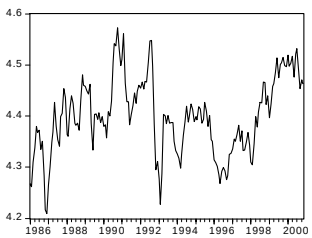

Figure 6e. UK pound

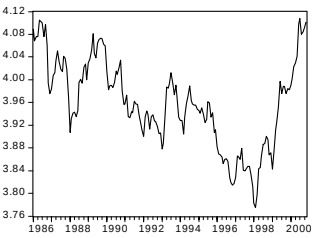

Figure 6f. US dollar

Figure 4 shows the graphs for real exchange rates when the WPI is used to proxy the price levels. In all the cases real exchange rates are not stationary in

levels. In other words, they do not return to their means after temporary deviations from them. Such properties of exchange rates refute the validity of PPP.

Econometric Evidence

Table 1
Estimation results for the restricted version of PPP

Exchange Rate	α_1	α_2	α_1=0, α_2=1	F-Statistic	R^2
Panel A. Based on consumer price index					
DM	3.414[a]	0.876[a]	23841.65[a]	1755.872[a]	0.908
FF	2.203[a]	0.832[a]	11464.57[a]	1896.873[a]	0.915
IR	0.576[a]	-1.314[a]	1520.71[a]	229.195[a]	0.564
JY	-0.806[a]	0.972[a]	1006.39[a]	2012.597[a]	0.919
UKP	4.434[a]	0.948[a]	63107.97[a]	1598.124[a]	0.900
USD	3.958[a]	0.902[a]	218984.10[a]	7814.670[a]	0.978
Panel B. Based on wholesale price index					
DM	3.410[a]	0.852[a]	31528.62[a]	2299.545[a]	0.929
FF	2.178[a]	0.776[a]	15010.50[a]	2537.288[a]	0.935
IR	0.637[a]	-0.811[a]	383.07[a]	60.087[a]	0.253
JY	-0.809[a]	0.913[a]	1143.38[a]	1805.145[a]	0.911
UKP	4.403[a]	1.042[a]	84659.23[a]	2701.940[a]	0.939
USD	3.941[a]	0.859[a]	155445.30[a]	4141.852[a]	0.959

Notes: DM, FF, IR, JY, UKP and USD denote the amount of Sri Lankan rupees per unit of German mark, French franc, Indian rupee, Japanese yen, British pound and the US dollar respectively. The equation estimated was $s_t = \alpha_1 + \alpha_2 (p_t - p_t^*) + \varepsilon_t$ The null hypothesis tested using a Wald-F test was α_1=0, α_2=1. Standard errors of the coefficients of the above equation were estimated using, the Newey-West method as the residuals were autocorrelated and heteroscedastic. a and b imply statistical significance at the 1% and 5% levels, respectively.

Panel A of Table 1 reports the estimation results of equation (2) using consumer price indices as proxies for the domestic and foreign price levels. As per the results, both the intercept and the coefficient of the ratio of the domestic price level to the foreign price level are statistically different from zero at the one percent level. In the fourth column of the table, test results for the null hypothesis that the constant is zero and coefficient of the ratio of the price levels is one are reported. Acceptance of this hypothesis provides statistical evidence in support the PPP. This hypothesis is rejected for all the six currencies during the sample period at the one percent level of significance. Therefore, the applicability of the PPP to Sri Lanka is rejected. This means that the spot exchange rate for each currency is not equal to the ratio of domestic and foreign price levels as posited by the PPP theory. The

Analysis carried out using WPI are reported in Panel B of the table. These results are consistent with those obtained using CPI as a proxy for the respective price levels in the two countries.

Table 2
Estimation results for the unrestricted version of PPP

Exchange Rate	α_1	α_2	α_3	Symmetry H_0: $\alpha_2 = -\alpha_3$	Proportionality H_0: $\alpha_2 = -\alpha_3 = 1$	F-Stat	R^2
Panel A. Based on consumer price index							
DM	1.568	0.763[a]	-0.359	0.228	3.087[b]	880.162[a]	0.909
FF	-17.909[a]	-0.256	4.641[a]	66.198[a]	39.947[a]	2070.657[a]	0.959
IR	1.896[a]	-0.298	0.002	14.944[a]	312.987[a]	219.098[a]	0.713
JY	-8.670[b]	0.750[a]	0.962	3.337[c]	1.864	1073.470[a]	0.924
UKP	-1.634	0.186	1.139[a]	23.870[a]	15.720[a]	1270.693[a]	0.935
USD	-1.002	0.445[a]	0.637[c]	18.439[a]	18.549[a]	4778.128[a]	0.982
Panel B. Based on wholesale price index							
DM	-3.383	0.703[a]	0.780	3.027[c]	6.737[a]	1260.322[a]	0.935
IR	2.696[a]	0.306[b]	-0.789[a]	83.535[a]	452.763[a]	311.013[a]	0.779
JY	2.265	0.880[a]	-1.548[a]	1.480	4.012[b]	909.201[a]	0.912
UKP	4.017[a]	0.998[a]	-0.913[a]	0.214	0.645	1345.432[a]	0.939
USD	0.311	0.684[a]	0.109	5.084[b]	21.164[a]	2368.107[a]	0.964

Notes: DM, FF, IR, JY, UKP and USD denote the amount of Sri Lankan rupees per unit of German mark, French franc, Indian rupee, Japanese yen, British pound and the US dollar, respectively. The equation estimated was $s_t = \alpha_1 + \alpha_2 p_t + p_t^* + \varepsilon_t$. The null hypotheses tested for symmetry and proportionality using a Wald-F test were respectively H_0: $\alpha_2 = -\alpha_3$ and H_0: $\alpha_2 = -\alpha_3 = 1$. Standard errors of the coefficients of the above equation were estimated using, the Newey-West method as the residuals were autocorrelated and heteroscedastic. a and b imply statistical significance at the 1% and 5% levels, respectively.

Table 2 reports the estimation results for equation (3). Panel A of the table shows the results when CPI and WPI respectively are used to measure the price levels in the two countries concerned. Columns two, three and four of the table reports the estimated values of intercept, coefficient of domestic and foreign price levels respectively. When CPI is used, domestic price level is a statistically significant determinant only of the German mark, the Japanese yen and the US dollar. Foreign price level is a statistically significant determinant only of the French franc, the UK pound and the US dollar exchange rates. According to the

results reported in column five, the hypothesis of symmetry of domestic and foreign price levels is rejected for all exchange rates but the German mark. According to column six proportionality hypothesis is overwhelmingly rejected for all but the Japanese yen exchange rate. *F*-statistics shown in column seven show that domestic and foreign price levels have statistically significant impacts on the respective exchange rates. R^2 statistics in column eight indicate that domestic and foreign price levels explain more than 70 percent of the variation in spot exchange rates for the six currencies.

Estimation results based on WPI reported in Panel B of the table show that domestic price level is a statistically significant determinant of all the exchange rates. However, according to the results shown in column four, foreign price level is a statistically significant determinant only of the Indian rupee, the Japanese yen and the UK pound. Column five shows that the hypothesis of symmetry is accepted only for Japanese yen and UK pound. For other exchange rates the hypothesis of symmetry is rejected. The proportionality test results shown in column six indicate that the hypothesis of proportionality is rejected for all but the UK pound exchange rate. These results indicate that the PPP applies only for UK pound exchange rate only. *F*-statistics and R^2 reported in columns six and seven respectively provide consistent results as for CPI based analysis.

Table 3
Autocorrelation test for real exchange rates

Lag	DM	FF	IR	JY	UKP	USD
Panel A: Based on CPI						
1	0.934[a]	0.940[a]	0.987[a]	0.943[a]	0.934[a]	0.942[a]
2	0.846[a]	0.862[a]	0.971[a]	0.867[a]	0.841[a]	0.850[a]
3	0.768[a]	0.796[a]	0.956[a]	0.794[a]	0.763[a]	0.776[a]
4	0.703[a]	0.739[a]	0.941[a]	0.730[a]	0.703[a]	0.746[a]
5	0.659[a]	0.700[a]	0.926[a]	0.687[a]	0.656[a]	0.733[a]
6	0.609[a]	0.657[a]	0.912[a]	0.645[a]	0.614[a]	0.712[a]
7	0.551[a]	0.603[a]	0.897[a]	0.614[a]	0.571[a]	0.660[a]
8	0.508[a]	0.560[a]	0.882[a]	0.590[a]	0.542[a]	0.604[a]
9	0.476[a]	0.527[a]	0.868[a]	0.564[a]	0.521[a]	0.571[a]
10	0.451[a]	0.504[a]	0.856[a]	0.536[a]	0.500[a]	0.582[a]
11	0.419[a]	0.477[a]	0.844[a]	0.500[a]	0.479[a]	0.616[a]
12	0.376[a]	0.439[a]	0.830[a]	0.444[a]	0.450[a]	0.631[a]
24	0.216[a]	0.296[a]	0.627[a]	-0.137[b]	0.121	0.324[a]
36	0.153[b]	0.229[a]	0.368[a]	-0.477[a]	-0.114[b]	0.124
Panel B: Based on WPI						
1	0.936[a]	0.952[a]	0.984[a]	0.954[a]	0.885[a]	0.945[a]
2	0.860[a]	0.896[a]	0.965[a]	0.897[a]	0.742[a]	0.879[a]
3	0.801[a]	0.851[a]	0.944[a]	0.841[a]	0.631[a]	0.819[a]
4	0.753[a]	0.810[a]	0.923[a]	0.779[a]	0.522[a]	0.757[a]
5	0.719[a]	0.780[a]	0.903[a]	0.725[a]	0.430[a]	0.693[a]
6	0.686[a]	0.752[a]	0.884[a]	0.678[a]	0.375[a]	0.640[a]
7	0.651[a]	0.718[a]	0.864[a]	0.648[a]	0.333[a]	0.603[a]
8	0.625[a]	0.689[a]	0.846[a]	0.621[a]	0.316[a]	0.577[a]
9	0.599[a]	0.661[a]	0.828[a]	0.592[a]	0.311[a]	0.551[a]
10	0.568[a]	0.633[a]	0.812[a]	0.559[a]	0.296[a]	0.530[a]
11	0.534[a]	0.604[a]	0.798[a]	0.520[a]	0.271[a]	0.518[a]
12	0.501[a]	0.576[a]	0.786[a]	0.467[a]	0.251[a]	0.507[a]
24	0.261[a]	0.358[a]	0.569[a]	-0.128	-0.075	0.125
36	0.129	0.235[a]	0.342[a]	-0.534[a]	-0.119	0.038

Notes: DM, FF, IR, JY, UKP and USD denote the amount of Sri Lankan rupees per unit of German mark, French franc, Indian rupee, Japanese yen, British pound and the US dollar respectively. The autocorrelation coefficient (ρ) at lag k was estimated using equation (6). a and b imply statistical significance at the 1% and 5% levels, respectively.

Table 3 reports the estimation results of autocorrelation coefficients of the real exchange rates calculated using equation (5). If the PPP holds, the real exchange rates should be mean reverting and there should not be any statistically significant autocorrelation at any lag of the real exchange rates. In other words,

although there may be temporary deviations from the mean of real exchange rates in the short-run, in the long-run real exchange rates should revert to their mean. Autocorrelation test results for all the currencies show that real exchange rates are auto-correlated at almost all the lags. This property of real exchange rates refutes the validity of PPP.

Table 4
Ljung-Box Q-Statistic test for real exchange rates

Lag	DM	FF	IR	JY	UKP	USD
Panel A: Based on CPI						
1	158.7[a]	160.8[a]	177.3[a]	161.8[a]	158.9[a]	161.6[a]
2	289.6[a]	296.9[a]	350.0[a]	299.4[a]	288.3[a]	294.0[a]
3	398.3[a]	413.5[a]	518.2[a]	415.4[a]	395.5[a]	404.9[a]
4	489.8[a]	514.5[a]	682.0[a]	514.1[a]	487.1[a]	507.9[a]
5	570.6[a]	605.9[a]	841.7[a]	601.9[a]	567.2[a]	607.9[a]
6	640.0[a]	686.7[a]	997.5[a]	679.9[a]	637.8[a]	702.7[a]
7	697.2[a]	755.2[a]	1148.9[a]	750.9[a]	699.2[a]	784.8[a]
8	746.1[a]	814.5[a]	1296.2[a]	816.9[a]	754.8[a]	854.0[a]
9	789.2[a]	867.5[a]	1439.9[a]	877.5[a]	806.6[a]	916.2[a]
10	828.1[a]	916.1[a]	1580.2[a]	932.5[a]	854.5[a]	981.0[a]
11	862.0[a]	960.0[a]	1717.5[a]	980.7[a]	898.8[a]	1054.2[a]
12	889.4[a]	997.4[a]	1851.2[a]	1018.9[a]	938.1[a]	1131.4[a]
24	1005.0[a]	1211.9[a]	3128.9[a]	1102.4[a]	1114.7[a]	1583.8[a]
36	1140.8[a]	1455.5[a]	3766.6[a]	1468.3[a]	1123.4[a]	1686.5[a]
Panel B: Based on WPI						
1	159.6[a]	165.0[a]	176.1[a]	165.7[a]	142.6[a]	162.4[a]
2	294.9[a]	312.0[a]	346.4[a]	313.0[a]	243.4[a]	303.9[a]
3	412.9[a]	445.3[a]	510.5[a]	443.1[a]	316.6[a]	427.5[a]
4	517.9[a]	566.9[a]	668.3[a]	555.3[a]	366.9[a]	533.5[a]
5	614.1[a]	680.2[a]	820.0[a]	653.2[a]	401.3[a]	622.8[a]
6	702.3[a]	786.1[a]	966.4[a]	739.3[a]	427.7[a]	699.6[a]
7	782.1[a]	883.2[a]	1107.0[a]	818.4[a]	448.6[a]	768.0[a]
8	856.0[a]	973.0[a]	1242.8[a]	891.5[a]	467.5[a]	831.1[a]
9	924.3[a]	1056.4[a]	1373.5[a]	958.3[a]	485.9[a]	888.9[a]
10	986.3[a]	1133.2[a]	1499.9[a]	1018.2[a]	502.8[a]	942.7[a]
11	1041.3[a]	1203.5[a]	1622.9[a]	1070.2[a]	516.9[a]	994.5[a]
12	1090.0[a]	1267.9[a]	1742.6[a]	1112.5[a]	529.1[a]	1044.4[a]
24	1365.1[a]	1726.8[a]	2845.3[a]	1213.1[a]	566.9[a]	1241.0[a]
36	1476.9[a]	1975.9[a]	3368.2[a]	1645.6[a]	624.9[a]	1248.1[a]

Notes: DM, FF, IR, JY, UKP and USD denote the amount of Sri Lankan rupees per unit of German mark, French franc, Indian rupee, Japanese yen, British pound and US dollar respectively. The Ljung-Box Q-Statistic at lag *k* was estimated using equation (7). a and b imply statistical significance at the 1% and 5% levels, respectively.

LB-Q statistics that are used to test the joint statistical significance of autocorrelation coefficients up to a particular lag are reported in Table 4. Panel A and B report the *LB-Q* statistics for CPI-based and WPI-based real exchange rates respectively. Results show that *LB-Q* statistics at all the lags are statistically significant at the one percent level. Therefore, these results provide evidence that the absolute version of the PPP does not hold for Sri Lanka.

Summary and Conclusions

This paper examines the empirical validity of PPP in Sri Lanka using exchange rates for six foreign currencies and two proxies for price levels, namely CPI and WPI. Two methodologies are used in the analysis. These methodologies include graphical analysis and econometric analyses. In the graphical methods, the validity of PPP is tested by examining whether actual and PPP exchange rates follow each other and whether the real exchange rate for each currency is stationary. The econometric methods include estimation of ordinary least squares regression where standard errors are estimated using Newey-West heteroskedasticity and autocorrelation consistent method, autocorrelation test and *LB-Q* statistics.

Graphical evidence for the PPP shows that none of the spot exchange rates has a one-to-one relationship with the exchange rates predicted by PPP theory although in some time periods they were equal to one another. Therefore, these results provide evidence against the validity of both the PPP to Sri Lanka.

In the next stage of analysis, ordinary least squares regression methodology was used to test the PPP. Two ordinary least squares equations, restricted and unrestricted, are used in the analysis. Results obtained using the restricted equation for the PPP show that spot exchange rates for the six currencies do not have a one

to one relationship with the ratio of domestic to foreign price level refuting the validity of PPP.

In order to test the symmetry and proportionality conditions, that should be satisfied to hold the PPP an unrestricted version of the PPP relationship was estimated using ordinary least squares and symmetry and proportionality restrictions were tested. Analysis based on consumer prices provided results against these two restrictions. Analysis undertaken using wholesale price indices confirmed the validity of PPP only for the UK pound providing evidence against the validity of PPP to Sri Lanka.

In the last stage of analysis, real exchange rates based on both consumer and wholes prices were examined to determine whether they are mean reverting or stationary. If the PPP holds there can be only temporary deviations from the means of real exchange rates. However, the autocorrelation test results and *LB-Q* statistic test results for both consumer price based and wholesale price based real exchange rates rejected the hypothesis of mean reversion thus providing evidence against the validity of PPP to Sri Lanka.

Overall the PPP test results in this paper refute the validity of PPP to Sri Lanka during the recent floating exchange rate regime. Future researchers can corroborate the findings of this paper using other econometric techniques. In addition, they can examine the impact of transition from a managed float to a free float in 2000 on the PPP in Sri Lanka.

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