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Purchasing power parity in Sri Lanka during the recent float: some empirical evidence

Abstract

This paper investigates the purchasing power parity (PPP) hypothesis in Sri Lanka using exchange rates for six currencies during the recent float. Both univariate (Enders and Granger and Ng and Perron unit root tests) and multivariate (asymmetric cointegration and error-correction models) techniques are used in the empirical analysis. Enders and Granger unit root tests strongly support the PPP hypothesis for both CPI and WPI-based UK pound real exchange rates and weakly support the PPP hypothesis for French franc real exchange rates. While results for the German mark are mixed, the real exchange rates for the Japanese yen, the US dollar and the Indian rupee provide no support for the PPP hypothesis. Ng-Perron tests provide strong support for the PPP hypothesis only for the UK pound for WPI-based real exchange rates. In the multivariate analysis, a PPP relationship is found only for the French franc and the UK pound exchange rates. These results are consistent with univariate test results. It is also found that these two exchange rates have different adjustment patterns for positive and negative gaps from the long-run PPP. However, the adjustments of the domestic and foreign price levels to positive and negative gaps from the long-run PPP are not statistically significant.

Keywords: purchasing power parity, Sri Lanka, real exchange rates, mean-reversion, asymmetric unit root tests, Japanese yen.
JEL Classification: F30, F31, G15.

Introduction

The purchasing power parity (PPP) hypothesis can be regarded as the cornerstone of many of the theoretical models in international finance that attracted considerable attention during the last two decades. According to the PPP hypothesis, the price of a commodity, when expressed in a common currency, say US dollar, should be the same in every country. The PPP hypothesis is important to policy makers in developing countries for two reasons (Holmes, 2001a). First, it can be used to predict exchange rates to determine whether a currency is over or undervalued. Determining whether a currency is over or undervalued is particularly important for less developed countries as well as for those experiencing large differences between domestic and foreign inflation rates. Second, the notion of PPP is used as the foundation on which many theories of exchange rate determination are built. Consequently, the validity of PPP is important to those policy makers in developing countries who base their judgments on the PPP (Liu and Burkett, 1995). There has been a plethora of empirical studies on PPP in relation to developed as well as developing economies. These studies use different data sets and different methodological tools providing mixed evidence.

The origins of the concepts of 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 PPP before the latter half of the 1980s was mainly based on ordinary least squares regression. With the development of unit root and cointegration techniques in the 1980s, testing methodologies have taken 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.

Previous studies on the PPP of Sri Lanka have focused only on the PPP between Sri Lanka and one other foreign country such as the US or Japan (Aggarwal et al., 2000; Holmes, 2001a and 2001b) and between Sri Lanka and a group of her trading partners (Weliwita, 1998) using nominal and real effective exchange rates. Methodologies used in these studies include symmetric unit root and cointegration tests, panel unit roots and principal component analysis. These studies have provided mixed results.

The objective of this study is to examine the empirical validity of PPP to Sri Lanka using both recent univariate and multivariate econometric techniques. The next section explains these econometric techniques in detail. In contrast to previous empirical studies using Sri Lankan data, this study examines whether PPP exists between Sri Lanka and countries such as France, Germany, the United Kingdom, the United States, Japan and India on a bilateral basis. These currencies for the above countries were selected as they are the major currencies traded in the foreign exchange market of Sri Lanka. Furthermore, they are the only currencies that are available in major sources of published data in Sri Lanka.

The paper is organized as follows: Section one discusses the methodology and data followed by a discussion of empirical results in the second section. The last section concludes the paper.

1. Methodology and data

Different econometric methodologies have been used to test the empirical validity of PPP. This paper uses both univariate and multivariate approaches. The univariate approach consists of recent unit root test procedures developed by Enders and Granger (1998) and Ng and Perron (2001). These techniques remedy certain weaknesses of the widely-used Dickey-Fuller type unit root tests. Univariate techniques are used to examine whether the real exchange rates are stationary which is a condition for the PPP to hold. Before applying univariate tests, the real exchange rates for each foreign currency are calculated using the following formula:

$$r_t = e_t + p_t^* - p_t \,, \tag{1}$$

where r_t is the natural logarithm of the real exchange rate, e_t is the natural logarithm of the spot exchange rate expressed as the amount of Sri Lankan rupees per unit of foreign currency (direct quotation), p_t and p_t^* are, respectively, the natural logarithms of domestic and foreign price levels. Both consumer price index (CPI) and wholesale price index (WPI) are used to represent the domestic and foreign price levels.

Standard time series tests such as that of Dickey and Fuller (DF) assume linearity and symmetric adjustment. In such models the null hypothesis of a unit root is tested against the alternative hypothesis of a symmetric adjustment of the variable of interest. However, recent studies have found that important economic and financial variables display asymmetric adjustment paths (see, for example, Nefti, 1984; Falk, 1986). Therefore, there is a possibility that well-known DF type unit root tests reject the null hypotheses of integration due to the tests being run against misspecified alternative hypotheses. To overcome this problem, Enders and Granger (1998) have generalized the DF test to allow for asymmetric adjustment processes of the variables. The two major alternative models proposed by Enders and Granger to deal with asymmetric adjustment paths of variables are known as the threshold autoregressive (TAR)[1] model and the momentum threshold autoregressive (MTAR) model depending on whether we use the lagged levels or the lagged differences of the variables of interest in defining the heaviside indicator functions.

The adjustment process of a variable, y_t, can be formally quantified as:

$$\Delta y_t = I_t \rho_1 y_{t-1} + (1-t)\rho_2 y_{t-1} + \varepsilon_t \,, \tag{2}$$

where I_t is the heaviside indicator function which can take one of the following four forms:

$$I_t = \begin{cases} 1 \text{ if } y_{t-1} \geq 0 \\ 0 \text{ if } y_{t-1} < 0 \end{cases}, \tag{3}$$

$$\text{or } I_t = \begin{cases} 1 \text{ if } y_{t-1} \geq a_0 \\ 0 \text{ if } y_{t-1} < a_0 \end{cases}, \tag{4}$$

$$\text{or } I_t = \begin{cases} 1 \text{ if } y_{t-1} \geq a_0 + a_1(t-1) \\ 0 \text{ if } y_{t-1} < a_0 + a_1(t-1) \end{cases}, \tag{5}$$

$$\text{or } I_t = \begin{cases} 1 \text{ if } \Delta y_{t-1} \geq 0 \\ 0 \text{ if } \Delta y_{t-1} < 0 \end{cases}. \tag{6}$$

The models which use the indicator functions of (3), (4) and (5) are known as TAR models. When equation (4) is used to set the heaviside indicator function, it is assumed that the long-run equilibrium occurs at point $y_t = a_0$, provided $-2 < (\rho_1, \rho_2) < 0$. In this case, if $\rho_1 = \rho_2 = 0$, the series is a pure random walk. When the heaviside indicator function is set according to equation (5) and if $-2 < (\rho_1, \rho_2) < 0$, then the trend line $y_t = a_0 + a_1 t$ is an attractor such that the (y_t) time series is trend stationary. When y_{t-1} is above the trend line, the time series tends to decay at the rate of ρ_1 and when it is below y_{t-1}, the time series tends to decay at the rate of ρ_2. If either ρ_1 or ρ_2 lies outside the interval (-2,0), the sequence may not be trend stationary.

If the heaviside indicator function in equation (3) is used, it is assumed that $y_t = 0$ is the long-run equilibrium value of the time series. Therefore, if $y_{t-1} > y_t$, the adjustment is $\rho_1 y_{t-1}$, and if $y_{t-1} < y_t$, the adjustment is $\rho_2 y_{t-1}$. The TAR model can capture aspects of the "deepness" nature of asymmetric movements in a time series. The models using the heaviside indicator functions in equation (6) are known as MTAR models. Replacing the heaviside indicator function (3) by the heaviside indicator function (6) is useful when adjustment is asymmetric such that the series exhibits more momentum in one direction than the other (Enders and Granger, 1998). The MTAR model allows a variable to display differing amounts of autoregressive decay depending on whether it is increasing or decreasing. It captures the possibility of the "steepness" nature of asymmetric movements in a time series.

Ng and Perron (2001) constructed four unit root test statistics that are calculated using generalized least squares (GLS) de-trended data for a variable. Com-

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[1] Threshold autoregressive model was initially developed by Tong (1993) and was formalized for unit root tests by Enders and Granger (1998).

pared to the widely-used Dickey-Fuller (DF) and Phillips-Perron (PP) unit root tests, these have better power and size properties. The first unit root test statistic developed by Ng and Perron calculates the Elliot, Rothenberg, and Stock (ERS) point optimal statistic for GLS de-trended data as follows:

$$MP_T^d = \begin{cases} (\bar{c}_k^2 - \bar{c}T^{-1}(y_T^d)^2)/f_0 & if\ x_t = \{1\} \\ (\bar{c}_k^2 + (1-\bar{c})T^{-1}(y_T^d)^2)/f_0 & if\ x_t = \{1,t\} \end{cases}, \quad (7)$$

where $k = \sum_{t=2}^{T}(y_{t-1}^d)^2 / T^2$,

$\bar{c} = \begin{cases} -7 & if\ x_t = \{1\} \\ -13.5 & if\ x_t = \{1,t\} \end{cases}$, f_0 is the zero frequency spectrum term, and y_T^d is the generalized least squares (GLS) de-trended value of the variable.

The other three statistics, MZ_α^d, MZ_t^d and MSB^d, are the enhancements of the Phillips-Perron (PP) test statistics which correct for size distortions when residuals are negatively correlated. These test statistics are calculated using the following equations:

$$MZ_\alpha^d = (T^{-1}(y_T^d)^2 - f_0)/2k, \quad (8)$$

$$MZ_t^d = MZ_\alpha \times MSB, \quad (9)$$

$$MSB^d = (k / f_0)^{1/2}, \quad (10)$$

All four test statistics above are based on a specification for x_t and a method for estimating f_0, the zero frequency spectrum term. The specification for x_t can take one of two forms. That is, a constant or a constant and a linear trend. The consistent estimate of the residual spectrum at frequency zero is obtained on the basis of autoregressive (AR) spectral regression (GLS-detrended).

For comparison, an analysis is also carried out using widely-used Augmented Dickey-Fuller test. A discussion of this test is not undertaken as it is well-known.

The multivariate approach used in this paper consists of two steps. First, a purchasing power parity equation is estimated for each exchange rate using equation (11) below.

$$e_t = \beta_0 + \beta_1 p_t + \beta_2 p_t^* + \mu_t, \quad (11)$$

where β_0, β_1 and β_2 are the coefficients to be estimated and μ_t is a white-noise error term. The other symbols are as defined previously. After estimating equation (11), the TAR and MTAR tests outlined previously are used to examine whether the residuals of the PPP equations are stationary which is a necessary condition to be met for there to be a long-run or a cointegrating relationship (Engle and Granger, 1987). To make inferences about the cointegrating relationships, the critical values tabulated in Enders and Siklos (2001) are used. According to Engle and Granger (1987), if there is a cointegrating relationship among the variables, it is justified to estimate the error-correction models depicted by equations (12)-(14).

$$\Delta e_t = A_{11}(L)\Delta p_{t-1} + A_{12}(L)\Delta p_{t-1}^* + A_{13}(L)e_{t-1} + \alpha_{11} z-plus_{t-1} + \alpha_{12} z-min\ us_{t-1} + \omega_{1t}, \quad (12)$$

$$\Delta p_t^* = A_{21}(L)\Delta p_{t-1} + A_{22}(L)\Delta p_{t-1}^* + A_{23}(L)e_{t-1} + \alpha_{21} z-plus_{t-1} + \alpha_{22} z-min\ us_{t-1} + \omega_{2t}, \quad (13)$$

$$\Delta p_t = A_{31}(L)\Delta p_{t-1} + A_{32}(L)\Delta p_{t-1}^* A_{33}(L)e_{t-1} + \alpha_{31} z-plus_{t-1} + \alpha_{32} z-min\ us_{t-1} + \omega_{3t}, \quad (14)$$

where $z-plus_{t-1}$ and $z-min\ us_{t-1}$ are, respectively, the positive and negative values of the residuals from the cointegrating equation (equation (11)) and $A_{ij}(L)$ is a polynomial in the lag operator L. Initially, the error-correction models are estimated with an arbitrarily chosen number of lags of seven. Then, insignificant lags are deleted provided this improves the AIC value for the respective model, and a final error-correction model is estimated. The positive and negative error-correction terms are retained in an error-correction model irrespective of whether they are significant or not. Error-correction terms provide useful information regarding the adjustment of the dependent variable in each error-correction model to positive and negative gaps from the long-run PPP relationship. Unlike previous studies using data from developing countries, the purpose of dichotomizing the error-correction term into positive and negative components in this study is to examine whether there are asymmetries in the response of the dependent variable in each error-correction model to positive and negative gaps from the long-run PPP relationship. Enders and Dibooglu (2001) who studied the long-run PPP relationship with asymmetric adjustment in a number of European countries also found evidence that the error-correction model has important nonlinear characteristics. They found that domestic and foreign prices and exchange rates have markedly different adjustment patterns for positive gaps from PPP than negative gaps.

Data used in the study are the average exchange rates expressed in terms of the amount of Sri Lankan rupees per unit of German mark (GM), French franc (FF), British pound (UKP), Indian rupee (IR), Japanese yen (JY) and US dollar (USD) and consumer and wholesale/producer price indices for Sri Lanka, Germany, France, the UK, 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 the producer price index for France, were obtained from the International Financial Statistics *CD-ROM*. The producer price index for France with base year 1995 was obtained from the *DX* database.

2. Empirical results

Table 1 shows the Enders and Granger asymmetric unit root test results for the real exchange rates. The results for the CPI-based real exchange rate are shown in Panel A of the table. The results of the TAR unit root tests are shown in column two. They show that real exchange rates for the French franc and the UK pound reject the null hypothesis of a unit root at the ten per cent and five per cent levels of significance, respectively indicating that these real exchange rates are stationary. Therefore, the PPP hypothesis holds for these two exchange rates[1]. However, as per the results reported in column four, there is no asymmetry in the adjustment of variables to lagged positive and negative changes.

Table 1. Asymmetric unit root test results for the real exchange rates

Exchange rate	Unit root test statistics		Test for symmetry (p-value)	
Panel A: CPI-based real exchange rates				
	TAR	MTAR	TAR	MTAR
GM	5.148 (T)	5.248 T)^c	0.208	0.397
FF	5.177 (T)^c	5.253 T)^c	0.612	0.527
IR	1.110 (T)	0.893 (T)	0.513	0.972
JY	2.314 (μ)	2.270 (μ)	0.766	0.956
UKP	5.492 (μ)^b	6.782 μ)^b	0.760	0.114
USD	1.886 (T)	1.430 (T)	0.335	0.844
Panel B: WPI-based real exchange rates				
	TAR	MTAR	TAR	MTAR
GM	5.860(T)^c	5.662 (T)	0.512	0.804
FF	5.843 T)^c	5.611 (T)	0.505	0.919
IR	1.233 (T)	0.991 (T)	0.490	0.986
JY	2.875 (T)	2.840 (T)	0.728	0.817
UKP	7.735 (T)^a	8.486 T)^b	0.898	0.239
USD	2.227 (T)	1.435 (T)	0.209	0.856

Notes: 1. GM, FF, IR, JY, UKP and USD denote German mark, French franc, Indian rupee, Japanese yen, the UK pound and the US dollar, respectively. 2. a, b and c imply statistical significance at the one, five and ten per cent levels, respectively. 3. Lag lengths in the TAR and MTAR equations were selected using the AIC.

The MTAR test results for the same real exchange rates are shown in column three. The results show that the null hypothesis of a unit root in real exchange rates for the French franc and German mark is rejected at the ten per cent level. However, the test results for the UK pound real exchange rates show that the same hypothesis is rejected at the five per cent level. These results indicate that real exchange rates for the French franc, German mark and UK pound are stationary providing evidence in support of PPP. However, as per column five, none of the real exchange rates responds asymmetrically to their past positive or negative changes.

Asymmetric unit root test results for the WPI-based real exchange rates are shown in Panel B of the table. As per the results reported in column two of the table for the TAR unit root test, the null hypothesis of a unit root is rejected for the German mark and French franc real exchange rates at the ten per cent level and that for the UK pound real exchange rate is rejected at the one per cent level. These results indicate that real exchange rates for the German mark, French franc and UK pound are stationary providing support in favor of PPP. However, as per the results shown in column four, none of the real exchange rates shows any asymmetry in its adjustment towards past changes.

[1] A preliminary analysis performed by examining the time series plots of the CPI and WPI-based real exchange rates indicates that none of the real exchange rates is mean-reverting. Such results are inconsistent with the PPP hypothesis.

The MTAR unit root test results for the WPI-based real exchange rates are shown in column three of Panel B. In this case, however, only the UK pound real exchange rate is stationary. This result indicates that PPP holds only in relation to the UK pound real exchange rate. Consistent with previous results for asymmetry, column five of Panel B shows that none of the real exchange rates rejects the null hypothesis of symmetry of the current real exchange rates to their positive and negative changes.

Table 2. Ng-Perron unit root test results for the real exchange rates

Exchange rate	Unit root test statistic							
	MZ_{α}^{d}		MZ_{t}^{d}		MSB^{d}		MP_{t}^{d}	
	CPI	WPI	CPI	WPI	CPI	WPI	CPI	WPI
Panel A: When the deterministic component is a constant								
GM	-1.959	-4.659	-0.942	-1.483	0.481	0.319	11.984	5.353
FF	-3.069	-4.382	-1.137	-1.252	0.370	0.292	7.822	6.053
IR	0.039	-0.165	0.033	-0.137	0.848	0.831	42.599	39.212
JY	-2.631	-5.435	-1.052	-1.560	0.400	0.287	8.939	4.765
UKP	-3.606	-6.255[c]	-1.308	-1.657[c]	0.363	0.265[c]	6.803	4.289[c]
USD	-2.605	-2.762	-1.112	-1.165	0.427	0.422	9.283	8.836
Panel B: When the deterministic component is a constant and a linear time trend								
GM	-2.367	-6.028	-0.942	-1.639	0.481	0.272	11.984	15.040
FF	-4.042	-9.326	-1.137	-2.072	0.370	0.222	7.822	10.138
IR	-5.414	-6.509	0.033	-1.581	0.848	0.243	42.599	14.097
JY	-8.297	-7.895	-1.052	-1.982	0.400	0.251	8.939	11.557
UKP	-7.064	-19.880[b]	-1.308	-3.153[b]	0.363	0.159[b]	6.803	4.584[b]
USD	-10.466	-7.836	-1.112	-1.664	0.427	0.212	9.283	12.447

Notes: 1. See notes for Table 1 for the definitions of variables. Lag lengths were selected using spectral GLS-detrended AR based on Akaike Information Criterion (AIC). The asymptotic critical values tabulated in Ng and Perron (2001, Table 1) are used. 2. b and c imply statistical significance at the one and five per cent levels, respectively.

Table 2 reports the Ng-Perron unit root test statistics for the bilateral real exchange rates for the six currencies. Panel A of the table shows the value of the test statistics when a constant is regarded as the deterministic component. According to the test statistics in Panel A, only WPI-based UK pound real exchange rates are mean-reverting providing support for the PPP hypothesis. All the other real exchange rates are not mean-reverting or non-stationary. These results are inconsistent with the PPP hypothesis.

Panel B reports the results for the four unit root tests when a constant and a linear trend are used as deterministic components. Interestingly, the results indicate that the UK pound real exchange rate is stationary under all four tests again. These results provide support for PPP hypothesis.

Table 3. ADF unit root test results for real exchange rates

Exchange rate	ADF-statistic	
Panel A: CPI-based real exchange rates		
	Constant	Constant and linear time trend
GM	-1.755 (2)	-2.800 (2)
FF	-1.225 (5)	-2.956 (5)
IR	-1.339 (1)	-1.309 (1)
JY	-2.518 (11)	-2.582 (11)
UKP	-2.771 (2)[b]	-2.905 (2)
USD	-1.126 (11)	-0.460 (11)
Panel B: WPI-based real exchange rates		
GM	-1.711 (2)	-3.357 (1)
FF	-1.110 (2)	-3.345 (1)[c]
IR	-1.676 (1)	-1.360 (1)
JY	-2.303 (1)	-2.364 (1)
UKP	-3.915 (1)[a]	-3.927 (1)[a]
USD	-2.062 (1)	-1.256 (1)

Notes: 1. a, b, and c imply statistical significance at the one, five and ten per cent levels, respectively. 2. Figures given with the ADF test statistics are the number of lags of the dependent variable included in the ADF test equation to obtain white-noise residuals. 3. These lags were selected using Akaike Information Criterion. The ADF test equation estimated is $\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 t + \varepsilon_t$. In this equation, y_t is the variable whose time series properties are examined, Δ is a difference operator, t is the linear time trend, and ε_t is a white-noise error term. 4. The null hypothesis that variable y_t contains a unit root is $\beta_1 = 0$. The ADF test equation is estimated both with a constant (β_0) and constant and linear time trend.

To compare the results of the recent unit root tests used in this paper, the results from the widely-used ADF test are reported in Table 3. Panel A of the table reports results for the CPI-based real exchange rates. The results indicate that the UK pound real exchange rate is stationary only when a constant is included in the ADF test equation.

Panel B of Table 3 reports the results for WPI-based real exchange rates. According to the results, the UK pound real exchange rate is stationary when both a constant and a linear time trend are included in the ADF test equation. The French franc real exchange rate provides support for PPP only when the linear time trend is included in the ADF test equation. Overall, these results are more or less consistent with those obtained using recent unit root tests. That is, the UK pound real exchange rate provides strong support for the PPP hypothesis. The reason for the consistency of results between new and old unit root tests may be due to the absence of asymmetry in the adjustments of the real exchange rates (Enders and Granger, 1998).

Table 4. Asymmetric cointegration test results

Exchange rate	Unit root test statistics		Test for symmetry (p-value)	
Panel A: CPI-based real exchange rates				
	TAR	MTAR	TAR	MTAR
GM	4.655	4.715	0.558	0.460
FF	7.057[c]	7.322[c]	0.986	0.485
IR	2.462	2.677	0.374	0.272
JY	2.736	2.747	0.499	0.489
UKP	5.604	5.640	0.808	0.723
USD	1.377	1.221	0.578	0.950
Panel B: WPI-based real exchange rates				
	TAR	MTAR	TAR	MTAR
GM	5.878	6.043	0.763	0.527
FF	5.840	5.771	0.418	0.468
IR	2.123	1.739	0.331	0.656
JY	3.050	2.924	0.575	0.786
UKP	7.631[b]	8.413[b]	0.816	0.224
USD	1.599	0.941	0.244	0.797

Notes: 1. See notes for Table 1 for definitions in column one and more details. c implies statistical significance at the ten per cent level. In making inferences about unit properties of the residuals from the cointegrating equation critical values tabulated in Enders and Siklos (2001) were used. 2. b and c imply statistical significance at the five per cent level.

Table 4 reports the results of the asymmetric cointegration tests. The results reported in Panel A for the CPI-based real exchange rates show that only the French franc exchange rate is cointegrated with the domestic and foreign price levels. Both TAR and MTAR tests provide consistent evidence. However, neither the TAR nor the MTAR test reveals any evidence of asymmetry in the cointegrating relationship (see columns four and five).

The asymmetric cointegration test results when WPI is used as a proxy for domestic and foreign prices are shown in Panel B of Table 4. The results of TAR and MTAR tests are consistent indicating that there is a cointegrating relationship only for the UK pound exchange rate. However, there is no asymmetry in the cointegrating relationship (see columns four and five). As there is no asymmetry in the cointegrating relationship, the DF-type unit root tests also provide reliable results in relation to the cointegrating properties (Enders and Granger, 1998) between the spot exchange rates and domestic and foreign price levels.

Table 5. Long-run PPP equations and asymmetric error-correction models

Panel A: French franc exchange rate						
Long-run PPP equation						
FF_t	-17.909[a]		$-0.256p_t$[a]		$4.641\ p_t^*$[a]	
Error-correction model						
Dependent variable	Δer_t		Δp_t		Δp_t^*	
	Indepent variable	Coefficient	Independent variable	Coefficient	Independent variable	Coefficient
	Constant	0.002	Constant	0.009[a]	Constant	0.001[a]
	Δe_{t-1}	0.366[a]	Δe_{t-4}	0.080[c]	Δe_{t-5}	0.019[a]
	Δe_{t-3}	0.155[b]	Δp_{t-1}	0.217[a]	Δp_{t-1}^*	0.179[a]

Table 5 (cont.). Long-run PPP equations and asymmetric error-correction models

Panel A: French franc exchange rate						
Long-run PPP equation						
FF_t	-17.909^{a}		$-0.256 p_t^{a}$		$4.641\ p_t^{*\ a}$	
Error-correction model						
Dependent variable	Δer_t		Δp_t		Δp_t^*	
	Indepent variable	Coefficient	Independent variable	Coefficient	Independent variable	Coefficient
	Constant	0.002	Constant	0.009^{a}	Constant	0.001^{a}
	$z-plus_{t-1}$	-0.109^{b}	Δp_{t-3}	-0.331^{a}	Δp^*_{t-2}	-0.171^{b}
	$z-min\ us_{t-1}$	-0.156^{a}	Δp^*_{t-5}	-1.004^{c}	Δp^*_{t-6}	0.314^{a}
			$z-plus_{t-1}$	0.024	$z-plus_{t-1}$	0.000
			$z-min\ us_{t-1}$	-0.029	$z-min\ us_{t-1}$	-0.002
Panel B: UK pound exchange rate						
Long-run PPP equation						
UKP_t	4.017^{a}		$0.998 p_t^{a}$		$-0.913\ p_t^{*\ a}$	
Error-correction model						
	Constant	0.001	Constant	0.003	Constant	0.002^{a}
	Δe_{t-1}	0.285^{a}	Δe_{t-1}	0.156^{b}	Δe_{t-1}	-0.024^{a}
	Δe_{t-5}	$- 0.127^{c}$	Δp^*_{t-7}	1.135^{b}	Δe_{t-4}	$- 0.023^{a}$
	Δp_{t-6}	$- 0.189^{b}$	$z-plus_{t-1}$	0.017	Δp_{t-3}	0.028^{a}
	Δp^*_{t-4}	1.449^{b}	$z-min\ us_{t-1}$	0.010	Δp_{t-4}	0.030^{a}
	Δp^*_{t-6}	1.375^{b}			Δp^*_{t-1}	0.199^{a}
	$z-plus_{t-1}$	-0.138^{a}			$z-plus_{t-1}$	0.007
	$z-min\ us_{t-1}$	-0.085^{c}			$z-min\ us_{t-1}$	0.008

Notes: 1. a, b and c imply statistical significance at the one, five and ten per cent levels, respectively. 2. CPI was used to proxy price levels in the case of French franc exchange rate and WPI was used to proxy the price levels in the case of UK pound exchange rate as only these price levels were cointegrated with these exchange rates.

Since cointegrating relationships are found only for the French franc and the UK pound exchange rates, estimation results of long-run PPP equations are reported only for these two exchange rates in Table 5. According to the estimation results for the long-run PPP equations reported in Panel A and Panel B, both domestic and foreign price levels are significant determinants of the French franc and the UK pound exchange rates.

Estimation results for the asymmetric error-correction models for the French franc and UK pound exchange rates are reported respectively in Panels A and B of Table 5. The results indicate that the French franc exchange rate falls (rises) whenever it lies above (below) its long-run PPP level. The point estimates indicate that the exchange rate adjusts by 10.9 per cent of a positive gap from long-run PPP and by 15.6 per cent of a negative gap. These results are consistent with Enders and Dibooglu's (2001) findings for the Swiss franc-German mark exchange rate. However, the domestic and foreign price levels do not show any statistically significant adjustment towards positive and negative deviations from the long-run PPP level. Panel B of the table reports the results for the UK pound exchange rate when WPI is used to represent the domestic and foreign price levels. According to the results, the positive and negative error-correction terms are statistically significant only when the change in exchange rate is used as the dependent variable of the error-correction model. The UK pound exchange rate falls (rises) whenever it is above (below) its long-run PPP level. The results indicate that the UK pound exchange rate adjusts by 13.8 per cent of a positive gap from the long-run

PPP and by 8.5 per cent of a negative gap. As in the case of the French franc exchange rate, domestic and foreign price levels do not show any adjustment towards the positive and negative gaps from the long-run PPP level.

Overall, the UK pound exchange rate provides strong support for the PPP hypothesis in both univariate and multivariate tests. This may be due to the low volatility of the UK pound exchange rate during the sample period of the study[1]. The absence of transportation costs, trade impediments, differences between capital and goods markets and productivity and imperfect competition are usually advanced for the PPP to hold (Pilbeam, 1992, pp. 159-160). However, as far as the UK and Sri Lanka are concerned, these factors cannot be safely assumed to be absent.

Conclusion

This paper examines the empirical validity of the purchasing power parity hypothesis to Sri Lanka during the recent float using exchange rates for six foreign currencies. The univariate test results provide evidence in favor of the PPP hypothesis for the WPI-based UK pound real exchange rate. The multivariate analysis reveals two long-run PPP relationships, for the French franc exchange rate and the UK pound exchange rate. Further, evidence is found that exchange rates have different adjustment patterns for positive and negative gaps from the long-run PPP relationship. Overall, both univariate and multivariate analyses provide evidence consistent with the PPP for the UK pound exchange. This result may be attributed to the low volatility of the UK pound exchange rate during the sample period of the study.

The above results have implications for the participants of the foreign exchange market of Sri Lanka. According to the results, four of the currencies studied in this paper are misaligned as they do not support the PPP theory. These misalignments affect foreign trade of Sri Lanka and that of her trading partners. Therefore, the Central Bank of Sri Lanka can intervene in the foreign exchange market in order to bring these exchange rates in line with the optimal exchange rates implied by the PPP theory. The deviations of exchange rates from the PPP also indicate the existence of economic exposure to foreign exchange risk of business firms. Normally, a firm's market value is often affected by the unexpected changes in foreign currencies. Therefore, the results of this paper are important for firm level decision making to manage economic exposure to maintain the market values of firms. Furthermore, the corporate foreign exchange dealers in Sri Lanka can engage in profitable trading activities based on the PPP deviations. They can purchase currencies that are undervalued and sell them when they are overvalued.

Future researchers can use the new methodologies employed in this paper to examine the validity of the PPP hypothesis to other developing as well as developed countries.

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[1] According to Bayoumi and MacDonald (1999), stickiness of the prices in goods markets, particularly in the short run, results in the volatility in nominal exchange rates being passed through to comparable real exchange rates.

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