EXAMINING THE VALIDITY OF PURCHASING POWER PARITY: EVIDENCE FROM SRI LANKAN CONTEXT IN RECENT PAST

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Abstract

This research study examined validity of Purchasing Power Parity (PPP) by studying the behaviour of nominal exchange rate and relative price levels between Sri Lanka and United States (US). The theory of PPP has been used to estimate the relationship between relative prices and nominal exchange rate between two countries. Exchange rate between USD/LKR has been taken as dependent variable whereas Relative Price Index between US Price Index and Colombo Consumer Price Index has been taken into consideration as independent variable. The study has been undertaken with the objective of estimating statistically whether Sri Lanka exists Purchasing Power Parity from January 2015 to December 2022. Data that has been collected for this study is monthly time series data from January 2015 to December 2022, which was collected from the data library of the Central Bank of Sri Lanka (CBSL) and data library of International Monetary Fund (IMF) have been used for this study. The results have been estimated using statistical techniques. These include mainly Augmented Dickey Fuller Test for Unit Root Testing, Descriptive Statistics, Ordinary Least Squared (OLS) method and Granger Causality Test. E-views statistical software is used to analyse the PPP model. Econometric Techniques are used to analyse the regression model.

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1. Introduction

Foreign exchange market can be defined as the market where different foreign currencies are exchanged. Foreign exchange rate is a rate at which one country's currency can be converted into other country's currency.

There are two methods to quote the exchange rate. They can be distinguished as direct and indirect quotes. A direct quote accounts for the number of local currency units per unit of foreign currency while an indirect quote accounts for the number of foreign currency units per unit of local currency.

In international finance and economics, foreign exchange rate is involved in playing a significant role in the economy and it can be considered the influence on exports and imports of good and service of an economy. For example, when a currency depreciation takes place the LKR against the US dollar. The exports goods and service of the Sri Lankan economy will become cheaper for the USA, which means that SL products will grow in the competitive market in the world. When such a currency depreciation takes place, it will be detrimental to SL imports, since payment will go in LKR. Conversely, an appreciation of LKR against the US dollar will result in an opposite impact.

This paper examines the validity of PPP during January 2015 to December 2022 in Sri Lankan context with exchange rate and relative price differences between United States and Sri Lanka which derive from competing econometric specifications. This econometric models are widely used for studying such behaviour with economic data collected to make effective policy decisions. In econometrics, most of the econometric models are assumed to be a linear relationship between independent and dependent variables and this can result for the poor forecasting performance of this model.

In international economics and finance, one of the most contentious subjects in both theory and practice is the exchange rate. Although, some empirical models done recent past have neglected the potential existence of the short and long run relationship between exchange rates and other economic fundamentals, this relationship between exchange rates and macroeconomic fundamentals plays an important role and it should be analysed in detail to make effective policy decisions under dynamic environment in business economics.

The theory of PPP is widely used in international economics and finance and has broadly drawn attention and has been explored in the literature in the field of applied econometrics which has contributed for development of international economics and finance for making rational business and economic decisions.

PPP explains that relative prices of goods are not influenced by changes in exchange rates that exchange rate changes will be in proportionate to relative inflation. This relationship between exchange rate and relative price levels helps not only because it has been a keystone of exchange rate models in international economics, but also to make effective decisions and it provides a benchmark and hence has some practical aspects for policymakers and others who are engaged in forex market and related functional areas. The fluctuations in inflation will affect for exchange rate significantly, hence, understanding of core concept brings to prevent unexpected risks and losses by making effective business and economics decisions.

2. The Law of One Price and Purchasing Power Parity (PPP)

According to the definition of the PPP, it explains using a unit of a currency, for an instance one United States Dollar (USD), which is the purchasing power that can be utilised for purchasing the same goods and services worldwide. This is based on theory of 'law of one price', which states that price of a good in Sri Lanka which denominates in LKR should be multiplied by the exchange rate (US$/LKR) then it will bring an equal price in USD. In other words, let's assume that the exchange rate between the LKR and USD states at 3/1 then goods that cost in LKR 300 in Sri Lanka should cost US$ 100 in the United States. If not, arbitrage profits will take place.

This PPP explains that nominal exchange rates and national price indices between two economies taken into consideration will proportionally be adjusted to maintain a given currency's purchasing power across countries. In simple, PPP states that the ratio of the domestic to the foreign price level should be equal to the nominal exchange rate between two economies.

This can be expressed by using logarithms (log)to identify the relationship as follows:

(1) St = Pt – Pt*+ dt

Where **(St)** Log Spot Rate = Log Price of domestic currency price **(Pt)** – Log of Price of Foreign Currency Price Level **(Pt*) and dt** states the deviation from PPP in period of time t.

This relationship which is shown **(1)** is called as ***absolute* PPP**, as opposed to relative PPP.

The formula **(2)** shows the first differences of the variables and it asserts that in the relative price indices are equivalent to shits in the nominal exchange rate between two nations.

(2) Δ St = Δ Pt – Δ Pt *+ dt

Where Δ denotes first difference

In international economics and finance, according to the given theories pertinent to determination of exchange rate in a given economy and role of the exchange rate, PPP has been tested to focus on empirical studies testing its consistency with the data collected from various sources.

The findings of such studies have given mixed results depending on the methodologies that were used according to the sample period, and the frequency of data. In general, there is an agreement that PPP does not hold in the short run, while PPP prevails in the long run according to the nominal exchange rates and relative prices. Whatever results are given in respect of PPP, this is useful in making effective economic and policy decisions. The popularity of PPP itself could be identified through various empirical studies that have been made so far since its inception to the world.

3. Literature Review

Most of the empirical studies have subjected to identify the results with macroeconomic variables of the research. Therefore, review of the literature depicts the variety of results in connection with the relationship between nominal exchange rate and other macroeconomic fundamentals, frequently for identical economies,

being identified from different time periods, economic policies and methodologies which gives conclusions on results with recommendations.

Even though, the validity of PPP theory have been tested by many empirical studies and, some of studies have rejected PPP,later economists have developed new methodologies and econometric applications to give solutions for the drawbacks in the earlier testing and procedures which brought significant improvements in PPP Model and ultimately results helped to make effective business and economic decisions.

Developed and developing nations have tested the validity of PPP to make economic decisions. Since many developing economies have shifted from a system of fixed exchange rate to floating exchange rate after adoption of the structural adjustment economic policy. Therefore, the influence of macroeconomic fundamentals on exchange rate has been significant important in literature since 1970's. Apart from, it is also a very important macroeconomic variable in international economics and finance.

Kolapo, Funso and Ajai (2012) observing a time series data to check the exchange rate volatility's impact on Nigeria's Macroeconomic Performance suggested that there is a strong correlation between the macroeconomic performance in both short and long run due to volatility of the exchange rate and investors utilize the opportunities of an appreciating Naira to import required capital and technology. Thus, reflecting the positive trend. They tested PPP validity in a way by applying unit root tests, cointergration tests and OLS methods soon.

Kurihara (2012) in a time series data for observing determination of exchange rate recommended that exchange rates are affected by some macroeconomic variables in the economy and some situations were identified particularly in the cases of the USA and Japan economies during which sample period was used. Monetary authorities have intervened for exchange rate movements and were expected to take exchange rate movements when they conduct monetary policies. He did in that way by applying chow break point tests, Unit root Tests, VAR analysis for USA, Japan and Euro area.

Hisali (2011) using a time series data for observing behaviour pattern of the regime of the nominal exchange rate in Uganda suggested that the Markov chain is not able to reduce. The fast depreciation appears to be the main driver of the overall time series' low and stochastic volatility. The likelihood that exchange rate process will continue to operate under an unstable regime which has decreased as a result of the operations of Central Bank in Uganda.

Appuhamilage and Alhayky (2010) in a time series for observing exchange rate fluctuations' impact on commerce between Sri Lanka and China recommended that the Sri Lanka's rupee decline in value against Chinese RMB resulted a favourable effect on china's import to Sri Lanka while increase in rupee value has an adversely affects its imports from China. Thus, volatility of exchange rate has significant negative impact for both exports and imports. They have applied the VAR analysis.

Hyrina & Serletis (2010) in a cross sectional series observed PPP over a period of century and recommended that as a whole, the result is opposite to the theory of PPP. The data set analysed for the study comes from for 23 OECD countries. They applied standard unit root tests.

Chocholata, M (2009) analysed the PPP and co integration evidence from Latvia & Slovakia using two econometric approaches in respect of co-integration theory namely the Engle-Granger method and the Johansen method. The application of the Engle-Granger method based on OLS estimation explained that the residuals from both countries were non-stationary. Therefore, PPP could not keep holding.

Wickremasinghe, G (2009) analysing the PPP in Sri Lanka during floating exchange rate regime identified and concluded that the PPP hypothesis is empirically supported by the UK pound exchange rate both in univariate and multivariate analysis. This result finds the low volatility of the UK pound against Sri Lankan Rupees during the sample period of the study.

Kemme and Roy (2006) using monthly data from 1995 to 2001 estimated the behaviour of exchange rate for Poland and Russia in long run. This study used ARIMA and GARCH error correction specification to check the short-run movements of the RER. The macroeconomic variables used in respect of study tested effect of openness, productivity, trade, capital flows and government spending on GDP. The results show a negative impact for the openness variable. This openness variable causes to a currency depreciation in long run.

Rowland and Oliveros (2003) examined an empirical study of nominal effective exchange rate in Colombia using the PPP model in combination with a multivariate co integration test. Furthermore, random walk forecasting is not as successful in this instance. This has been explored in many research pertinent to PPP, and empirical data clearly indicates that PPP is not a viable theory about the short-term relationship between nominal exchange rate and national price level.

Islam and Ahmed (1999) in a time series for observing the PPP relationship, causality and co integration tests using Korea and U.S. exchange rate and prices suggested that nominal exchange rate and the relative price level are non-stationary in their levels but stationary in their first differences relative PPP holds almost exactly in the long run.

Boyd and Smith (1998) using a time series data and panel data tested PPP, econometric issues and application in respect of developing countries by applying econometric applications namely ADF unit root tests and recommended that relative PPP holds almost exactly in the long term.

Flood and Taylor (1996) in a cross-sectional data found when comparing changes in nominal exchange rates to relative national price levels over a period of those yields 10 or 20 years, yield a very strong connection. Numerous research conducted starting in the 1980s have also examined the PPP link.

All of above discussion depicts different results according to data and methodologies. Therefore, this study highlights significant relationship between Sri Lanka and United States according to most recent secondary data using statistical analytical tools mainly, ADF, OLS and Granger Causality Test.

4. Major Policy Instruments

4.1. Exchange rate as a policy instrument

In simple, an exchange rate system is a method where a country or an economy controls its local currency in relation to other currencies. In Sri Lanka, there are two

major types of exchange rate regimes namely the floating exchange rate regime and fixed exchange rate regime.

A fixed exchange regime could be identified in 1948 at the time of independence from British. The currency board of the nation issued and controlled the exchange rate, which was pegged to the value of the Indian rupee. Later, the central bank replaced its currency board in 1950 in line with its core objectives of the Central Bank to achieve stabilizing the external and domestic value of the rupee and promoting economic growth.

A free floating system can be defined as a regime where market forces relating to exchange rate determine the rate without intervention of monetary authority of the economy. On the other hand, it is usually taking place based on the supply for foreign exchange and demand for the foreign currency where market forces operate. In this part researcher wishes studying policy implementation of exchange rate after 1977. That is the period where open market economic policy was adopted.

It is required to identify the way of a rising demand and supply for foreign exchange.In simple, demand for a foreign currency arises to import required goods and to make payments for capital investment etc, whereas supply of a currency arises owing to the exports of goods, capital receipts and financial receipts etc.

In Sri Lanka, to facilitate licensed commercial banks with a more flexible in quoting exchange rate, the margin was increased to 2 percent in 1995 later on, it was gone up by 5 percent in the face of a large balance of payments deficits in Sri Lanka. In 2001, the Central Bank of Sri Lanka took a significant economic policy decisions towards foreign exchange markets by allowing the commercial banks to determine the exchange rate based on market forces which means that free floating exchange rate system was introduced. That means the central bank no longer buys and sells exchange rates at preannounced rates and it is determined without intervention of the monetary authority. However, monetary authority has to make some interventions when it is deemed necessary by monitoring and buying and selling foreign exchange rate at or near market price. The objective of this intervention is to prevent from excessive volatility in short run and to build up the international reserve position of the economy in medium run to maintain healthy balance of payment.

There are policies implemented to regulate and control the quantity of the foreign exchange in the market. These are direct controls, market intervention and moral suasion.

Interventions means central banks or monetary authority intervene to the foreign exchange market to buy and sell of foreign exchange at times to influence foreign exchange rate or reduce its risk. This intervention causes to market liquidity or money supply thereby interest rates. Sterilized intervention means intervention is sterilized when a central banks intervene to open market operations in the domestic market in opposite directions to its dealing in the foreign exchange market so that existing level of liquidity in domestic currency or money supply would remain constant.

4.2. Inflation rate as a policy instrument

Inflation is one of the most widely used buzz word in the field of business, economics. On the one hand, it is a common enemy that man made in this world while some argues that lowest inflation is desirable and improve the investments, economic conditions.

In nutshell, inflation can be defined as the continuous increase in general price level. Inflation is calculated using changes price indices taken into consideration.

In Sri Lanka the Central Bank of Sri Lanka and the Department of Census and Statistics key institutions that are measured inflation rate in order to make economic and policy decisions. Few main indices are Colombo Consumer Price Index (CCPI) which is the official index for measuring inflation in Sri Lanka seasonally adjusted CCPI, the whole sale price index, Gross Domestic product deflator, producer's price indices etc. However, CPIs are most widely used price indices since they represent the price variations faced by most people in an economy.

Most of people know that rising price level continuously is inflation. However, it is more important to understand that rising of one commodity or service is not an inflation as prices rise or fall in a market economy. Similarly, deflation can be identified as the continuous decrease in general price level. On the one hand, maintaining price stability is one of the core objectives of government and monetary authority to run the economy in conducive manner. On the other hand, when there is no economic, social and political stability of a country. It is low expected a stable price level. Crucially, it is an essential ingredient for sustainable economic growth in investments, outputs, jobs. If inflation falls so adverse economic condition somebody may ask why the central bank don't target a zero inflation rather than a low inflation. The answer is the calculated or measured inflation is likely to be overstate rather than actual inflation.

Hence, changes in prices should be recorded and maintained by keeping the quality of goods fixed to estimate and measure the inflation properly. However, this is not a possible task always, since some prices recorded increases may reflect some extra feature and outlook. Therefore, targeting a zero inflation may pose an uncertain and a risk of occurring by shifting to deflation. Further, since it doesn't take place negative nominal interest rates figure. Some inflation provide cushion for some critical situations like a deep recession or downturn which is required negative real interest rates to stimulate the economy. In addition, Core Inflation and Headline Inflation are measured for economic purposes.

5. Methodology
Data collection

This study used secondary data in respect to United States and Sri Lanka from January 2015 to December 2022. Data pertinent to Sri Lanka has been collected from the database of the CBSL whereas data pertinent to the United States is collected from a database available at International Monetary Fund Date Library. Monthly time series data is used to analyse results. Reasons for selecting such period for study is that Sri Lanka has a free floating exchanged regime. Key macroeconomic variables involved

in this are Exchange rate and inflation. The E-views 12 software has been used to analyse the model using econometric applications.

This paper contains main analysis which is related to PPP. All these are tested using Ordinary Least Squared Method (OLS). Gujarati and Porter (2009) in regression analysis this method is used frequently as well as a most powerful tool in regression analysis.

Accordingly, the data set collected seem to have non-linear form, it is more useful in converting it into linear form using log. In order to get a better estimation, non-liner form of the equation has been converted into linear form of the equation. In PPP, following methodology has been followed by researcher.

Since the econometric analysis is a major part of this study, error term has been included at the end of every equation. In Econometric specification formal Tests of the PPP can be expressed in different ways. The researcher has selected a one simple method is to regress the(log) change in exchange rate with respect to the inflation.

$\log S_t + h\text{-}\log S_t = \alpha 0 + \alpha 1(\pi t^* - \pi t) + \varepsilon t$

Where,

$\log S_t + h\text{-}\log S_t$ = Nominal exchange rate differentials (all data are expressed in logarithms for instance log (LKR/US$)

πt^* is the foreign price level, πt is the domestic price levels,

$(\pi t^* - \pi t)$ = differentials in relative prices between two countries $\log(CCPI_{SL}/CPI_{UK})$.

εt is a zero mean error term respectively.

Since, the nominal exchange rate between Sri Lanka and the United States are expressed in terms of domestic currency per unit of foreign currency and it is expected a positive relationship between nominal exchange rate and inflation rate. Similarly, increase in price levels tends to depreciate LKR against US$.

The beta coefficients are observed to have the following signs in the estimates.

$$\beta 1 > 0 \; and \; \beta 2 > 0$$

$\beta 1$ =Intercept of the model.it is expected to positive sign.

$\beta 2$ =Inflation rate (relative price levels) because when inflation increase, exchange rate must be increased. The relationship between inflation and exchange rate is positive.

Hypothesis testing of the PPP as follows

$H0: \beta 1 < 0, \beta 2 < 0$ = There is no a significant relationship between nominal exchange rate and relative price level between two countries.

$H1: \beta 1 > 1, \beta 2 > 0$ = There is a positive relationship between nominal exchange rate and relative price levels between two countries.

According to the OLS method if the coefficients of relative price levels as well as intercept are greater than zero, null hypothesis is rejected , that implies there is a positive relationship between exchange rate and price levels.

If the coefficients of relative price levels as well as intercept are less than zero, null hypothesis is rejected, that implies there is no positive relationship between nominal exchange rate and relative price levels.

Table 01: Macroeconomic variables and measurements

Macroeconomic variables	Measurements
Exchange Rate	Log of Nominal Exchange Rate (USD/LKR)
Inflation Rate	Log of Relative Prices (CPI Price Index)

Empirical Model Specification
Findings and discussions
Verifying the stationary for macroeconomic variables using unit root test.

Table 02: Analysis of variables using unit root

Variables	Level Zero		First difference	
	t-statistic	Probability	T-statistic	Probability
Exchange Rate	0.616196	0.9895	-5.818384	0.0000
Relative Price Index	0.348282	0.9796	-4.358173	0.0006

Source: Author's calculation based on CBSL and IMF data

      Using the Augmented Dickey-Fuller (ADF) Test, one can verify whether data is stationary or not. All the variables that were taken into consideration in this investigation were not stationary at the zero level, based on the ADF unit root test findings as shown in Table 2. Thereafter, the first level difference for all the variables in ADF was tested and the results were found to be stationary at first stationary level. Accordingly, Nominal Exchange rate and Relative Consumer Price Index were 5% level of significance.

Table 03: Descriptive Statistics

	LOG EXR	LOG RCPI
Mean	2.250906	0.051120
Median	2.246049	0.037499
Maximum	2.560373	0.254725
Minimum	2.119093	-0.010712
Std. deviation	0.113584	0.061359
Skewness	1.592323	2.163922
Kurtosis	5.098923	7.355867
Jargue Bera	58.18980	150.8153
Probability	0.000000	0.000000
Sum	216.0870	4.907557

Source: Author's calculation based on CBSL and IMF data

Analysis of the results of PPP in the form of log it can be shown as follows.

$$LOGEX = \beta1 + \beta2 LOGRCPI + \varepsilon$$

      Where Log EX= log of nominal exchange rate (LKR/US), log RCPI= log of relative price of CCPI.($CCPI_{SL}/CPI_{US}$),ε = error term. In order to calculate

purchasing power parity (PPP), nonlinear function has been converted into linear function.

Table 04: Regression results coefficients

Variable	Coefficient	Standard error	T-statistics	Probability
C	2.159144	0.003714	581.3861	0.0000
LOG RCPI	1.795034	0.046645	38.48291	0.0000

Dependent Variable: EXR

According to the table coefficient of consumer price index is 1.795034 implying a one percent increase in consumer price index increase in exchange rate by 1.795034. Probability value of consumer price index is significant (0.0000),that is clear evidence that exchange rate increase when consumer price index increase.

If all other variable constant, estimated regression equation is as follows.

$$EX = 2.159144 + 1.795034 \, CPI + \varepsilon$$

Table 05: Model Summary

R-Square	Adjusted R Square	F-Statistic	Probability F- Statistic	Durbin Watson	Standard Error
0.940315	0.939680	1480.935	0.0000	0.318968	0.027896

a. Predictors: constant, LOGRCPI
b. Dependent variable: EXR

From the table it can be said that goodness of fit R^2 value is 0.940315 that is almost 94.03% of the variation in exchange rate in Sri Lanka is explained by log of relative Consumer Price Index. The adjusted R^2 is 0.939680 (93.96%).

According to the table value of F-Statistic is 1480.935 which indicates that R^2 is statistically significant.

The "F" test: the null and alternative hypothesis are:

$$H0 = \beta1 = \beta2 = 0$$
$$H1 = \beta1 = \beta2 \neq 0$$

The F-value of the output is 1480.935 since probability F- value (0.0000) is less than significant value (at 5% level) the null hypothesis is rejected. That is called as the estimated equation is significant.

The GCT is an econometric tool that is used to test the usefulness of one variable to forecast another.

Table 06: The Granger Causality Test (GCT)

Null Hypothesis	F-Statistic	Probability	Null Hypothesis
LOG RCPI Doesn't Granger Cause LOG EXR	3.24559	0.0436	rejected
LOG EXR Doesn't Granger Cause LOG RCPI	38.7937	8.E.13	rejected

Probability < 0.05 then Null Hypothesis is rejected.[2]
Source: Author's calculation based on CBSL and IMF data

6. Conclusion

The results suggest that when relative price level increases by one percentage nominal exchange rate between Sri Lankan Rupee and United States Dollars will increase by 1.795034. On the other hand, result is statistically significant which reflects Sri Lankan Rupee depreciated against US$. This may perhaps due to SL prices go up faster than US$. Further, it could be noted that Sri Lanka adopted free floating exchange rate system. The exchange rates are highly volatile under free floating exchange rate system than during managed floating exchange rate system.

This model has been undertaken with the objective of statistically estimating whether the notion of PPP exists in Sri Lanka between the time periods of 2015 to 2022. The results of this appeared to suggest that PPP did hold in Sri Lanka during the period of 2015 to 2022 where sample period was tested. Thus, it was revealed that there is a significant positive relationship between the nominal exchange rate (US$ LKR) and the relative prices between Sri Lanka and USA.

Further, according to the results, this paper highlighted important suggestions whether exchange rates can be empirically explained by macroeconomic variables in the economy. Accordingly, changes in relative price index between SL and USA affects for determination of PPP in Sri Lankan Context as per the econometric analysis.

This paper has identified that some macroeconomic fundamentals affect for the behaviour of nominal exchange rate between the US and Sri Lanka. Monetary authority has intervened to control exchange rate movements when they implement monetary policy in the economy.

However, there have been identified some problems in connection with this study. Firstly, only two macroeconomic variables have been used to test the behaviour which is difficult to make judgment or conclusions for determination of exchange rate based on PPP itself. Therefore, it is recommended to collect more data in respect of other macroeconomic fundamentals. Second, there are different methods that are used to calculate estimations based on econometric analysis.

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[2] Pro.Clive W.J. Granger, recipient of the 2003 Noble Prize in Economics introduced Granger causality in 1960 which is a statistical concept of causality that is based on prediction. This mathematical formulation is based on two variable liner regression model. This granger causality test is popular in simple linear regression model.

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