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PURCHASING POWER PARITY HOLD IN MAJOR SAARC COUNTRIES? PANEL COINTEGRATION ANALYSIS

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ABSTRACT

In an effort to provide a better understanding of the large variation in price levels between countries, this paper examines the validity of the purchasing power parity (PPP) hypothesis using monthly data of SAARC countries over the period of 2000-2017. We utilized four econometric tests to examine the existence of this hypothesis in the understudy region. Panel results show that PPP seems to be moderately held in a panel of SAARC, while in the country by country analysis we find partial support of PPP for all economies. We also find that the price and exchange rate have a long-run relationship while ECM analysis shows that the exchange rate and price differential are correlated in the short run, and price and exchange rate have bidirectional causality relationship. In addition, the dummy variable analysis shows that the Global Financial Crisis 2007-08 significantly affect the SAARC countries exchange rate in terms of depreciation. However, these types of external shocks do not have any permanent effect on the real exchange rate and other things remaining the same, no active policy intervention is warranted for the sustainability of external balance.

Contribution/Originality: This contributes to the existing literature by estimating the long-run parameters and short-run dynamics to check the speed of adjustments towards the long-run equilibrium.

1. INTRODUCTION

Exchange rate plays a fundamental role in international economics. The exchange rate assists in furnishing a key link both in goods and assets market amongst a country and the rest of the world. Inadequate exchange rate policy peril misrepresents in trade openings, causing a misallocation of resources. There are certain factors which determine exchange rates and all these factors are interrelated with financial transactions and international trade between the two countries. The country which depends upon its external trade has more chances of currency fluctuations which can affect its economy. The uncertainty of exchange rate can sometimes have opposing effects on financial stability. Exchange rates are relative and are stated as an association of the currencies of two countries.

The Purchasing Power Parity (PPP) remains a fundamental base of several exchange rate theories in international finance. The concept of PPP has a very long rational history and can be linked with the 16th-century fictions of scholars from the Salamanca University Spain. The modern principle of PPP normally credited to Cassel (1916) is quite native which is, PPP postulates that the exchange rate among two countries must be equal to the proportion of two related price levels. Otherwise, if we unite the nominal exchange rate and relative prices to get the real exchange rate, this novel ration should meet to its mean value, in the long run, to hold for PPP. Hence, a

real exchange rate which is non-stationary disconfirms the PPP which means that there is no relationship between the nominal exchange rate domestic and foreign prices in the long run. PPP is often expressed in terms of the real exchange rate which stated that purchasing power of a currency relative to another at the currency exchange rate and prices. The determination of the real exchange rate is frequently used to accomplish the legitimacy of PPP. The real exchange rate is constant if PPP holds continuously.

PPP is a major building block of most exchange rate determination models in international economics. Thus the significance of these models and their policy implications critically depends on the legitimacy of PPP. PPP is used to compare the stages of development and economic performance of individual countries. This is because the PPP rate is not subject to extreme fluctuations (on a daily basis), but usually only changes (marginally) for years. It can also help in determining economic trends in the exchange rate in the long run because exchange rates tend to move in the direction of the PPP exchange rate. PPP can be used to determine the living standards and developments of countries and it is one of the important features of PPP. It can serve as a criterion of exchange rate misalignment used to compare national income levels across countries.

Given the importance of PPP theory in an open economy and to build models of exchange rate equilibrium, the PPP in the long-run has been thoroughly analyzed, using different methodologies. In the case of SAARC countries, the majority of the study focused either on the mean-reverting hypothesis or PPP to holds in the long run and short run both in times series and panel data analysis. However, no study has estimated the long-run parameters and short-run dynamics to check the speed of adjustments towards the long-run equilibrium. Furthermore, to the best of our knowledge, no studies have incorporated the effect of the Global Financial crisis on the exchange rate determination. This study covers all such research gaps.

Specified the significance of PPP theory in exchange rate determination, the main goal of this study is to inspect whether exchange rate shows steady vital developments in a panel of selected SAARC countries, namely Pakistan, India, Bangladesh, Sri Lanka, and Nepal. The reason for choosing the SAARC countries is that, after the United States and China, SAARC countries economy is the world's third-largest in terms of GDP (PPP), and fifth in terms of nominal GDP. The SAARC countries containing 3% of the world's surface and contains almost 21% of the world population. SAARC countries comprise about 9.12% of the global economy from 2015. Furthermore, SAARC member countries are divided into two different income group; least developed countries and developing countries. Pakistan, India, and Sri Lanka are included as developing economies and fall in the middle-income group while Bangladesh, Bhutan, Nepal, and the Maldives are included into least developed countries (LDC). There is huge diversity in the member states and also appears diversity in the exchange rate system as well. India, Pakistan, and Sri Lanka have adopted a managed float exchange rate while others have pegged the exchange rate.

Remaining paper is structured is follow. Section 2 provides literature review. Section 3 deals with theoretical framework and estimation technique. Section 5 presents the results. Section 6 concludes the paper with suitable policy implications.

2. LITERATURE REVIEW

An immense number of study has been done on the rationality of the PPP theory. It has developed together with the econometric literature. Since the 1970s, the PPP philosophy has been the query of continuing active debate. During the year 1980, it was claimed that for a long run or in comparative terms PPP does not seem to be valid. The dependence of this conclusion comes out to be on Time-series investigations of key exchange rates by the period between the 1970s and 1980s. Since the 1990s, new dimensions have been explored by using extended time series and higher-frequency data, together with the use of panel data, nonlinear econometric analysis, Cointegration analysis, and long data frequency studies that involved an upsurge in the number of observations included in the regression analysis.

Papell and Prodan (2006) investigated two different varieties of PPP: constant mean reversion and decline in steady trends in the spirit of Cassel, Samuelson, and Balassa methodologies respectively, by employing long frequency data of real exchange rate for industrialized countries. The traditional tests, in former studies, find the evidence of some alternative PPP for nine out of the 16 countries. Evidence of alternative PPP of five countries has detected by using the unit root test when they have structural changes which are restricted. Yearly nominal exchange rates and price indices were used. Price indices are calculated as consumer price index or as GDP deflators. The data was acquired from International Financial Statistics, containing 107 to 129 years of real exchange rates for 16 manufacturing countries, starting between 1870 and 1892 and ending in 1998.

Ahmed (2005) empirically tested PPP grounded on capital account, exchange rate legitimacy, and Cointegration. The main focus of the research is to observe the theory of PPP for developing countries. Quarterly observation has taken for the period 1975: Q1 to 2003: Q4 from India, Pakistan and Bangladesh. Outcomes gained by conducting penalty of tests e.g., regression and non-regression and Cointegration based. The results, in general, do not find any support in favor of PPP. Output also showed that, if we rely on a capital account, PPP still not seems to be valid. Solitary in the case of Pakistan, a relative version of PPP has shown some support in the determination of prices.

Another prominent study conducted by Janjua and Ahmad (2006) examines the PPP by making mean reversion theory, as a base, they applied Engle-Granger co-integrating test to find an association between four South Asian countries employing monthly data of CPI, WPI and the nominal exchange rates for the period 1984 to 2002. The results showed that PPP seems not to be held among any of the South Asian countries. The conclusion of Cointegration analysis directed that PPP holds partially just in case of Pakistan. The validation for Sri Lanka and India is weak while there is strong evidence which showed a lack of PPP for the case of Bangladesh.

Khan and Qayyum (2007) presented the experiential indication on PPP for Pak rupee against USD exchange rate, by applying the bound testing approach from 1982Q2 to 2005Q4 and Johansen n Juselius multivariate co-integration. Final results of the error correction model suggested that in excluding divergence from long-run PPP the nominal exchange rate was positively affecting it. Further analysis showed a huge association of foreign exchange and goods markets incorporation. The major policy insinuation resulting in the conclusion is that the central bank should comprehend the growth of money supply in order to stable the price level and also to decrease the balance of payments deficits.

Zhou *et al.* (2008) examine the PPP hypothesis for the post-Bretton Woods era including the period after the adaptation of the euro. This finding applied a modern nonlinear unit root test to the bilateral real exchange rates (RERs) of both European and other manufacturing countries with the French franc and German mark (and the euro after 1998), also the US dollar as numeric currencies by taking different frequency data from the period 1973 to 2006. For industrial countries, this results provide evidence for PPP than the original studies of bilateral PPP. The PPP looks to hold according to his findings before the adoption euro as currency in the EU. The results also showed that the proof for PPP getting much important including both the European Union and non-European Union countries when the expansion of sample period occurs to the euro era, and conjunction to PPP within the EU countries, particularly amongst the countries of euro-area, turns out that it is linear for the non-EU industrial countries.

Kasman *et al.* (2010) investigated the legitimacy of PPP for the eleven Central and East European changeover states and three of the market economies country, Malta, Turkey, and Cyprus. Dissimilar former studies on PPP, their analysis the structural breaks in the data by applying the test LM unit root. The results revealed that for the case of one and two structural breaks there is a little indication for the validity of PPP, for a U.S dollar-based exchange rate. For a Deutsche mark, an indication of stationary of eight exchange rates was found by considering one and two, both structural breaks. The empirical findings may provide a track for policymakers to organize monetary policies for the process of European monetary integration.

Correspondingly, Kim and Moh (2010) resume the empirical expression of PPP under the present float by circular mean adjustment (RMA). They first smack great strength of the RMA-based test of a unit root in the finite samples relative to the ADF test through Monte Carlo simulations for sixteen autoregressive data generating a process of linear and nonlinear. They originate that RMA based unit root test rejects the null of no stationary for 16 out of 20 floating real exchange rates, where the ADF test rejects five floating exchange rates at 10% level of significance. They also created that the estimation RMA base large confidence interval can provide a valuable clue about the half-life of the exchange rate.

Chang *et al.* (2010) employed a threshold Cointegration test developed by Enders and Siklos (2001) and investigated the characteristics of asymmetric alteration on long-run PPP in G-7 countries using the date from January 1994 and April 2010. While Yahya *et al.* (2011) re-examine the long-run PPP correlation for five Asian countries comparative to US dollars through a period with structural breaks. Results assigned the existence of PPP for all countries with comparative to the USA after permitting for a single break in the last quarter of 1997 and also in 2008. Evidence also gathered that Asian countries have been wedged by the 1997 Asian crisis and the 2008 Global Financial crisis. The results suggested that if structural breaks are present but overlooked, the traditional Johansen process can produce an erroneous result and lead policymakers to make choices which are invaluable.

Chang *et al.* (2012) empirically examine an influential and simple nonlinear unit root test proposed by Sollis (2009) to investigate the legitimacy PPP in a sample of ASEAN countries in the long-run. Results showed that PPP only holds for three ASEAN countries and changing is found to be asymmetric and nonlinear towards PPP. Dimitriou and Simos (2013) empirically measured the strong and weak systems for the United States and Japan of PPP hypothesis over the period of January 2000 to October 2012. Probable structural shifts and breaks were taken into account by employing (Lee and Strazicich, 2004) tests of a unit root. Results showed that a break consistent is not allowed to the start of the United States subprime crisis. Moreover, by employing the Cointegration methodologies of Gregory and Hansen (1996) a partial system of PPP is accepted under DOLS. He concluded that the PPP hypothesis is accepted for the time, the prior United States global financial crisis in equate to the after time.

Likewise, He and Chang (2013) examine the Sequential Panel Selection Method (SPSM), proposed by Chortareas and Kapetanios (2009) to test the legitimacy of long-run PPP for a sample of 14 countries, using real effective exchange rates, for the period 1994 to 2012 both for monthly and quarterly. Empirical results from the SPSM using the Panel KSS unit root test which was proposed by Ucar and Omay (2009) indicated that PPP holds true for most of these transition countries studied. Likewise, Cuestas and Regis (2013) empirical re-examine the PPP in a panel of OECD countries. They applied (Harvey *et al.*, 2008) linearity test and the (Kruse, 2011) nonlinear unit root test. The conclusions of these tests were that the PPP theory holds in a greater number of countries than have been labeled in earlier studies.

Rashid (2013) empirically tested the aspects of the 2008 financial crisis on exchange rate determination in PPP-UIP framework for four emerging countries and used monthly data over the period 1981-2012. Outcomes of this study recommended that the consequence of this new financial crisis guided to modify the role to manage the rate of exchange in the determination of exchange. Also, results suggested that the impacts of the financial crisis are dissimilar over completely four rising countries on the exchange rate. The results were important for policymakers in crafting an operative plan of actions as a mean to decrease the outcomes of the financial crisis on exchange rates. Hoque and Banerjee (2014) mentioned that nonstationary of the real exchange rate in Pakistan, India, Bangladesh, and Sri Lanka over the period 1957-2011 by employing unit root of both multiple and single endogenous structural breaks. He also concluded that there is long-run PPP does not hold in major countries of South Asian.

Arize *et al.* (2015) investigate the Cointegration attribute of exchange rates and prices employing the techniques receiving imperfect attention in numerous studies on the legitimacy of the Purchasing Power Parity (PPP) hypothesis. This also provides an inclusive indication of the PPP hypothesis using monthly data for 1971

through 2011. Besides they explored the symmetry and proportionality conditions in PPP. Additionally, estimates of the short-run dynamics are obtained for all countries, utilizing the ECM. Results showed that there is an existence of long-run PPP from the half-lives and short-run dynamics as well as long-run Cointegration analysis.

Munir and Kok (2015) prove the theory of PPP in five ASEAN countries on monthly data over the period of 1968-2009 by employing Cointegration test of LM (Lagrange multiplier). Results were listed in three points: firstly, the determination by panel stationary trials that seem to be not switching for cross-sectional dependence are supposed to have a clear indication against PPP. Secondly, the indication for monitoring of dependence of cross-sectional opposes PPP on the entire period and periods of pre-financial crisis in 1997 by panel tests. Yet then again, they found adequate grounds to be in favor of PPP in five ASEAN countries after the financial crisis time. Additionally, Bahmani *et al.* (2015) examine whether the long-run PPP holds in transition economies (the Czech Republic, Bulgaria, Latvia, Lithuania, Hungary, Romania, Poland, and Russia) using monthly data over 1995: M1 to 2011: M12 period. Newly presented panel stationary test, considered for sharp breaks and smooth shifts. It indicates that the PPP maintains itself in only two countries.

2.1. Data Sources

This study uses monthly panel data for the period 2000M1 to 2017M12. The variables are as follows. The nominal exchange rate s_{it} is dependent variable and domestic and the foreign price differential $(p-p^*)_{it}$ is the independent variable. The nominal exchange rate has taken as a monthly average for all countries[4]. For the case of Pakistan Consumer Price Index (CPI, 12 major cities all included), for India CPI (industrial workers), for Bangladesh CPI (national 2010=100), for Sri Lanka CPI (Colombo 455 manual worker) and for Nepal CPI (national urban) have taken. For foreign prices, USA CPI (all items city average) have taken. To find price differential $(p-p^*)_{it}$, we subtracted domestic prices from foreign prices using this formula $(p-p^*)_{it}$. All the data have collected from the International Financial Statistics (IFS) 2017 and supplemented the missing values from World Development Indicators (WDI).

3. THEORETICAL FRAMEWORK AND METHODOLOGY

The modern theory of PPP generally accredited to Cassel (1916) is relatively native which is, PPP posits that the exchange rate between two currencies should be identical to the ratio of the two levels of prices related. Otherwise international will intervene in the market and purchase the goods from the cheaper market and sell where prices are high. Law of one price (LOP) states that without tariff, quotas, shipping cost and further trade barriers the identical goods should cost the same when measured in the same currency (Yunus, 2000; Khan and Qayyum, 2007). If prices are different then arbitrager will purchase from the cheaper market and sell where prices are high. The main difference between PPP and LOP is that the former concept refers to the index of prices for different goods and the latter refers to the actual prices. In addition, PPP has two versions, absolute PPP postulates that the exchange rate between two countries will be identical to the relationship between the price levels for these two countries. As in Equation 1:

$$S=\frac{P}{P^*} \qquad (1)$$

Where S is the nominal exchange rate measured in domestic currency units per unit of foreign currency, P represents the domestic price level and P^* represents foreign price. Bhatti (2000) argued that it is difficult to test absolute PPP due to non-availability of similar data on absolute prices through the nations. In order to cope up this

issue, Relative PPP is considered which postulates that exchange change is relative to the ratio of domestic prices in Equation 2:

$$S=\alpha\left[\frac{P}{P^{*}}\right] \qquad (2)$$

Where α represents a constant parameter which accounts for transportation cost and other trade barriers. In logarithmic form, we can represent the above equation in form of Equation 3:

$$s=\alpha+p-p^{*} \qquad (3)$$

Where α represents constant parameter and s, p and p^{*} are logarithmic values of the nominal exchange rate, domestic and foreign prices correspondingly. In absolute PPP, movements in the associated prices, and in exchange rate balance each other to holds the parity condition. While the PPP is relatively less stringent condition and requires only that the ratios of exchange rate deviations are the same as the ratio of the differences in relative prices. PPP principle is an important concept for two main reasons. First and foremost, PPP theory is supposed to be held in monetary theory to determine the exchange rate, therefore PPP expresses the basis for determining the exchange rate. Second, it is one of the naive theory that measures the long-run equilibrium exchange rate. Thus, testing the long-run legitimacy of PPP is important due to these reasons.

The methodology consists of three steps. At the very first step, we employed (Im *et al.*, 2003) panel unit root test to determine for each variable the order of integration. In the second step, we employed a panel Cointegration test proposed by Kao (1999) to examine the long-run relationship between the variables. In the third step, after detecting Cointegration we have estimated long-run parameters using FMOLS proposed by Phillips and Hansen (1990). In the fourth step, we have estimated short-run dynamics by employing an Error Correction Model (ECM) in order to determine the source of causality between exchange rate and domestic and foreign price differential in the SAARC countries. Finally, we will check the impact of the Global Financial Crisis in major SAARC exchange rates. Our main model is of the following form.

$$s_{it}=\alpha_{i}+\beta_{1}(p-p^{*})_{it}+\varepsilon_{it} \qquad (4)$$

Where α represents constant parameter and s_{it}, p_{it} and p_{it}^{*} are logarithmic values of the nominal exchange rate, domestic and foreign prices respectively, i represents the number of countries and t is the time period. If the condition (α,β) = (0, 1) is not rejected then PPP holds precisely well. Equation 4 impose one to one proportionality between the exchange rate and price differential. Taylor (1988) argued that in the presence of transportation cost and other trade barriers, proportionality may hold but it will not necessarily be equal to one e.g., $\beta_{1}\neq 1$. So there are two conditions for PPP to hold in the SAARC region. 1st is the presence of Cointegration in the exchange rate and price differential, this is a necessary condition. The 2nd one is sufficient condition which states that coefficient restrictions should not reject .e.g., α,β = (0, 1).

3.1. Panel Unit Root Test

It is important to estimate the stationarity of variables before estimating the long-run correlation between s_{it} and $(p-p^{*})_{it}$ because it is essential to check whether the variables are stationary or not. If the variables have a stationary problem then the estimated results will be spurious and harmful for policy implications. To avoid this

problem, we employ IPS panel unit root to examine the order of integration. Since we are using balanced data, so IPS is more reliable in dealing with heterogeneous cross-sectional units. The IPS test delivers distinct approximations for each i cross-section, letting dissimilar conditions of the parameter values, the residual variance, and the lag lengths. The IPS model is given in Equation 5 as:

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{j=1}^{\rho_i} \phi_{ij} \Delta y_{i,t-1} + Z_{it\gamma} + \varepsilon_{it} \qquad (5)$$

Where $Z_{it\gamma}$ shows fixed or random effect. The null and alternative hypothesis of IPS are:

H_0: Panel data is non-stationary ($\rho_i = 1$ for all i).

H_a: Panel data is stationary ($\rho_i < 1$).

IPS $\bar{t}$-statistic is the average of individual ADF t-statistic, as presented in Equation 6:

$$\bar{t} = N^{-1} \sum_{i=1}^{N} t(\rho_i) \qquad (6)$$

Where $\bar{t}$ represents the average of non-stationary panels and N represents a total number of cross-sectional observations and t_i shows ADF t- statistic from country i.

3.2. Panel Co-Integration Test

In the second step, we employed a panel Cointegration test to examine the long-run relationship between the exchange rate and price differential. the literature highlighted three basic tests for panel Cointegration e.g., Kao (1999); McCoskey and Kao (1999) and Pedroni (1999;2004). But we employ (Kao, 1999) because it is more appropriate in the case of two variables. Kao considered the following regression model in form of Equation 7, Equation 8 and Equation 9:

$$y_{it} = \alpha_i + \beta x_{it} + \mu_{it} \qquad (7)$$

Where

$$x_{it} = x_{it-1} + \varepsilon_{it} \qquad (8)$$

$$y_{it} = y_{it} + v_{it} \qquad (9)$$

Where α_i are the fixed effects varying across cross-sectional units, while β are slope parameters, x_{it} and y_{it} are $I(1)$ processes for all i, ε_{it} and v_{it} are the error terms which are assumed to be stationary. Kao derives two forms of residual-based panel Cointegration tests. The Dickey-Fuller (DF) type test can be computed from the following Equation 10 estimated residuals:

$$\hat{e}_{it} = \rho \hat{e}_{i,t-1} + v_{it} \qquad (10)$$

Where $\hat{e}_{it}$ is the estimated residual. The Ordinary Least Square (OLS) estimate of ρ is as follows in Equation 11:

$$= \frac{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}\hat{e}_{it-1}}{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{it}^{2}} \quad (11)$$

The null hypothesis of no Cointegration (H_0: $\rho=1$), in contrast with the alternative hypothesis of Cointegration (H_1: $\rho<1$) is tested using the following statistic in Equation 12:

$$t_{\rho} = \frac{(\rho-1)\sqrt{\sum_{i=1}^{N}\sum_{t=2}^{T}\hat{e}_{i,t-1}}}{s_e} \quad (12)$$

Where $$s_e^2 = \frac{1}{NT}\sum_{i=1}^{N}\sum_{t=2}^{T}\left(\hat{e}_{it}-\rho\hat{e}_{i,t-1}\right)^2$$

For the ADF test, the following ADF regression is proposed by Kao (1999) as in Equation 13:

$$\hat{e}_{i,t} = \rho\hat{e}_{i,t-1} + \sum_{j=1}^{p}\delta_j\hat{e}_{i,t-j} + v_{i,tp} \quad (13)$$

Where p is the lag length selected such that the error terms v_{it} are serially uncorrelated. Under the null hypothesis of no Cointegration (i.e. H_0: $\rho=1$), in contrast with the alternative hypothesis of cointegration (H_1: $\rho<1$).

3.3. Fully Modified Ordinary Least Square (FMOLS)

Several latest econometric methodologies were presented to examine the validity of a long-run association among variables. This study employs the Phillips and Hansen Modified OLS (FMOLS) methodology to determine the long-run association among exchange rate and price differentials. This method yields consistent estimates for a small sample and delivers an outline for a fixed and random effect. It also modifies for both short- and long-run dependency through equation errors, therefore, the corrected t-ratios permit inference through the standard distributions. The FMOLS technique was formerly introduced by Phillips and Hansen (1990) for estimating a single Cointegration relationship that has a mixture of $I(1)$. The FMOLS technique has a benefit over the Engle-Granger methods in introducing suitable alteration to overwhelm the extrapolation problem in Engle-Granger methodology. A simple summary of FMOLS is given by, consider a linear regression as in Equation 14 and Equation 15:

$$Y_{it} = \alpha_i + \beta Z_{it} + e_{it} \quad (14)$$

Where $$Z_{it} = Z_{it-1} + v_{it} \quad (15)$$

The panel FMOLS estimator for β is given by the Equation 16:

$$\beta_{NT}^{*} = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(Z_{it}-\overline{Z}_i)^2\right)^{-1}\left(\sum_{t=1}^{T}(Z_{it}-\overline{Z}_i)Y_{it}^{*}-T\hat{\tau}_i\right) \quad (16)$$

Its t-statistic follows a standard normal distribution.

3.4. Granger Causality Test

If we have the two stationary variables z_{it} and x_{it}, then the Granger causality test includes as a 1st stage the estimation of following Equation 17 and Equation 18 VAR models.

$$z_{it} = \alpha_{1i} + \sum_{i=1}^{n}\beta_i x_{t-i} + \sum_{j=1}^{m}\gamma_j z_{t-j} + u_{1t} \quad (17)$$

$$x_{it} = \alpha_{2i} + \sum_{i=1}^{n}\lambda_i x_{t-i} + \sum_{j=1}^{m}\delta_j z_{t-j} + u_{2t} \quad (18)$$

Where u_{1t}, u_{2t} are assumed to be uncorrelated white noise error term. The null hypothesis of Granger causality test $H_0 : \sum_{i=1}^{n}\beta_i = 0$ against the alternative $H_1 : \sum_{i=1}^{n}\beta_i \neq 0$. The test statistic of Granger causality is same as F-statistic.

3.5. Error Correction Model

Finally, we estimated short-run dynamics between s_{it} and $(p-p^{*})_{it}$. The short-run dynamics between exchange rate and price differential can be expressed as in Equation 19:

$$\Delta s_{i,t} = \mu + \sum_{i=1}^{k}\gamma_{1i}\Delta s_{i,t-i} + \sum_{i=0}^{k}\gamma_{2i}\Delta(p-p^{*})_{i,t-i} + \lambda\varepsilon_{it-i} + \upsilon_{it} \quad (19)$$

Where $\gamma's$ are short-run coefficients, λ is error correction term which measures the speed of adjustment towards long-run equilibrium and υ_{it} is error term.

4. RESULTS AND DISCUSSIONS

The results of IPS presented in Table 1 shows that and are non-stationary at levels and becomes stationary when we take the first difference.

Table-1. IPS unit root test.

Series	Specification	Levels		First differences	
		Average *t*- stats	Prob.	Average *t*-stats	Prob.
s_{it}	C and T	-2.60 (12)	0.093*	-7.94 (12)	0.0000*
$(p-p^{*})_{it}$	C and T	-2.08 (12)	0.516*	-3.49 (12)	0.0001*

Figures in brackets show lags (selected on the basis of AIC) and * indicates values of probabilities at 1% level of significance. C and T represent constant and trend terms.

After determination of the order of integration, now we look forward to applying the Cointegration test. We employed (Kao, 1999) Cointegration test to find the long-run relationship among the variables. The results of Kao (1999) Cointegration test are presented in Table 2. From Table 2 when we take S_{it} as a dependent variable, we can see that the null hypothesis with no Cointegration is rejected by the ADF statistic at a 1% level of significance. This means that the exchange rate and price differential have long-run relationship. Next, when we take $(p-p^*)_{it}$ as the dependent variable, the ADF statistic also rejects the null of no cointegration at 1% level of significance. This also confirms that and $(p-p^*)_{it}$ have long-run relationship with S_{it}. Overall findings show that S_{it} and $(p-p^*)_{it}$ have long-run correlation with each other.

Table-2. Cointegration test results.

Dependent variables	Tests	t-statistics	Prob.
Series:1			
	ADF	-3.38	0.0004*
S_{it}	Residual	0.0002	-
	HAC	0.0003	-
	$Resid_{t-1}$	-5.273	0.000*
Series: 2			
	ADF	-2.43	0.0075*
$(p-p^*)_{it}$	Residual	0.00012	-
	HAC	0.00022	-
	$Resid_{t-1}$	-4.3	0.000*

* indicates the level of significance at 1%.

Given the presence of a long-run relationship between variables, now we estimate long-run parameters by employing FMOLS, and the results are reported in Table 3. We can see that when we take the exchange rate as the dependent variable, the price differential is significantly affecting the exchange rate. The coefficient of the price differential is 0.49, which means that a 1% increase in the prices of SAARC countries relative to US price levels, this lead to depreciate SAARC exchange rate by 0.49%. The reason could be that when the price of a basket of goods in the domestic country (SAARC) becomes high than the foreign country (USA), then people will start purchasing goods from foreign market and this will cause the exchange rate to rise up. This also means that PPP partially holds in a panel of SAARC countries. R square is 94% which shows the goodness of fit of our model. Table 4 suggests that, when the price differential is taken as a dependent variable, the exchange rate also exerts a significant impact on the price differential. The estimated coefficient of the exchange rate is 1.92 which means that if we increase the exchange rate by 1% the price differential will increase by 1.92% in the long run.

Table-3. Long run FMOLS results.

Dependent variable: S_{it}

Independent variable	Coefficient	Standard error	t-statistic	Prob.
$(p-p^*)_{it}$	0.493	0.0475	10.37	0.000*
R^2	0.942			
$\overline{R}^2$	0.941	S.E. of regression	0.071	

* indicates the level of significance at 1%.

Table-4. Long run FMOLS results.

Dependent variable: $(p-p^*)_{it}$

Independent variable	Coefficient	Standard error	t-statistic	Prob.
S_{it}	1.923	0.197	9.75	0.000*
R^2	0.673			
$\overline{R}^2$	0.671	S.E. of regression	0.15	

* indicates the level of significance at 1%.

In order to analyze the effect of coefficient restrictions, we employ the Wald Test to test for coefficient restrictions. For this, we put $\alpha_i = 0$ and $\beta_1 = 1$. The results in Table 5 suggest that we reject the null hypothesis and conclude that $\beta_1 \neq 1$. This may be because of transportation cost and other trade barriers according to Taylor (1988). But on this basis, we cannot say that PPP does not hold in the SAARC region because in this study we already have tested that exchange rate and price differential have long-run relationship.

Table-5. Wald test for coefficient restrictions.

Test statistic	Value	df	Probability
F-statistic	1788139	(2, 894)	0.000*
Chi-square	3576279	2	0.000*

* indicates 1% level of significance.

4.1. Country by Country Analysis

To examine the long-run parameters of the price differential of each country, we estimate Equation 4 for each country. The results are reported in Table 6 to suggest that if the price differential increase by 1% the exchange rate will tend to depreciate by 0.58% in the case of Bangladesh. For the case of India, if the price differential increases by 1% the depreciation of the exchange rate will lead to 0.38%. For Pakistan, if we increase price differential by 1% the exchange rate will depreciate by 0.67%. If we increase price differential by 1% the exchange rate will tend to depreciate by 0.35% in the case of Nepal.

Table-6. Country-by-country FMOLS estimates of long-run exchange rate.

Dependent variable: S_t

Countries	Variable	Coefficient	t-statistic	Prob.
Bangladesh	$(p-p^*)_t$	0.585[a]	15.25	0.000
	R^2	0.856		
India	$(p-p^*)_t$	0.384[a]	6.75	0.0000
	R^2	0.537		
Nepal	$(p-p^*)_t$	0.353[a]	6.12	0.0000
	R^2	0.495		
Pakistan	$(p-p^*)_t$	0.679[a]	28.15	0.0000
	R^2	0.951		
Sri Lanka	$(p-p^*)_t$	0.421[a]	16.19	0.0000
	R^2	0.868		

a=indicates the level of significance at 1%.

Finally, for Sri Lanka, the exchange rate will tend to depreciate by 0.42% if we increase price differential by 1%. The overall conclusion is that PPP partially holds in case of these countries because there is no evidence of a one-

to-one relationship between s_t and $(p-p^*)_t$. The reason could be the trade barriers which involves tariff, quotas, duties, customs, etc. are normally charged to maintain country account balance.

After estimating the long-run parameters, we now apply Granger causality test to analyze the direction of causalities between the exchange rate and price differential. The results reported in Table 7 suggest that there is bidirectional causality between s_{it} and $(p-p^*)_{it}$, because of s_{it} causes $(p-p^*)_{it}$ and $(p-p^*)_{it}$ causes s_{it}. Overall our finding depicts that both exchange rate and price differentials are interdependent because from results we can see that exchange rate Granger cause price differential and price differential Granger cause exchange rate.

Table-7. Pairwise Granger causality test (lag length = 2).

Null hypothesis	F-statistic	Prob.
s_{it} does not Granger Cause $(p-p^*)_{it}$	4.82	0.008*
$(p-p^*)_{it}$ does not Granger Cause s_{it}	4.22	0.015**

* indicates 1% level of significance and ** indicates a 5% level of significance.

To examine the short-run dynamics, we estimate an Error Correction Model (ECM). Table 8 suggests that there exist a short-run relationship between exchange rate and inflation differential. The exchange rate is affected by its own lags up to fifth months. On average past behavior of the exchange rate significantly affecting the current exchange rate. The reasons could be market expectations due to which exchange rate depreciate. After some time when market expectations adjusted, then the exchange rate starts appreciating in the second month. In the third month, again exchange rate depreciated and the reason could be the market news which influences the exchange rate.

Table-8. Error correction model for short run dynamics

Dependent variable: Δs_{it}

Variables	Coefficients	t-statistics	Prob.
Δs_{it-1}	0.362*	10.72	0.000
Δs_{it-2}	-0.064***	-1.79	0.072
Δs_{it-3}	0.128*	3.72	0.000
Δs_{it-4}	-0.061***	-1.80	0.072
Δs_{it-5}	0.119*	3.68	0.000
$\Delta(p-p^*)_{it}$	0.109*	2.69	0.007
$\Delta(p-p^*)_{it-1}$	0.074***	1.81	0.070
$\Delta(p-p^*)_{it-10}$	0.110*	2.84	0.004
EC_{it-1}	-0.032*	-4.97	0.000
R^2	0.185		
$\overline{R}^2$	0.172		
DW Statistic	2.044		

* shows 1% level of significance, *** shows the level of significance at 10%.

The coefficients of $\Delta(p-p^*)_{it}$ are positive in the 1st and the 10th month, which means that when inflation differential increases by 1%, the exchange rate will tend to depreciate by 0.074% in the 1st month, and 0.11% in 10th

month respectively. The lagged error correction term has a significant relation with the exchange rate. Negative sign implies that inflation differential correcting the disequilibrium at the speed of 3.2% per month.

Table 9 shows the short-term relationship between inflation differential and exchange rate. There is a significant relationship of inflation differential with its previous lags, up to twelve lags inflation differential effect current inflation. The coefficient of Δs_{it-1} shows that exchange rate depreciated by 1% leads to increase in domestic inflation relative to foreign inflation by 0.063% after one month. The lagged error term is insignificant which implies that price differential is weakly exogenous, it needs no adjustments and all the adjustments should take place by changing the exchange rate.

Table-9. Error correction model for short-run dynamics.

Dependent variable, $\Delta(p-p^*)_{it-1}$

Variables	Coefficients	t-statistics	Prob.
C	0.002*	5.214	0.0000
$\Delta(p-p^*)_{it-1}$	0.216*	6.812	0.0000
$\Delta(p-p^*)_{it-2}$	-0.098*	-3.21	0.0014
$\Delta(p-p^*)_{it-5}$	-0.072**	-2.497	0.0127
$\Delta(p-p^*)_{it-11}$	0.111*	3.649	0.0003
$\Delta(p-p^*)_{it-12}$	0.374*	11.914	0.0000
Δs_{it-1}	0.063*	3.117	0.0019
EC_{it-1}	-0.0002	-0.047	0.9623
R^2	0.304		
$\overline{R}^2$	0.294		
DW Statistic	2.025		

* shows 1%, ** indicates 5% and *** indicates 10% level of significance respectively.

To check the impact of the Global Financial Crisis on SAARC exchange rates, we introduce a dummy variable taking value one from 2007M7 to 2009M6 and zero otherwise. The results are shown in Table 10. The coefficient of a dummy variable (-0.027) shows that due to the Global Financial Crisis the US economy becomes slow and interest rate decreased, which cause the dollar to depreciate.

Table-10. Dummy variable for global financial crisis.

Dependent variable: S_{it}

Variable	Coefficient	t-Statistic	Prob.
C	4.365	1511.97	0.000
$(p-p^*)_{it}$	0.505*	59.75	0.000
Dummy	-0.027*	-4.26	0.000
Weighted statistics		**Unweighted statistics**	
R^2	0.952	R^2	0.945
F-statistic	2955.79	*SSR*	4.337
Prob.	0.0000		
SSR	4.31		

* indicates the level of significance at 1%. And *SSR* represents the sum of square resid.

Therefore, in response to the Global Financial Crisis SAARC exchange rates appreciated. R^2 is 0.95 which means that our model is a good fit. F-statistics (Prob. 0.0000) shows the joint significance of the exchange rate and price differential.

5. CONCLUSION AND POLICY IMPLICATION

The main objective of this study was to check that whether PPP holds in major SAARC countries, by estimating the long-run relationship between exchange rate and price differential using the monthly panel data over the period 2000M1 to 2017M12. We employ a panel unit root test to test the stationarity, and cointegration was tested to examine the long-run relationship and also applied FMOLS to estimate long-run parameters. To determine the short-run dynamics effects, an Error Correction Model has been estimated. Granger Causality test is also used to determine the causality relationship between and. Finally, we test for the SAARC that whether Global Financial Crisis effects the SAARC countries or not. The main outcomes can be summarized as PPP seems partially hold in Panel of SAARC countries while for single equation PPP seems to be partially held in all countries. Our result showed the two-way causality between exchange rate and price differential, which implies that exchange rate and price differential are interlinked with each other in the SAARC region. Error Correction Model showed that exchange rate and price differential are also correlated in the short run, the exchange rate is significantly affected by its own lag. Our results also suggest that in response to the Global Financial crisis the SAARC exchange rates appreciated.

The outcomes of the present study contain major policy implication for SAARC countries. Firstly, since PPP partially holds in a panel of SAARC countries this could be due to the trade barriers and other impediments. Therefore, there is a need to remove trade barriers in order to promote economic and social welfare. The current low level of intra-trade among the SAARC countries is essential because of the relatively low level of industrialization of the member countries, political conflicts are also affecting the SAARC countries trade. Lenient trade policies and removing trading barriers may increase trade among the SAARC region, which can increase the living standard of the people of SAARC countries. Secondly, we have also seen that our results are showing two-way causality, which means that if domestic inflation increases relative to US inflation then exchange rate of SAARC countries depreciated, so possible policy implication which can derive from this result is that the authorities of SAARC countries should change exchange rate policies to stabilize inflation. Furthermore, it is also important to increase the international reserves which will assist in stabilizing the exchange rate.

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