TESTING THE MODIFIED-COMBINED PPP AND UIP HYPOTHESIS IN SOUTH ASIAN ECONOMIES

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Abstract

In this paper, the interrelations between PPP and UIP are modified and tested for South Asian economies using multivariate cointegration approach. The study uses monthly data and sample period varies cross-country according to floating exchange rate regime. The results obtained are highly supportive of this version of the combined PPP and UIP, which takes into account the non-traded and imperfect capital mobility phenomena. Consistent with the capital enhanced equilibrium exchange rates (CHEERs) approach, the determination of the nominal exchange rate is consistent with the UIP-PPP conditional equilibrium. The interaction between PPP and UIP has consequential implications for financial reforms, an exchange rate based stabilization program and exchange rate policy alike.

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1. Introduction

Since the last few years, both financial reforms and trade liberalization are at the great concern of economic policies. The principle objective of these policies is to contribute to the deepening of the financial sector, and ultimately to the stability and considerable growth of the reforming economies. Forex markets have an immediate and direct impact on an economy. Particularly, economies that rely strongly on remittances of overseas contract workers or tourism are quite sensitive to forex rate instabilities.

A competitive exchange rate is the sign of growth process via positive impact on foreign investments (foreign portfolio and foreign direct investment as well) and international trade activities. While the exchange rate dynamics implied in models of inter-temporal smoothing of traded goods consumption and cross-country wealth redistribution/transfer makes the determination of equilibrium exchange rate a meaningful for one to examine[1].

Moreover, the exchange rate plays a central role in maintaining external (balance of payments) and domestic equilibriums. Besides, interest rate also plays a very important role, as an instrument of monetary policy, to promote the saving, investment and hence economic growth. Therefore, the role of foreign exchange rate along with interest rates in policymaking has been increasing in emerging and developing economies and understating its response to shocks is important to policy-makers.

Of particular interest to a central bank is whether interest rate liberalization affects the behavior of the exchange rate market with given price level that is one other crucial determinant of exchange rate. In thinking about this phenomenon, the reader should

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[1]For fuller discussion on these issues, See Rogoff (1996) and Obstfeld and Rogoff (1995), respectively.

recall that there is a natural link between the interest rate differential and exchange rate via the uncovered interest rate parity (UIP) hypothesis and purchasing power parity (PPP) describes exchange rate–price levels association alike (see, for details Flood and Rose (2002), and Sarno and Taylor (2002), respectively).

However, the empirical findings do not still provide adequate and conclusive answers to simple questions about the determinants of exchange rates. Is the exchange rate determined by the level of prices as the PPP theory suggests? Is the exchange rate determined by the spread between the interest rates in the two countries as the UIP theory claims? How prices respond to changes in exchange rates and interest rates? Answering to these issues becomes more complicated when economic theory assumes that PPP and UIP hold while both are empirically found non stationary in the short and medium-long run as well. Indeed it has been difficult to prove that there was any convergence toward PPP and UIP in the long run.

In general, the empirical evidences for either PPP or UIP individually are mixed at best. Regarding PPP, time series studies have shown that real exchange rate is not only very volatile in the short run but also the speed of convergence to PPP in the long run is extremely slow (see Rogoff (1996), among others). Forecasts based on the PPP condition alone, have also provided mixed results (see, for instance, Fritsche and Wallace (1997)). Similarly, concerning UIP, empirical evidence has also generally led to a strong rejection, particularly, in the Post Bretton Woods period.

In the light of overall findings about PPP and UIP[2], it can be concluded that a large number of preexisting studies have been failed to establish a clear long-run relationship between exchange rate, interest rates, and price levels under separately PPP and UIP conditions. Johansen and Jueslius (1992) have suggested that one possible reason is why so many researchers have failed to find evidence in support of the PPP as well as the UIP condition is the fact that researchers have ignored the links between goods and capital markets when modeling the exchange rate. Thus, the failure of the two fundamentals parities, PPP or UIP, may due to the omitting of variables (interest rates and price levels, respectively) from cointegrating vector rather than any inherent deficiency in exchange rate, price levels and interest rates associations. Indeed by modeling the both parities jointly one is better able to capture the interactions between the nominal exchange rate, the price differential and the interest rate differentials, as well as allowing for different short- and long-run dynamics.

The current study therefore aims to combine the two-arbitrage conditions into a single relationship, as the empirical literature is more supportive of such a combined relationship than of either PPP or UIP separately. For instance, Johansen and Juselius (1992), Juselius and MacDonald (2000), and Caporale et al. (2001), among many others, have been provided empirical evidence for international parity conditions by modeling PPP and UIP jointly.

Moreover, under rational expectations, deviations from PPP and UIP will determine exchange rate expectorations, thereby providing a link between the goods and capital market (see Juselius (1995)). However, empirical evidence on combined PPP-UIP is

[2] Among others, Johansen and Jueslius (1992), Engle and Rogers (1996), Rogoff (1996), Meese and Rogoff (1988), Edison and Pauls (1993) and Mark and Wu (1996) have provided excellent survey of the empirical literature on PPP and UIP.

still fairly thin and only concentrated on developed countries, leaving a gap of developing countries studies with time series data.

This study therefore attempts to fill this gap as a multivariate cointegration procedure is used to explore the long-run linkage between domestic exchange rate, domestic and foreign price levels, and domestic and foreign interest rates for South Asian countries. The exchange rates are bilateral rates against the U.S. dollar, designating the United States as the "foreign country" in this study. Estimated relationship may enable us to identify whether the exchange rates, interest rates and prices were consistent with PPP and UIP over the examined period.

The findings of the analysis are in line with the evidence provided by the preexisting studies, which tested the combined PPP and UIP and reported that there exists a constant long-run equilibrium relationship between exchange rate, price levels and interest rates. However, the evidence provides a quite contrast with the results of those studies, which primarily focused on to test the PPP and UIP separately. Such studies tended to find no evidence of cointegration in these variables in general. In particular, the paper finds evidence that there exists a valid, stationary long-run relationship between the nominal exchange rates, price levels and interest rates for all the examined economies.

The remainder of this study is organized as follows. Section 2 briefly reviews the theories of PPP and UIP and explains how the two theories can be combined in a single equation framework. Section 3 tells about estimation techniques and data sources. The choice of variables, countries and sample period are also discussed in this section. Section 4 covers estimation. Finally, Section 5 summaries the key findings and concludes the study.

2. The Theory of Purchasing Power Parity and Uncovered Interest Rate Parity

2.1 Purchasing Power Parity (PPP)

The most restrictive definition of the PPP has origin from the Law of One Price (LOOP) through which international arbitrage causes the price of every good to be equalized, when expressed in a common currency. Absolute PPP states that nominal exchange rate between two countries should equal the ratio of the two countries' price level of a fixed basket of goods and service. In practice, PPP may not hold due to a variety of reasons, such as productivity differentials and the existence of non-traded goods and services. Relative PPP therefore allows for a permanent wedge caused by those factors between the price levels of two countries (see Brook and Hargreaves (2001)). Thus, its Relative form is formally expressed in the following way:

$$e_{it} = \alpha_i + \beta_i (p_{it}^d - p_t^f) + \varepsilon_t \qquad t = 1, \ldots, T \tag{1}$$

Where e_{it} = log nominal exchange rate for domestic country at time t, defined as the number of domestic currency units required to purchase one foreign currency unit.

p_{it}^d = log domestic price level for country i at time t

p_t^f = log of foreign country price level at time t

ε_{it} = trade shock with zero mean and finite variance

α_i is a constant, representing the permanent deviation from absolute PPP due to productivity differentials and other factors. T refers to the number of observations over time.

In reality, of course, there are many factors, which could drive the exchange rate temporarily away from PPP, such as relative growth differentials, commodity prices, speculative price movements, or interest rates. Whenever there is a deviation from PPP, it is expected that the exchange rate will drift in the direction of restoring relative PPP, expressed algebraically by:

$$\Delta e_{it+1} = \eta_i (p_{it}^d - p_t^f - \alpha_i - e_{it}) \quad (2)$$

where, the value of η lies between zero and one.

Early tests for PPP focused on estimates of the coefficient on relative price levels. Stage II tests consist of testing the hypothesis that the log of real exchange rate follows a random walk. Another sort of tests (Stage III) utilizes cointegration techniques to test for a long-run equilibrium relationship between the nominal exchange rate and price levels. Long-run Purchasing Power Parity has been extensively tested using these tests but the empirical evidence is mixed at best. Surveys by Macdonal (1995), Froot and Rogoff (1995), Breuer (1994), and Schotman (1989) provide a comprehensive literature review of the evidence for long-run PPP.

As highlighted by several authors including most important MacDonald and Marsh (1997), and Juselius and MacDonald (2000), the balance of payment implies that any imbalance in the current account has been financed through the capital account. Shocks that force the real exchange rate away from PPP has to be captured through the fluctuations in interest rates, since they reflect expectations of future purchasing power. Consequently, massive movements in capital flows in response to interest rate differentials can keep the exchange rate away from purchasing power parity for long run. The PPP condition in the goods market will therefore be strongly related to the UIP condition in the capital market.

2.2 Uncovered Interest Rate Parity (UIP)

The theory of UIP is related to capital market. It states that interest rate differential between domestic and foreign country is equal to the expected change in the nominal spot exchange rate. In simplest form, UIP can be expressed as follows:

$$E_{it}(e_{it+1}) - e_{it} = \lambda_i + \delta_i (i_{it}^d - i_t^f) + u_{it} \qquad t = 1, \ldots, T \quad (3)$$

where

$i_{it}^d =$ domestic nominal interest rate for country i at time t

$i_t^f =$ an equivalent foreign nominal interest rate at time t

$\lambda_i =$ constant, which capture the fixed effect specific domestic country

$E_{it}(\cdot) =$ the expectations operator conditional upon information available at time t

u_i is the risk premium associated with holding domestic currency assets (see for details, Svensson (1992)). Under the assumption of rational expectations in exchange markets, the future spot exchange rate will equal the value expected at time t plus a random term with zero mean and finite variance that is uncorrelated with all information available at time t, including interest rate differential and spot exchange rate. Thus, equation (3) can be rearranged as follows:

$$\Delta e_{it+1} = \lambda_i + \delta_i (i_{it}^d - i_t^f) + \mu_{it} \quad (4)$$

A large number of studies have been done to test UIP. The results of these studies are, however, inconclusive. The findings of Flood and Rose (2002), Chinn and Meredith (2000), MacDonal and Nagayasu (2000), and Chinn and Meredith (2004) provided evidence to support the Uncovered Interest Rate Theory. Whereas, some empirical studies reject UIP include Meese and Rogoff (1988), Edison and Pauls (1993), and Mark and Wu (1996).

2.3 Combining PPP and UIP

In the renowned literature, equilibrium exchange rates are often defined either in terms of PPP or UIP but hardly ever together. However, empirical tests of theses two-arbitrage separately have often failed to yield any conclusive conclusion. It has been seen that failure of PPP was generally caused by factors such as imperfect markets, the composition of price indices, information costs, transport costs and trade barriers. Whereas the existence of time varying risk premium and limited capital mobility, for instance, are responsible of failure of UIP.

The rejection of PPP and UIP, individually, by many studies may be due to a systematic relationship between the two conditions. Indeed, for a financially open economy, PPP is based on the arbitrage in goods market, hence postulated as an adjusted mechanism for the current account equilibrium. Equilibrium in capital account, on the other hand, may need adjustments in the variables determining the UIP. By definition, balance of payments consists of the sum of the current account and capital account. Thus, disequilibrium in one market may have consequences on the other. Therefore, the two international parity conditions (PPP and UIP) may not be independent of each other in the long run evaluation of the balance of payments equilibrium and are supposed to hold simultaneously.

The study thus follows Stephens (2004) in order to propose a scheme for combining PPP and UIP in a single equation framework to allow for interactions among prices, interest rates and exchange rates. This approach is referred to as Capital Enhanced Equilibrium Exchange Rates (CHEER). The main idea of the CHEER is that non-stationary deviation from the PPP and UIP forms a stationary relationship consistent with the interdependence of adjustments in the assets and goods markets towards equilibrium.

Since the PPP is a long-run condition, it is assumed that PPP forms the basis of expectations in the UIP condition. Algebraically, this relationship is obtained by plugging equation (2) into equation (4), yielding:

$$\eta_i (p_{it}^d - p_t^f - \alpha_i - e_{it}) = \lambda_i + \delta_i (i_{it}^d - i_t^f) + \mu_{it}$$

Rearranging:

$$e_{it} - p_{it}^{d} + p_{t}^{f} + \frac{\delta_i}{\eta_i}(i_{it}^{d} - i_{it}^{f}) + \Psi = 0$$

(5)

where $\Psi = a_i + \frac{\lambda_i}{\eta_i} + \frac{\mu_{it}}{\eta_i}$

Equation (5) can be assumed to represent the equilibrium condition. In the real world, however, nominal exchange rates are not, always and everywhere, determined by price levels and interest rates. For example, speculative activity or commodity price movements could lead to a sustained and significant deviation from equation (5).

Therefore, macro-economists and policy makers are keen to know rather equation (5) can be considered as an equilibrium condition toward which exchange rates, price levels, and interest rates tend to move in the long run[3]. In other words, whether price levels, interest rates, and the exchange rate are cointegrated or nominal exchange rates could be expected to deviate from this equilibrium condition, such that:

$$e_{it} - p_{it}^{d} + p_{t}^{f} + \frac{\delta_i}{\eta_i}(i_{it}^{d} - i_{it}^{f}) + \Psi = \xi_{it}$$

(6)

where ξ_t has zero mean and finite variance and represents the deviation from equilibrium PPP-UIP condition. It is therefore posited in equation (6) that interest rates, prices and exchange rate are cointegrated, that is, there exists a long-run relationship among them.

2.4 The Modified Form of the Combined PPP and UIP

The standard versions (presented in Eq.(6)) of both propositions namely PPP and UIP principally assume that all goods prices are flexible, the capital is perfectly mobile, and domestic and foreign assets are perfect substitutes[4]. However, South Asian countries do no allow perfectly free capital mobility. None of the country has a perfectly freely- floating exchange rate regime.

There are numerous trade barriers that make hard to achieve the assumption of price flexibility and the law of one price[5]. In this context the standard combined form of PPP and UIP is not suitable. Since the traditional PPP and a standard UIP conditions do not take into account the puzzle of tradable and non-tradable goods and the imperfection in capital markets, there is needed to modify the PPP and UIP.

In an attempt to account for these theoretical as well as empirical shortcomings, we replaced the CPI with ratio of WPI/PPI to CPI indices to proxy for the shares of tradable and non-tradable goods and modified the UIP by including the ratio of net

[3] However, the rejection of the equation (5) implies that there are some other factors, such as productivity differentials, existence of non-traded goods, speculative activities, authorities intervention, etc. which could drive the exchange rate away from PPP and UIP parities.

[4] See Frenkel (1976) and Bilson (1978) for details.

[5] The law of one price across countries applies to internationally traded homogenous commodities in the absence of trade barriers and there is full pass through of the changes in exchange rates to domestic prices of commodities.

foreign asset to GDP as a measure of risk premium or the degree of capital mobility in equation (6)[6,7]. Accordingly, it can be reshaped as follows:

$$e_{it} - (cpi/wpi)_{it}^{d} + (cpi/wpi)_{t}^{f} + \frac{\delta_i}{\eta_i}(i_{it}^{d} - i_{it}^{f}) + x_{it} + \Psi = \xi_{it}$$

(7)

where x_{it} is the log of the ratio of exports to imports for country i. The rest of the variables are as defined above.

This modified form of the combined PPP and UIP seems more compatible with institutional realities of South Asia. In the next section, the study empirically estimated equation (7), using multivariate cointegration approach to test for long-run equilibrium relationship. Formally, this study, using the Johansen technique, tests whether there exists one or more vectors of coefficients.

3. Empirical Framework

3.1 Econometric Methodologies

A number of tests are available in literature to examine the long-run relationship. In most previous empirical studies, the linkages between the said variables have been examined by using the OLS regression analysis. However, some studies employed the Engle-Granger (EG) two-step cointegration approach and Johansen (1988) full-information maximum likelihood technique to explore the long-run relationship. In this study, Johansen's test is employed, which provides more robust results than the EG procedure.

Johansen cointegration methodology is used to examine the long-run equilibrium relationship between prices, interest rates and exchange rates according to PPP and UIP. Consider an m-dimensional Vector Autoregressive (VAR) process, with and without trend, is employed to perform the Johansen's test (1988, 1991, 1995).

$$Y_t = A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots + A_j Y_{t-j} + \psi_t$$

(8)

where Y_t is a k-vector (n × 1) of I(1) variables[8], j is the maximum lag, ψ_t is assumed to be k-vector (n × 1) of Gaussian error term, and A_i's are (n × n) matrices of coefficients to be estimated. The Vector Error Correction (VEC) model counterpart to the VAR model is expressed below:

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[6] The justification/motivation behind the use of the ratio of net foreign asset to GDP as measure of risk premium or the degree of capital mobility is straightforward. In the context of less-than-freely-floating exchange rate regime, purchases and sales of international reserves are common means for smoothing exchange rate fluctuation alongside interest rate policies.

[7] However, the Bank of England (BE) used the ratio of exports to imports as a measure of risk premium in order to develop the BE exchange rate model for UK economy and Her Majesty's Treasury has defined the risk premium as the ratio of short-term capital flows to the lagged money stocks. For further evidence on this issue, see Fisher et al. (1990).

[8] $Y_t = \left[e_{it}, (pci/wpi)_{it}^{d}, (pci/wpi)_{t}^{f}, i_{it}^{f}, i_{it}^{d}, x_t\right]$

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots + \Gamma_{m-1} \Delta Y_{t-m+1} + \Pi Y_{t-m} + \psi_t \quad (9)$$

where $\psi_t \approx Niid_p(0, \Sigma)$, ΔY_t is the first difference of the variables in the Y_t matrix, Γ_m is the short-run adjustment parameters for the variables ΔY_{t-m} for $m = 1,2,\cdots, j-1$ and $\Pi = \alpha\beta'$, where β' is the matrix of cointegrating parameters and α represents the speed of adjustment to disequilibrium. Thus, the term $\beta' Y_{t-1}$ is equivalent to the error-correction term.

Jhansen's test for cointegration centers on estimating the matrix Π in an unrestricted form and then testing whether Π has less than full rank. The number of the independent cointegrating vectors depends on the rank of Π. Before starting the tests, a rationale choice of the variables, the sample period and the dada set will be discussed in the next section.

3.2 The Choice of Variable and Sample Period

As per the discussion in Section 2, the empirical models contain the following variables:

e_{it} = domestic exchange rate against USA dollar for country i

$(pci/wpi)_{it}^{d}$ = the ratio of consumer price index to wholesale price index for country i

$(pci/wpi)_{t}^{f}$ = the ratio of consumer price index to wholesale price index for USA

i_{it}^{d} = market interest rate in country i

i_{t}^{f} = market interest rate in USA

x_{it} = the ratio of net foreign assets to GDP for country i

All the variables are transformed in natural logarithms. The analysis focuses on South Asian countries namely Bangladesh, Indian, Pakistan and Sri Lanka. Monthly data is used for investigating the validity of combined PPP and UIP[9]. All the said variables are taken from International Financial Statistics databases prepared by International Monetary Fund (IMF). The default measure of interest rates is monthly market interest rate. However, India does not have the market rate of interest available over the period from May 1998 to April 2006. The treasury bills rate therefore is used in case of India. The data has been checked and corrected for errors and Figure A.1 to A.3 in the appendix contains time-series plots of the variables[10].

Empirically validity of PPP and UIP is very sensitive to the choice of countries, exchange rate regime, and the use of price index and interest rates. For this study, the choice of the countries, the sample period and the variables may be justified in the following way. It is always worth not to mix different regime. An economic relation might have economic meaning in one period and be nonsense for another in which a

[9] To enjoy the gains of floating period, the study covers the period from July 1996 to December 2006 for Bangladesh, from April 1993 to December 2006 for India, from June 1999 to December 2006 for Pakistan, and from January 1999 to December 2006 for Sri Lanka.

[10] See IFS databases for further details.

different regime prevails. Often it is worth to divide the sample in regime periods, and conduct a different analysis for the different regimes.

The study about the behavior of the exchange rate and its responses to macro-economic variables, particularly prices and interest rates, assume significance for South Asian economies, which have recently shifted to a market-determined (thought managed) exchange rate regime[11].

Apart from changes in exchange rate regimes, trade liberalization and relaxation in foreign exchange restrictions during the past decade have increased the importance of exchange rate dynamics in these countries. These countries have almost homogeneity not only in context of economic but also in social and political structure. Moreover, phenomenon of one currency and inter-regional trade are at great concern in these days. This paper therefore aims to investigate whether combined PPP-UIP holds for South Asian countries during the managed float period, which may have a lot of mutual interest. And there is a massive future potential with regard to trade and cross-border direct and indirect investments.

The issue concerning which category of prices and interest rates should be analyzed to test PPP and UIP is very controversial. Should one consider the consumer price index (CPI), producer price index (PPI) or the ratio of wholesale price index (WPI) and consumer price index to proxy for the shares of tradable and non-tradable goods? However, generally the consumer price index is used as deflator to construct the real exchange rate series. Likewise there is no right measure for the UIP. Should one consider the long- or the short-term interest rate?

The ratio of wholesale/producer to consumer price indices (for all the said countries and for the USA) is used as price indices for testing the PPP and UIP jointly, on the assumption that these price series proxy for the share of tradable and non-tradable goods respectively. In view of the fact that a greater proportion of tradable goods' prices is covered by the producer price index, one would expect that PPP might to hold more strongly with these indices.

4. Empirical Results and Discussions

Prior to testing for cointegration, it is tested for stationarity and the order of the integration of the variables, in the levels as well as in the first differences. More specially, the study tested whether all the said variables are integrated of order one, $I(1)$. This was achieved by estimating the augmented Dickey-Fuller (ADF) unit root tests. The estimated results are presented in Table 1 in the Annex.

All the ADF test regressions are estimated, at levels as well as at first differences, for each country with a constant term. The Akaike Information Criterion (AIC) is used to select an appropriate lag length for ADF tests in order to remove any manifest serial correlation. The results depict that the null hypothesis of non-stationary cannot be rejected at any common level of significance for all the said series at their levels.

[11] As reported by Froot and Rogoff (1995), changes in exchange rate regime imply that deviation from parity might eliminated through different processes altogether. In a fixed exchange rate regime, adjustments to parity are made through domestic price level or/and market interest rate movements. However, when the regime is float, the movements in nominal exchange rate play a vital role in parity reversion.

However, the first differences of the series appear stationary. Thus, each of variables in Y_t is integrated of order 1, $I(1)$.

The next step to carry on the cointegration testing procedure is to determine the autoregressive order (m) of the corresponding model (equation (9)). The prime objective here is to select the optimal lag-length (m) that eliminates any autocorrelation present in the residuals[12]. In this study, sequential modified likelihood ratio (LR) test is used to decide on the number of lags to be included in the empirical models.

The modified LR statistic is used to test for the exclusion of the maximum lag (say 8th). If the exclusion of the 8th lag is not rejected, the VAR order is reduced to 7, and the significance of the 7th lag is tested. The method continues until the reduction of the lag order by 1 at the 5 per cent significance level cannot be rejected.

The VAR models are first estimated with 8 lags. However, the estimated LR statistics suggest 1 lag for Pakistan, 5 lags for India, 3 lags for Bangladesh and 2 for Sri Lanka in equation (9). Table 3 details the diagnostic tests on the residuals of the VAR models. Autocorrelation of the residuals was examined using the joint F-form of the Lagrange Multiplier (LM) test, which is valid for systems with lagged dependent variables. The null hypothesis of no serial autocorrelation was accepted at the 5 per cent level for all the four countries. However, in case of Pakistan and Sri Lanka, the VAR system does not pass the normality[13]. Table 3, in the Annex, reports the trace $(\lambda_{trace(r)})$ and the maximum eigenvalue $(\lambda_{\max})$ statistics for all the four countries. The results are obtained using the Johansen cointegration technique, assuming no deterministic trend in the cointegration vector. Both the statistics indicate that there are two cointegration vectors in the system for Bangladesh, Pakistan and Sri Lanka. For India, the tests statistics provide evidence of a single cointegration vector at the 5% level of significance. Thereby, it can be said that there is significant evidences that the exchange rates, domestic and foreign prices levels, and domestic and foreign interest rates have co-movement in the long run in South Asian economies.

Despite the tests indicate the two significant cointegration vectors for Bangladesh, Pakistan and Sri Lanka, the first cointegrating vector has the highest eigenvalue, and is therefore the "most associated with the stationary part of the model"[14]. Another explanation/justification is that the signs of the first cointegration vector are in line with the theory of combined PPP and UIP, while the second cointegration vector signs do not match the theory. Thus, the first cointegration vector is normalized by the nominal exchange rates relating to each country and is recorded in Table 4.

[12] As suggested by Cheuny and Lai (1993), autocorrelation is a serious problem for the Johansen's approach.

[13] The results for the Univariate Jarque-Bera test suggested that it is basically excess kurtosis causing the rejection of normality in case of Pakistan and Sri Lanka (these results are not reported here to save the space but are available from the author upon request). The residual non-normality may no be alarming as cointegration results appear robust to excess kurtosis (see, Gonzalo (1994), for details discussion on this issue).

[14] See, Johansen and Juselius (1995) for fuller discussion on this issue.

Table 1: Unrestricted Cointegration Vectors Normalized on Exchange Rate Term

	Bangladesh	**India**	**Pakistan**	***Sri Lanka***
e	1.00	1.00	1.00	*1.00*
$(cpi/wpi)^d$	-2.26	-2.06	-15.44	*-12.57*
$(cpi/wpi)^f$	0.21	9.20	35.20	*6.56*
i^d	2.33	-1.34	1.64	*2.37*
i^f	-0.14	-0.36	-0.03	*-0.57*
x	*11.97*	*-3.70*	*-12.37*	*12.24*

Note: The absolute magnitudes of the coefficients do not represent elasticities (as given by levels) because the model is being tested in first difference. Therefore only relative signs and magnitudes matter.

It can be observed from the table that the cointegrating vectors have signs that match the theory of the modified-combined PPP and UIP for all the countries excluding India, where the domestic interest appears with negative sign in the cointegration vector.

Table 2: Standardized Adjustment Coefficient α

	Bangladesh	**India**	**Pakistan**	***Sri Lanka***
e	-0.038	0.004	0.006	*0.000*
$(cpi/wpi)^d$	-0.003	0.000	-0.001	*0.005*
$(cpi/wpi)^f$	-0.008	-0.001	-0.003	*0.000*
i^d	0.006	-0.015	0.152	*-0.004*
i^f	-0.000	0.009	0.014	*0.006*
x	*-0.004*	*0.003*	*-0.002*	*0.000*

The standardized adjustment coefficients are reported in Table 5. The next is to test the whether the cointegrating vectors match the theoretical restriction postulated by strict PPP and/or UIP or not, as represented in equation (7). This is performed by imposing and testing four types of restriction on the cointegration coefficients as given by the cointegrating vector, which are expressed as follows:

A. PPP only forms a cointegrating vector

$$\beta_1 = -\beta_2 = \beta_3 = 1; \text{ and } \beta_4 = -\beta_5 = 0$$

B. PPP augmented by interest differentials forms a cointegrating vector

$$\beta_1 = -\beta_2 = \beta_3 = 1;\ \beta_4 = -\beta_5$$

C. PPP augmented by unconstrained interest rates forms a cointegrating vector

$$\beta_1 = -\beta_2 = \beta_3 = 1$$

D. PPP and **UIP** simultaneously form a cointegrating vector

$$\beta_1 = -\beta_2 = \beta_3 = 1; \text{ and } \beta_4 = -\beta_5 = 1$$

The likelihood ratio (LR) test is used to test the validity of the restrictions. The LR statistics are shown in Table 6 below together with their probability values. The hypothesis that the first cointegrating vector only includes PPP is strongly rejected at the 5% level of significance for all the countries. For Bangladesh, Pakistan and Sri

Lanka, the hypothesis that PPP augmented by interest differentials is stationary cannot be rejected at the 5% level. For India, the less restricted hypothesis that PPP augmented by unconstraint interest rates form a cointegrating vector is not rejected.

Table 3: Results from LM Tests for Testing Restrictions of Cointegration Vectors

Null Hypothesis	**Bangladesh**		**India**		**Pakistan**		***Sri Lanka***	
	LM Statistics	p-value	LM Statistics	p-value	LM Statistics	p-value	LM Statistics	*p-value*
A	8.60	0.04	4.43	0.05	22.81	0.00	14.27	*0.00*
B	6.86	0.08	5.76	0.02	5.37	0.14	7.28	*0.09*
C	6.83	0.03	4.45	0.13	5.32	0.04	13.64	*0.01*
D	*6.90*	*0.15*	*3.74*	*0.44*	*29.98*	*0.00*	*14.28*	*0.00*

Table 4: Standardized Restricted Cointegrating Vectors

	Bangladesh		**India**		**Pakistan**		***Sri Lanka***	
e	1.00	1.00	1.00	1.00	1.00	1.00	1.00	*1.00*
$(cpi/wpi)^d$	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	*-1.00*
$(cpi/wpi)^f$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	*1.00*
i^d	0.85	1.00	-0.32	1.00	-6.09	1.00	0.04	*1.00*
i^f	-0.85	-1.00	-0.83	-1.00	6.09	-1.00	-0.04	*-1.00*
x	*-35.36*	*-36.59*	*1.43*	*16.07*	*-0.67*	*-14.15*	*-66.74*	*-97.90*

Overall, the evidences suggested that the exchange rate versus relative prices configuration would be established only when interest rates are incorporated into the cointegrating set. Thus, the two international parities are not independent of each other and the non-stationary deviations from one of them form a stationary relationship consistent with the interdependent of adjustments in asset and good markets towards equilibrium.

The hypothesis that the exchange rate is proportionally and symmetrically affected by price differentials and interest rate differentials as well is also tested (PPP and UIP simultaneously form a cointegrating vector). The table reveals that the hypothesis is not rejected at the 5% level in case of Bangladesh and India; however, for Pakistan and Sri Lanka, the tests do not provide significant evidence in favor of rejection of the hypothesis. The standardized restricted cointegrating vectors are given in Table 7[15].

5. Concluding Remarks

This paper attempted to test the hypothesis that the modified-combined PPP and UIP holds as a long run stationary relationship. The core objective was to identify whether the determination of the nominal exchange rate is consistent with the UIP-PPP conditional equilibrium or there are some other factors, such as productivity differentials, speculative activities, government intervention, etc., which are deriving

[15] The standardized restricted cointegrating vector for all the countries is presented here just for comparison.

the exchange rate away from the conditional equilibrium. The analysis has been performed relatively to the four bilateral cases Bangladesh/USA, India/USA, Pakistan/USA and Sri Lanka/USA. The data spans monthly observations and the sample period varies cross-country.

The augmented ADF tests are performed to check the time series properties of the variables. The multivariate Full Information Maximum Likelihood (FIML) cointegration approach developed by Johansen has adopted to investigate the existence of a cointegrating relation. Finally, Lagrange Multiplier (LM) tests are used for diagnostic testing of the VAR models specified by the sequential modified LR test.

The results of the Johansen cointegration analyses suggest the existence of the long-run co-movement among the said variables. Since the first cointegration appears more robust to the economic theory outlined in section 2, it is normalized by the nominal exchange rate for all the countries. The value of the estimated loading coefficients suggests that the adjustments of interest rates to disequilibria are relatively fast. There are strong evidences in support of the hypothesis that the system contains PPP and UIP relations. However, the hypothesis is strongly rejected when PPP is formulated in isolation. The results are robust to the CHEER approach of exchange rate determination and suggest that the deviations from PPP can be explained by the interest rates differentials while the deviations from both PPP and UIP can be explained by the variable (the ratio of net foreign assets to GDP) used as proxy to measure the risk premium and capital market imperfections.

In General, the following two questions arise regarding this sort of analysis. First, whether the tested empirical model namely the modified-combined form of PPP and UIP is compatible with institutional realities of the examined countries. Second, how one can make economic interpretation of the empirical findings and can effectively use in policy making purpose.

The "pure float" and "perfect capital mobility" are artifacts of economics textbooks[16]. Of course, the South Asian countries do not have perfectly free floating exchange rate regime, however, they are classified as having a managed float exchange rate regime[17]. Thus, they have common practice to manage their exchange rates fluctuation within band. However, the exchange rate variability is quite low even in the countries that say they allow their exchange rate to float freely. The low variability of the nominal exchange rate does not owe to the absence of the real or nominal shocks in these economies; nevertheless, it suggests that they be reluctant to allow large swings in their exchange rates – there seems to be an epidemic case of "fear of floating"[18].

[16] The textbook definition of a free floating exchange rate regime states money as the nominal anchor and assumes that central banks do not intervene in the market for foreign exchange. Similarly, the perfect capital mobility means that investors have same sort of risk in domestic as well as in foreign markets and they can invest whatever amount they want to invest with out facing any barriers cross the borders.

[17] According to IMF's classification scheme, countries are grouped into four types of exchange rate arrangements: pegs, limited flexibility, managed floating and, free-floating.

[18] See Calvo and Reinhart (2000) for convincing evidence on this issue. They reported that when countries retain voluntary access to international capital market, lack of credibility will lead to fear of floating, high interest rate volatility and procyclical interest rate policies.

The fear of exchange rate variability is persistent, even among some of the developed countries[19]. And this is fact, if policy makers are allowed to make choice between stabilizing exchange rate or stabilizing interest rate then they will prefer to stabilize exchange rate in general. Exchange rate stabilization provides a mechanism that prevents the economy from unnecessary nominal dynamics, while stabilizing interest rate does not.

Moreover, despite the South Asian countries have a number of trade barriers[20], their trade volume is increasing significantly and they are gradually removing, or at least giving relief in tariffs and other barriers. With given institutional circumstance of South Asian countries, the standard forms of PPP and UIP perhaps not compatible; however, the modified form of the combined PPP and UIP seems more well-matched and robust for the South Asian countries.

As claimed by many researchers since the Asian financial crisis and the two subsequent crises in Russia and Brazil, intermediate exchange rate regimes are on their last legs and most of the countries in the world are moving toward corner solutions – at the one end, hard pegs, such as currency boards, currency unions or dollarization, or, at the other end, freely-floating exchange rate regimes[21]. However, some observers have argued that there is relatively more change of speculative attacks and currency crises if countries have either hard pegs or freely-floating exchange rates (for instance, see Goldstein (1999))[22].

A question that comes up about the South Asian countries is that "is there possibility of a common single currency or dollarization, or fully freely-floating exchange rate regime?" I don't think so. However, it can be said, with a view to managing the exchange rate taking into account the orderly and balanced development of the economy, the South Asian countries need to balance the forex market intervention to smooth fluctuations to reduce the estimated misalignment against its potential effects on inflation, financial stability and on the economy in general. Definitely, appropriate measures taken on the fiscal and monetary fronts under the hypothesis that the equilibrium rate is determined simultaneously by PPP and UIP would definitely limit the required exchange rate adjustments.

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[19] For empirical evidence on this issue, see Calvo and Reinhart (2000b) and Hausmann et al. (1999).

[20] Principally it seems that these trade barriers slow down the process of pass through of the changes in exchange rates to domestic prices of commodities. However, as said by Calvo and Reinhart (2000), the pass through from exchange rate swings to domestic prices is far higher in emerging economies (including India and Pakistan) than in developed economies.

[21] For further discussion of these issues, see Frankel et al. (2000).

[22] Calvo and Reinhart (2000) have also claimed that the Asian financial crises countries' exchange rates prior to the 1997 crisis were looked very much like pegs to the U.S. dollar for extended period of time.

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Annex

Figure A.1: South Asian Countries: Exchange Rate Fluctuations

BER, *IER*, *PER* and *SER* denote the logarithm values of nominal exchange rates for Bangladesh, India, Pakistan and Sri Lanka, respectively.

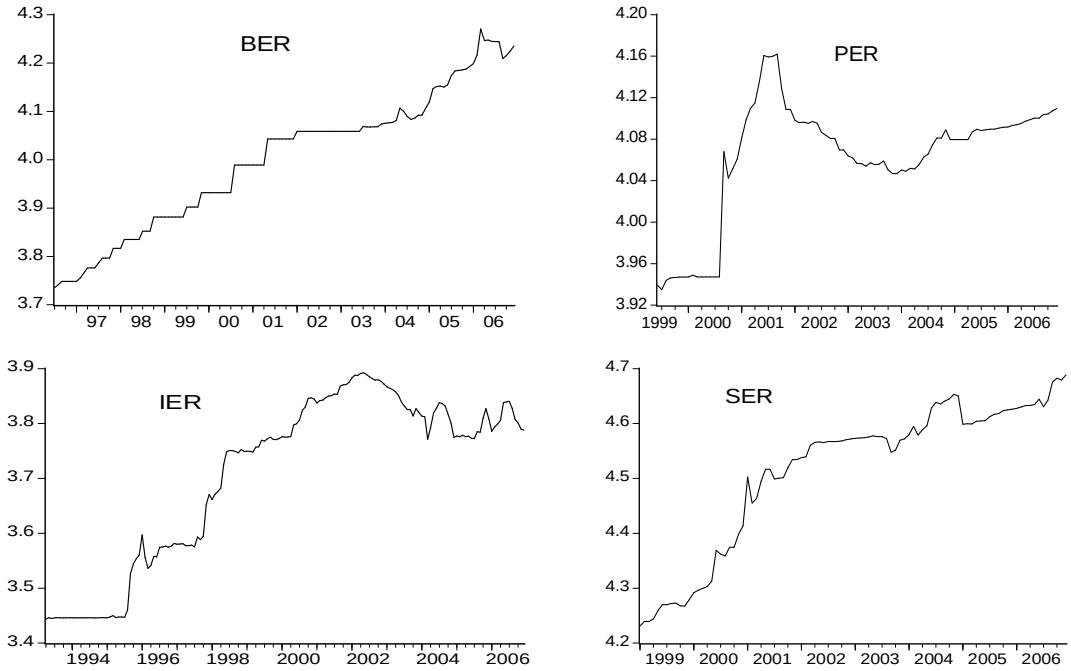

Figure A.2: South Asian Countries: Interest Rate Fluctuations

BDR, *ITBR*, *PMIR* and *SMIR* denote the logarithm values of nominal interest rates for Bangladesh, India, Pakistan and Sri Lanka, respectively.

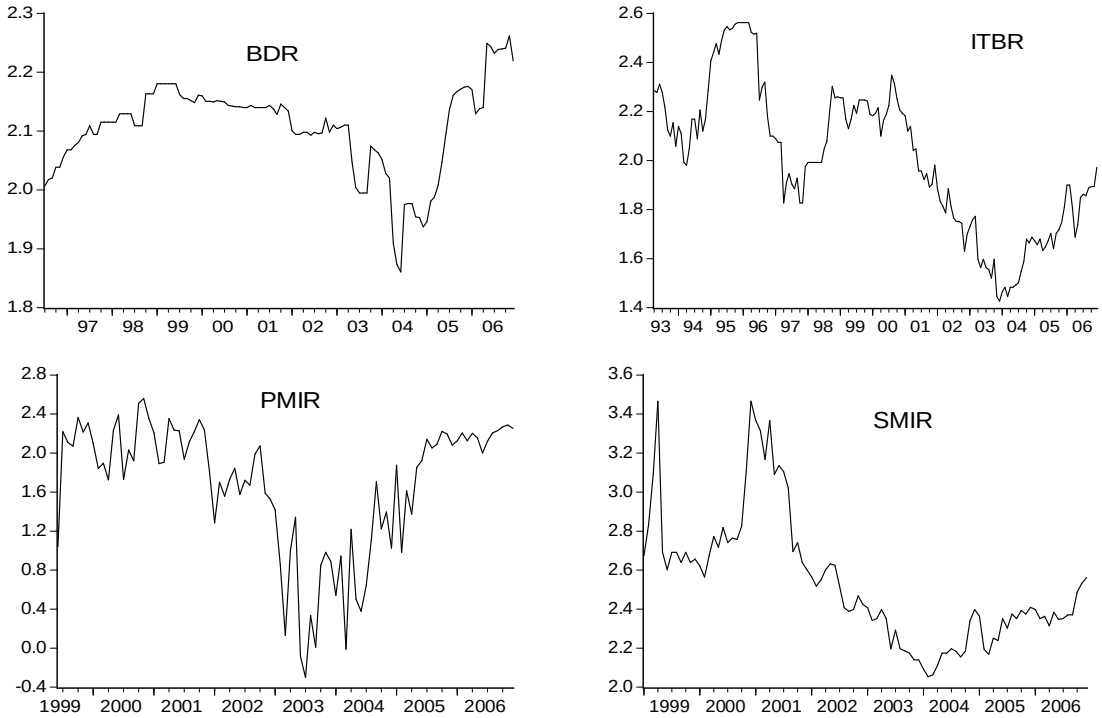

Figure A.3: South Asian Countries: Fluctuations in Monthly CPI

BCPI , *ICPI* , *PCPI* and *SCPI* denote the logarithm values of consumer price index for Bangladesh, India, Pakistan and Sri Lanka, respectively.

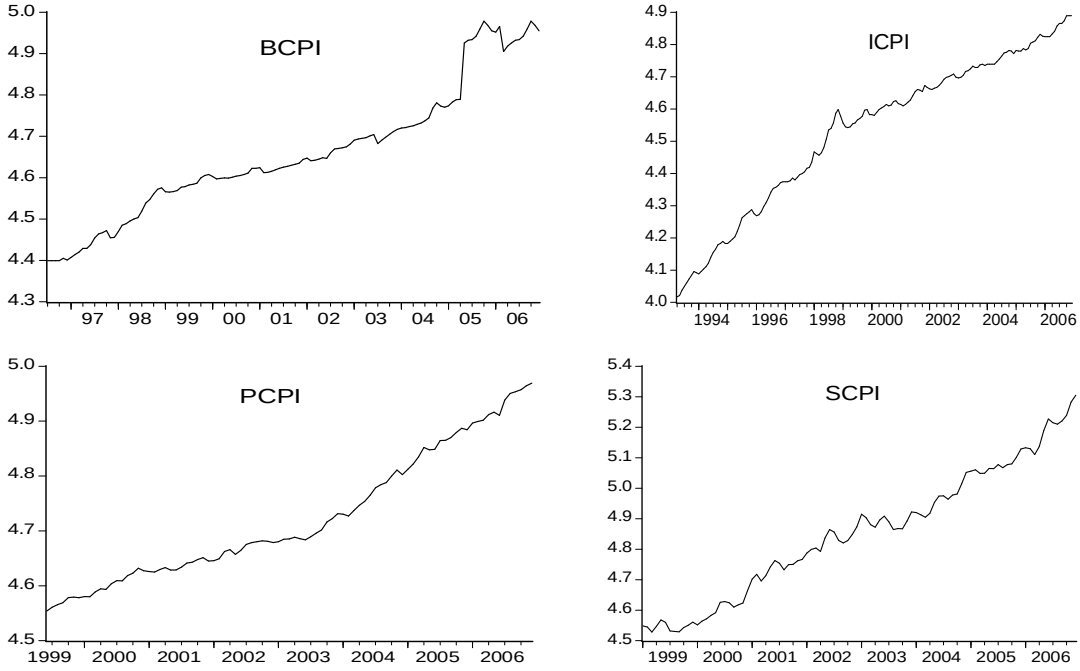

Table 1: Results from Augmented Dickey-Fuller (ADF) Test

Countries	e_t		$(cpi/wpi)_t$		i_t		x_t	
	λ_{Levels}	$\lambda_{1st.diff.}$	λ_{Levels}	$\lambda_{1st.diff.}$	λ_{Levels}	$\lambda_{1st.diff.}$	λ_{Levels}	$\lambda_{1st.diff.}$
Bangladesh	-1.10(9)	**-2.78**(8)	0.33(5)	**-4.61**(9)	-1.67(3)	**-7.22**(2)	0.37(0)	***-11.07(0)***
India	-1.67(1)	**-10.09**(0)	-1.56(8)	**-10.25**(0)	-1.55(0)	**-13.00**(1)	1.73(3)	***-9.40(2)***
Pakistan	-1.89(0)	**-13.05**(0)	-1.72(1)	**-7.70**(0)	-1.77(2)	**-10.10**(1)	-1.67(8)	***-8.63(0)***
Sri Lanka	-1.85(0)	**-10.59**(0)	-2.49(2)	**-5.91**(8)	-1.90(6)	**-3.54**(5)	1.60(2)	***-4.94(1)***
USA	-	-	*-1.43(3)*	***-6.14(2)***	*-2.51(7)*	***-3.92(2)***	-	-

Note: All the test regressions contain a constant term. Bold values indicate the rejection of unit root null hypothesis at the 1% or 5% level of significance. Numbers in parentheses are optimal lags selected by AIC and used in the augmentation of the regressions.

Table 2: Results from LM Tests for System Evaluation

Multivariate Tests:	**Bangladesh**	**India**	**Pakistan**	***Sri Lanka***
Residual Autocorrelation LM1($\chi^2(36)$)	*37.02*	*41.76*	*24.29*	*35.98*
Residual Autocorrelation LM5 ($\chi^2(36)$)	*37.42*	*42.12*	*42.19*	*35.51*
Normality Test: LM $\chi^2(12)$	*25.76*	*18.54*	***51.56***	***48.98***

Note: Test statistics in bold faces are significant at the 1% level of significance.

Table 3: Results from Johansen Cointegration Analysis

Null Hypothesis	**Bangladesh**		**India**		**Pakistan**		***Sri Lanka***	
	$\lambda_{\max}$	λ_{Trace}	$\lambda_{\max}$	λ_{Trace}	$\lambda_{\max}$	λ_{Trace}	$\lambda_{\max}$	λ_{Trace}
$r = 0$	48.49*	115.80*	43.52*	43.52*	109.69*	40.07*	49.28*	*137.19**
$r \leq 1$	33.58*	67.32*	55.38	21.57	69.61*	31.87*	36.32*	*87.91**
$r \leq 2$	15.90	33.72	33.81	16.67	37.75	20.14	24.99	*51.59*
$r \leq 3$	12.97	17.82	17.13	9.57	17.59	11.99	11.84	*26.59*
$r \leq 4$	4.48	4.84	7.59	6.39	5.60	5.17	8.94	*14.74*
$r \leq 5$	*0.35*	*0.35*	*1.18*	*1.18*	*0.43*	*0.43*	*5.79*	*5.79*

Note: *denotes the significant tests at the 5% level of significance.