An Empirical Analysis of the Combined PPP and UIP: Evidence from South Asia

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Abstract

Purchasing Power Parity (PPP) and Uncovered Interest Parity (UIP) represent two of the main building blocks of international macroeconomics. When combined they can provide a relationship between the exchange rate, price levels and interest rates. Therefore, the combined PPP and UIP are tested using multivariate cointegration approach for South Asian countries viz. Bangladesh, Indian, Pakistan and Sri Lanka. The study uses monthly data and sample period varies cross-country according to floating exchange rate regime.

The empirical results based on ADF and KPSS unit roots tests indicate that all the said variables are stationary in their first differences. The estimated statistics of Johansen's cointegration test provide evidence in support of the combined PPP and UIP for all the examined countries. However, we found that the modified form of the combined PPP and UIP produces more robust results than the standard form of the combined PPP and UIP. In the light of the empirical findings, it can be stated that nominal exchange rate of domestic country, prices levels and interest rates of domestic and foreign country move together in the long run. Thereby, the equilibrium exchange rate may be determined according to PPP and UIP for South Asian economies. The empirical findings of the analysis have consequential implications for financial reforms and exchange rate policy.

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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[1]. 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 (Rogoff (1995)) and cross-country wealth redistribution/transfer (Obstfeld and Rogoff (1995)) makes the determination of equilibrium exchange rate a meaningful for one to examine.

Moreover, the exchange rate plays a central role in maintaining external (balance of payments) and domestic equilibriums. 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 policymakers.

Monetary policy is the most important tool that policymakers have to stabilize an economy. However, if policymakers have choice to stabilize either exchange rate or interest rate, then, in general, they prefer to stabilize the exchange rate. Exchange rate stabilization, no doubt, provides the economy with a clear-cut nominal anchor, while stabilizing interest rates does not[2]. Similarly, policy makers do no allow the exchange

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[2] The classical instrument for stabilizing the exchange rate volatility is interest rate. A week currency can be strengthened by higher interest rates and a strong currency can be dampened by a lower interest rate.

rate as fully absorber of fluctuations in commodity prices – consistent with the view that the exchange rate may not be allowed to adjust in response to terms of trade shocks[3].

Regarding capital flows, the two issues are hotly debatable in the literature: absorption and sterilization. A study by Lal at el. (2003) argues that the annual growth of economy may increase if central bank would stop buying dollars in the markets and allow them to be absorbed by the economy. They stated that purchasing of excess supply of dollars in the market by the central bank limits the appreciation of the real exchange. As they said, "If it is desired that the capital inflows be absorbed into the economy, the real exchange rate must necessarily appreciate". The study further claims that significant growth in India is "foregone as a result of non-absorption of capital inflows".

However, a question arises, is the availability of capital alone the determinant of investment and hence growth? Capital may be a necessary but not a sufficient condition. Moreover, the currency appreciation in an open economy may have little attraction for entrepreneurs to make capital investment in the tradable sector. Due to openness of the economy, the output has to be competitive in third markets as also in the domestic markets with imports. An appreciating currency would surely cause to lower inflation in the non-tradable sector, making investment less attractive.

They also compare monetization of fiscal deficits with sterilization of capital inflows and claim that "as with capital inflow that is sterilized, a fiscal deficit is not monetized will leave the real exchange rate unchanged, but reduce investment, through of the capital and growth rate". However, Sing and Srinivasan (2004) said that "in the case of capital inflows, the growth or welfare effects differ depending on whether the inflows is absorbed or not, and not from whether it was sterilized"[4]. They further said that the issue of absorption of capital inflow is independent from the issue of sterilization. As defined by them, absorption involves the use of the additional resources from the inflow for

[3] For more details, see Calvo and Reinhart (2000).

[4] Sing and Srinivasan (2004) developed a model in a coherent framework that incorporates the real and monetary sectors of the economy. However, the real and monetary models of Lal et al. (2003) are not integrated and the consumers' demand for money and other nominal assets have no influence of their conniptions decisions.

financing additional imports. They concluded that "the government's prepayment of part of its external debt from reserves can be viewed as absorption …. and if the returns on domestic investment is no higher that on foreign debt, such absorption is appropriate".

To discuss absorption in further details, Sing and Srinivasan (2004) do comparison of two equilibriums: before and after receiving a gift, say F units, in terms of exports to private consumers in the economy. If the domestic relative prices of non-traceable (the export real exchange) does not change then the production of the economy will remain unchanged. However, the consumers now have more to spend on imports so that it will result an increase in supply. The price of importable goods will not change as long as the tariff rate will remain unchanged and under the assumption of homothetic preferences the demand will be increased from its initial level. Thus, there is an excess demand for non-tradables and an excess supply of tradables. With the same tariff rate, the relative price of non-tradables has to increase, so that the export and import real exchange rates appreciate by the same proportion. Assuming that both goods are normal in consumptions, definitely, consumers' welfare at the new equilibrium will be higher than at the initial equilibrium. This is the case of full absorption in the domestic economy of the gift F[5].

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 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).

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,

[5] For more discussion on this issue, see Sing and Srinivasan (2004).

have been provided empirical evidence for international parity conditions by modeling PPP and UIP jointly.

This study contributes into growing literature on the determinants of exchange rate in following four ways. First, it tests the combined PPP-UIP hypothesis in four developing countries in contradiction of existing body of literature, which just focused on developed countries. Second, the more robust unit root test namely KPSS is used to examine the properties of time series data. Thirdly, it modifies the combined PPP-UIP which seems more compatible with institutional realities of examined countries. Finally, it uses monthly time series data for a single managed float regime instead of combining fixed and floating exchange rate regimes.

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. In Section 2, we discuss the roles of different exchange rate regimes in an economy. In Section 3, we discuss the motivation for combining PPP and UIP in a single framework. Section 4 briefly reviews the theories of PPP and UIP and explains how the two theories can be combined in a single equation framework. Section 5 reports the previous empirical work. Section 6 tells about estimation techniques and data sources. The choice of variables, countries and sample period are also discussed in this section. Section 7 covers estimation. Finally, Section 8 summaries the key findings and concludes the study.

2. Exchange Rate Regimes: A Theoretical Comparison

Every country that has its own currency must decide about the type of exchange rate regime and the decision is often posed as a choice between a fixed and a flexible exchange rate. However, there are different varieties of fixed and flexible exchange arrangements, providing a range of different alternatives. Different alternatives have different implications for the extent to which national authorities participate in the foreign exchange markets. Based on their degree of flexibility, exchange rate regimes are classified into three categories: (1) fixed-rate regimes (include currency union, dollarization, currency boards and conventional fixed pegs), (2) intermediate regimes (horizontal bands, crawling pegs, crawling bands are included in this category), and (3) flexible regimes – managed and independent floats are defined as flexible regimes[6].

A conventional view on the exchange rate regime is that a fixed exchange rate regime can reduce exchange rate volatility and provide a credible anchor for monetary policy. A flexible exchange rate regime, on the other hand, can allow for more independent monetary policy. Accordingly, under a fixed exchange rate regime with perfect capital mobility, domestic interest rates move closely with the interest rate of the country to which domestic currency is pegged. Under a flexible exchange rate regime, by contrast, the monetary authority can set domestic interest rates independently. Other thing being equal, shocks to international financial markets do not necessary cause domestic interest rates to move. In other words, domestic interest rates under a flexible exchange rate regime can be insulted for shocks to international financial markets[7]. In this context, the question arises "Does the choice of exchange rate regime matter?" Below we theoretically discuss the conscientiousness of the two main exchange rate systems regarding effectiveness of policy, exchange rate stability, balance of payments adjustments, external shocks and industrial policy.

[6] For a brief discussion on features and definition of each exchange rate arrangement, see Appendix.

[7] In this paper we define the nominal exchange rate between two countries in terms of foreign currency units per unit of domestic currency. A decrease in exchange rate is called a depreciation of the domestic currency (fewer units of foreign currency are needed to buy one unit of domestic currency). An increase in exchange rate means an appreciation of the domestic currency (more units of foreign currency are needed to buy one unit of domestic currency).

The countries – that have ability to make good monetary policy – may choose flexible exchange rate system to enhance monetary policy effectiveness. However, in some countries the central banks are irresponsible in terms of printing money and increasing the money supply. Even though such increases in the money supply only served to expand output, over time excessive printing of money leads to higher prices (inflation) as too much money stars chasing too few goods. The resulting inflation makes the domestic price level rise, leads to a real appreciation and large current account deficits, which in turn lead to substantial depreciation of the currencies. For such countries, a fixed exchange rate can actually be beneficial by rendering the central bank important.

Regarding exchange rate stability, one potential weakness of flexible exchange rates is that it produces more fluctuations in nominal exchange rate because the nominal exchange rates fluctuate according to supply and demand conditions in the foreign exchange rate market. Such fluctuations lead to greater uncertainty and can reduce trade flows because importers and exporters are worried about whether the payments they end up receiving differs in value from what they thought they were going to get at the time the sale was agreed upon[8]. Under a fixed exchange rate, in contrast, the exchange rate does not move around at least in the short run; exporters and importers do not worry about hedging open currency positions. They also do not have to worry about demand for their goods constantly fluctuating along with the relative price.

As regard to balance of payments (BOP) adjustments, under fixed exchange rate system it is possible for a country's account deficit to become substantially than its capital account surplus. If the country does not have an adequate amount of reserves, then the country could face a BOP crisis requiring an international bailout or a drastic devaluation. In contrast, countries with flexible exchange rates not going to face or at least can reduce the chance of a balance of payments crisis. Any unsustainable BOP deficit is going to bring about an exchange rate depreciation of a magnitude sufficient to restore equilibrium in the BOP again. This does means that the impact of that depreciation will not be painful

[8] However, the existence of forward markets, futures markets and options markets allow exporters and importers to hedge their transactions.

but the pain of depreciation is likely to be far more preferable to the pain of a full blown BOP crisis.

Concerning external shock, flexible exchange rates act as automatic stabilizers shock – they facilitate a relatively painless adjustment to negative events in other countries that affect domestic economy. Let suppose a small open economy that faces two types of external shocks: a fall in foreign demand for domestic goods and a rise in foreign interest rates. Consider the first case, a fall in foreign demand for the domestic economy's goods; this reduces net exports (NX) and simple shift the Investment-Saving (IS) curve in (downwards). Thus, in a flexible exchange rate system, the interest rate falls below the world interest rate leading to an outflow of money. This outflow of money causes the currency to depreciate in value and helps stimulate NX, shifting the IS curve out (upwards). The BOP curve also shifts down since the immediate depreciation lowers the expected future depreciation. This helps mitigate the adverse impact of the fall in NX.

In contrast, under a fixed exchange rate system, when the IS curve shift in, the interest rate falls below the world interest rate leading to an outflow of money. This outflow of money causes the money supply to decrease, shifting the Liquidity for Money (LM) curve back. This exacerbates the adverse impact of the fall in NX.

Now consider the second case, an increase in foreign interest rates. This increase will shift the BOP curve up initially and raise the return from abroad above the return from investing at home. This will result in an outflow of money. However, under flexible exchange rate system this outflow of money brings about a depreciation of the domestic currency. This depreciation will shift the IS curve out due to an increase in NX and move the BOP curve back down because the expected depreciation falls. Thus, the end result is that the domestic economy benefits from the higher foreign interest rates.

On the other hand, under a fixed exchange rate system, an increase in foreign interest rate will result in sharp reduction in output. The higher foreign interest rate will shift the BOP curve up initially and raise the return from abroad above the return from investing at

home. This will result in an outflow of money. The outflow of money reduces the money supply and shifts the LM curve back until domestic and foreign interest rates are equal again. The end result is that the domestic economy contracts sharply as a result of the higher foreign interest rates.

Countries may choose a fixed exchange rate over a flexible exchange rate system because they can artificially set the value of the fixed rate to satisfy some industrial policy goal of the country. Overall, there are three advantages of having a flexible exchange rate: more monetary policy flexibility, the absence of BOP crises and insulation from shocks. Similarly, there are three arguments for having fixed exchange rates: reducing the effectiveness of the monetary policy makers, greater exchange rate stability and finally, the ability to pursue a particular industrial policy like boosting exports through an artificially cheap currency.

Another exchange rate system namely management floating exchange rate is attractive for countries that want to have the best of both worlds: some exchange rate stability combined with some monetary policy flexibility. Under a managed float, management of reserves is essential as the central bank has to intervene in the currency markets to ensure that the exchange does not stray too much from the targeted value.

3. Motivation for Combining PPP and UIP in a Single Framework

The empirical findings do not 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 Purchasing Power Parity (PPP) theory suggests? Is the exchange rate determined by the spread between the interest rates in the two countries as the Uncovered Interest Rate Parity (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 (for details, 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[9], 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 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

[9] 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.

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.

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, for details Juselius (1995)). However, empirical evidence on combined PPP-UIP is 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. Knowledge of the forex rate determinants is very important for not only policy makers and macroeconomic managers in government and banking sectors but also for individual businesspersons and consumers.

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

4.1 Purchasing Power Parity (PPP)

The most restrictive definition of the Purchasing Power Parity 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[10]. When a country's domestic price level is increasing (i.e., a country experiences inflation) that country's currency value must depreciated in order to return to PPP. 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, for details Brook and Hargreaves (2001)). Relative PPP is formally expressed in the following way:

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

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

[10] According to relative PPP, exchange rate movements should just cancel out changes in the foreign price level relative to the domestic price level. These offsetting movements should have no effect on the relative competitive positions of domestic firms and their foreign competitions.

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

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

As said by Frankel (1976), PPP holds only when price disturbances are originating from monetary resources. For example, an expansion in the domestic money stock will cause both the domestic level and the exchange rate to increase in the same proportion[11]. However, this proportionality between the price level and exchange rate will not be maintained when a real shock impacts the exchange rate. For instance, consider an increase in productivity in tradable goods. This will lead to a rise in domestic incomes, causing the demand fro non-tradables to rise. The higher demand definitely will result a rise in the domestic price level and an appreciation of the real exchange rate to restore equilibrium. However, now the increase in the exchange rate is not equal to the increase in price level.

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

[11] An increase in the money stock will reduce the purchasing power of money both in terms of a domestic basket of goods and in terms of foreign basket of goods. Exchange rate here is defined as the units of domestic currency required to buy one unit of foreign currency.

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.

4.2 Uncovered Interest Rate Parity (UIP)

The theory of Uncovered Interest Rate Parity 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. According to UIP, if interest rate in domestic country is higher than similar interest rate in foreign country, then foreign investors have more incentive to purchase domestic country's assets, driving the domestic country's spot rate down (the domestic currency appreciates). In simplest form, UIP can be expressed as follows:

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

where

i_t^d = domestic nominal interest rate for country i at time t

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

λ = constant, which capture the fixed effect specific domestic country

$E_t(\cdot)$ = 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)). The null hypothesis of UIP can be expressed as $H_o : \lambda = 0, \delta = 1$, through in practice almost all the focus in the literature has been on δ. 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:

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

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).

4.3 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.

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:

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

Rearranging:

$$e_{it} + p_{it}^d - p_t^f + \frac{\delta_i}{\eta_i}(i_{it}^f - i_{it}^d) + \Psi = 0 \qquad (5)$$

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[12]. 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:

$$e_{it} + p_{it}^{d} - p_{t}^{f} + \frac{\delta_i}{\eta_i}(i_{it}^{f} - i_{it}^{d}) + \Psi = \xi_{it} \tag{6}$$

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. In the next section, the study empirically estimated equation (6), 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 such that:

$$\begin{array}{ccccccc} w_{1i}e_{it} & + w_{2i}p_{it}^{d} & + w_{3i}p_{it}^{f} & + w_{4i}i_{it}^{d} & + w_{5i}i_{it}^{f} & + w_{6} & \sim I(0) \\ 1 & 1 & -1 & -\delta/\eta & \delta/\eta & \Psi & \end{array} \tag{7}$$

The values of $w_{1i}, \ldots, w_{6i}$ implied by equation (6) are displayed underneath.

5. Previous Empirical Work

Johansen and Juselius (1992) first tested combined PPP and UIP, for the United Kingdom, over the period from 1972 to 1987. They rejected the hypothesis that the PPP relation is stationary by itself. However, they found support for combined PPP and UIP. . Juselius (1995) tested the PPP and UIP for Denmark in the period 1972 to 1991. She found the co-movements of exchange rate, prices levels and nominal interest rates. Other

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

studies like Sjoo (1995) and Pesaran et al. (2000) also provided evidence to support the combination of PPP and UIP.

Bjørnland and Hungnes (2002), using a multivariate cointegrating framework, showed that a (weak) version of PPP holds against a basket of Norway's trading partners only when they incorporate the interest rate differential in the long run. However, pure PPP was rejected. Helg and Serati (1996) focused on the post Bretton Woods period and analyzed whether PPP and UIP are accepted by the data for Italy, United States and Germany. They found that there is a cointegrating vector involving the real exchange rate and the interest rates differential. They also reported that interest rate variables, from the point of view of the PPP, play a role only in the short run. Aysum and Erdal (2001) employed the Johansen cointegration analysis to test combined PPP and UIP for Turkish data and reported the existence of combined PPP and UIP.

Bjørnland and Hungnes (2005) examined whether a parsimonious dynamic exchange rate model for Norway that combines the purchasing power parity condition with the interest rate differential in the long run, can outperform a random walk model in an out-of-sample forecasting exercise. Their results show that the long-run results can be embedded in a parsimonious representation, which outperforms a random walk in an out-of-sample forecasting competition. Ignoring the long run interest differential (that is focusing only on PPP in the long run), however, the fundamental model can no longer outperform a random walk.

Similarly, another study by Hatzinikolaou and Polasek (2005) tested the PPP and UIP using Australian quarterly data from the post-float period 1984:1 – 2003:1. They identified and estimated two cointegrating relations one for the interest rate differential and the other for the nominal exchange rate. They reported that the PPP and UIP cannot be rejected so long as commodity prices are included in the cointegrating relations.

Bevilacqua (2006) replaced the consumer price index (CPI) considered by Juselius and MacDonald (2000) with the producer price index (PPI) to check whether the international parity relationships still cointegrate. He reported that even if there is no direct

cointegration relation between CPI and PPI both in Germany and USA, the cointegration relation found between *PPP* and *UIP* still holds notwithstanding of how *PPP* is measured

Stephen (2004) used Johansen's cointegration method to test combined PPP and UIP, for New Zealand, over the period 1992 to 2003. They were unable to find any significant evidence of combined PPP and UIP. However, their findings are in favor of strict PPP combined with weak form of UIP. Similarly, another study by Jose and Peter (2004) examined the impact of interest rate liberalization on exchange rate expectations in the Dominican Republic by using combined PPP and UIP along with random walk (RW) specification. They found that the most significant driver of exchange rate expectations is the interest rate differential between the Dominican Republic and the United State.

Calvo and Reinhart (2000) analyzed the behavior of exchange rates, foreign exchange reserves, the monetary aggregates, interest rates, and commodities prices across the spectrum of exchange rate arrangements to assess whether the "official labels" provide an adequate representation of actual country practices or not. The study uses monthly data for thirty-nine countries over the period from January 1970 to November 2007.

They divide their analysis into two parts. In first part, they simply find the probability of the deviations in the said variables and compare across the exchange rate regimes namely peg, limited flexibility, managed floating and free-floating. They reported that exchange rate variability is least for pegs and greatest for floaters and reserve variability is highest for floaters and least for the limited flexibility arrangements. Regarding interest rates, they concluded that interest rates are the most stable for the limited flexibility group and least stable for the managed floating group. Similarly, the results provide evidence that the monetary aggregate show a high degree of variability relative to the more committed floaters. Finally, they said that commodity prices are far more volatile than exchange rate.

Secondly, they estimated a vector autoregressive (VAR) model to examine both temporal and contemporaneous links among the variables. The lag length was chosen on a case-by-case basis using the Schwartz criteria. They reported that in 46 per cent cases, the coefficient on the interest rate change is positive, which is what can be expected when

there are credibility problems and interest rate increases signal future depreciations. In the remaining 54 per cent of the cases, the coefficient is negative. This would be the case when tight monetary policies (raising interest rates) lead to a future appreciation.

6. Empirical Framework

6.1 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. Before proceed to testing cointegration, the study started by testing the time-series properties of the said variables.

6.1.1 Unit Root Tests

A large number of economic time series are trending, which suggests that they may be non-stationary. A stationary time series is one whose basic properties don't change over time, more formally, a time-series, U_t, is stationary if: (i) The mean of U_t is constant over time, (ii) The variance of U_t is constant over time, and (iii) The simple correlation coefficient between U_t and U_{t-k} depends on the length of the lag (k) but on no other variable. If one or more of these three properties are not met, then U_t is a non-stationary time series. However, until the early 1980s, it was generally assumed that the economic series were stationary. Granger and Newbold (1974), in a Monte Carlo study, have demonstrated that the presence of non-stationary variables may lead to spurious regression result in the sense that estimate of a regression with non-stationary variables may generate high R^2 and t-statistics that may appear to be significant when in fact there exists no meaningful relationship between the dependent variable and the independent variables. Thus, running regressions on non-stationary data can give rise to misleading

value of R^2 Durbin-Watson and t statistics, causing economists erroneously to conclude that a meaningful relationship exists among the regression variables.

Therefore, it is useful to examine first whether the variables employed in the study contain unit roots in their autoregressive components as the presence of unit roots has serious implications for model building, estimation strategy and statistical inference. For example, if a data series contains a unit root (it is called non-stationary time series), then the effects of exogenous shocks on the variables in question are permanent in the sense that the effects of the shocks appear over time. On the other hand, if the data series does not contain a unit root (it means series is stationary) then the exogenous shocks have transient affects on the variable in question. The affects of such shocks disappear over time and in the long run the variable reverts back to their long-run path.

Anther problem with time-series analysis is exogeneity. Particularly, in a cointegrated system, if a variable does not respond to the discrepancy from the long-run equilibrium relationship is called weakly exogenous[13]. Hence, if the speed of adjustment parameter (α) is zero, the variable in question is weakly exogenous. The practical importance is that a weakly exogenous variable does not experience the type of feedback that necessitates the use of a vector autoregressive (VAR) process.

A number of the empirical studies in econometrics literature have reported that the classical or conventional non-stationarity tests (such as DF, ADF and PP tests) are not very powerful against relevant alternatives. For instant, Delong et al. (1989) found that the Dickey-Fuller tests are not able to reject a unit root null hypothesis against stable autoregressive alternatives with roots close to unity. Similarly, Diebold and Rudebusch (1990) provided empirical evidence that standard unit root tests have low power against fractionally integrated alternatives.

[13] Engle et al. (1983) provide a comprehensive analysis of various types of exogeneity. In general, a variables X is weakly exogenous fro the parameter set F if the marginal distribution of X contains no useful information for conducting inference on F. Hence, the variable X can be exogenous in one econometric model but not another.

To avoid this problem the present study uses the KPSS (Kwiatowski et al. (1992)) methodology (the LM statistic), in addition to ADF test, to test for the stationarity. Under this method, the null hypothesis is stationarity and the alternative is the presence of a unit root. This ensures that the alternative will be accepted (null rejected) only when there is strong evidence for (against) it. The KPSS test statistic is defined as follows:

$$\hat{\eta} = T^{-2} \sum \frac{S_t^2}{s^2(l)}$$

where S_t is the partial sum process of the residuals ξ_t are from a regression of the respective variable on only intercept in case of level stationary, and on intercept and trend in case of trend stationary; that is defined as: $S_t = \sum_{i=1}^{t} \xi_i$ and $s^2(l) = T^{-1} \sum_{t=1}^{T} \xi_t^2 + 2T^{-1} \sum_{m=1}^{l} w(m,l) \sum_{t=m+1}^{T} \xi_t \xi_{t-m}$, $w(m,l)$ is an optional weighting function; this is, $w(m,l) = 1 - m/(1+l)$, where l is the maximum lag.

6.1.2 Cointegration Tests

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 a higher-order-autoregressive (VAR) process for a multivariate model:

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + A_3 x_{t-3} + \ldots + A_j x_{t-j} + \psi_t \qquad (8)$$

where x_t is the (n × 1) vector $((x_{1t}, x_{2t}, \ldots, x_{nt})'$, j is the maximum lag, ψ_t is assumed to be k-vector (n × 1) of Gaussian error term $(\psi_t \approx Niid(0, \Sigma))$, and A_i's are (n × n) matrices of coefficients to be estimated[14]. Equation (8) can put in a more useable form by adding and subtracting $A_j x_{t-j+1}$ to right-hand side to obtain

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + A_3 x_{t-3} + \ldots + A_{j-2} x_{t-j+2} + (A_{j-1} + A_j) x_{t-j+1} - A_j \Delta x_{t-j+1} + \psi_t$$

Next, add and subtract $(A_{j-1} + A_j) x_{t-j+2}$ to obtain

[14] In our case, $x_t = \left[e_{it}, (p)_{it}^d, (p)_t^f, i_{it}^f, i_{it}^d \right]$

$$x_t = A_1 x_{t-1} + A_2 x_{t-2} + A_3 x_{t-3} + \ldots - (A_{j-1} + A_j)\Delta x_{t-j+2} - A_j \Delta x_{t-j+1} + \psi_t$$

We continue with this fashion to obtain the following Vector Error Correction (VEC) model

$$\Delta x_t = \pi x_{t-1} + \sum_{i=1}^{j-1} \pi_i \Delta x_{t-i} + \psi_t \qquad (9)$$

where $\pi = -(1 - \sum_{i=1}^{j} A_i)$ and $\pi_i = -\sum_{j=i+1}^{j} A_j$

where π is rank of the matrix. The rank of π is equal to the number of independent cointegrating vectors. Clearly, if rank (π) = 0, the matrix is null and equation (9) is the usual VAR model in first differences. Instead, if π is of rank n, the vector process is stationary. In intermediate cases, if rank (π) = 1, there is single cointegrating vector and the expression πx_{t-1} is the error-correction term. For other cases in which $1 < rank(\pi) < n$, there are multiple cointegrating vectors. $\pi = \alpha\beta'$, where β' is the matrix of cointegrating parameters and α represents the speed of adjustment to disequilibrium. Johansen's test for cointegration centers on estimating the matrix π in an unrestricted form and then testing whether π has less than full rank. Johansen's approach for testing the null hypothesis of no cointegration depends on likelihood ratio, the trace $\{\lambda_{trace}\}$, that is defined as:

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda}_i)$$

where T is the number of useable observations, r = 0, 1,…,k – 1, and $\hat{\lambda}_i$ is the $i-th$ largest eigenvalue. Before starting the tests, a rationale choice of the variables, the sample period and the dada set will be discussed in the next section.

6.2 Variable Description, Sample Period and A Visual Analysis

6.2.1 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

p_{it}^{d} = consumer price index for country i

p_{t}^{f} = USA consumer price index

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

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

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. All the said variables are taken from International Financial Statistics database prepared by International Monetary Fund (IMF)[15]. 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 which is obtained for Indian Reserve Bank database. The data has been checked and corrected for errors.

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 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[16].

[15] One of the aims of the study is to make the comparison of South Asia countries in term of PPP and UIP hypothesis. As we assumed that the use of the same database for all the countries would provide robust estimates for comparison, we preferred to use IFS database instead of national data sources.

[16] 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.

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.

Pakistan pursued a fixed exchange rate policy until January 1982 when it shifted to a managed floating rate. The depreciation of Pak-rupee against US dollar from January 1982 to April 1996 was 71.5 per cent. Pakistan continued to pursue a managed floating exchange rate policy until July 21, 1998. In order to minimize the adverse effects of economic sanctions, Pakistan moved to a dual exchange rate system in July 22, 1998[17]. The dual exchange rate system was replaced with managed floating unitary exchange rate system in May 19, 1999. In July 21, 2000, however, the unified exchange rate system was also replaced with free-floating exchange rate regime.

The sample period for Pakistan therefore starts from June 1999 and ends in December 2006. This period may indeed be considered too short to test the PPP and UIP hypotheses. But the sample period can not be extend backwards as gains from long-sample estimates may be offset by the fact that the free float period is very small proportion of the long sample.

India followed an exchange rate regime with rupee linked to the pound sterling during the period 1950 to mid-December 1973. However, the rupee's ties to the pound sterling were broken on September 24, 1975. India conducted a managed floating exchange rate with the rupee's effective rate placed on a controlled, floating and linked to a basket of

[17] Under this exchange rate regime there existed two exchange rates, namely the inter-bank floating rate and the composite rate. Market forces of demand and supply determined the inter-bank floating rate and the State Bank of Pakistan determines the official exchange rate. The composite rate was the weighted average of official exchange rate and the inter-bank floating rate.

currencies of Indian's major trading partners. This exchange rate regime came under severe pressures from the increase in trade deficit and net invisible deficit in early 1990s. India therefore introduced the Liberalized Exchange Rate Management System (LERMS) in March 1992 and hence adopted a dual (official as well as market determined) exchange rate. Just one year later in March 1993, the LERMS was replaced by the unified exchange rate system and hence the system of market determined exchange rate was adopted. Therefore, for India, the study covers the period from April 1993 to December 2006 to enjoy the gains of floating period.

The Pakistan rupee was replaced by Bangladesh taka in January 1972. In July 1972, a Secondary Exchange Market (SEM) System, comprised of the Wage Earner's Scheme (WES) and Export Performance Benefit Scheme (XPB), was formed. Started 1979, the Bangladesh Bank followed a semi-flexible exchange rate policy and the value of taka was determined on the basis of a weighted basket of currencies, with fluctuation margins of 2.5 per cent on either side. In 1992, the SEM system was abolished and the dealings of Bangladesh Bank with domestic authorized banks were restricted to U.S. dollar as well as the currencies of member countries of the Asian Clearing Union (ACU)[18]. However, Bangladesh Bank ceased to deal in the currencies of the other ACU member countries in 1996. However, the starting date of sample for Bangladesh is July 1999, because consumer price index and interest rate are available only from that date.

Sri Lanka moved to independently floating exchange rate regime from 23 January 2001. The behavior of exchange rate is monitored against a basket of 24 currencies. The exchange rate has been depreciated at an annual rate of about 5 to 7 per cent during the period from 2002 and 2004. For example, the depreciation against US dollar in 2004 was 6.2 per cent. However, the exchange rate has appreciated against US dollar in 2005. In view of that, the study tests the combined PPP-UIP in Sri Lanka using monthly data over the period from January 1999 to December 2006.

[18] Members of the ACU are Bangladesh, India, the Islamic Republic of Iran, Myanmar, Nepal, Pakistan, and Sri Lanka.

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 consumer price index and market interest rate are used in this study[19]. The CPI and PPI/WPI are highly correlated in the said countries (for instance, 99%, 98% and 98.7% in Pakistan, India and Sri Lanka, respectively). Therefore, it can be assumed that the empirical findings might not significantly be affected by the use of CPI instead of PPI/WPI, or vice versa[20].

However, India has currently four consumer price indices (CPI) measuring the changes over time in the general level of prices of goods and services that four different reference population groups acquire, use or pay for consumption. These indices are CPI for Urban Non-Manual Employees (CPI-UNME), CPI for Industrial Workers (CPI-IW), CPI for Agriculture Labourers (CPI-AL) and CPI for Rural Labourers (CPI-RL)[21]. CPI-UNME is compiled and released by Central Statistical Organization (CSO), Ministry of Statistics and Program Implementation, while the rest three are complied and released by Labour Bureau, Ministry of Labour. CPI-IW is the most well known of these indices, as it is used for wages indixation in government and organized sector.

Now the question arises that which ones is more relevant to test PPP and UIP jointly. If we see the correlation estimates presented in Table 15, we find that all the price indices are highly and significantly correlated. For instance, the correlation estimate for CPI-IW and CPI-UNME is 0.92, implying that both the indices are 92% correlated. Similarly, CPI-RL and CPI-AL are 99% correlated. Since all the four price indices are highly

[19] Apart from India, where the Treasury-Bills (T-bills) rates are used as a domestic interest rate and US T-bills rate as foreign interest rate.
[20] Here description of price indices is as defined in International Financial Statistics (IFS).
[21] The silent features of these price indices are present in Table 14.

correlated, it can be assumed the choice of price index does not matter for significance of the estimates for testing the said hypothesis. However, we use the IMF database and they compile the CPI for Industrial Worker for India using the Laspeyres formula. The CPI complied by IMF and the CPI-IW complied by Labour Bureau (Ministry of Labour, India) are same by definition. The only difference is that the latter one is complied using information collected from 76 centers/villages, however, in case of farmer; they focused on 50 centers/villages of India. CPI-IW is weighted price index and in both cases the weights are allocated on the basis of consumer expenditure survey.

To test the modified form of combined PPP-UIP, the ratio of wholesale/producer to consumer price indices (for all the said countries and for the USA) is used as price indices, 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.

6.2.2 A Visual Analysis

As said by Enders (1995), the visual inspection of the data is a critical first step in any econometric analysis. The graphs of the time series of all the variables relevant for the study are shown in levels and first differences as well[22].

The nominal exchange rates are bilateral rates against the U.S. dollar, designating the United States as the foreign country in this study, for the all the said countries. Figure A.1 in the appendix contains time-series plots of the exchange rates. Since scales and sample periods differ cross-country, the plots should be interpreted carefully. The breaks in series are usually associated with currency crises or other regime breaks. The exchange rates in Bangladesh show a gradual increase between the periods 1997 to 2000 and a more stable pattern since 2001 till 2003 and a rapid increase for subsequent period.

[22] The software EViews 5.0 has used for all computations and graphical output in this study.

It can be noticed that in 1999 exchange rates in Pakistan was stable and there was a rapid increase in exchange rates in 2000 and it has been reached its peak in the mid of 2001. However, in the end of 2001, the exchange rates have been started to decline and this declining trend has been continued till the end of 2003. Finally, for the following period, the exchange rates show a more stable pattern. For remaining two countries (India and Sri Lanka), the exchange rates have more or less an increase trend through the sample period.

Figure A.2 and A.3 show the fluctuations in interest rates and consumer price index, respectively. Here the currency crises appear as spikes in interest rates. The interest rates in Pakistan seem more dynamic as compared to other countries. It had decreasing trend on average up to mid of 2003 and increasing trend for the subsequent period. Analogously, the interest rates in Bangladesh show a decline on average before the mid of 2004 and after that vice versa. On the other side, Indian interest rate had increasing trend between the periods of 1994 to 1996. However, the rate has been significantly declined during the period from 1997 to 2003, on average. For the following period, once again interest has upwards trend. The market interest rates show a rapid decline on average after reaching at its maximum level in the end of 2000 in Sri Lanka. It was lowest in the beginning of 2004 and shows a slowing up pattern for the subsequent period.

As regards price levels, consumer price indices have an increasing trend for all the four countries. Figure A.4 is an analogue showing fluctuations in wholesale or producer price indices. It can be observed from the figure that the wholesale/producer price indices are more fluctuated relatively to consumer price indices for all the said countries. However, they also have significant upwards trend like consumer price indices. Figure A.5 provides a look at the ratio of exports to imports. Interestingly, the export-import ratio is less than one for all the said countries. The ratio is more fluctuated in Bangladesh as compared to other countries. However, it seems much more stable in case of Sri Lanka.

7. Empirical Results

7.1 Unit Root Tests Results

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 ADF and KPSS unit root tests. The estimated statistics of ADF and KPSS tests are presented in Table 1 and 2, respectively.

The ADF statistics are calculated, at levels as well as at first differences, for each country with a constant and a constant plus a linear time trend, respectively. To find an appropriate lag length for ADF tests, the analysis employs the criteria developed by Campbell and Perron (1991). Accordingly, it is started with a lag length of k, and sequentially deleted insignificant lags until the last lag was significant. Generally, the results of the ADF tests 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. However, in some cases, the positive statistics are indicating positive autocorrelation.

The Indian consumer price index appears stationary at its levels when the ADF equation is estimated without a linear trend. However, the ADF statistic does not provide any significant evidence to reject the null hypothesis of that CPI has a unit root when the equation is remodeled with a constant plus a linear trend. Because the linear trend term is statistically significant at any common level of significance, therefore, it can be considered that the consumer price is non-stationary at its levels. However, the exports-imports ratio series is stationary around only a constant and a linear trend plus constant both in India and in Sri Lanka.

Insert Table 1 about here

The last two columns of the table report the ADF tests at first differences. It can be observed from the table that the estimated statistics are significantly greater than the critical values at 1 per cent level of significant for all the variables except the exchange

rate in Bangladesh, for which the null hypothesis of unit roots is rejected at 5 per cent level of significance only when the ADF equation is estimated without a linear trend.

The KSPP test statistics η_u and $\hat{\eta}_\tau$ are estimated at the values of lag (l) from 1 through 3 to test the null hypothesis of stationarity with and without a time trend, respectively. The choice of three as the maximum value l is based on wisdom that the autocorrelations in monthly series has considerably died at l = 3. Since the estimated test statistic, η_u, is greater than the critical values (at all examined lag values) for all the said series expect for exchange rate in India at l = 3, therefore, we reject the null of stationarity in favor of the alternative of unit roots, that is, all the series have unit roots. However, if the deterministic trends are present in the series then the rejections of the hypothesis of level stationarity are not considered reliable. The study therefore proceeds to test the null hypothesis of stationarity around a deterministic linear trend. The estimated $\hat{\eta}_\tau$ statistics of lag 1 to 3 are reported in column 5-7 of Table 2.

Insert Table 2 about here

The table provides evidence that the calculated test statistics are significantly greater than critical values expect for the ratio of export to imports in Bangladesh. Consequently, the null hypothesis of trend stationarity is rejected at any usual level of significance. In general, it can be concluded that all the said series follow unit roots (non-stationary) both around a level and around a linear trend in their levels apart from the ratio of exports to imports in Bangladesh that is trend stationary in its level. Overall, the results of the KPSS tests are strongly supporting the results of the ADF tests except for one case[23]. Thus, the results of the ADF and KPSS unit root tests conducted on all the series for the period under study suggest that all the series are $I(1)$, apart from the ratio of exports to imports in Bangladesh[24].

[23] The ADF test rejects the null hypothesis of unit root for the ratio of exports to imports in Sri Lanka at its levels; however, the KPSS test provides quite contrary evidence i.e., it is non-stationary at its levels.
[24] The KPSS tests at first differences of the series show that all the series are stationary in first differences. The results of these tests are not reported here to save the space, however, are available from author upon request.

7.2 Lag Determination

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. Cheuny and Lai (1993) suggested that autocorrelation is a serious problem for the Johansen's approach.

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 8^{th}). If the exclusion of the 8^{th} lag is not rejected, the VAR order is reduced to 7, and the significance of the 7^{th} 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 three lags for both Pakistan and India, two lags for Bangladesh and 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.

In addition to this, VAR residuals cross-correlations (with 2Std.Err. bounds) are presented in Figure B.1 to B.4 of the Appendix; provide evidence that there is no significant autocorrelation in VAR residuals. White's Heteroskedasticity test (joint Chi-sq) is used to test the null of no heteroskedasticity against heteroskedasticity of some unknown general form. The estimated test statistics do not provide any significance evidence to reject the null hypothesis apart from Sri Lanka, where the test has fail to accept the null hypothesis of no heteroskedasticity at 5 per cent level of significance.

Insert Table 3 about here

7.3 Determining the Cointegration Rank

The specification of the VEC model is based on the presence of a cointegration relation. If such a relation exists, then it can be posited that at least one linear combination of the non-stationary series is stationary and that there is therefore a long-run equilibrium relationship among the variables. As said above, the Johansen cointegration procedure is used to test for the presence of one or more cointegration vectors.

Insert Table 4 about here

Table 4 reports the eigenvalues, 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 an intercept but no trend in the cointegration vector. The trace tests statistics indicate two cointegration equations at the one per cent level of significance whereas the maximal eigenvalue tests statistics provide evidence of a single cointegration vector at the same level of significance for both Bangladesh and Pakistan.

For remaining two countries, both the tests statistics provide identical evidence about the cointegration rank and they reject the hypothesis of no cointegration but not the hypothesis of at most one cointegration relation at the one per cent level of significance. Thereby, it can be concluded that there is one cointegrating equation for India and Sri Lanka. Since both tests are agree on at least one cointegration equation (the first one) at one per cent level of significance for all the said countries, which is normalized on nominal exchange rates and is shown below in Table 5[25].

Insert Table 5 about here

The presence of the cointegration is implying that the exchange rates, prices and interest rates are related (in PPP and UIP sense) in long run for South Asian countries. The existence of combined PPP and UIP is indicating that domestic price level, domestic

[25] In addition to this, the first cointegrating vector in case of Bangladesh and Pakistan has the highest eigenvalue, and is therefore the "most associated with the stationary part of the model" (Johansen and Juselius (1995)). Another explanation 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.

interest rate, foreign price level and foreign interest rate are simultaneously playing important role to determine the equilibrium nominal exchange rate.

It can be seen from Table 5 that the cointegrating vectors, normalized by the nominal exchange rates relating to each country, have signs that match the theory of combined PPP and UIP for all the countries excluding India, as depicted in equation (7)[26]. It is interesting to note that, in case of India; both domestic and foreign interest rates as well as price levels appear with the signs that do no match the theory of combined PPP and UIP. 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 three types of restriction on the cointegration coefficients as given by the cointegrating vector, which are expressed as follows:

1. **Strict Form PPP and UIP:** price differentials affect the exchange rate proportionally and interest rates in the two countries affect the exchange rate symmetrically. It is expressed as:

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

2. **Strict PPP and Weak Form UIP:** price differentials affect the exchange rate proportionally while interest rates are allowed the exchange rates non-symmetrically. It is described as:

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

3. **PPP Symmetry and Weak Form UIP:** domestic and foreign price movements affect the exchange rates but they do not necessarily affect the exchange rate proportionately. It is can be tested as:

   $$\beta_2 = -\beta_3$$

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.

Insert Table 6 about here

[26] It is important to note here that 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.

The table provides some fascinating information on the restrictions imposed on the first cointegrating vector. For Bangladesh, the estimated LR test statistics provide evidences, which are not in favor of to impose any type of restriction on the first cointegrating vector. Thus, the unrestricted cointegrating vector will perform better as compared to restricted versions of combined PPP and UIP in order to estimate the equilibrium exchange rate. On the other hand, the validity of all of the restrictions is confirmed for Pakistan as well as for India. For Sri Lanka, strict form PPP and UIP as well as PPP symmetry and weak form UIP both are rejected at the 5 per cent significance level. The LR test, however, fails to reject the strict PPP and weak form UIP. Accordingly, the restricted cointegrating vectors are displayed in Table 7.

Insert Table 7 about here

It can be seen that the restricted cointegrating vectors have signs according to the theory of combined PPP and UIP for all the countries, even for India the coefficients on interest rates are of the correct sign where unrestricted cointegrating vector's sighs were not matching the theory. Taking into account only the relative signs and magnitudes, it can be observed from the table that domestic interest rates have more effect on the nominal exchange rates than the foreign interest rates for all the examined countries. These restricted cointegrating vectors can be used to derive the exchange rate that would have restored the exchange rate, prices and interest rates to their long run relationship according to PPP and UIP.

7.4 Testing the Modified Form of the Combined PPP and UIP

The standard versions 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[27]. 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

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

price flexibility and the law of one price[28]. In this context the standard combined form of PPP and UIP is not suitable. Since the traditional Purchasing Power Parity (PPP) and a standard Uncovered Interest Rate Parity (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 exports to imports as a measure of risk premium or the degree of capital mobility in equation (6)[29,30]. Accordingly, it can be reshaped as follows:

$$w_{1i} e_{it} + w_{2i} p_{it}^{d} + w_{3i} p_{it}^{f} + w_{4i} i_{it}^{d} + w_{5i} i_{it}^{f} + w_{6i} x_{it} + w_{7} \sim I(0) \qquad (10)$$

where p_t denotes the log of the ratio of wholesale/producer index to consumer price index and x_t is the log of the ratio of exports to imports. 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.

To proceed with equation (10), first, the VAR models are estimated with 8 lags and the appropriate lag length is selected based of LR statistics and Schwarz Information Criteria (SC). LM test fails to reject the null of no serial correlation in the VAR residuals and the White's Heteroskedasticity test provide significance evidences to accept the null of homoscedasticity[31].

[28] 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.

[29] See Patterson et al. (1978) for justification behind the use of the log of the ratio of exports to imports as measure of risk premium or the degree of capital mobility. Moreover, in the Keynesian framework, regarding exchange rate determination, interest focused on goods market flows. The "equilibrium" exchange rate is assumed to be determined by the export and import of goods (see Pentecost (1993) for a historical account of Keynesian approach).

[30] However, National Institute of Economics and Social Research used the ratio of net foreign assets to GDP as a measure of risk premium in order to develop the NIESR 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).

[31] The estimated statistics with their p-values are reported in Table 8.

To identify the cointegrating relations, the Johansen cointegration technique is applied to equation (10). Assuming an intercept but no trend in the cointegrating vector[32], the estimated trace ($\lambda_{trace(r)}$) and the maximum eigenvalue ($\lambda_{\max}$) statistics are reported in Table 9.

Insert Table 9 about here

The trace test indicates the presence of one cointegrating relation for both India and Sri Lanka at 1 per cent level of significance. Evidence, however, strongly supports the two and three cointegrating relations for Pakistan and Bangladesh, respectively[33]. As said by Maddala and Kim (1998, pp 214-220), the Johansen procedure is always biased towards finding too many cointegrating vectors. The first cointegrating vector has the highest eigenvalue and is the least likely to have been spuriously identified as stationary. Thus, to proceed to the next, we normalized the first cointegrating relation by nominal exchange rate and present in Table 10.

Insert Table 10 about here

As mentioned above, only relative signs and magnitudes are considered because the model is being tested in first differences. As the table indicates that the first cointegrating relation, normalized by the nominal exchange rate, has signs that match the theory of the combined PPP and UIP for all countries excluding Sri Lanka, where the signs of the foreign price ratio and interest rate do not match the theory. It is interesting to note that the modified form of the combined PPP and UIP seems robust for India, as compared to simple version of the combined PPP and CIP. The coefficient on the lag of the ratio of exports to imports (a measure of risk premium) has positive sign for three out of four countries. For Sri Lanka, however, the risk premium factor has more effect on the nominal exchange rate as compared to other countries.

Finally, note that for Pakistan, the ratios of domestic and foreign price indices have approximately the same effect on the nominal exchange rate; however, the exchange rate

[32] These specifications are robust to Schwarz information criterion.
[33] However, maximal eigenvalue tests indicate one and two cointegrating relations for Pakistan and Bangladesh, respectively.

is more affected by the foreign interest rate as compared to domestic interest rate. Quite contrary, the domestic interest rate has more effect on the exchange rate than the foreign interest rate for Bangladesh, Indian and Sri Lanka.

Having identified the cointegrating relations and estimated the normalized cointegrating vectors, we are able now to impose the above mentioned three types of restriction on the cointegration coefficients. Using the LR test, we are not able to reject any restriction for both Bangladesh and Sri Lanka at any common level of significance. On the other side, the test rejects the restricted form of PPP and UIP for Pakistan and India (see, for details Table 11). Since the LR test provides inconclusive evidence for the PPP-UIP restrictions in the first cointegrating relation, we select the restricted cointegrating vector in which the estimated residuals have minimum standard deviation (misalignment)[34].

Insert Table 11 about here

The residuals are plotted in Figure B.2 of the Appendix. For India, the strict form of modified combined PPP and UIP seems more robust as it produces less misalignment than others. Similarly, strict combined PPP and weak UIP are selected for Pakistan and Bangladesh. However, strict form PPP and UIP as well as strict PPP and weak form UIP are suitable for Sri Lanka. The restricted cointegrating vectors are displayed in Table 12.

Structural tests (normality and stationarity) reveal no strong evidence against the restricted cointegrating vectors, so the estimates of Table 12 are deemed useable. We discuss the most important of them. Note that, Bangladesh is the only country where the ratio of the exports to imports has a negative impact on the nominal exchange rate (it has positive impact for the remaining three countries). In case of India, the ratio of exports to imports, however, plays a leading role in determine the equilibrium value of exchange rate.

Regarding interest rates, Bangladesh and Sri Lanka exchange rates are more affected by domestic interest rates than the foreign market rate of interest. In contrary, foreign

[34] The ADF unit root test confirms these choices as the $t-statistic$ appears with the highest magnitude in these cases. Accordingly, these restricted cointegrating vectors are least likely to have been spuriously identified as stationary, and are therefore the safest to adopt.

interest rate has more effect on Pakistan exchange rate as compared to domestic interest rate.

Insert Table 12 about here

8. Discussion and Concluding Remarks

This paper attempted to test the hypothesis that the combined PPP and UIP holds as a long run stationary relationship. 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.

ADF and KPSS 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) and White's Heteroskedasticity tests are used for diagnostic testing of the VAR models specified by the sequential modified LR test.

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 the exchange rate away from the conditional equilibrium. The simple version of the combined PPP and UIP and the modified form of the PPP and UIP, in order to take into account the puzzle of tradable and non-tradable goods and the imperfection of capital markets as well, are tested. The main findings of the paper are as follows:

First, the evidence is that nominal exchange rates, interest rates, prices and the other said variables are non-stationary at their levels. However, the first differences of the series appear stationary. It implies that all the series are $I(1)$.

Second, the analysis has provided evidence that there is a cointegrating relationship between the exchange rate, interest rates and prices implying that the exchange rate is determined by combined two- fundamental arbitrage conditions viz., UIP and PPP. This

suggests that prices (domestic and foreign) and interest rates (domestic and foreign) are playing significant role to derive the current exchange rate. Fluctuations in currency value can be prevented by controlling interest rate movements and through achieving price stability as well.

Third, the first cointegrating relation is normalized by the nominal exchange rates for each country and we found that the estimates of the normalized cointegrating vector have signs that match the theory of combined PPP and UIP.

Fourth, the validity of the combined PPP and UIP restrictions are tested by LR test and the restricted cointegrating relations are estimated accordingly. The estimates provided evidence that domestic interest rates have more effect on the nominal exchange rates than the foreign interest rates for all the examined countries apart from Pakistan where foreign interest rate has more impact than domestic rates.

Fifth, taking into consideration the puzzle of tradable and non-tradable goods as well as capital market imperfection, we tested the modified form of the combined PPP and UIP. In general, we observed that the modified form of the combined PPP and UIP is more robust and provide more reliable (both theoretically and statistically) results than the simple form of combined PPP and UIP.

Finally, the restricted cointegrating relations are derived from the modified form of the combined PPP and UIP, which can be used to estimate conditional equilibrium exchange rates.

The paper used the econometric approach to assess the behavior of exchange rates, interest rates and commodity prices. An advantage of this kind of statistically oriented approach is that the empirical analysis follows a well-defined reduction process so that more emphasis is placed on understanding whole structural rather than isolated parameters or relations. However, the disadvantage is that the empirical results tend to be

sample dependent. Therefore, a great care required to associate the statistical results with an economic interpretation[35].

As mentioned above, the conclusion of the analysis is that the nominal exchange rates, price levels and interest rates of domestic and foreign currency move together in the long run. However, the following two questions arise regarding this sort of analysis. First, whether the tested empirical model namely the 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. Below we answer both the questions.

The "pure float" and "perfect capital mobility" are artifacts of economics textbooks[36]. 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[37]. 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"[38].

The fear of exchange rate variability is persistent, even among some of the developed countries[39]. 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

[35] See Juselius (1995) for further discussion on this issue.
[36] 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.
[37] According to IMF's classification scheme, countries are grouped into four types of exchange rate arrangements: pegs, limited flexibility, managed floating and, free-floating.
[38] 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.
[39] For empirical evidence on this issue, see Calvo and Reinhart (2000b) and Hausmann et al. (1999).

the economy from unnecessary nominal dynamics, while stabilizing interest rate does not.

Moreover, despite the South Asian countries have a number of trade barriers[40], 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.

Table 13 in appendix provides some interesting information about variability of the exchange rates, interest rates and commodity prices. It can be observed from the table that exchange rate is less volatile than interest rate in Indian, Pakistan and Sri Lanka. The higher variability of interest rate relative to exchange rate may be a positive indication of lack of credibility. This evidence suggests that they stabilize exchange rate at the cost of interest rate volatility (see Calvo and Reinhart (2000)). However, the interest rate is less volatile as compared to exchange rate in Bangladesh. It suggests that the monetary authority may not frequently use interest rate to prevent the abrupt changes in exchange rates. Similarly, the evidence suggests that commodity prices are more volatile than exchange, however, the difference does not seem statistical significant.

Regarding contemporaneous links among exchange rates, interest rates and commodity prices, the correlation coefficients provide evidence that there is highly statistically significant positive correlation between exchange rate and domestic prices. The less volatility of commodity prices and the presence of the significant correlation are consistent with view that the exchange rate may be allowed to adjust in response to terms of trade shocks[41]. Interest rate is negatively correlated with exchange rate in case of

[40] 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.

[41] See Calvo and Reinhart (2000) for empirical evidence on this issue.

Indian and Sri Lanka, which suggests that an expansionary monetary policy (decreasing interest rates) lead to a future depreciation.

On the other hand, we observed a positive correlation between interest rate and exchange rate for Pakistan and Bangladesh – although the correlation coefficient is close to zero in case of Bangladesh. This indicates credibility problems and interest increases signal future depreciations. All these evidences are in line with the cointegration analysis's findings – that are, exchange rates, interest rates and commodity prices are cointegrated and move together in the long run. It implies that equilibrium conditions of asset and commodity markets may not be independent of each other. No doubt, at different points in time, there may have been varying degrees of misalignment compared to estimated equilibrium. These misalignments pertain mostly to the state of the domestic market, which is not fully aligned with conditions given by the combination of PPP and UIP.

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[42]. 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))[43].

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?" We don't think so. However, we can say, 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. Appropriate measures taken on the fiscal and monetary fronts would definitely limit the required exchange rate adjustments.

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

Table1
ADF Unit Root Tests at Levels and at First Differences

Country	At Levels		At First Differences	
	Constant	Constant & Trend	Constant	Constant & Trend
Bangladesh				
Exchange Rate	-1.008 (10)	-2.629 (0)	-2.943** (8)	-2.771 (8)
Interest Rate	-1.668 (3)	-1.713 (0)	-7.222* (2)	-7.196* (1)
Consumer price index	0.331 (9)	-1.868 (0)	-4.614* (9)	-4.646* (0)
Wholesale price index	----------	----------	----------	----------
Ratio of Exports to Imports	-2.163 (12)	-2.479 (12)	-4.199* (12)	-4.178* (12)
India				
Exchange Rate	-1.675 (1)	-0.613 (1)	-10.086* (0)	-10.245* (0)
Interest Rate	-1.550 (0)	-1.740 (0)	-13.007* (0)	-12.986* (0)
Consumer price index	-3.388* (7)	-2.397 (1)	-8.247* (0)	-8.476* (0)
Wholesale price index	-2.353 (0)	-4.323 (0)	-10.642* (0)	-10.816* (0)
Ratio of Exports to Imports	-5.773* (0)	-7.807* (0)	-8.401* (0)	-8.383* (0)
Pakistan				
Exchange Rate	-1.895 (0)	-1.707 (0)	-11.046* (0)	-11.011* (0)
Interest Rate	-1.778 (2)	-1.602 (2)	-10.009* (1)	-7.953* (2)
Consumer price index	3.049 (2)	0.011 (2)	-4.894* (2)	-8.862* (1)
Wholesale price index	1.077 (2)	-2.311 (1)	-7.349* (0)	-5.986* (0)
Ratio of Exports to Imports	-1.372 (1)	-2.811 (1)	-10.269* (1)	-10.322* (1)
Sri Lanka				
Exchange Rate	-1.850 (0)	-1.659 (0)	-10.592* (0)	-10.740* (0)
Interest Rate	-1.909 (6)	-2.121 (6)	-10.351* (0)	10.313* (0)
Consumer price index	1.429 (9)	-1.239 (9)	-8.929* (2)	-9.113* (2)
Wholesale price index	1.109 (0)	-2.568 (0)	-10.195* (0)	-10.460* (0)
Ratio of Exports to Imports	-11.296* (0)	-11.129* (0)	-9.780* (4)	-9.726* (4)
United States				
Interest Rate	-0.158 (2)	-2.805 (2)	-10.676* (1)	-10.642* (1)
Consumer price index	-1.494 (2)	-1.572 (2)	-4.561* (1)	-4.554* (1)
Wholesale price index	0.643 (3)	-1.117 (3)	-6.346* (2)	-6.492* (2)

*, **Statistics those are significant at the 1 and 5 per cent level of significance, respectively. Numbers is parentheses are the number of lags used in the augmentation of the regressions. Evidence strongly supports that all series are stationary at their first difference, i.e., all series are $I(1)$.

Table 2
KPSS Unit Root Tests
$\hat{\eta}_u$ and $\hat{\eta}_\tau$ Statistics for Level and Trend Stationarity

Country	Lag Truncation Parameter (l)					
	1	2	3	1	2	3
	η_u: 5% critical value is 0.463			η_τ: 5% critical value is 0.146		
Bangladesh						
Exchange Rate	6.108	4.116	3.117	0.661	0.459	0.357
Interest Rate Price	0.585	0.403*	0.312*	0.538	0.371	0.289
Consumer price index	5.753	3.882	2.946	0.735	0.503	0.387
Wholesale price index	------	------	------	------	------	------
Ratio of exports to imports	o.343*	0.316*	0.311*	0.037*	0.036*	0.035*
India						
Exchange Rate	6.892	4.620	3.484	1.819	1.226	0.929
Interest Rate	5.180	3.488	2.648	0.427	0.291	0.223
Consumer price index	7.953	5.349	4.045	1.837	1.243	0.946
Wholesale price index	8.152	5.485	4.149	0.783	0.545	0.426
Ratio of exports to imports	3.715	2.772	2.249	0.400	0.328	0.286
Pakistan						
Exchange Rate	1.517	1.037	0.796	0.535	0.365	0.279
Interest Rate	0.897	0.630	0.491	0.735	0.518	0.405
Consumer price index	4.402	2.979	2.265	1.078	0.733	0.559
Wholesale price index	4.489	3.033	2.303	0.897	0.627	0.485
Ratio of exports to imports	2.864	2.000	1.548	0.856	0.626	0.501
Sri Lanka						
Exchange Rate	4.159	2.816	2.143	1.019	0.694	0.529
Interest Rate	2.709	1.862	1.434	0.433	0.307	0.243
Consumer price index	4.740	3.210	2.440	0.253	0.191	0.161
Wholesale price index	4.713	3.184	2.418	0.386	0.279	0.224
Ratio of exports to imports	0.802	0.829	0.864	0.029*	0.033*	0.039*
United States						
Interest Rate	2.809	1.880	1.416	0.756	0.508	0.385
Consumer price index	8.234	5.530	4.176	0.464	0.326	0.257
Wholesale price index	6.663	4.485	3.393	1.393	0.941	0.714

Note: In KPSS tests, the lag orders are used to correct for error autocorrelation.
*Statistics those do not reject the null hypothesis of stationarity at the 0.05 level.

Table 3
VAR Residual Serial Correlation and Heteroscedasticity Tests

Country	LM-Stat H_0: No serial correlation	$p-value$	Chi-sq H_0: No heteroskedasticity	$p-value$
Bangladesh	27.56	0.324	492.48	0.081
India	18.90	0.270	808.11	0.062
Pakistan	14.50	0.950	442.27	0.593
Sri Lanka	25.64	0.426	370.30	0.003

Table 4

Results of the Johansen's Cointegration Test for each Country, Monthly Data: Sample varies cross countries

Eigenvalue	$(\lambda_{trace(r)})$	1 Per cent Critical Values	$(\lambda_{\max})$	1 Per cent Critical Values	Hypothesized No. of CE(s)
		Bangladesh			
0.313	110.34	84.45	46.14	39.79	None
0.226	64.19	60.16	31.51	33.24	At most 1
0.124	32.69	41.07	16.38	26.81	At most 2
0.078	16.30	24.60	10.03	20.20	At most 3
0.049	06.27	12.97	06.27	12.97	At most 4
Result: Trace test indicates 2 cointegration equations at 1% significance level Max-Eigenvalue test indicates 1 cointegration equation at 1% significance level					
		India			
0.302	104.59	84.45	57.96	39.79	None
0.114	46.63	60.16	19.57	33.24	At most 1
0.067	27.63	41.07	11.29	26.81	At most 2
0.054	15.76	24.60	09.02	20.20	At most 3
0.041	06.74	12.97	06.74	12.97	At most 4
Result: Trace test indicates 1 cointegration equation at 1% significance level Max-Eigenvalue test indicates 1 cointegration equation at 1% significance level					
		Pakistan			
0.479	126.78	84.45	59.38	39.79	None
0.274	67.41	60.16	29.11	33.24	At most 1
0.194	38.30	41.07	19.61	26.81	At most 2
0.122	18.69	24.60	11.86	20.20	At most 3
0.072	06.82	12.97	06.82	12.97	At most 4
Result: Trace test indicates 2 cointegration equations at 1% significance level Max-Eigenvalue test indicates 1 cointegration equation at 5% significance level					
		Sri Lanka			
0.399	104.62	84.45	48.89	39.79	None
0.244	55.73	60.16	26.79	33.24	At most 1
0.119	28.94	41.07	12.79	26.81	At most 2

0.097	16.77	24.60	09.76	20.20	At most 3
0.074	07.01	12.97	07.01	12.97	At most 4

Result: Trace test indicates 1 cointegration equation at 1% significance level
Max-Eigenvalue test indicates 1 cointegration equation at 1% significance level

Table 5

Unrestricted Cointegrating Vector for Bangladesh

Exchange Rate	Bangladesh CPI	US CPI	Bangladesh Interest Rate	US Interest Rate	Constant
1.000	0.441	-0.834	-2.538	0.064	7.457

Unrestricted Cointegrating Vector for India

Exchange Rate	India CPI	US CPI	India Interest Rate	US Interest Rate	Constant
1.000	-1.624	2.431	0.360	-0.0731	-7.510

Unrestricted Cointegrating Vector for Pakistan

Exchange Rate	Pakistan CPI	US CPI	Pakistan Interest Rate	US Interest Rate	Constant
1.000	0.372	-0.049	-2.181	0.048	4.098

Unrestricted Cointegrating Vector for Sri Lanka

Exchange Rate	Sri Lanka CPI	US CPI	Sri Lanka Interest Rate	US Interest Rate	Constant
1.000	1.849	-0.549	-9.266	0.188	30.690

Table 6
Restrictions Test for PPP and UIP

Country	Strict PPP and UIP		Strict PPP and Weak UIP		PPP Symmetry and Weak UIP	
	LR Statistics	*p – value*	LR Statistics	*p – value*	LR Statistics	*p – value*
Bangladesh	8.964	0.029	6.634	0.036	5.922	0.015
India	1.743	0.626	0.827	0.661	0.316	0.573
Pakistan	3.632	0.304	3.576	0.167	0.464	0.496
Sri Lanka	7.718	0.052	4.661	0.097	4.065	0.043

Table 7

Restricted Cointegrating Vectors for India

Exchange Rate	India CPI	US CPI	India Interest Rate	US Interest Rate	Constant
1.000	1.000	-1.000	-0.203	0.203	-6.249
1.000	1.000	-1.000	-2.022	0.664	-5.014
-2.434	2.997	-2.997	-0.848	0.187	8.786

Restricted Cointegrating Vectors for Pakistan

Exchange Rate	Pakistan CPI	US CPI	Pakistan Interest Rate	US Interest Rate	Constant
1.000	1.000	-1.000	-0.188	0.188	-2.833
1.000	1.000	-1.000	-0.203	0.178	-2.834
4.647	-8.806	8.806	-0.066	0.329	-20.91

Restricted Cointegrating Vector for Sri Lanka

Exchange Rate	Sri Lanka CPI	US CPI	Sri Lanka Interest Rate	US Interest Rate	Constant
1.000	1.000	-1.000	-3.081	0.195	-9.758

Table 8

VAR Residual Serial Correlation and Heteroscedasticity Tests

Country	LM-Stat H_0: No serial correlation	$p-value$	Chi-sq H_0: No heteroskedasticity	$p-value$
Bangladesh	41.90	0.230	515.216	0.355
India	33.55	0.585	529.162	0.211

Pakistan	40.04	0.295	560.084	0.042
Sri Lanka	48.49	0.081	545.553	0.097

Table 9
Results of the Johansen's Cointegration Test for each Country, Monthly Data: Sample Varies Cross-Country

Eigenvalue	$(\lambda_{trace(r)})$	1 Per cent Critical Values	$(\lambda_{\max})$	1 Per cent Critical Values	Hypothesized No. of CE(s)
		Bangladesh			
0.347	160.315	111.01	52.361	46.82	None
0.283	107.953	84.45	40.834	39.79	At most 1
0.231	67.119	60.16	32.267	33.24	At most 2
0.135	34.852	41.07	17.924	26.81	At most 3
0.084	16.927	24.60	10.768	20.20	At most 4
0.049	06.159	12.97	06.159	12.97	At most 5
Result: Trace test indicates 3 cointegration equations at 1% significance level Max-Eigenvalue test indicates 2 cointegration equations at 1% significance level					
		India			
0.282	113.54	111.01	53.931	46.82	None
0.136	59.612	84.45	23.921	39.79	At most 1
0.090	35.690	60.16	15.434	33.24	At most 2
0.052	20.256	41.07	8.794	26.81	At most 3
0.047	11.461	24.60	7.906	20.20	At most 4
0.021	03.556	12.97	03.555	12.97	At most 5
Result: Trace test indicates 1 cointegration equations at 1% significance level Max-Eigenvalue test indicates 1 cointegration equations at 1% significance level					
		Pakistan			
0.456	151.158	111.01	55.419	46.82	None
0.398	95.739	84.45	46.199	39.79	At most 1
0.257	49.540	60.16	27.104	33.24	At most 2
0.139	22.435	41.07	13.663	26.81	At most 3
0.056	8.772	24.60	5.340	20.20	At most 4
0.037	03.431	12.97	03.432	12.97	At most 5
Result: Trace test indicates 2 cointegration equations at 1% significance level Max-Eigenvalue test indicates 1 cointegration equations at 5% significance level					

Sri Lanka

0.467	136.290	111.01	60.347	46.82	None
0.224	75.943	84.45	24.296	39.79	At most 1
0.186	51.944	60.16	19.735	33.24	At most 2
0.154	31.912	41.07	16.108	26.81	At most 3
0.106	15.804	24.60	10.790	20.20	At most 4
0.051	05.014	12.97	05.014	12.97	At most 5

Result: Trace test indicates 1 cointegration equations at 1% significance level
Max-Eigenvalue test indicates 1 cointegration equations at 1% significance level

Table 10

Unrestricted Cointegrating Vector for Bangladesh

Exchange Rate	**Bangladesh CPI**	**US CPI**	**Bangladesh Interest Rate**	**US Interest Rate**	**Ratio of Exports to Imports**	**Constant**
1.000	0.074	-1.564	-0.789	0.075	-0.391	4.328

Unrestricted Cointegrating Vector for India

Exchange Rate	**India WPI/CPI**	**US WPI/CPI**	**India Interest Rate**	**US Interest Rate**	**Ratio of Exports to Imports**	**Constant**
1.000	1.237	1.629	-0.091	0.015	1.020	-3.439

Unrestricted Cointegrating Vector for Pakistan

Exchange Rate	**Pakistan WPI/CPI**	**US WPI/CPI**	**Pakistan Interest Rate**	**US Interest Rate**	**Ratio of Exports to Imports**	**Constant**
1.000	3.130	-3.464	-0.142	0.309	0.079	-4.208

Unrestricted Cointegrating Vector for Sri Lanka

Exchange Rate	**Sri Lanka WPI/CPI**	**US WPI/CPI**	**Sri Lanka Interest Rate**	**US Interest Rate**	**Ratio of Exports to Imports**	**Constant**
1.000	1.317	2.519	-0.330	-0.051	2.801	-2.934

Note: for Bangladesh, the CPI is used instead of the ratio of WPI to CPI due to unavailability of WPI/PPI

Table 11

Restrictions Test for Modified PPP and UIP

Country	Strict PPP and UIP		Strict PPP and Weak UIP		PPP Symmetry and Weak UIP	
	LR Statistics	*p – value*	LR Statistics	*p – value*	LR Statistics	*p – value*

Bangladesh	5.144	0.162	1.624	0.444	1.059	0.303
India	16.655	0.000	14.588	0.007	13.645	0.000
Pakistan	16.359	0.000	7.149	0.028	0.096	0.755
Sri Lanka	3.059	0.383	1.506	0.470	0.657	0.417

Table 12

Restricted Cointegrating Vector for Bangladesh

Exchange Rate	Bangladesh CPI	US CPI	Bangladesh Interest Rate	US Interest Rate	Ratio of Exports to Imports	Constant
1.000	1.000	-1.000	-4.010	0.360	-2.785	2.838

Restricted Cointegrating Vector for India

Exchange Rate	India WPI/CPI	US WPI/CPI	India Interest Rate	US Interest Rate	Ratio of Exports to Imports	Constant
1.000	1.000	-1.000	-0.274	0.274	2.275	-3.067

Restricted Cointegrating Vector for Pakistan

Exchange Rate	Pakistan WPI/CPI	US WPI/CPI	Pakistan Interest Rate	US Interest Rate	Ratio of Exports to Imports	Constant
1.000	1.000	-1.000	-0.150	0.235	0.207	-4.023

Restricted Cointegrating Vectors for Sri Lanka

Exchange Rate	Sri Lanka WPI/CPI	US WPI/CPI	Sri Lanka Interest Rate	US Interest Rate	Ratio of Exports to Imports	Constant
1.000	1.000	-1.000	-0.071	0.071	1.290	-4.094
1.000	1.000	-1.000	-0.348	0.106	1.762	-3.317

Note: for Bangladesh, the CPI is used instead of the ratio of WPI to CPI due to unavailability of WPI/PPI

Table 13

Standard Deviation and Correlation Coefficients

Variables	Bangladesh	India	Pakistan	Sri Lanka
Exchange Rate	0.144	0.153	0.058	0.134
Prices	0.159	0.239	0.118	0.214

Market Interest Rate	0.076	0.296	0.674	0.331
Corr. b/w Exchange Rate and Prices	0.956	0.925	0.497	0.913
Corr. b/w Exchange Rate and Interest Rates	0.461	-0.597	0.039	-0.579

Table 14

Salient Features of Indian Consumer Price Indices

S. No.		CPI-UNME	CPI-IW	CPI-AL	CPI-RL	WPI
1	Weights allocated on the basis of	Consumer Expenditure Survey				Weights allocated based on wholesale transactions
		First:1958-59 Latest: 1982-83	First:1958-59 Latest: 2001	First:1956-57 Latest:1983	First: 1983 Latest: a983	
2	Base year of the current series	1984-85	2001	1986-87	1886-87	1993-94
3	No of commodities in basket	146-365	120-160	260	260	435
4	No of centers/villages	59	76	600	600	1918 quotations
5	Time lag of the index	2 weeks	1 month	3 weeks	3 weeks	2 weeks
6	Frequency	Monthly	Monthly	Monthly	Monthly	weekly

Source: Indian Economic Survey 2006-2007.

Table 15

Correlations between Different Price Indices for India

Sample Period: 2001 to 2007

	CPI-AL	CPI-IW	CPI-RL
CPI-IW	0.66		
CPI-RL	0.99	0.76	
CPI-UNME	0.82	0.92	0.83

Note: the estimates are calculated using data obtained from different economic surveys of Indian economy.

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

BEX , *IEX* , *PEX* and *SER* denote the logarithm values of nominal exchange rates for Bangladesh, India, Pakistan and Sri Lanka, respectively.

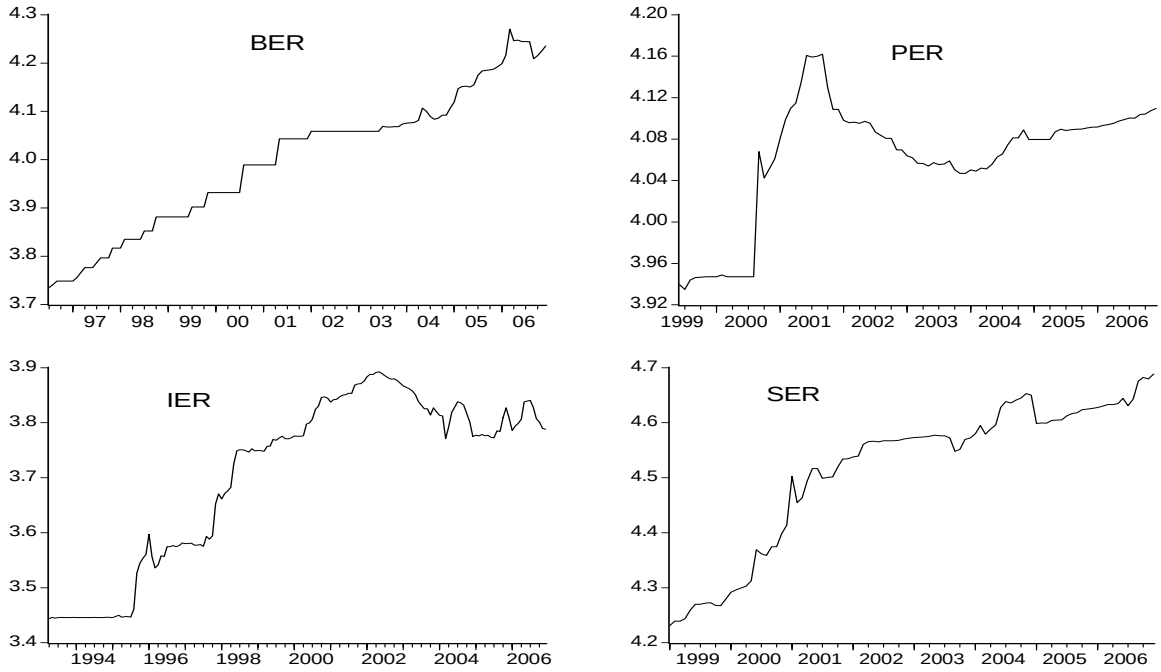
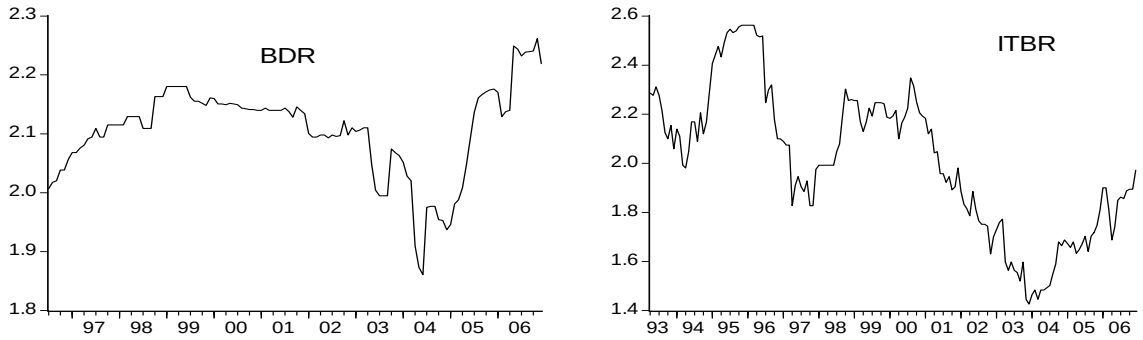


Figure A.2: South Asian Countries: Interest Rate Fluctuations

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



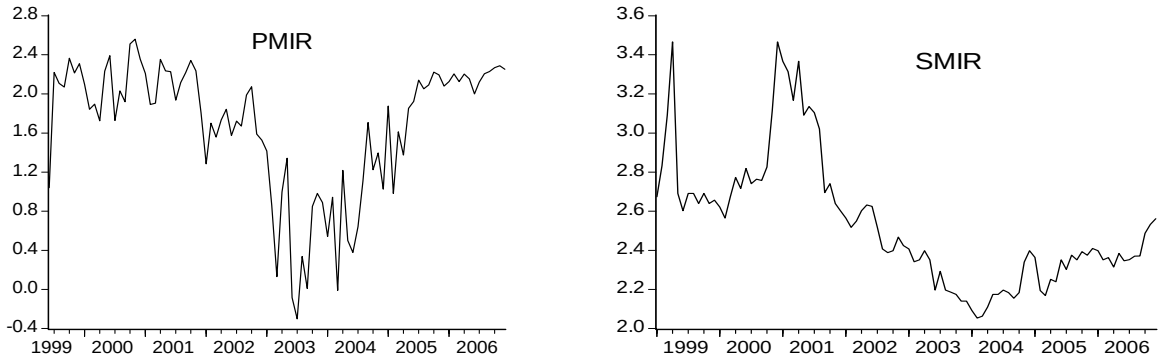


Figure A.3: South Asian Countries: Fluctuations in Monthly CPI

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

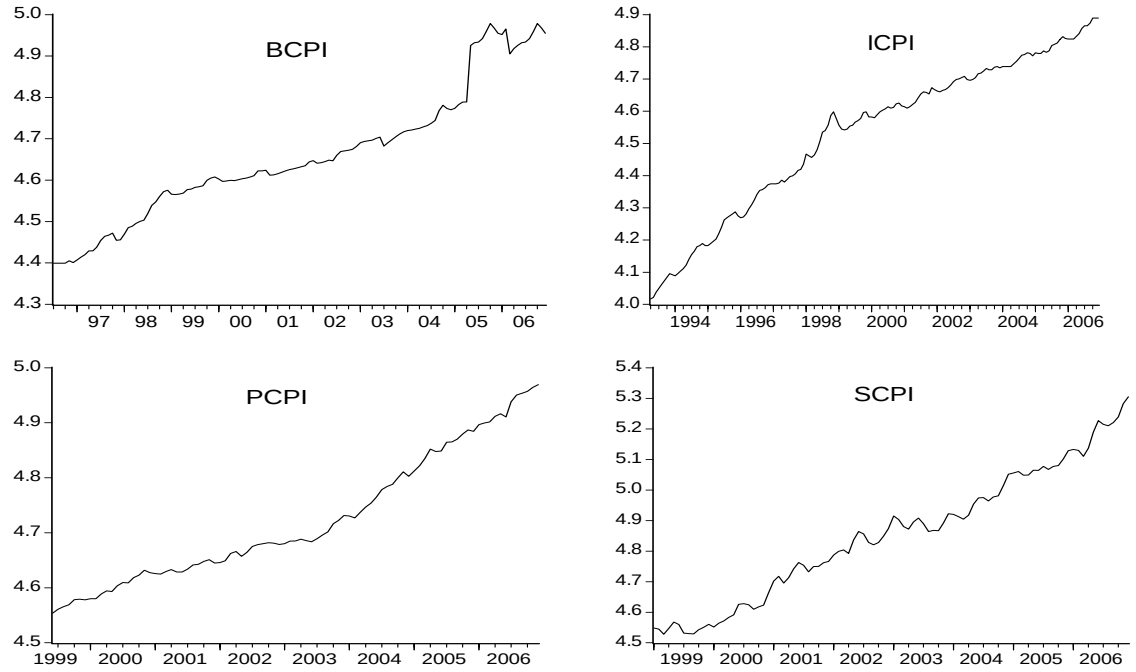
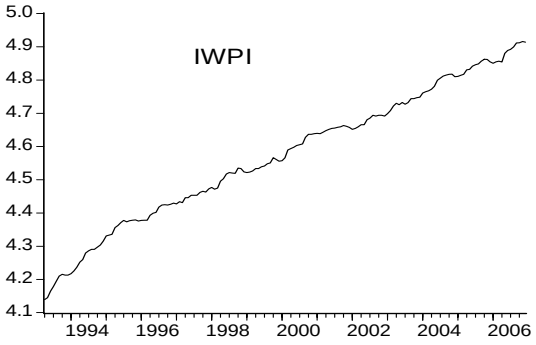


Figure A.4: South Asian Countries: Fluctuations in Monthly WPI/PPI

BWPI , *IWPI* , *PWPI* and *SWPI* denote the logarithm values of wholesale/producer price index for Bangladesh, India, Pakistan and Sri Lanka, respectively.



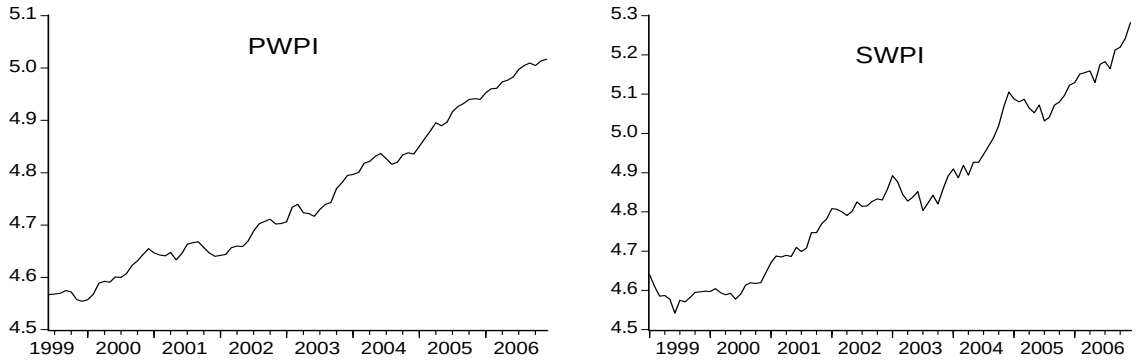


Figure A.5: South Asian Countries: Fluctuations in Ratio of Exports to Imports

BRXM , *IRXM* , *PRXM* and *SRXM* denote the logarithm values of the ratio of exports to imports for Bangladesh, India, Pakistan and Sri Lanka, respectively.

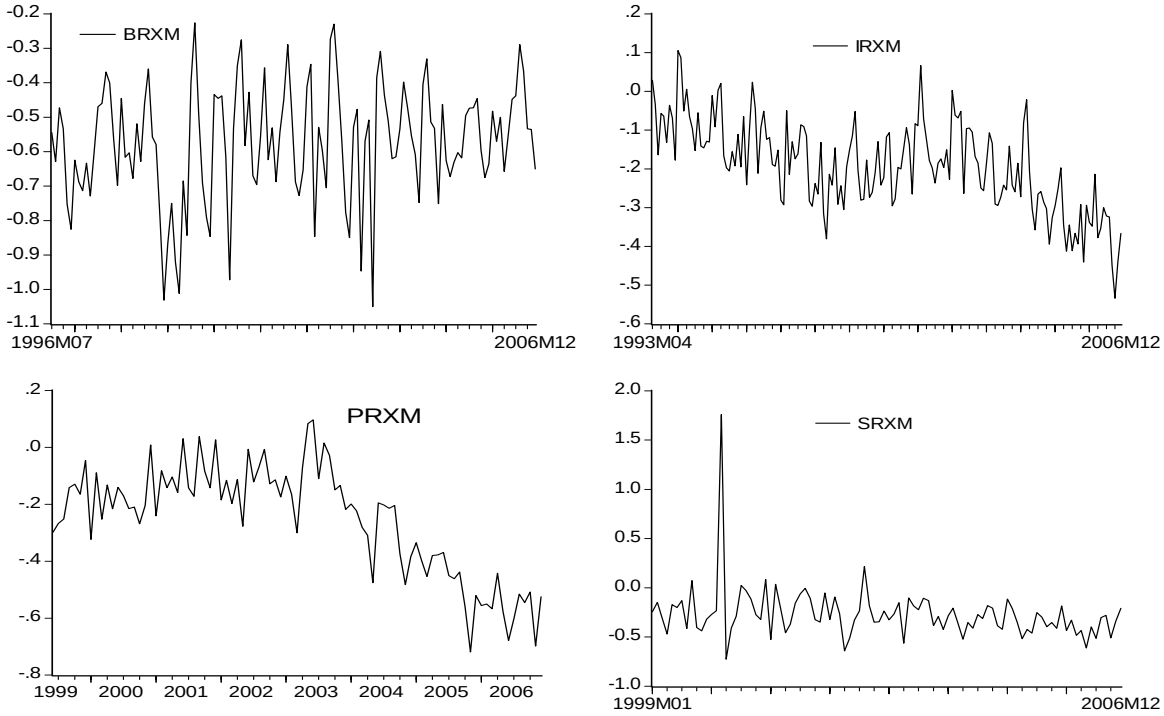


Figure A.6: USA: Fluctuations in Monthly CPI, WPI/PPI and Interest Rate

UMIR , *UTBR* , *UCPI* , and *UWPI* denote the logarithm values of market interest rates, treasury bill rate, consumer price index and wholesale price index, respectively, for United States.

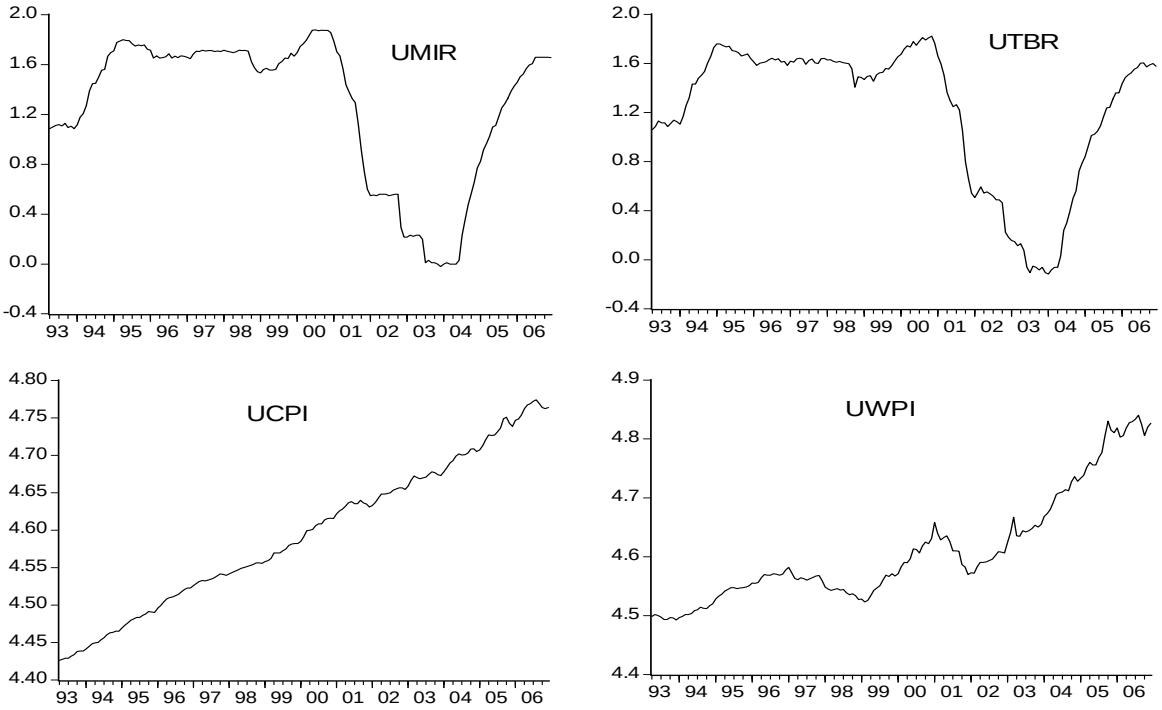


Figure B.1: Autocorrelation with 2 Std.Err. Bounds for Pakistan

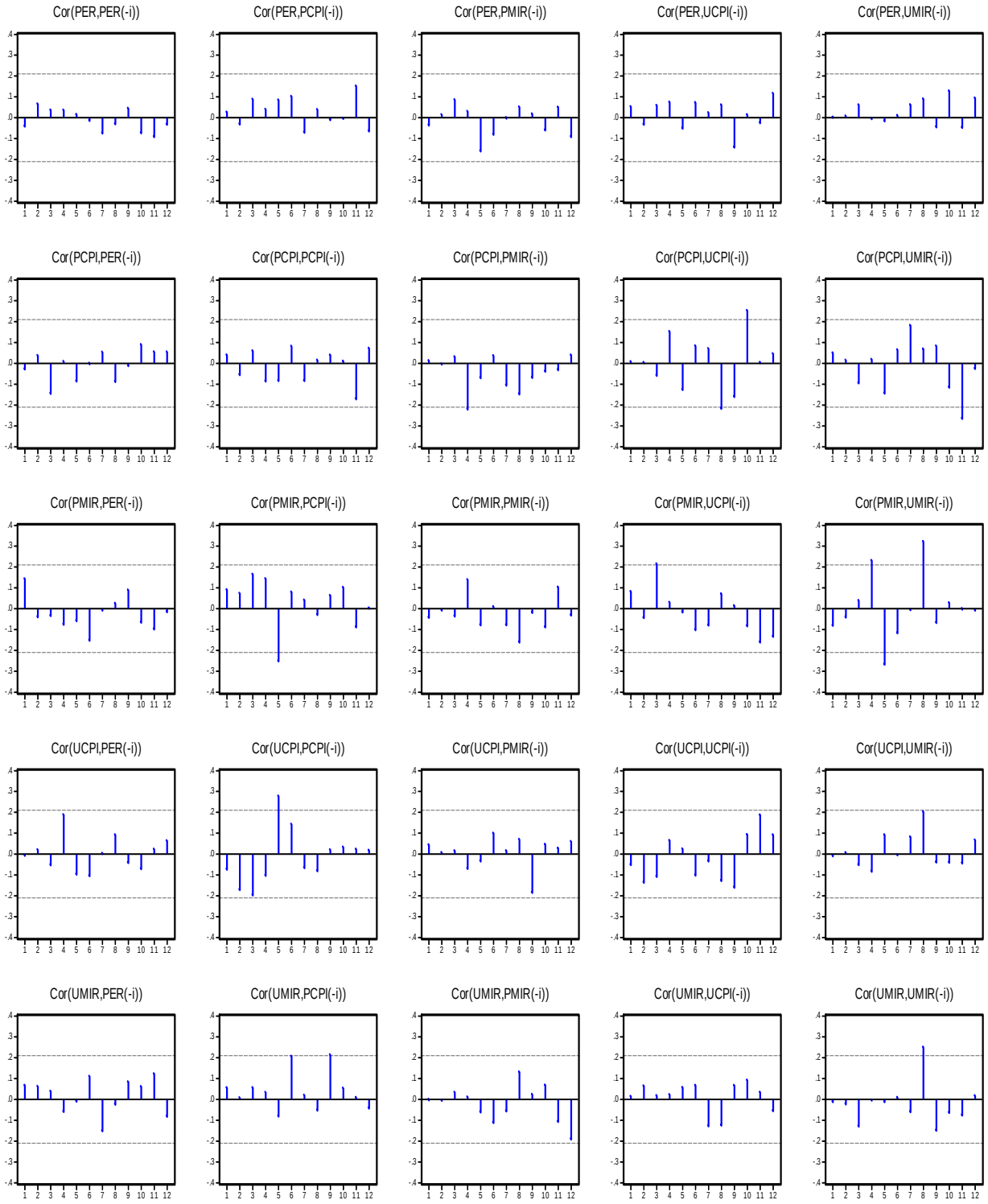


Figure B.2: Autocorrelation with 2 Std.Err. Bounds for India

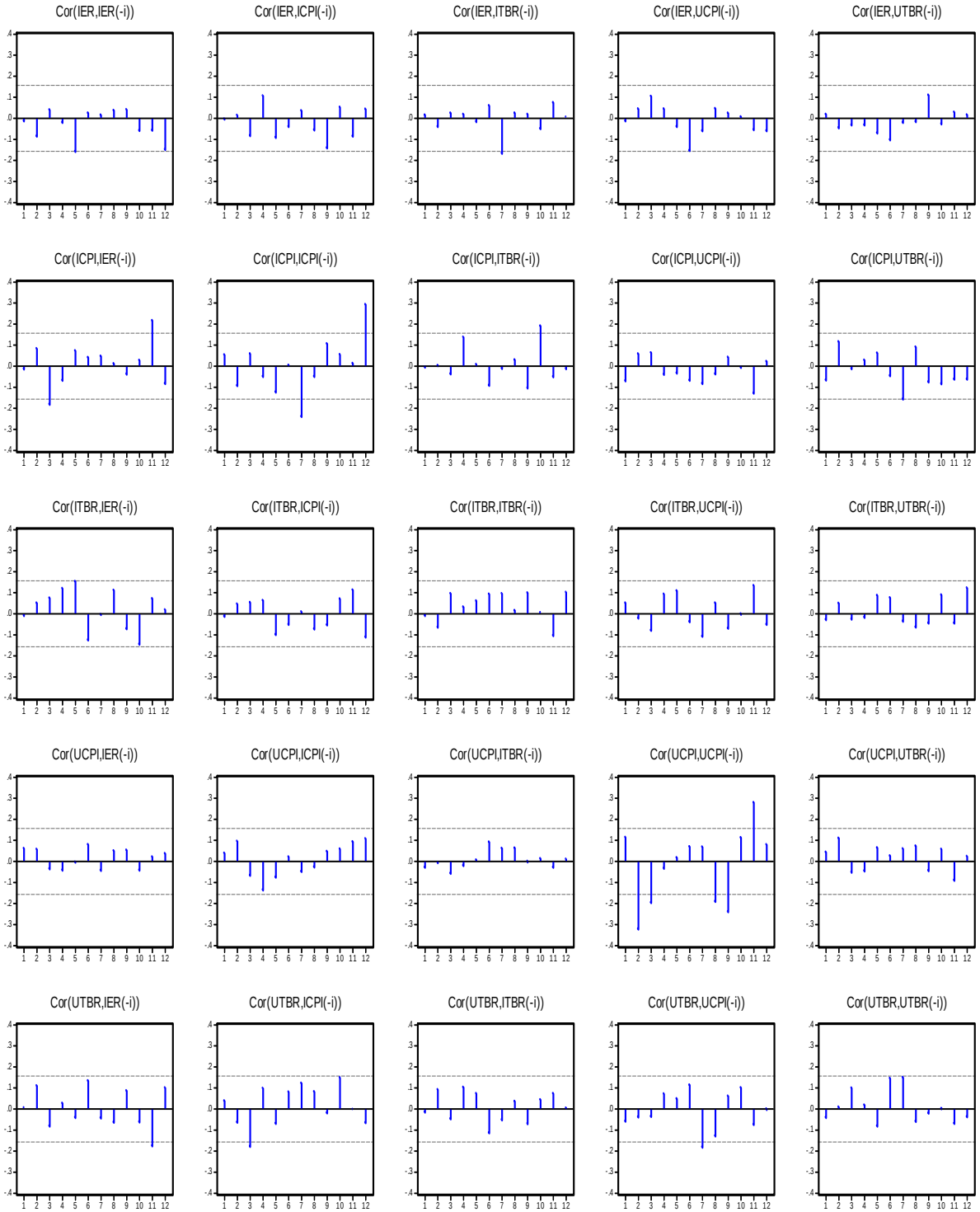

Cor(IER,IER(-i))
Cor(IER,ICPI(-i))
Cor(IER,ITBR(-i))
Cor(IER,UCPI(-i))
Cor(IER,UTBR(-i))
Cor(ICPI,IER(-i))
Cor(ICPI,ICPI(-i))
Cor(ICPI,ITBR(-i))
Cor(ICPI,UCPI(-i))
Cor(ICPI,UTBR(-i))
Cor(ITBR,IER(-i))
Cor(ITBR,ICPI(-i))
Cor(ITBR,ITBR(-i))
Cor(ITBR,UCPI(-i))
Cor(ITBR,UTBR(-i))
Cor(UCPI,IER(-i))
Cor(UCPI,ICPI(-i))
Cor(UCPI,ITBR(-i))
Cor(UCPI,UCPI(-i))
Cor(UCPI,UTBR(-i))
Cor(UTBR,IER(-i))
Cor(UTBR,ICPI(-i))
Cor(UTBR,ITBR(-i))
Cor(UTBR,UCPI(-i))
Cor(UTBR,UTBR(-i))

Figure B.2: Autocorrelation with 2 Std.Err. Bounds for Bangladesh

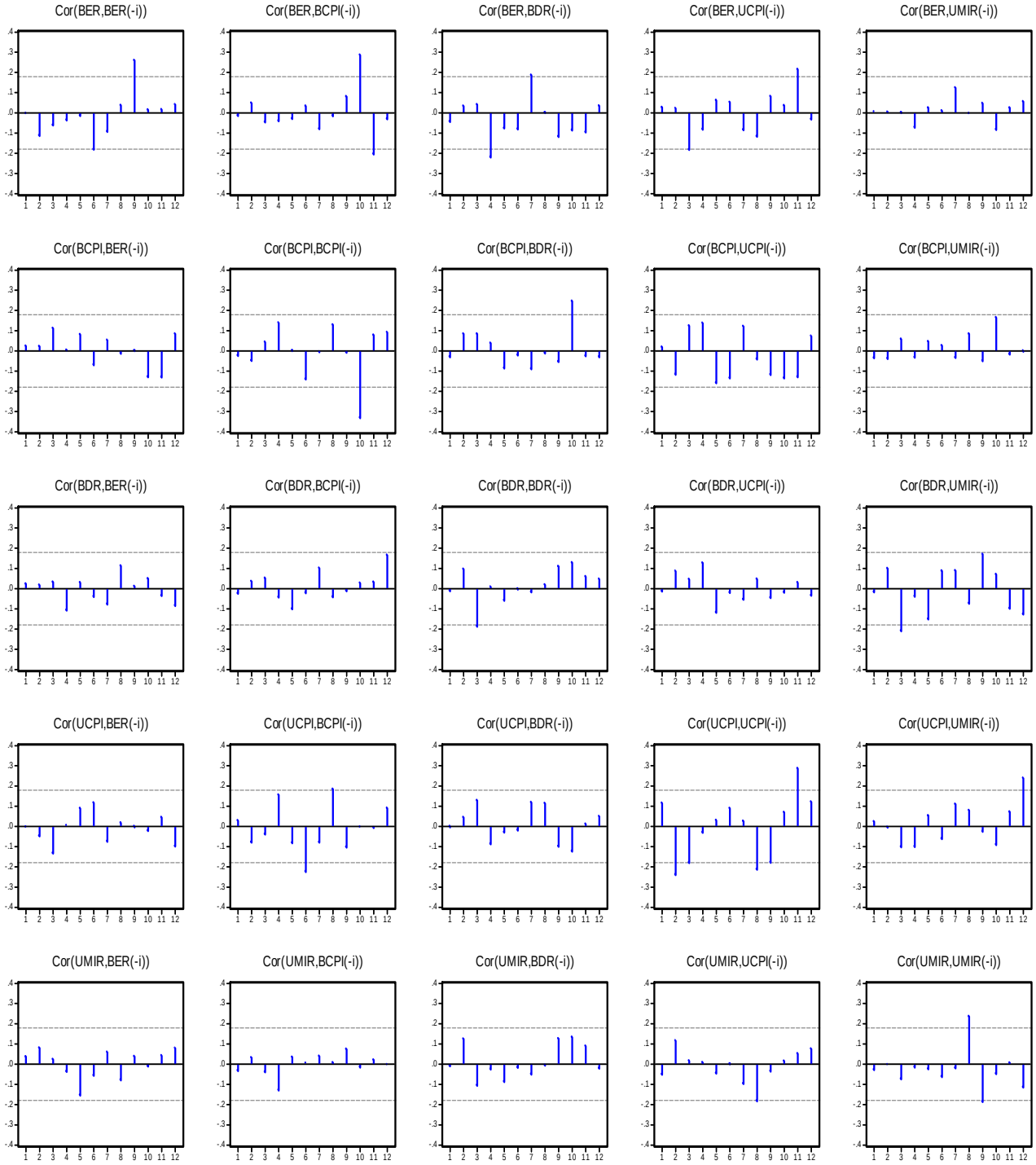


Figure B.2: Autocorrelation with 2 Std.Err. Bounds for Sri Lanka

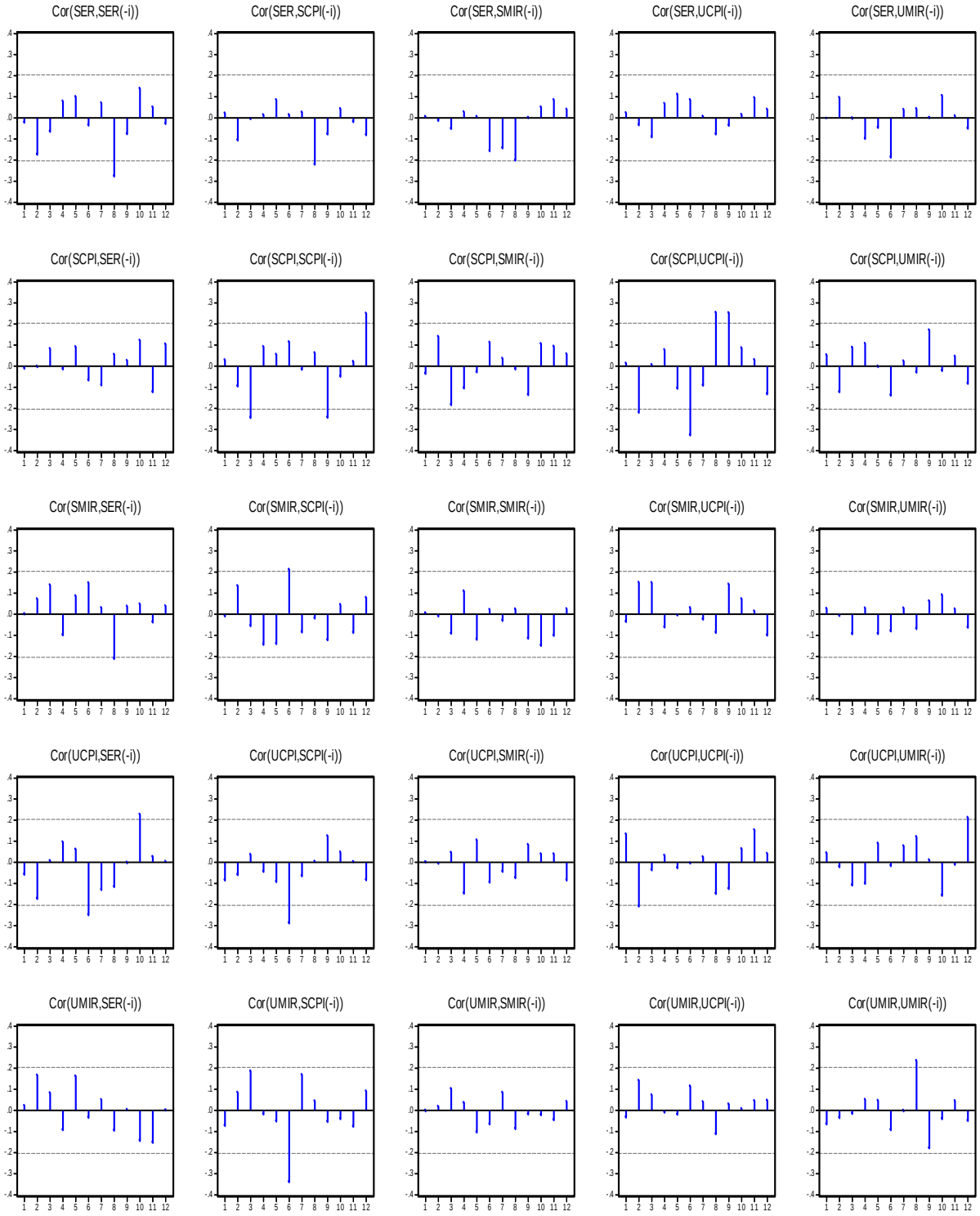
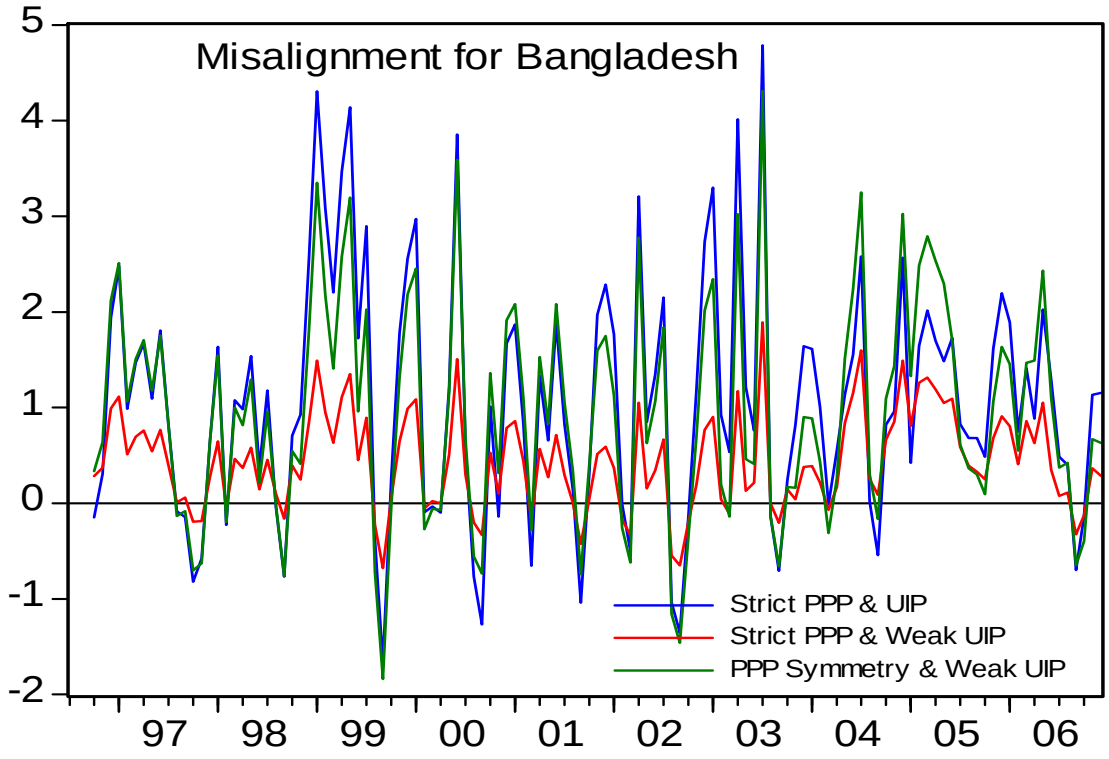
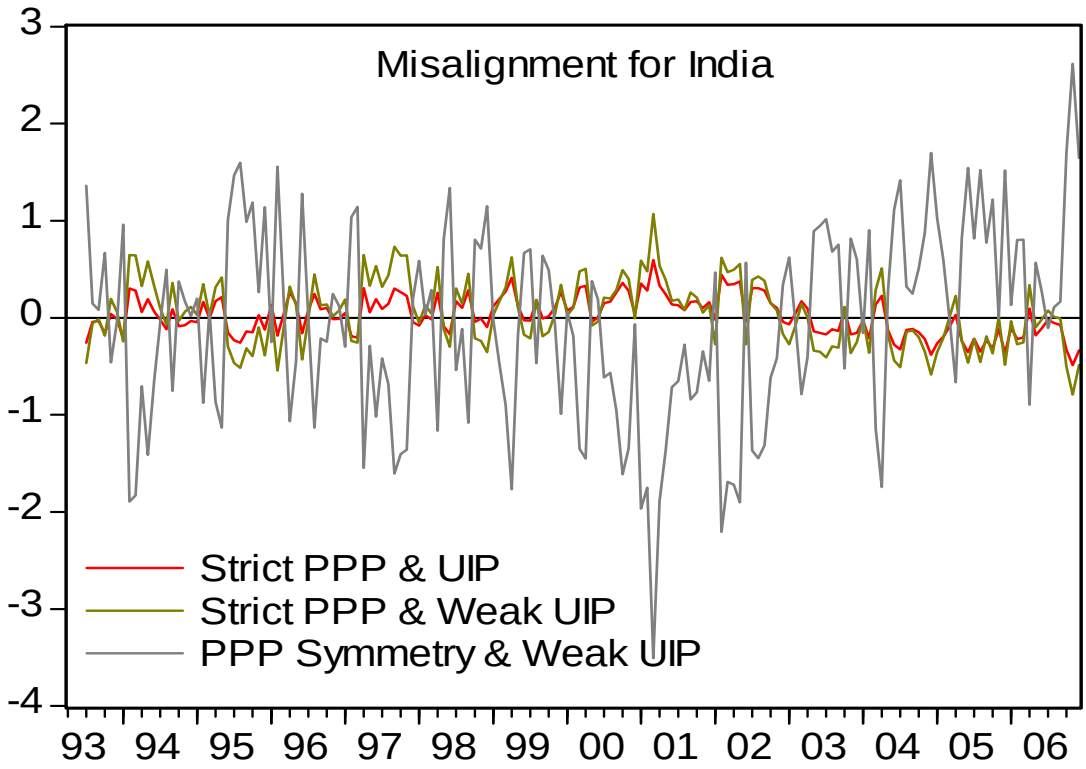
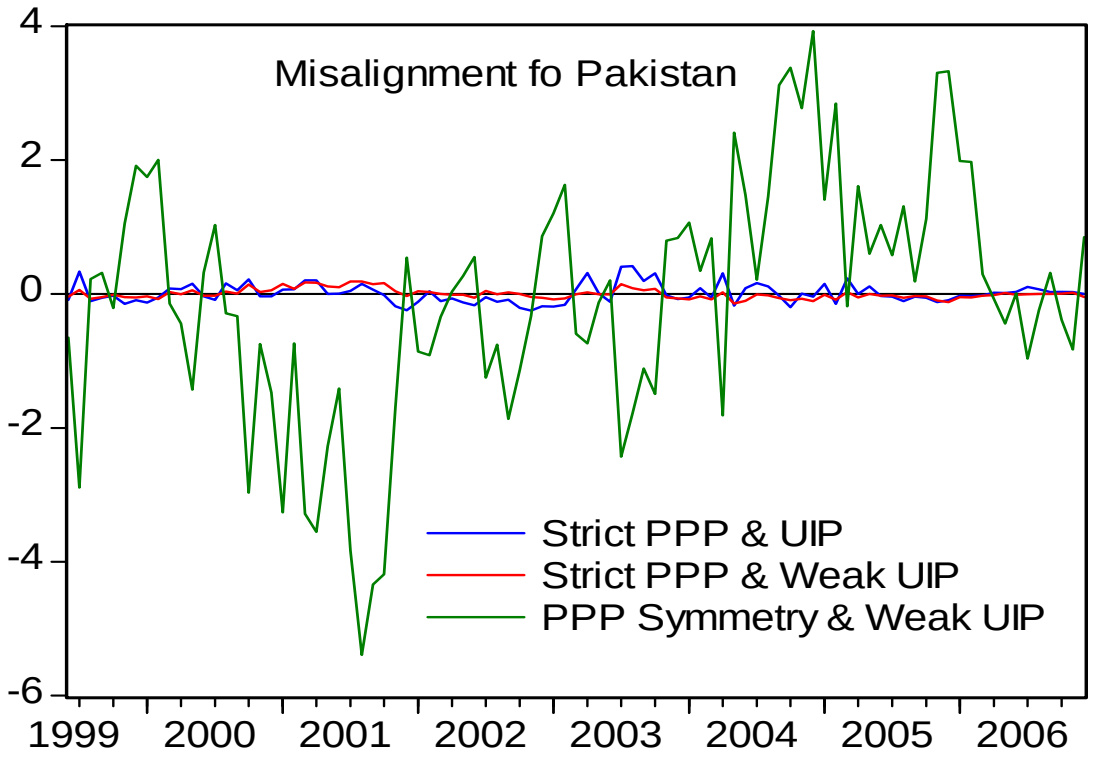
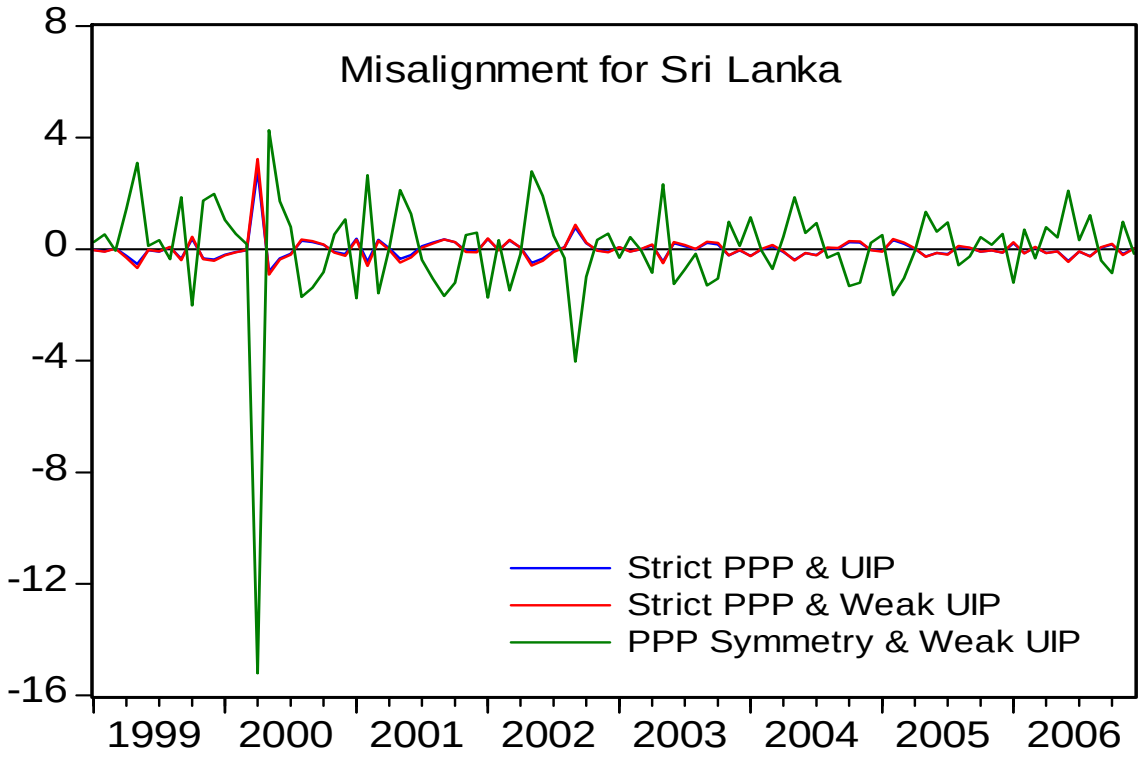


Figure B.3: Misalignment According to Modified Form of PPP and UIP






Misalignment fo Pakistan
4
2
0
-2
-4
-6
1999
2000
2001
2002
2003
2004
2005
2006
Strict PPP & UIP
Strict PPP & Weak UIP
PPP Symmetry & Weak UIP


Misalignment for Sri Lanka
8
4
0
-4
-8
-12
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1999
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Strict PPP & UIP
Strict PPP & Weak UIP
PPP Symmetry & Weak UIP

Different Exchange Rate Systems: Definition and Characteristics

1. Monetary Union

Monetary union is a zone which has common monetary and fiscal policy to ensure control over the creation of high-powered money and the expansion of government debts. This system has a central management of the common pool of foreign exchange reserves, external debts and exchange rate policies. Moreover, it has a single currency or currencies, which are perfect substitutes, which circulate(s) freely in the zone. By adopting the same currency they encourage trade with each other, but by allowing that currency to float with the rest of the world they get the benefit of a flexible exchange rate and the ability to conduct monetary policy for the region as a whole. The monetary union reduces the time inconsistency problem by requiring multinational agreement on policy and reduces real exchange rate volatility. However, the potential drawback is that member countries suffering asymmetric shocks lose a stabilization tool.

2. Dollarization

Dollarization is a summary measure of the use of foreign currency in its capacity to produce all types of money services in the domestic economy. Under dollarization exchange rate movements cannot buffer external shocks and it reduces the time inconsistency problem and real exchange rate volatility.

3. Currency Board

Currency board is monetary regime adopted by countries that intend to discipline their central banks, as well as solve their external credibility problems by "tying their hands" with institutionally binding arrangements. A currency board combines the following three:

1. An exchange rate that is fixed to an anchor economy.
2. Automatic convertibility.
3. A long-term commitment to the system.

A currency board system can be credible only if central bank holds official foreign exchange rate reserves sufficient to at least cover the entire monetary base. However, it reduces the time inconsistency problem and real exchange rate volatility as well. Moreover, under this system, exchange rate movements cannot buffer external shocks.

4. Fixed Peg

Under this system, exchange rate is fixed against a single currency or a currency basket. Devaluation option provides potentially valuable policy tool in response to large shocks. The time inconsistency problem is reduced through commitment to a verifiable target. This system has following major drawbacks:

1. It provides a target for speculative attacks.
2. It avoids real exchange rate volatility but not necessarily persistent misalignments.
3. It does not by itself place hard constraints on monetary and fiscal policy, and
4. The credibility effect depends on accompanying institutional measures and record of accomplishment.

5. Crawling Peg

Crawling peg means an attempt to combine flexibility and stability. This system is often used in high inflation countries pegging to low inflation countries in attempt to avoid trend real appreciation. This system may be better suited – to limit vulnerability to a balance of payment crisis – for a country that has a history of bad monetary policymaking that led to high inflation. At the margins a crawling peg provides a target for speculative attacks. The credibility effect depends on accompanying institutional measures and record of accomplishment.

6. Bands

Exchange rate is flexible within a present band and endpoints are defended through intervention. It is an attempt to mix market-determined rates with exchange rate stabilizing intervention in a rule based system. This system contains the following characteristics:

1. It provides a limited role for exchange rate movements to counteract external shocks and partial expectation and thus motivates development of exchange rate risk management tools.
2. On the margin a band is subject to speculative attacks.
3. It provides only partial solution against the time inconsistency problem.
4. The credibility effect depends on accompanying institutional measures, record of accomplishment and the characteristics of the band of the band.

7. Managed Float

In this system, exchange rate is determined in the foreign exchange market. Authorities can and do intervention, but are not bound by any intervention rule. This system often accompanied by a separate nominal anchor, such as inflation target. Moreover, the arrangements provide a way to mix market-determined rates with stabilizing intervention in a non-rule-based system. In other words, it combines some exchange rate stability with some monetary policy flexibility. Under a managed floating system, the central bank has to intervene in the foreign currency markets to ensure that the exchange rate does not stray too much from the targeted value. Its potential drawbacks are following:

1. This system does not place hard constrains on monetary and fiscal policy.
2. There is limited transparency.
3. There is absence of rule conditions creditability.

8. Pure Float

Under this system, exchange rate is determined by market forces without public sector intervention. This system has following characteristics:

1. Adjustments to shocks can take place through exchange rate movements.
2. It eliminates the requirement to hold large reserves.
3. It does not provide an expectations anchor.
4. It does not place restrictions on monetary and fiscal policy.
5. Time inconvenience arises unless addressed by other institutional measure.