Purchasing Power Parity in Developing - 8 Countries: Evidence from Time Series Data

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ABSTRACT

Purpose: This study aims to empirically assess the rationality of Purchasing Power Parity (PPP) theory in Developing-8 (D-8) countries. For this purpose, the data of PPP, Consumer Price Index (CPI), and Wholesale Price Index (WPI) were used from 1990 to 2015, with annual frequency.

Methodology: This paper attempted to set up the long-run association between the nominal exchange rate and relative prices as opposed to old investigations. This study applies the ADF, PP, and the recently developed KPSS test to test data stationarity, followed by a cointegration test, granger casualty test, and vector error correction model.

Findings: Time-series properties of this study specify that the real exchange rates are stationary for sample countries, indicating PPP holds in these countries, whereas Cointegration results demonstrate that a strong cointegrating relationship exists among the variables of Bangladesh and Turkey only.

Practical Implications: The findings of the study have some policy implications, which suggest some recommendations for bilateral trade among these countries.

Originality: Findings of the paper suggest that the structure of these developing eight (D-8) countries tends to be less diverse, and fewer economic changes occur than in developed countries.

Limitations: Findings of this paper can vary on a different set of databases depending on the changing pattern of CPI and WPI.

1. Introduction

Purchasing power parity (PPP) delivers a measure of price level disparities across countries which are used to develop the exchange rate determination model. It indicates what drives the exchange rate of a country. PPP implies that the price of similar goods sold in multiple countries should be identical when expressed in a mutual currency, but trade barriers or geographic distances among countries may hamper it. Without arbitrage, there will be no surplus demand for foreign currency, and the foreign exchange rate will have no movement; thus, PPP may not hold in less exposed to trade countries and countries that are geographically far apart (Alba & Papell, 2005).

PPP emphasizes the function of commodities and/or services prices in the direction of exchange rate movements. The two forms of PPP theory are absolute PPP or an intense form of PPP, while another one is relative PPP or a weak form of PPP. The strong form of the PPP is based on the law of one price (LoP), which indicates the attainable quality of indistinguishable goods or services in all business sectors at a similar cost. On the contrary, the weak form of PPP or relative PPP is the

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less preventive form of the theory. The relative version of PPP highlights that the exchange rate should acknowledge a steady adjusted association to the national price levels ratio.

The LoP grips under some stringent assumptions. Firstly, the presence of perfect financial markets without blockades such as tariffs, quotas to global trade. Secondly, the perfectly competitive commodity markets with homogenous commodities. Thirdly, there should be a perfect information market. Moreover, there should not be any transportation costs.

At the point when LoP does not grip, then arbitrages arise. Arbitrage is when the costs of the same products are not indistinguishable in different nation's markets than the arbitrageurs purchase from the lower estimated market and sell at the extravagant market. Thus, the relative PPP says that the inflation discrepancy between the home and the foreign country is equivalent to the percentage change in the (nominal) exchange rate.

The PPP condition assumes no transaction costs because PPP will not hold exactly in the existence of transaction costs. Literature support that PPP grips better for countries with high inflation. This is caused by the fact that in the countries with high inflation, vast magnitudes of inflation crush the relative price effects, while in countries with moderate or low inflation, the drive of individual prices (that is, relative price impacts) dominates the movements of the exchange rate. The cause is that in wealthy nations, the price of non-traded goods is higher. For instance, a medical examination is more expensive in the U.S. than in Bangladesh. The real exchange rate deviation from PPP occurs if the price of non-traded commodities enters the price indices; thus, PPP may not be constant.

Given the context, this paper intends to inspect whether PPP holds in developing eight (D-8) countries, namely Bangladesh, Iran, Indonesia, Malaysia, Egypt, Nigeria, Pakistan, and Turkey, to see whether these economies are open to trade. The significance of the study can be described as follows. First, it uses standard ADF, PP, and KPSS unit root tests for testing data stationarity. Second, since Rogoff (1996) uncovered that PPP differences vanish at an exceptionally loosened up rate, researchers necessitate utilizing a significant stretch data set to recognize mean inversion in the statistics. This paper uses a data set of 26 years for all countries except the WPI data for Nigeria, which is not available. Third, in contrast to the study by Noman and Rahman (2010), the present paper involves the consumer price index (CPI) and wholesale price index (WPI) in light of tradable and non-tradable products correspondingly.

Thus, the rest of the paper has been organized as follows. After this concise overview, a brief review of the literature is introduced in Section 2. Section 3 depicts the methodology of the current study, followed by the results of the data analysis in section 4. Finally, the last section has made concluding remarks with policy implications.

2. Literature Review

First suggested by Cassel (1918), purchasing power parity (PPP) is one of the most experienced theories in the international finance literature. There is ample literature on PPP, and the empirical findings for the PPP hypothesis from the existing literature are mixed. It has developed alongside the econometric literature.

Most of the early research did not get the result in favour of PPP except for the paper of Frenkel (1978), where proof in favour of PPP was found, but that study does not contemplate the chance of the regressors and residuals being non-stationary. Thus, the usual deductions of that study are not proper. However, the contemporary works in PPP can get growing support for the theory and find that low power influences the stability of the real exchange rate in the long run.

The long-run PPP association has been empirically explored using various methods over time to understand its significance in open economy macroeconomic models. Unit root tests are the widely used technique to check the validity of PPP theory. If the real exchange rate of a country holds a unit root, that means there is no equilibrium for the exchange rate in the long run; thus, PPP does not hold.

Confirmatory analysis, a join testing, can be applied to assess the null of stationarity. For example, Nusair (2003) estimates PPP for the Asian financial crisis countries. That paper uses the ADF, PP, and KPSS test to check the data stationarity, and the study gets evidence favouring null stationarity for every country except one country.

Although there is an increasing voluminous literature on testing PPP in developing countries over the last two decades, there is very little literature on validating PPP theory in developing economies. Earlier literature on developing countries predominantly verified by using F-tests, and there are no efforts to investigate the probable reasons for those findings.

In general, the existence of PPP theory from the empirical studies is somewhat mixed (Rogoff, 1996; Taylor & Taylor, 2004). Witnessing that PPP theory is the premise of the economic model for determining the exchange rate, Anorou, Habtu and Yusuf (2005), Dornbusch (1976), and Musa (1982) suggest that nonconformities from PPP arise essentially in the shortrun. The short-run nonconformities are upheld in researches mainly by Frenkel (1978). However, similar conclusions are not established in every case of finding the rationality of PPP theory in the long run. While for example, Meese and Rogoff (1988), Kim (1990), Abuaf and Jorian (1990), Becketti, Hakkio, and Joines (1995), Glen (1992), and Pippenger (1993) find confirmation of the theory in the long run, whereas Ahking (1997) and Cooper (1994) find the opposite result. However, the studies by Baillie and Patrick (1989), Chowdhury and Sdogati (1993), Corbae and Ouliaris (1988), Flynn and Boucher (1993), and Beng (1991) find proof in support of rejecting the hypothesis.

Different researchers use diverse approaches for obtaining desired results. For example, Whitt (1992); Manzur and Ariff (1995) have used Sim tests; Johansen (1988) has employed the maximum likelihood procedure and Monte-Carlo simulations; Ahking (1997) has used the Bayesian unit root approach; Engle and Granger (1987) two-step approach has been used by Huang and Yang (1996) and generalized error correction model has been tested by Lee (1999) using the data of 13 Asian countries. Several studies also test the stationarity of real exchange rates based on the post-Bretton-Woods period information. Notwithstanding, for Eastern European countries, the findings from stationarity tests of real exchange rates are mixed. However, Acaravci and Ozturk (2010), Beirne (2007), Christev and Noorbakhsh (2000), and Thacker (1995) find weak support for the empirical fulfilment of PPP; Cuestas (2009), Mahdavi and Zhou (1994), and Sideris (2006) trace robust indication in favour of PPP.

Philips-Perron cointegration and unit root tests are employed by Thacker (1995) to inspect the validity of PPP theory for Hungary and Poland. The tests are done using data for the period of 1981:1 from 1993:2 and find support in favour of random walk of the exchange rate. However, the paper of Ahmed (2005) finds that PPP does not hold up regardless of whether they depend on capital account in PPP induction. This study likewise finds that just the weak form of PPP in Pakistan does not have many experimental supports among the four countries. For achievement of the scientists level headed, a progression of tests has been utilized – regression-based, non-regression based, and cointegration based.

The study of Ahmad and Marwan (2012) covers sufficiently long periods and provides additional evidence contrary to PPP theory using the data of the East Asian emerging economies. Whereas, the paper of Jayaraman and Choong (2014) examines whether the PPP theory grasps concerning five Pacific Island countries (PICs), namely Samona, Tonga, Fiji, Vanuatu, and the Solomon Islands, using a fixed exchange rate. Their results depict evidence of PPP in the long run for all the sample counties.

The paper of Cuestas (2009) aims to test the evidence of PPP in different Central and Eastern European nations. Two different unit root tests have been used to achieve the paper's goal, and it is evident that PPP grasps in most sample countries considering non-linear deterministic patterns and smooth changes.

The study of Hoque and Banerjee (2012) investigates the rationality of PPP for four developing economies, namely Bangladesh, India, Pakistan and Sri Lanka, using a 55-year sample. In this study, the researchers do not get proof of long-run PPP and give helpful policy directions in monitoring and safeguarding the exchange rate policies for the growth potential of garment export of these sample nations.

The paper of Islam (2013) utilizes the information on the proportion of GDP deflators and exchange rate of Bangladesh and India from 1971 to 2011 to rationalize the existence of the PPP hypothesis between these two nations. That study does not find any causal relationship using the Granger causality test, which needs to be addressed to ensure the exchange rate's soundness and keep up favourable trade relationships dependent on PPP.

Al-Zyoud (2015) paper witnesses the long-run exchange rates between the U.S. dollar and Canadian dollar using the information from 1995-2008 of monthly frequency. The study employs the Engle-Granger cointegration test. The result shows the evidence favouring the absence of a long-run relationship between these two currencies indicating the absence of an absolute form of PPP.

The study of Bahmani-Oskooee, Chang, and Wu (2015) examines whether PPP grasps in transition economies in the long run, using monthly data from 1995 to 2011. Countries considered for the study are Hungary, Bulgaria, Lithuania, the Czech Republic, Romania, Russia, Latvia, and Poland. Panel stationary test has been used in that study which considers sharp breaks as well as smooth shifts. The study's outcome shows the existence of PPP in only two countries, namely Poland and Lithuania.

The study of Abu-Lila and Ghazo (2018) intends to assess the validity of PPP theory in Jordan using the exchange rate data from 1980 to 2017 of their home currency denominated in the US

dollar. The study finds proof in favour of rejecting the PPP theory in Jordan. That outcome is affected by some issues, such as transaction costs, trade obstacles, and price differences between countries.

Finally, it can be concluded from the above literature that there are mixed results in support of the PPP theory both in the short-run and long-run irrespective of developing economies and developed countries. However, there is no study on the developing eight (D-8) countries. In particular, it is a global arrangement to improve the economic position of these counties by enhancing and setting out new open doors in trade relations and upgrading support in decision making at the global level to improve the living standards of these countries. Thus, the researchers of these studies have tested the theory on these established sets of economic cooperation.

3. Methodology

3.1 Theoretical Model

This is a descriptive study that adopts quantitative analysis methods using empirical data. Both regression and non-regression based tests have been utilized in the present study to observe the rationality of the PPP theory. Adopted from the paper of Ahmed (2005), P, P*, and S stand for the home price, foreign price, and nominal exchange rate, respectively. As indicated by PPP theory, it can be written:

$$P_t = S_t P_t* \tag{1}$$

If a fixed exchange rate and the home country is small contrasted with a foreign country, then the home price will be determined by the foreign price. However, it (1) can be written as given below in case of a flexible exchange rate:

$$S_t = P_t / P_t* \tag{2}$$

The above conditions address PPP theory in its absolute form, dealing with absolute price levels, yet the relative version of (1) can be inferred.

Besides, non-regression based indication can be checked by concentrating on visual evidence, such as how consistently the nominal and real exchange rate moves in a similar direction, observing the exchange rate volatility. The real exchange rate can be defined as:

$$Q = SP* / P \tag{3}$$

Rearranging can be as follows:

$$S = QP / P* \tag{4}$$

If PPP grasps, it is anticipated that $Q = 1$ (or a constant) as the movement of nominal exchange rate ought not to impact real exchange rate in a similar direction. If the price ratio P*/P increases, then S should tumble to keep Q constant. However, PPP will not hold if S increases along with an increase in P*/P, which will increase Q.

3.2 Econometric Equation

The objective of the present study is to examine whether PPP holds in D-8 countries. For that purpose, the below econometric model has been used:

$$S_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 P^*_{it} + \varepsilon_{it} \qquad (5)$$

where,

S = Purchasing Power Parity (PPP);

P = Consumer Price Index (CPI);

P* = Wholesale Price Index (WPI);

ε_{it} = random error term;

β_0 represents the constant term in the model; and

β_1 and β_2 indicate the unknown parameters of the model to be estimated.

Also, i = 1, 2, 3, . . ., 8 and t = 1, 2, 3, . . ., 26.

3.3 Type and Source of Data

For this paper, the data used are secondary. Data from 1990 to 2015 has been taken depending on publicly available data to test the theory. The PPP data analyzed in this paper are taken from the International Financial Statistics, International Monetary Fund. The paper uses a similar data set of the sample period for all countries based on data availability. However, the CPI and WPI data were taken from the World Development Indicators database of the World Bank. CPI data of all of these countries are available, but due to the unavailability of data, the WPI data of Nigeria could not be included in the study. Similarly, there are partial data on WPI of Bangladesh and Iran due to data unavailability. However, all of the series were in logarithmic form.

3.4 Data Analysis Technique and Statistical Tools

In this study, data for the unit root test for each sample developing economy include the following: a) the nominal exchange rate against the US dollar; b) the yearly CPI and the yearly WPI of the US dollar as the foreign price index; and c) the yearly CPI and the yearly WPI as the home grown price index. However, to identify whether the PPP theory hold, time series analysis has been conducted using statistical software STATA.

4. Results and Data Analysis

The broad objective of the study is to observe the rationality of the PPP as a long-run equilibrium condition in D-8 countries. The time-series properties of the study have been experimented with to achieve the broad objective of the paper. They have concluded the relationship between the CPI and WPI of each country.

4.1 Unit Root Test of Time Series

Time-series econometrics necessitates an investigation of its properties to find out the long-term relationship among all the variables. It is a must to have non-stationary in levels and stationary in the first differences.

Initially, we have used three standard univariate tests, namely, Augmented Dickey-Fuller (ADF), PP (Phillips and Perron), and KPSS (Kwiatkowski, Phillips, Schmidt, Shin) tests to each

country's data. The table presented below depicts that all three tests indicate data stationarity for these sample countries, implying PPP holds in these countries.

Table 1. Results of the Unit Root Tests

	Level (Constant & trend)			First Difference (Constant & trend)			Remarks
	ADF	PP	KPSS	ADF	PP	KPSS	
PPP							
Bangladesh	-1.60	-1.01	0.35***	-3.67**	-18.30***	0.07	*I*(1)
Egypt	-3.14**	-5.80	0.12	-58.07***	-28.96***	0.10	*I*(1)
Indonesia	-1.39	-2.58	0.44***	-20.64***	-25.23***	0.11	*I*(1)
Iran	-2.05	-3.68	0.27***	-9.352***	-24.21***	0.09	*I*(1)
Malaysia	-1.33	-3.64	0.43***	-102.7***	-24.99***	0.13*	*I*(1)
Nigeria	-1.97	-2.83	0.44***	-4.98***	-24.15***	0.05	*I*(1)
Pakistan	-1.85	-1.10	0.38***	-38.76***	-25.22***	0.13*	*I*(1)
Turkey	-5.34***	-2.43	0.64***	-37.03***	-25.15***	0.13*	*I*(0)/ *I*(1)
CPI							
Bangladesh	2.01	0.51	0.56***	-3.50**	-17.13**	0.08	*I*(1)
Egypt	-0.36	-0.15	0.38***	-52.77***	-26.04***	0.10	*I*(1)
Indonesia	-1.45	-0.78	0.51***	-16.63***	-24.87***	0.15*	*I*(1)
Iran	-1.29	-0.37	0.38***	-52.24***	-24.74***	0.12*	*I*(1)
Malaysia	-2.59	-0.78	0.39***	-129.2***	-25.24***	0.13*	*I*(1)
Nigeria	-4.36***	-1.92	0.47***	-27.99***	-24.19***	0.12	*I*(0)/ *I*(1)
Pakistan	-0.43	-0.14	0.35***	-57.48***	-25.21***	0.12	*I*(1)
Turkey	-8.30***	-2.08	0.65***	-32.68***	-25.13***	0.14*	*I*(0)/ *I*(1)
WPI							
Bangladesh	-9.26***	-3.11	0.21**	-2.31	-8.60	0.09	*I*(0)/ *I*(1)
Egypt	-0.67	-0.41	0.342***	-2.68*	-22.17***	0.11	*I*(1)
Indonesia	-0.82	-0.63	0.34***	-2.58	-25.58***	0.09	*I*(1)
Iran	-3.74**	-1.36	0.43***	-2.88	-19.31***	0.15*	*I*(1)
Malaysia	-1.05	-0.91	0.138*	-83.89***	-24.94***	0.13*	*I*(1)
Nigeria							
Pakistan	-0.69	-0.31	0.32***	-44.62***	-24.69***	0.14	*I*(1)
Turkey	-7.26***	-2.05	.65***	-31.37***	-24.98***	0.14*	*I*(0)/ *I*(1)

Note: *, ** and *** imply that the coefficient is significant at 10, 5 and 1 per cent level, respectively

Source: Authors' Calculation

In an earlier study, Liew, Baharumshah and Chong (2004) used KPSS, a non-linear stationary test, and ADF test on quarterly data for eleven Asian economies to examine the data stationarity and find evidence favouring PPP. Again, the paper of Olayungbo (2011) examines the rationality of PPP theory in sixteen selected sub-Saharan African countries using this traditional ADF test with a data set of the year starting from 1980 to 2005. The univariate ADF unit-root test exposes the presence of

unit root in the chosen real exchange rate series of all the selected sub-Saharan countries except Ghana and Uganda.

4.2 Cointegration Test

Determining the maximum order of vector autoregression (VAR) is essential for cointegration analysis. The results presented below demonstrate that a strong cointegrating relationship exists among the variables of Bangladesh and Turkey only. This table also shows that there is another cointegrating relationship among the variables of Indonesia in a weaker form.

Table 2. Results of Country-Level Cointegration Test

Country	Maximum Rank	Eigenvalue	Trace Statistic	5% Critical Value
Bangladesh	0	-0.895	24.395	15.41
	1		6.330	3.76
Egypt	0	-0.363	10.550	15.41
	1		0.189	3.76
Indonesia	0	-0.302	14.337	15.41
	1		5.723	3.76
Iran	0	-0.519	14.284	15.41
	1		2.586	3.76
Malaysia	0	-0.399	15.405	15.41
	1		3.183	3.76
Nigeria	0			15.41
	1			3.76
Pakistan	0	-0.383	11.977	15.41
	1		0.394	3.76
Turkey	0	-0.393	21.511	15.41
	1		9.520	3.76

Source: Authors' Calculation

PPP between Romania, Russia and Slovenia, United States and Poland is confirmed using fractional and Harris-Inder cointegration test methods and the evidence of (relative) PPP in the paper of Choudhry (1999). He finds very little confirmation in favour of strict (absolute) in Russian and Slovenian data.

However, from the analysis of the present paper, we can see that there are three significant long-run cointegrating relationships among the D-8 countries; we next move to the granger causality test to find if there is any significant indication in favour of PPP theory over the short run for these sample countries.

4.3 Granger Causality

Granger causality test has been employed to conclude whether one time series is significant in predicting another. The test is based on the following regressions:

$$Y_t = \beta_0 + \sum_{k-1}^{M} \beta_k \ Y_{t-k} + \sum_{l=1}^{N} \alpha_l \ X_{t-1} + u_t \tag{6}$$

$$X_t = \gamma_0 + \sum_{k-1}^{M} \gamma_k \, X_{t-k} + \sum_{l=1}^{N} \partial_l \, Y_{t-1} + \nu_t \tag{7}$$

Where Y_t and X_t are the variables which will be tested, and u_t and ν_t are mutually uncorrelated errors, and t denotes the time period, and 'k' and 'l' are the number of lags.

Table 3. Granger Causality Tests of D-8 Countries

	H_0: PPP does not Granger-cause CPI		H_0: CPI does not Granger-cause PPP		H_0: PPP does not Granger-cause WPI		H_0: WPI does not Granger-cause PPP		H_0: CPI does not Granger-cause WPI		H_0: WPI does not Granger-cause CPI	
	F	χ^2	F	χ^2	F	χ^2	F	χ^2	F	χ^2	F	χ^2
Bangladesh	0.26	0.30	0.11	0.13	0.31	0.46	0.00	0.01	0.06	0.09	4.06	6.10
Egypt	0.00	0.01	5.04**	5.73**	0.52	0.60	5.26**	6.01**	1.05	1.60	16.58	18.95
Indonesia	0.70	0.80	0.72	0.81	0.06	0.06	0.37	0.42	3.14**	3.56**	0.38	0.43
Iran	0.93	1.06	3.43*	3.89**	12.19**	14.80**	1.81	2.20	0.12	0.15	0.93	1.12
Malaysia	3.11*	3.54*	0.95	1.08	0.13	0.15	0.35	0.40	0.57	0.65	4.37**	4.97**
Nigeria	0.90	1.02	1.44	1.63								
Pakistan	6.74**	7.66**	4.33**	4.92**	0.87	0.98	4.04*	4.59**	0.11	0.12	2.09	2.37
Turkey	16.97**	19.28***	1.89	2.15	19.98**	22.70***	3.16*	3.59*	5.20**	5.91**	3.09*	3.51*

Note: *, ** and *** imply that the coefficient is significant at 10, 5 and 1 per cent level, respectively

Source: Authors' Calculation

From the results reported in the above table of the Granger causality test, it can be inferred that only CPI data can be used to forecast WPI data of Indonesia, whereas WPI data can be used to predict CPI data of Malaysia. Only Turkey data of CPI and WPI influences both, while there is strong evidence of the absence of PPP for the rest of the sample countries.

The paper of Janjua and Ahmad (2006) also applies Engle-Granger cointegrating relationship for four South Asian countries using the data from 1984 to 2002 in monthly frequency where the outcomes indicate the weaker form of PPP only in the case of Pakistan and a strong sign of the lack of PPP for Bangladesh.

4.4 Vector Error Correction Model (VECM)

A causal relationship can be predicted by assessing the Vector Error Correction Model (VECM) among the sample variables if at least one cointegrating relationship exists among those variables. If cointegration is recognized among the variables, then the ECM framework is ideal for analysis because it signals evidence of the speed of adjustment towards short-run equilibrium. Moreover, it also avoids the forged regression issue (Engle and Granger, 1987). In this study, the pertinent short-run VECM equation with a lag length p can be modelled as follows, and each of the following equations can be estimated.

$$\Delta PPP_t = \alpha_1 + \sum_{j=1}^{k} \beta_j^1 \Delta PPP_{t-j} + \sum_{j=1}^{k} \gamma_j^1 \Delta CPI_{t-j} + \sum_{j=1}^{k} \theta_j^1 \Delta WPI_{t-j} + \sum_{j=1}^{k} \omega_j^1 \Delta ECT_{t-j} + u_{1t} \tag{8}$$

$$\Delta CPI_t = \alpha_2 + \sum_{j=1}^{k} \beta_j^2 \Delta CPI_{t-j} + \sum_{j=1}^{k} \gamma_j^2 \Delta PPP_{t-j} + \sum_{j=1}^{k} \theta_j^2 \Delta WPI_{t-j} + \sum_{j=1}^{k} \omega_j^2 \Delta ECT_{t-j} + u_{2t} \qquad (9)$$

$$\Delta WPI_t = \alpha_3 + \sum_{j=1}^{k} \beta_j^3 \Delta WPI_{t-j} + \sum_{j=1}^{k} \gamma_j^3 \Delta PPP_{t-j} + \sum_{j=1}^{k} \theta_j^3 \Delta CPI_{t-j} + \sum_{j=1}^{k} \omega_j^3 \Delta ECT_{t-j} + u_{3t} \qquad (10)$$

$$\Delta ECT_t = \alpha_4 + \sum_{j=1}^{k} \beta_j^4 \Delta PPP_{t-j} + \sum_{j=1}^{k} \gamma_j^4 \Delta CPI_{t-j} + \sum_{j=1}^{k} \theta_j^4 \Delta WPI_{t-j} + \sum_{j=1}^{k} \omega_j^4 \Delta ECT_{t-j} + u_{4t} \qquad (11)$$

where *ECT* denotes the error-correction term(s) resulting from the long-run cointegrating relationship via the Johansen maximum likelihood method. Also, where α_1, α_2, α_3, and α_4 represent short-run elasticities.

Table 4. Results of Vector Error Correction Model

		Bangladesh	Egypt	Indonesia	Iran	Malaysia	Pakistan	Turkey
ΔPPP	CE1	-0.985***	.023	-.155	-1.11***	-.123	.029	-.132
		(0.138)	(.039)	(.230)	(.179)	(.079)	(.059)	(.107)
	ΔPPP(-1)	1.042***	.223	1.333**	.303**	.067	.245	-.456
		(.149)	(.288)	(.596)	(.118)	(.260)	(.274)	(.548)
	ΔCPI(-1)	.989***	-.371	-5.366**	10.041**	3.720	.390	2.365
		(.150)	(.567)	(2.425)	(3.804)	(2.437)	(.970)	(1.544)
	ΔWPI(-1)	-1.050***	.010	.471	-5.976**	.279	.111	-.105
		(.167)	(.531)	(1.281)	(2.613)	(.968)	(.683)	(1.630)
	Constant	.017*	.091**	.065	-.0001	.014	.008	-.002
		(.009)	(.044)	(.460)	(.423)	(.063)	(.038)	(.079)
ΔCPI	CE1	.511***	-.067***	.018	.006	.020**	.049**	.012
		(.140)	(.012)	(.075)	(.028)	(.010)	(.028)	(.045)
	ΔPPP(-1)	-.583***	.379***	.423**	.030	.024	-.127	.114
		(.151)	(.094)	(.194)	(.018)	(.033)	(.133)	(.232)
	ΔCPI(-1)	.441**	.302	-1.131	.590	-.473	.112	1.527**
		(.153)	(.184)	(.792)	(.604)	(.311)	(.473)	(.653)
	ΔWPI(-1)	.058	-.607***	-.008	-.125	-.025	.462	-.773
		(.170)	(.173)	(.418)	(.414)	(.123)	(.333)	(.689)
	Constant	.032**	.001	.177	.104	.014**	.017	-.011
		(.009)	(.014)	(.150)	(.067)	(.008)	(.018)	(.033)
ΔWPI	CE1	.394**	-.070**	-.124	-.019	.041	.143**	-.033
		(.151)	(.031)	(.129)	(.045)	(.035)	(.046)	(.058)
	ΔPPP(-1)	-.198	.584**	.683**	.056	-.047	-.347	.014
		(.164)	(.232)	(.334)	(.030)	(.115)	(.214)	(.300)
	ΔCPI(-1)	-.360**	-.088	-1.751	.694	-3.477**	-.623	1.050
		(.165)	(.456)	(1.361)	(.966)	(1.078)	(.757)	(.847)
	ΔWPI(-1)	993***	-.770**	.031	.115	.318	1.098**	-.095
		(.183)	(.427)	(.719)	(.663)	(.428)	(.533)	(.894)
	Constant	.001	.028	-.055	.041	.037	-.007	.003
		(.010)	(.035)	(.258)	(.107)	(.028)	(.030)	(.043)
Highest lag order:		Bangladesh	Egypt	Indonesia	Iran	Malaysia	Pakistan	Turkey
		3	2	1	1	1	1	3

Notes: CE1 = Error correction term in the equation;

Identification: beta is exactly identified;

Maximum lag selected using Akaike Information Criterion (AIC) and the Schwarz Bayesian Information Criterion (SIC/BIC/SBIC)

Source: Authors' Calculation

A negative error correction coefficient denotes that in the event of an affirmative deviation of the model from the long-run equilibrium, in the absence of variation in the independent variables is corrected by changes in the dependent variable. Results reported in the table on the previous page confirm the existence of PPP in Bangladesh, Egypt, and Malaysia in the short run.

5. Conclusion

The principal motivation behind this study has been to analyze the existence of Purchasing Power Parity (PPP) theory in developing eight economies. This motive has been achieved by conducting a series of tests – linear and non-linear assumptions of unit root test and cointegration. Since the exhibition of unit-root tests, the distinctive test has been applied, but these have not provided consistent results favouring the theory. We have used different time series approaches for these eight developing countries from 1990 to 2015. The time-series approach was chosen to test the theory as some other studies, such as Arize, Malindretos, and Grivoyannis (2004), have used this to examine the validity of the theory in the longrun.

Time-series properties (ADF, PP, and KPSS) of the study demonstrate that the real exchange rates are stationary for these economies, inferring PPP grasp in these economies. As opposed to the unit root test, Cointegration tests reveal that a strong cointegrating relationship exists among these variables of Bangladesh and Turkey only. Also, there is another cointegrating relationship among the variables of Indonesia in a weaker form.

The Granger causality test infers a strong sign of the absence of PPP for all the sample countries except Indonesia and Turkey. Finally, the Error correction coefficient affirms the short-run relationship of Bangladesh, Egypt and Malaysia.

The findings of this study have some significant policy implications. The policy-makers ought to know that purchasing power parity ought not to be used as a means of exchange rate determination; further, it ought not to be utilized as a means of price determination in the developing economies. The development of a price index with befitting weight on traded commodities deserves consideration in developing economies.

Specification of suitable price index, changes in demand structure, changes in productivity, monetary development, and institutional and structural obstacles to competitive markets are a few elements influencing PPP in developing countries. Government intervention and trade restrictions of the countries also significantly impact hold or deviate from PPP. Holding PPP in these developing countries indicates that it will be less assorted, and there are fewer economic changes than that of developed economies. Holding PPP in these countries also demonstrates how these currencies appear to have a long-run equilibrium value to which they can relapse.

The findings of our paper are similar to Telatar and Hasanov (2009), where PPP holds in those set of twelve Central and Eastern European countries (CEECs). In contrast, it is contrary to the study of Janjua and Ahmad (2006), where they found weak evidence on the set of four South Asian countries.

References

Abuaf, N., & Jorion, P. (1990). Purchasing Power Parity in the Long Run. *Journal of Finance, 45*(1), 157-174.doi:10.1111/j.1540-6261.1990.tb05085.x

Abu-Lila, Z., & Ghazo, A. (2018). Testing the Validity of Purchasing Power Parity for the Jordanian Economy. *International Journal of Academic Research in Economics and Management Sciences, 7*(4), 192–200. doi: 10.6007/IJAREMS/v7-i4/5418

Acaravci, A. & Ozturk, I. (2010). Testing Purchasing Power Parity in Transition Countries: Evidence from Structural Breaks. *Economic Interferences, 12*(27), 190–198.

Ahking, F. W. (1997). Testing long-run purchasing power parity with a Bayesian Unit Root Approach: The experience of Canada in the 1950s. *Applied Economics*, *29*(6), 813–819. doi:10.1080/000368497326732

Ahmad, M., & Marwan, N. F. (2012). Purchasing Power Parity Theory in Three East Asian Economies: A New Evidence. *MPRA Paper No. 42159, Universiti Teknologi MARA*.

Ahmed, M. (2005). Purchasing power parity based on capital account, exchange rate volatility and cointegration: evidence from some developing countries. *Applied Econometrics and International Development, 5*(3), 105-116.

Alba, J. D., & Papell, D. H. (2007). Purchasing power parity and country characteristics: Evidence from panel data tests. *Journal of Development Economics*, *83*(1), 240–251.doi:10.1016/j.jdeveco.2005.09.006

Al-Zyoud, H. (2015). An empirical test of purchasing power parity theory for Canadian dollar-US dollar exchange rates. *International Journal of Economics and Finance*, *7*(3). doi.org/10.5539/ijef.v7n3p233

Anoruo, E., Braha, H., & Ahmad, Y. (2002). Purchasing power parity: Evidence from developing countries. *International Advances in Economic Research*, *8*(2), 85–96. doi:10.1007/bf02295339

Arize, A. C., Malindretos, J., & Grivoyannis, E. C. (2004). Purchasing power parity in developing countries: Evidence from conventional and Fractional Cointegration tests. *International Journal of Banking and Finance. 2*(1), 29-43. doi: 10.32890/ijbf2004.2.1.8343

Bahmani-Oskooee, M., Chang, T., & Wu, T. (2014). Revisiting purchasing power parity in African countries: Panel stationary test with sharp and smooth breaks. *Applied Financial Economics*, *24*(22), 1429–1438. doi:10.1080/09603107.2014.925068

Baillie, R., & Patrick, M. (1989). The Foreign Exchange Market: Theory and Econometric Evidence. *Cambridge: Cambridge University Press*.

Becketti, S., Hakkio, C., & Joines, D. (1995). Exchange rates in the long run. *Working Paper No.95, Federal Reserve Bank of Kansas City*.

Beirne, J. (2007, May). Purchasing power parity in the European Union: A cointegrated approach and transition economies. In: *European Economics and Finance Society, 6th Annual Meeting of the EEFS International Conference. Sofia, Bulgaria*.

Beng, G. W. (1991). On the deviations from purchasing power parity: The case of the ringgit effective exchange rate. *Applied Economics, 23*(9), 1461-1471. doi:10.1080/00036849100000197

Cassel, G. (1918). Abnormal deviations in international exchanges. *The Economic Journal*, *28*(112), 413. doi:10.2307/2223329

Choudhry, T. (1999). Purchasing power parity in high-inflation Eastern European countries: Evidence from fractional and Harris-Inder Cointegration tests. *Journal of Macroeconomics*, *21*(2), 293–308. doi: 10.1016/s0164-0704(99)00104-4

Chowdhury, A. R., & Sdogati, F. (1993). Purchasing power parity in the major EMS countries: The role of Price and exchange rate adjustment. *Journal of Macroeconomics,15*(1), 25-45. doi:10.1016/0164-0704(93)90051-m

Christev, A., & Noorbakhsh, A. (2000). Long-run purchasing power parity, prices and exchange rates in transition. *Global Finance Journal,11*(1-2), 87-108. doi:10.1016/s1044-0283(00)00016-8

Cooper, J. C. (1994). Purchasing power parity: A cointegration analysis of the Australian, New Zealand and Singaporean currencies. *Applied Economics Letters,1*(10), 167-171. doi:10.1080/135048594357934

Corbae, D., & Ouliaris, S. (1988). Cointegration and tests of purchasing power parity. *The Review of Economics and Statistics,70*(3), 508. doi:10.2307/1926790

Cuestas, J. C. (2009). Purchasing power parity in central and Eastern European countries: An analysis of unit roots and nonlinearities. *Applied Economics Letters,16*(1), 87-94. doi:10.1080/13504850802112252

Dornbusch, R. (1976). Expectations and Exchange Rate Dynamics, *Journal of Political Economy*, *84*, 1161–1176.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica,55*(2), 251. doi:10.2307/1913236

Flynn, N.A., & Boucher, J. L. (1993). Tests of long-run purchasing power parity using alternative methodologies. *Journal of Macroeconomics,15*(1), 109-122. doi:10.1016/0164-0704(93)90055-q

Frenkel, J. A. (1978). Purchasing Power Parity: Doctrinal Perspective and Evidence from the 1920s. *Journal of International Economics*, *8*, 169−191.

Glen, J. D. (1992). Real exchange rates in the short, medium, and Long Run. *Journal of International Economics,33*(1-2), 147-166. doi:10.1016/0022-1996(92)90054-n

Hoque, A., & Banerjee, R. (2012). Does purchasing power parity hold for garment export-oriented developing countries? *Procedia - Social and Behavioral Sciences,65*, 8-13. doi:10.1016/j.sbspro.2012.11.083

Huang, B., & Yang, C. W. (1996). Long-run Purchasing Power Parity Revisited: A Monte Carlo Simulation. *Applied Economics,28*(8), 967-974. doi:10.1080/000368496328092

Islam, S. (2013). Testing the Existence of Purchasing Power Parity in Bilateral Trade between Bangladesh and India. *Bangladesh Development Studies, 36*(1), 121-132.

Janjua, S. A., & Ahmad, E. (2006). Tests of Purchasing Power Parity for South Asian Countries. *Pakistan Economic and Social Review, 44*(2), 235-243.

Jayaraman, T. K., & Choong, C. K. (2014). Purchasing Power Parity Theory and Its Validity in Pacific Island Countries. *Bank of Valletta Review*, *48*, 1-13.

Johansen, S. (1988). Statistical Analysis of Co-integration Vectors. *Journal of Economic Dynamics and Control*, *12*, 231–254.

Kim, Y. (1990). Purchasing power parity in the long run: A cointegration approach. *Journal of Money, Credit and Banking,22*(4), 491. doi:10.2307/1992433

Lee, D. Y. (1999). Purchasing power parity and dynamic error correction. *International Review of Economics & Finance,8*(2), 199-212. doi:10.1016/s1059-0560(99)00015-5

Liew K. S., Baharumshah A. Z., & Chong T. L. (2004). Are Asian Real Exchange Rates Stationary? *Economics Letters*, *83*, 313–316.doi:10.1016/j.econlet.2003.10.021

Mahdavi, S., & Zhou, S. (1994). Purchasing power parity in high-inflation countries: Further evidence. *Journal of Macroeconomics,16*(3), 403-422. doi:10.1016/0164-0704(94)90014-0

Manzur, M., & Ariff, M. (1995). Purchasing power parity: New methods and extensions. *Applied Financial Economics,5*(1), 19-26. doi:10.1080/758527667

Meese, R. A., & Rogoff, K. (1988). Was it Real? The Exchange Rate-Interest Differential Relation over the Modern Floating- Rate Period. *Journal of Finance*, *43*, 933-948. doi:10.1111/j.1540-6261.1988.tb02613.x

Musa, M. (1982). Model of Exchange Rate Dynamics, *Journal of Political Economy, 90*(2), 74-104.

Noman, A. M., & Rahman, M. Z. (2010). Stationarity of South Asian real exchange rates under Exponential Star (ESTAR) framework. *Journal of Developing Areas*, *43*, 41-50. doi:10.1353/jda.0.0068

Nusair, S.A. (2003). Testing the validity of purchasing power parity for Asian countries. *Journal of Economic Development*, *28*(2), 129-147.

Olayungbo, D. O. (2011). Purchasing Power Parity in Selected Sub-Saharan African Countries: Evidence from Panel Unit-Root Tests. *Journal of Emerging Trends in Economics and Management Sciences (JETEMS)*, *2*(4), 270-274.

Pippenger, M. (1993). Cointegration test of purchasing power parity: the case of Swiss exchange rate. *Journal of International Money and Finance*, *12*, 46-61.

Rogoff, K. (1996). The Purchasing Power Parity Puzzle. *Journal of Economic Literature*, *34*, 647-668.

Sideris, D. (2006). Purchasing power parity in economies in transition: Evidence from Central and East European countries. *Applied Financial Economics,16*(1-2), 135-143. doi:10.1080/09603100500390141

Taylor, A. M., & Taylor, M. P. (2004). The Purchasing Power Parity Debate. *Journal of Economic Perspectives, 18*(4), 135-158. doi:10.3386/w10607

Telatar, E., & Hasanov, M. (2009). Purchasing power parity in Central and East European countries. *Eastern European Economics,47*(5), 25-41. doi:10.2753/eee0012-8775470502

Thacker, N. (1995). Does PPP hold in the transition economies? The case of Poland and Hungary. *Applied Economics,27*(6), 477-481. doi:10.1080/00036849500000134

Whitt, J. A. (1992). The long-run behaviour of the real exchange rate: A reconsideration. *Journal of Money, Credit and Banking, 24*(1), 72. doi:10.2307/1992792

Appendix

Sources of Data:

Variable	Description	Units	Source
PPP	Home currency per U.S. Dollar at year end	Yearly data	International Financial Statistics (IFS)
CPI	Domestic Price	Yearly percentage	World Development Indicators (WDI)
WPI	Foreign Price		