Eurasian Journal of Business and Economics, 17(33), 81-96, (2024).

An Assessment of Purchasing Power Parity in the Long-Run: Evidence from India and its four Major Trading Partners

Manjinder KAUR [a], **Navpreet KULAAR** [b]

Received: August 4, 2023. **Revised:** May 10, 2024. **Accepted:** May 26, 2024.

Abstract

The present study focuses on evaluating the validity of the Relative Purchasing Power Parity (RPPP) theory for India and its four major trading partner nations namely the United States, China, the United Arab Emirates, and Saudi Arabia using monthly time series spanning January 2001 to March 2021. For the purpose of empirical analysis, standard Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests, as well as the Johansen-Juselius cointegration technique, have been applied. Firstly, the stationarity of the real exchange rate has been investigated using standard unit root tests. The findings indicate that each country's real exchange rate is nonstationary signifying the absence of strong PPP. Thereafter, the weak form of PPP was tested in the second stage using the Johansen cointegration test. The findings of the cointegration test confirm the presence of a long-run relationship among bilateral exchange rates, domestic price levels, and foreign price levels for all countries undertaken except for the UAE. Since three economies from among the total four trading partners' country-pair support the existence of PPP, it can be said that PPP holds for the Indian rupee exchange rate for the economies so considered. The study further signals that India's trade with the UAE could lead to arbitrage opportunities.

Keywords: *Purchasing Power Parity, Cointegration, Unit root, Long-run PPP, Trading Partner currencies.*

JEL Classification Codes: *E31, F17, F31, F32*
UDC: *339.5*
DOI: *https://doi.org/10.17015/ejbe.2024.033.04*

[a] Assistant Professor, Department of Commerce, Guru Nanak Dev University College, Chung, Tarn Taran, India. E-mail: manjindergndu@gmail.com
[b] Research Scholar, University School of Financial Studies. Guru Nanak Dev University, Amristar, India. E-mail: navpreetkaur7005@gmail.com

1. Introduction

Purchasing power parity (PPP) and the sustainability of real exchange rate has been the subject of a persistent and massive discussion among academicians and professionals all over the world, especially since the introduction of a flexible exchange rate system subsequent to the collapse of the Bretton Woods (Taylor, 2006). One of the oldest and sound economic theories is the purchasing power parity theory which has been extensively analysed and used by economists for assessing the long-term fluctuations of exchange rates over the past thirty years. The theory explicitly states that exchange rates and prices have an impulse-response association. PPP uses a fundamental exchange rate which is determined by the price levels in two countries expressed in terms of a single currency. This theory is based on the principle of the sale of identical goods and services at the same price and at the same time in two different countries. As per PPP, the difference in price levels of two countries for similar goods can be used as a measure to reflect the relative exchange rate fluctuations of the two currencies (Hoque and Banerjee, 2014).

PPP theory signifies that when two currencies' purchasing power is equal in the two nations being considered, the law of one price holds as far as the exchange rate of the two currencies is concerned and the currency values of both nations are set to be in equilibrium. If a particular nation is experiencing inflation, its currency exchange rate must depreciate up to the extent that the price of the goods becomes equal in both nations if both currencies are converted into a single currency unit. This is due to the fact that the purchasing power parity position pulls the value of the currency of a nation in high inflation downward.

PPP theory maintains that the exchange rate between two currencies should be equal to the ratio of the price levels prevailing in two nations.

$$E(0) = \frac{P^*}{P} \tag{1}$$

where, E(0), P*, and P are the current nominal exchange rate, current foreign price level, and current domestic price level respectively. This implies national price level and currency value are inversely related.

$$r = E(0)\,\frac{P^*}{P} \tag{2}$$

After taking logs, it could further be expressed as below,

$$\log(r) = \log(E(0)) + \log(P^*) - \log(P) \tag{3}$$

where r denotes the real exchange rate, E is the nominal exchange rate, P is the domestic price index, and P^* is the foreign price index. While the relative version of PPP postulates that the percentage of exchange rate fluctuations of a nation's currency is just equal to the difference between price level change in the home country and a foreign country. This is explained with the help of the following equation:

$$E(1) = \frac{P^*}{P}\left[\frac{(1+\Delta^*)}{(1+\Delta)}\right]^1 \quad (4)$$

Considering equation (1) which states E(0) =P^*/P, equation (4) can be rewritten as below:

$$E(1) = E(0)\left[\frac{(1+\Delta^*)}{(1+\Delta)}\right]^1 \quad (5)$$

where E(1) is the exchange rate for the current period while E(0) is the exchange rate of the previous period, $\boldsymbol{\Delta^*}$ denotes price level change in a foreign country and **Δ** denotes price level change in the home country.

Further simplifying, it is pertinent to mention here that the rate of price level change in the foreign country can be denoted as $\Delta^* = \frac{P^*_t - P^*_{t-1}}{P^*_{t-1}}$ where P^*_t is the foreign price level in the current period and P^*_{t-1} is the foreign price level in the previous period. Similarly, the rate of price level change in the domestic economy using Δ can be expressed as $\Delta = \frac{P_t - P_{t-1}}{P_{t-1}}$ where P_t is the domestic price level in the current period and P_{t-1} is the domestic price level in the previous period.

Relative Purchasing Power Parity (RPPP) asserts that the exchange rate will resort towards equalising price levels in the two economies by means of such an amount of depreciation or appreciation in the nominal exchange rates of the two countries as equal to prevailing price differentials in the two nations which subsequently renders the purchasing power of economies considered constant (Suranovic, 1997).

The present study focuses on analysing the RPPP position of India vis-a-vis selected trading partners, considering the price differentials in respective bilateral pair of economies consisting of home country and foreign country inflation indices.

2. Review of Literature

PPP has remained the subject of extensive discussion and is primarily concerned with the law of one price globally. Here, an effort is being made to present the studies that highlight PPP evaluations relative to price differentials for the considered pairs of economies in the chronological order below:

Apte et al. (1994) using monthly observations from 1972-91 examined the relative purchasing power parity (RPPP) theory in 19 economies employing ordinary least square and generalised least square regression methodology. The tests were based on exchange rates vis-a-vis the US dollar across considered currencies. The findings revealed that regression coefficients in both methods turned equal to unity approximately and significant. Also, the majority of the lead-lag effects could be detected with a lag of six months. The study observed the existence of short-run and medium-run purchasing power parity.

Narayan (2005) considered seventeen OECD countries to empirically analyse the theory of relative purchasing power parity (RPPP). The sample covers Austria, Japan,

Canada, Belgium, France, Germany, Finland, USA, Italy, Denmark, Netherlands, Norway, Spain, Portugal, Switzerland, United Kingdom, and Sweden using monthly data for the UK spanning January 1973 to December 2002 while data for the nations other than the UK covers the period January 1973 to September 2003. Nominal bilateral exchange rates have been translated into real bilateral exchange rates based on consumer price indices. A unit root test with a structural break in the intercept and slope simultaneously has been applied. The real exchange rate for France, Portugal, and Denmark has been found to be stationary at the 10 percent level of significance. When the considered real exchange rate was based on the Deutschmark, the real exchange rate for seven countries namely, Austria, Belgium, Norway, Denmark, Spain, Switzerland, and the Netherlands was found to be stationary and consistent with PPP. On the contrary, the unit root test result shows that when the real exchange rate based on the US dollar is used, real exchange rates were stationary for only three nations i.e., France, Portugal, and Denmark, and thus consistent with the RPPP hypothesis.

Jiranyakul and Batavia (2009) assessed the validity of the PPP using fragmented data between Thailand and its six trading partners employing the monthly dataset for the period July 1997 to December 2007. The six trading partners considered for the study were namely Singapore, Indonesia, Malaysia, the United States, Japan, and the United Kingdom. The bilateral real exchange rate between Thailand's exchange rate and each of the trading partners' currencies, together with the producer price index has been used to measure the price levels. In order to verify the stationarity of the real exchange rate series to determine relative PPP, the author applied various unit root tests such as ADF test, PP test, DF-GLS test, Ng- Perron, and KPSS test along with ARDL bounds test of cointegration. Since the null hypothesis of non-stationarity of the real exchange rate could not be rejected at the 5% level of significance for all the six nations' bilateral real exchange rates, RPPP does not hold. Further, the results of Bounds testing revealed that a long-run relationship exists only in the case of Indonesia and Singapore. Thus, the study concluded that RPPP does not appear to be valid between Thailand and its trading partners.

Simpson and Grossman (2011) developed a time-varying equilibrium exchange rate for six bilateral US dollar-based exchange rates vis-a-vis the Canadian Dollar, British pound, German Mark, Japanese Yen, Euro, and Swiss Franc using the relative purchasing power parity (PPP) model. Here, the PPP model analysis has relied on proxy variables such as CPI, PPI representing price indices for goods traded, and the time period during which a relative PPP-based model surpassed a random walk for the anticipated exchange rates. The study found that the US Dollar-British Pound exchange rate could be predicted most consistently with the relative PPP model which was based on a proxy of price indices for the traded goods. Further, the time period during the post-Plaza Accord provided more robust results as compared to the random walk.

Findreng (2014) analysed whether relative purchasing power parity holds for Germany vis-a-vis six economies namely, North Macedonia, Croatia, Romania, Bulgaria, Albania, and Turkey based on data spanning January 1999 to May 2013 using Dickey Fuller, Engle-Granger cointegration test and error-correction model (ECM). The findings revealed the non-existence of PPP over the sample period when the real exchange rate among the pairs was tested using the Dickey Fuller method. However, on following a trend, the real exchange rate has been detected to revert to the mean value for Turkey-Germany and Croatia-Germany, implying, the presence of PPP in these country-pairs. Further, the results of Engle-Granger cointegration tests highlighted the PPP existence but only for the Turkey-Germany country-pair. Moreover, inconclusive results have been obtained regarding the speed of adjustment towards PPP equilibrium in the ECM model.

Shim et al. (2015) investigated the relative purchasing power parity (PPP) employing exchange rate data based on the Korean won vis-a-vis the U.S. dollar and Japanese yen and inflation proxies that have been derived from stock market returns in Korea, the US, and Japan respectively. The authors assessed the relative PPP hypothesis in terms of short-run price volatility using monthly, quarterly, and bi-monthly observations spanning January 1, 1998, to December 31, 2012. The findings refuted the relative PPP hypothesis except for the Korean won–US dollar market with a relatively lower inflation rate when the sample excluded the Asian Financial Crisis period.

Yildirim (2017) examines the empirical validity of the relative PPP hypothesis between Turkey and its top 4 trading partners namely- the United States, Russia, the European Union, and China during the period of floating exchange rates i.e., from March 2001 to October 2015. The author applied a number of recently established nonlinear unit root tests to capture the nonlinear behaviour of real exchange rates. Additionally, conventional unit root tests such as ADF, PP, and Ng-Perron test have also been employed. Further, to capture the structural breaks in the data series, Zivot and Andrews (1992) as well as Lumsdaine and Papell (1997) unit root tests have also been considered. In each case, the wholesale price index (WPI) has been used to determine the real exchange rate and thereafter it has been converted into natural logarithm form. In contrast to conventional unit root tests, the empirical findings show that nonlinear unit root tests provide better evidence in support of the PPP hypothesis where non-linear ties in real exchange rates are appropriately stated. The overall findings demonstrate that non-linear unit root tests provide stronger support for the existence of the PPP hypothesis for bilateral real exchange rates of Turkey and its respective trading partner nations in relation to the price level of Turkey and trading partners.

Sharma et al. (2019) scrutinised both the short-term and long-term influence of exchange rate shocks and crude oil price fluctuations on domestic inflation (CPI) prevailing in India using the Autoregressive Distributed Lag (ARDL) framework while covering the monthly observations from April 1994 to February 2018. The findings

disclose that the fluctuations in oil price and exchange rate have a positive and substantial influence on the Indian inflation rate. The results of the ARDL error correction mechanism depict that the system is adjusting toward long-run equilibrium at a speed of 25.2 % per month. Further, the breakpoint unit root test shows that there was a severe impact of the 2008 global financial turmoil on Indian inflation. The overall results signal that any attempt to reduce fuel subsidies will sharply escalate the cost-push inflation since the Indian economy is heavily dependent on energy imports.

Kasem and Al-Gasaymeh (2022) made an attempt to explore the applicability of relative purchasing power parity between Jordan and its five trading partner countries which includes Iraq, Qatar, Saudi Arabia, the United Arab Emirates, and Turkey considered from the first quarter of 2000 to the fourth quarter of 2020. The results of the ADF unit root test confirm that all the variables are non-stationary at levels but stationary at first difference. Hence, the author further applied the Johansen-Juselius cointegration test to examine the doctrine of purchasing power parity. The findings of the Johansen-Juselius cointegration test demonstrated that the nominal bilateral exchange rate in terms of the trading partner's currency, and domestic and foreign price levels all exhibit the existence of cointegration which in turn confirms the validity of real exchange rate PPP relative to domestic and foreign price level in Jordanian economy. Ozdogan (2022) examined the Exchange Rate Pass-through (ERPT) of Turkey and its impact on the country's inflation (CPI) using a reduced form of Vector Auto Regression Mechanism. The analysis was based on monthly data from January 1997 to January 2022 which has been further split into two sub-samples to capture the shift in Turkey's exchange rate regime after 2001. The time before the implementation of the floating exchange rate, i.e., from January 1997 to January 2001 represents the first sample while the floating exchange rate regime from January 2002 to January 2022 has been taken into account in the second sample. The results show that ERPT has a distinct pattern both before and after the implementation of the floating exchange rate system besides being incomplete. Further, during 2001 and 2017, the ERPT decreased but after 2017 increased substantially for which the reason could be high inflation and excessive currency rate volatility for the period considered.

Although the review of literature as discussed above brings out some key results which are quite helpful in predicting the RPPP relationship among any interested nations but it does not provide an insight on the fact that whether PPP holds among India and its trading partners. In the present paper, an attempt is being made to make an assessment, of whether Relative Purchasing Power Parity (RPPP) holds among India and its trading partners.

3. Data Description

For the purpose of analysing the validity of the Relative Purchasing Power Parity (RPPP) theory, the monthly data for currencies of economies, namely, India and its

four major trading partner nations- the United States, China, the United Arab Emirates (UAE) and Saudi Arabia and concerned inflation indices spanning over January 2001 to March 2021 has been considered. However, the data considered for the UAE runs from January 2007 due to the non-availability of data from 2001 to 2006. The US dollar has been chosen as the common currency which has been used to estimate the real exchange rates for other nations. In order to calculate the real exchange rate (r) being the main input for evaluating RPPP, the nominal bilateral exchange rate of the Rupee vis-a-vis respective trading partner (end period spot rate) and Consumer Price Index (CPI) representing the national price level of India while US Producer Price Index (PPI), CPI of China, CPI of the UAE and CPI of Saudi Arabia proxy for foreign price levels has been taken into account. The real exchange rate for the current period E(1) for the concerned bilateral set has been computed applying the equation (5) as mentioned earlier in the introduction section:

$$\mathrm{E}(1) = \mathrm{E}(0)\,\frac{P^*}{P}\left[\frac{(1+\Delta^*)}{(1+\Delta)}\right]^1 \tag{5}$$

where E(1) is the exchange rate for the current period while E(0) is the exchange rate of the previous period, Δ^* denotes price level change in a foreign country and Δ denotes price level change in the home country.

4. Research Methodology

4.1. Unit Root Tests

The unit root in real bilateral exchange rates per unit of foreign currency is analysed with the univariate test, i.e., Augmented Dickey Fuller's (1979) unit root test. If the null hypothesis for the existence of the unit root is rejected then it signifies that real exchange rates follow mean reversion (Alba & Park, 2003). Hence, PPP holds in such a situation. For empirical analysis purposes, the model with intercept and without a trend has been employed. The reason is that introducing a linear time trend would theoretically be incompatible with the hypothesis of long-run PPP and since the majority of previous empirical work has found that the time trend in real exchange rate is incommensurate with the PPP hypothesis (Alba & Park, 2003; Acaravci & Acaravci, 2007; Al-Rabbaie & Hunt, 2004; Zhang & Lowinger, 2006). For this the following types of Augmented Dickey Fuller (ADF) regression equations have been considered:

$$\Delta \mathrm{Y_t} = \alpha_1 \mathrm{Y_{t-1}} + \sum_{\mathrm{m=1}}^{\mathrm{n}} \beta_{\mathrm{m}}\, \Delta \mathrm{Y_{t-m}} + \mu_{\mathrm{t}} \tag{6}$$

$$\Delta \mathrm{Y_t} = \alpha_0 + \alpha_1 \mathrm{Y_{t-1}} + \sum_{\mathrm{m=1}}^{\mathrm{n}} \beta_{\mathrm{m}}\, \Delta \mathrm{Y_{t-m}} + \mu_{\mathrm{t}} \tag{7}$$

where Δ is the first difference operator, α_0 is intercept or constant, Y_t is a time series, n is the optimum number of lag length of the dependent variables and μ_t is the error term which is pure white noise. The first equation i.e., equation (6) is without intercept, but equation (7) is with intercept. On the basis of the above equations, the following hypotheses have been framed to assess the stationarity level of the series:

H_0: The series are non-stationary [Integrated of order one I(1)]

H_1: The series are stationary [Integrated of order zero I(0)].

4.2. The Johansen-Juselius Cointegration Test

The Johansen cointegration approach (Johansen & Juselius, 1990) has been employed in order to investigate the validity and existence of PPP. To analyse whether PPP holds for the exchange rate of the Indian rupee, three variables viz., the nominal bilateral exchange rate of India in terms of trading partners' currencies, domestic price index, and foreign price index have been taken into account, thus, the rank should be $\pi_k \leq 2$ since k=3. The number of co-integrating vectors between the variables taken into consideration is indicated by the rank of the coefficient matrix Π_k.

The cointegration result is confirmed on the basis of the trace statistics (LR_{trace}) and the maximum eigenvalue statistics (LR_{max}) given by the Likelihood Ratio (LR) test. The trace statistic has been computed to test the null hypothesis of r co-integrating relations against the alternative hypothesis of r+1 co-integrating relations and is specified below:

$$\mathrm{LR}_{\mathrm{trace}}\left(\frac{\mathrm{r}}{\mathrm{k}}\right) = -\mathrm{T}\sum_{\mathrm{i=r+1}}^{\mathrm{k}} \log\left(1 - \lambda_i\right) \quad (8)$$

where, λ_{r+1}, _____ λ_k are the smallest squared canonical correlation or eigen value. Further, the maximum eigen value statistic has also been calculated to determine the number of cointegrating vectors (r) in the following manner:

$$LR_{max}(r / r+1) = -T \log(1- \lambda_{r+1}) \quad (9)$$

where, r = 0, 1,2,....., k-1, λ_{r+1} is the $(r+t)^{th}$ largest squared canonical correlation or eigenvalue. The null hypothesis is r co-integrating vectors against the alternative hypothesis of r+1 co-integrating vectors. For stationarity purpose, the Schwartz Bayesian information criterion has been used to select the optimum lag length while for determining the lag length for cointegration purpose, the Akaike information criterion (AIC) has been used.

5. Results and Discussion

5.1. Long-run Theory of PPP (Based on Unit Root Test)

The strong form of long-run PPP theory advocates that the real exchange rate ought to remain constant over time. The existing literature highlights that PPP doctrine authenticates that the real exchange rate should follow a mean-reverting trend. In other words, it implies that at levels, the real exchange rate is stationary, and it will return back to its mean value following any shock or disturbance hence, supporting the existence of PPP. This interpretation seems to be relevant as PPP can be empirically tested through the unit root method. The statistics and probabilities

values of the ADF unit root tests only with intercept and excluding the trend are categorised by trading partners' country pair and presented in Table 1.

Table 1. Results of Augmented Dickey Fuller Unit Root Test

S. No.	Variables	t- statistics	Probability value
1	r India/US	-1.832	0.364
2	r India/China	-2.504	0.115
3	r India/UAE	-2.577	0.099
4	r India/Saudi Arabia	-2.592	0.096

Note: All series are in log transformation form. The null hypothesis depicts that the series have unit root.

The ADF unit root test results demonstrate that the null hypothesis for the existence of unit root in real exchange rate cannot be rejected at the 5% level of significance for each country pair. It highlights that RPPP fails to hold in these nominal bilateral real exchange rates among India and its major trading partners' currencies. Even when Phillips-Perron test (1988) was applied, similar results have been obtained which further support ADF unit root results. It highlights that RPPP fails to hold in these bilateral real exchange rates among India and its major trading partners' currencies. Therefore, based on the results of ADF unit root tests, it can be concluded that the real exchange rate between the Indian rupee and its trading partners' currencies representing the strong form of RPPP is non-stationary at levels. Thus, strong RPPP does not hold in the case of the Indian rupee. It can be further said that long-run RPPP fails for the Indian rupee exchange rate for the considered bilateral sets, that is, RPPP does not hold between the US and India, China and India, the UAE and India, and Saudi Arabia and India.

Graphical representation of Indian real bilateral exchange rate per unit of foreign currencies is as in Figures 1, 2, 3, and 4.

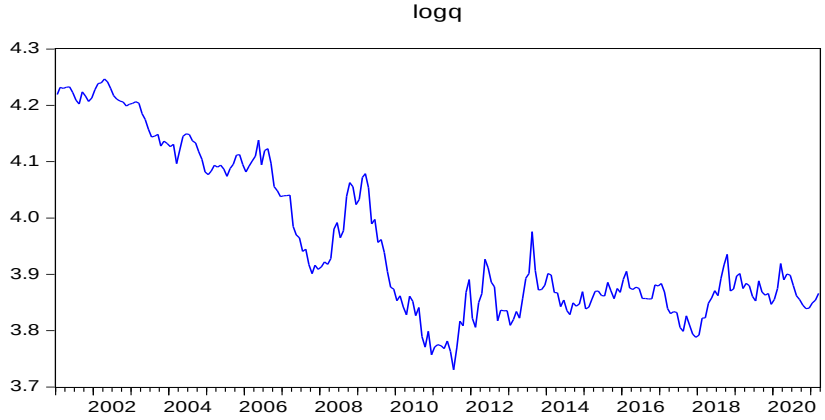

Figure 1. Indian Real bilateral exchange rate per unit of US Dollar

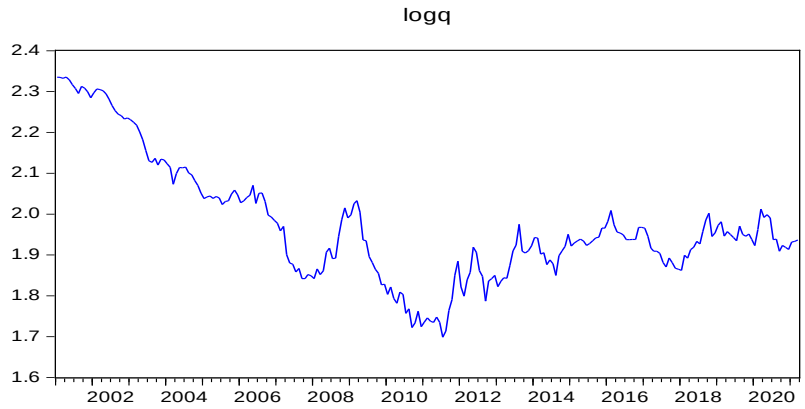

Figure 2. Indian Real bilateral exchange rate per unit of Chinese Yuan.

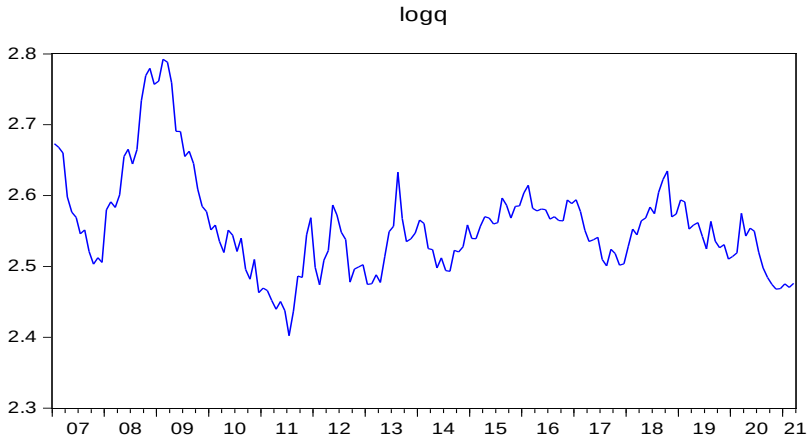

Figure 3. Indian Real bilateral exchange rate per unit of UAE Dirham.

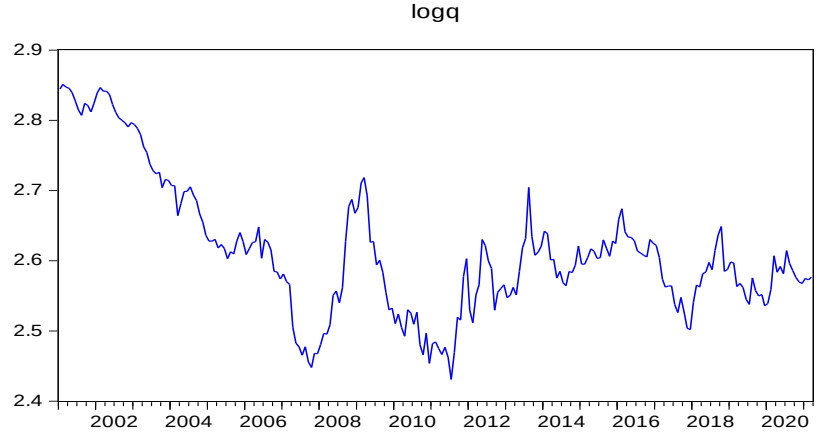

Figure 4. Indian Real bilateral exchange rate per unit of Saudi Arabian Riyal

5.2. Long-run Theory of PPP (Based on Johansen Multivariate Cointegration Test)

The failure of long-run RPPP existence may be due to the low power of univariate unit root tests. Also, the proportionate restriction between exchange rates and prices is enforced by unit-root testing of real exchange rates. In order to overcome this problem, a more robust multivariate cointegration test has been implemented in order to confirm the estimations.

The preliminary condition of cointegration is that all the variables must be integrated of the same order or I(1) that is, integrated of order one. In order to apply the cointegration technique, first of all, the standard Augmented Dickey Fuller (ADF) unit root tests have been used to test the null hypothesis of non-stationarity and to identify the order of integration. If the series undertaken are found to be integrated of the same order, then Johansen multivariate cointegration techniques will be applied to examine whether there exists any cointegrating relationship between the exchange rates and their relative national price levels.

Results from ADF unit root tests are presented in Table 2 and it clearly brings out that for all countries, the null hypothesis of unit root existence cannot be rejected when all the variables are tested at level, but it can be rejected when the variables are tested at the first difference. Thus, it can be concluded that at the first difference, all variables are stationary and all the series are I(1), i.e., integrated of order one which is a prerequisite for applying the cointegration test.

Table 2. Results of ADF Unit Root Test

Variables	Levels		First Difference	
	With Intercept	With Trend and Intercept	With Intercept	With Trend and Intercept
EXR India/US	0.946	0.537	0.000*	0.000*
CPI India	0.998	0.110	0.000*	0.000*
PPI US	0.919	0.161	0.000*	0.000*
EXR India/China	0.946	0.543	0.000*	0.000*
CPI China	0.998	0.116	0.000*	0.000*
EXR India/UAE	0.845	0.112	0.000*	0.000*
CPI UAE	0.083	0.897	0.000*	0.000*
EXR India/Saudi Arabia	0.946	0.537	0.000*	0.000*
CPI Saudi Arabia	0.959	0.858	0.000*	0.000*

Note: * and ** show 1% and 5% levels of significance respectively.

5.2.1. Results of Johansen's Cointegration Test (Weak RPPP)

In accordance with the unit root test results, all of the series are I(1) which is the prerequisite for applying the cointegration test. Hence, in order to examine the long-run relationship or cointegration among the considered variables, the Johansen cointegration technique has been utilised employing the likelihood ratio (LR) test. Here, the null hypothesis is the presence of r cointegrating vectors against the

alternative hypothesis of the r+1 cointegrating vectors and the underlying assumption in each cointegrating equation is with intercept and no trend.

Table 3 exhibits the results of the Johansen cointegration test for India and the US which is India's largest trading partner. Here, the null hypothesis that there is no cointegrating vector will be rejected if the values of the maximum eigen statistic and trace statistic both were higher than the 5% critical value. According to both statistics, the null hypothesis that there are no cointegrating vectors could be clearly rejected at a 1% level of significance. It implies that there exists one cointegrating vector. These results confirm the existence of a long-run relationship among the three variables, that is, the real exchange rate of India and the US, the CPI of India, and the PPI of the US. Hence, the RPPP hypothesis is valid for India and the US.

Table 3. The Johansen's Cointegration Test for India- United States

Likelihood Ratio Tests	Null Hypothesis	Test Statistic	Critical Values at 0.05 level	Probability value
VAR Lag: 8				
Trace Test (λtrace)	H_0: r=0	42.63	29.79	0.001*
	H_0: r≤1	11.31	15.49	0.192
	H_0: r≤2	0.006	3.841	0.934
Maximum Eigenvalue Test (λmax)	H_0: r=0	31.32	21.13	0.001*
	H_0: r=1	11.30	14.26	0.139
	H_0: r=2	0.006	3.841	0.934

Note: r stands for the number of cointegrating vectors among the time series variables. *, **, and *** show 1%, 5%, and 10% levels of significance respectively. Both the Trace test and the Max-eigenvalue test indicate 1 cointegrating equation at the 1% level of significance.

Table 4 demonstrates the results of the Johansen cointegration test for India and China which is India's second largest trading partner. The results reveal that the null hypothesis of no cointegrating vector is rejected as both the maximum eigen statistic and trace statistic are higher than the 5% critical value at a 1% level of significance. This implies that the variables in this model are cointegrated with at least two cointegrating vectors meaning that there is the existence of cointegration among the real bilateral exchange rate of India and China, CPI of India, and CPI of China. Thus, the doctrine of RPPP does hold in the context of India and China for the considered sample period.

The results of the Johansen test for cointegration between India and the United Arab Emirates have been presented in Table 5. The findings depict that the null hypothesis of no cointegrating vector could not be rejected since the trace statistic value i.e., 21.84 does not exceed the 5% critical value of 29.79. Similarly, the maximum eigen value i.e., 12.69 is lesser than the 5% critical value of 21.13. Therefore, it is inferred that there is no existence of cointegration between the real bilateral exchange rate of India and the UAE, the CPI of India, and the CPI of the UAE. Hence, the theory of RPPP does not hold between India and the UAE.

Table 4. The Johansen's Cointegration Test for India- China

Likelihood Ratio Tests	Null Hypothesis	Test Statistic	Critical Values at 0.05 level	Probability value
VAR Lag: 2				
	H_0: r=0	60.57	29.79	0.000*
Trace Test	H_0: r≤1	24.14	15.49	0.002*
(λ_{trace})	H_0: r≤2	0.465	3.841	0.495
Maximum	H_0: r=0	36.43	21.13	0.000*
Eigenvalue Test	H_0: r=1	23.67	14.26	0.001*
(λ_{max})	H_0: r=2	0.465	3.841	0.495

Note: r stands for the number of cointegrating vectors among the time series variables. *, **, and *** show 1%, 5%, and 10% levels of significance respectively. Both the Trace test and the Max-eigenvalue test indicate 2 cointegrating equations at the 1% level of significance.

Table 5. The Johansen's Cointegration Test for India- the UAE

Likelihood Ratio Tests	Null Hypothesis	Test Statistic	Critical Values at 0.05 level	Probability value
VAR Lag: 8				
Trace Test (λtrace)	H_0: r=0	21.84	29.79	0.307
	H_0: r≤1	9.148	15.49	0.351
	H_0: r≤2	0.587	3.841	0.443
Maximum	H_0: r=0	12.69	21.13	0.480
Eigenvalue Test	H_0: r=1	8.560	14.26	0.324
(λmax)	H_0: r=2	0.587	3.841	0.443

Note: r stands for the number of cointegrating vectors among the time series variables. Both the Trace test and the Max-eigenvalue test indicate no cointegrating equation at the 5% level of significance.

The findings of the Johansen test of cointegration for India and Saudi Arabia have been depicted in Table 6 which clearly exhibits that at conventional significant levels, the null hypothesis of no cointegration between nominal bilateral exchange rate and relative price indices can be rejected as per the outcomes of both the maximum eigen statistic and the trace statistic.

Table 6. The Johansen's Cointegration Test for India- Saudi Arabia

Likelihood Ratio Tests	Null Hypothesis	Test Statistic	Critical Values at 0.05 level	Probability value
VAR Lag: 8				
Trace Test (λtrace)	H_0: r=0	49.09	29.79	0.001*
	H_0: r≤1	20.26	15.49	0.008*
	H_0: r≤2	0.136	3.841	0.711
Maximum	H_0: r=0	28.82	21.13	0.003*
Eigenvalue Test	H_0: r=1	20.13	14.26	0.005*
(λmax)	H_0: r=2	0.136	3.841	0.711

Note: r stands for the number of cointegrating vectors among the time series variables. *, **, and *** show 1%, 5%, and 10% levels of significance respectively. Both the Trace test and the Max-eigenvalue test indicate 2 cointegrating equations at the 1% level of significance.

The results highlight that the variables are cointegrated with at least two cointegrating vectors. Consequently, it confirms the presence of a long-run relationship between the real exchange rate of India vis-a-vis Saudi Arabia, the CPI of India, and the CPI of Saudi Arabia, which in turn confirm the existence of the RPPP doctrine between Saudi Arabia and India over the sample period.

6. Conclusion

The study brings out some important facts regarding the evaluation of the Relative Purchasing Power Parity (RPPP) hypothesis for India and its four major trading partners namely the United States, China, the United Arab Emirates (UAE), and Saudi Arabia using monthly time series spanning January 2001 to March 2021. The study attempts to determine how well-developed the economic and trade relations between India and its trading partner nations are through the examination of the RPPP hypothesis. The RPPP existence in India has been analysed by applying standard Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests on the logarithmic form of each country's real exchange rates. The results on four bilateral real exchange rates fail to discover any evidence of RPPP based on Relative Purchasing Power Parity. This failure of RPPP existence may be due to the low power of conventional univariate unit root tests and the proportionate restriction between exchange rates and price indices enforced through unit-root testing of real exchange rates. Hence, Johansen multivariate cointegration test, a more robust tool has been employed further in order to confirm whether RPPP holds between India and each of its trading partners so considered. The stationary tests confirmed that all the series considered are integrated in the same order i.e., I(1).

The findings of the cointegration test reveal a long-run equilibrium relationship between real bilateral exchange rates and relative price levels in almost all considered major trading partner countries in relation to the Indian rupee exchange rate. The only exception where no cointegration has been found is the UAE. To sum up, strong evidence of cointegration and proportionality restriction has been found in three out of four country pairs considered. Hence, RPPP holds in the context of the Indian economy except for the UAE.

This analysis clearly signals that PPP is more likely to exist in nations with deeper financial integration in terms of their import and export relations with India. The existence of RPPP between India and its major trading partners suggested that the Indian economy is well integrated with these economies and arbitrage opportunities do not exist for the considered nations except the UAE. Thus, the study as a whole provided invaluable insight regarding the law of one price as advocated by RPPP theory.

7. Discussion and Implications

PPP is one of the key tools for forecasting exchange rate movements which provides an important insight on the bilateral exchange rates and relative price levels for the

economies being studied. For instance, it aids arbitrageurs in exploring the arbitrage opportunities.

The study found that trading with the UAE provides arbitrage opportunities since RPPP does not hold for India-UAE bilateral exchange rates and a further search of the UAE market could lead the Indian traders to trade in such items that offer gains and similarly the UAE traders could also book profits through trading with India.

However, care should be taken while assessing profits due to misalignment in prices of goods traded between two nations since PPP relies on zero transportation cost and the absence of differential for taxes applicable between two markets. These factors such as high transportation costs, substantial tax differential, and import tariffs may pose a challenge for profit seekers. Further, the relative competitive strength of the trading countries often reflects relative profit opportunities for the goods traded that could also be considered to evaluate trade decisions.

Although, PPP analysis equips the investors, policymakers, and traders with a powerful mechanism to estimate the values of international trade and make an assessment regarding relative trade competitiveness in the international market simultaneously assumptions of PPP, particularly regarding the absence of transportation costs, import barriers, and tax implications, should be given due thought for sound investment and trade decision.

References

Acaravci, S. K., & Acaravci, A. (2007). Purchasing Power Parity Under the Current Float. *International Research Journal of Finance and Economics*, *10*, 167–174. https://doi.org/10.2139/ssrn.1395924

Alba, J. D., & Park, D. (2003). Purchasing Power Parity in Developing Countries: Multi-Period Evidence Under the Current Float. *World Development*, *31*(12), 2049–2060. https://doi.org/10.1016/j.worlddev.2003.06.008

Al-Rabbaie, A., & Hunt, L. (2004). *Panel unit roots and Cointegration: Evidence for OECD energy Demand*. IEEE European Conference.

Apte, P., Kane, M., & Sercu, P. (1994). Relative PPP in the medium run. *Journal of International Money and Finance*, *13*(5), 602–622. https://doi.org/10.1016/0261-5606(94)90008-6

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, *74*(366a), 427–431. https://doi.org/10.1080/01621459.1979.10482531

Findreng, J. H. (2014). Relative Purchasing Power Parity and the European Monetary Union: Evidence from Eastern Europe. *Economics & Sociology*, *7*(1), 22–38. https://doi.org/10.14254/2071-789X.2014/7-1/3

Hoque, A., & Banerjee, R. (2014). The Stationarity of South Asian Real Exchange Rates Allowing for Structural Breaks. *Australasian Accounting, Business and Finance Journal*, *8*(3), 45–54. https://doi.org/10.14453/aabfj.v8i3.4

Jiranyakul, K., & Batavia, B. (2009). Does Purchasing power parity holds in Thailand? *International Journal of Applied Economics & Econometrics*, *17*(3), 268–280.

https://mpra.ub.uni-muenchen.de/47032/

Johansen, S., & Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration- with application to the demand for money. *Oxford Bulletin of Economics and Statistics*, *52*(2), 169–210. https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x

Kasem, J., & Al-Gasaymeh, A. (2022). A Cointegration analysis for the validity of Purchasing Power Parity: Evidence from Middle East countries. *International Journal of Technology, Innovation and Management (IJTIM)*, *2*(1), 54–67. https://doi.org/10.54489/ijtim.v2i1.60

Lumsdaine, R.L., & Papell, D.H. (1997). Multiple trend breaks and the unit root hypothesis. *Review of Economics and Statistics,* 79(2), 212-218. https://doi.org/10.1162/003465397556791

Narayan, P. K. (2005). New evidence on purchasing power parity from 17 OECD countries. *Applied Economics*, *37*(9), 1063–1071. https://doi.org/10.1080/00036840500081713

Ozdogan, Z. (2022). An Analysis of Exchange Rate Pass-Through to Domestic Prices: Evidence from Turkey. *Eurasian Journal of Business and Economics*, *15*(29), 67–86. https://doi.org/10.17015/ejbe.2022.029.05

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335–346. https://doi.org/10.1093/biomet/75.2.335

Sharma, A., Rishad, A., & Gupta, S. (2019). Measuring the Impact of Oil Prices and Exchange Rate Shocks on Inflation: Evidence from India. *Eurasian Journal of Business and Economics*, *12*(24), 45–64. https://doi.org/10.17015/ejbe.2019.024.03

Shim, H., Kim, H., Kim, S., & Ryu, D. (2015). Testing the relative purchasing power parity hypothesis: The case of Korea. *Applied Economics*, *48*(25), 1–13. https://doi.org/10.1080/00036846.2015.1119795

Simpson, M. W., & Grossmann, A. (2011). Can a relative purchasing power parity-based model outperform a random walk in forecasting short-term exchange rates? *International Journal of Finance & Economics*, *16*(4), 375–392. https://doi.org/10.1002/ijfe.435

Suranovic, S. (1997). *Introduction to Purchasing Power Parity (PPP) Chapter 30*.

Taylor, M. P. (2006). Real exchange rates and Purchasing Power Parity: Mean-reversion in economic thought. *Applied Financial Economics*, *16*(1–2), 1–17. https://doi.org/10.1080/09603100500390067

Yildirim, D. (2017). Empirical investigation of purchasing power parity for Turkey: Evidence from recent nonlinear unit root tests. *Central Bank Review*, *17*(2), 39–45. https://doi.org/10.1016/j.cbrev.2017.03.001

Zhang, S., & Lowinger, T. C. (2006). An empirical test of purchasing power parity in selected developing countries: A panel data approach. *International Economic Journal*, *20*(1), 79–86. https://doi.org/10.1080/10168730500515266

Zivot, E., & Andrews, D.W.K. (1992). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business and Economic Statistics* 10(3), 251-270. https://doi.org/10.1080/07350015.1992.10509904