Exchange Rate Behaviour after Recent Float: The Experience of Pakistan

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I. INTRODUCTION

Exchange rate is a price of traded goods in the world market. To maintain the commodities competitive in the market, exchange rate should be adjusted according to the change in prices. If it is adjusted accordingly, then we say that purchasing power parity (PPP) holds in that country. However, phenomenon of PPP is completely kicked out under floating exchange rate regime in the short run [see for example, Rogoff (1999); Mark and Choi (1997); MacDonald (1999); Obstfeld and Taylor (1997); Coleman (1995); O'Connel (1998) and Michael, *et al.* (1997)]. Recent statement by the President of the National Bank of Pakistan, that the exchange rate and the interest rate are two faces of the same coin [Bokhari (2004)], shows that the changes in the exchange rate is strongly associated with the changes in the interest rate differential.[1] It is also argued that under free float the value of currency is determined by demand and supply of foreign exchange and to control the value of currency using open market operations interest rate is used as the key monetary policy tool. Moreover, deterioration of trade balance leads to deprecation in exchange to make the exports competitive in the market and vice versa.

The primary objective of the paper is to check the short-run linkages of the exchange rate with the money differential between the two countries, the relative prices of the two countries, the interest rate differential between the two countries, foreign exchange reserves in the country and the changes in exports and imports which determine the trade balance. Second Objective is to check the adjustment behaviour of the exchange rate due to an exogenous shock or a shock caused the other variables.

Organisation of the study is as follows; Section II discusses the theoretical aspects and reviews the past studies briefly, Section III explains the data issues,

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[1]This phenomenon is known as uncovered interest parity (UIP).

Section IV describes the methodology used for the estimation, Section V gives insights on the past behaviour of the variables, Section VI explains the empirical findings and Section VII draws some important conclusions.

II. THEORETICAL ASPECTS

Issue of forecasting/modeling exchange rate in the short run is highly debatable topic in international economics for the last four decades and severity of the problem has started after adopting the flexible exchange rate in 1973. In 1962 Mundell and Fleming gave idea about how fiscal and monetary policy affects in different regimes of exchange rate. Mundell-Fleming (M-F) model is a sticky price model which assumed given prices, static expectations and imperfect capital mobility.

There are several criticisms on the assumptions and validity of M-F model [see, Pilbeam (1998)], therefore, economists formulate monetary model of the exchange rate determination. Frenkel (1976); Mussa (1976) and Bilson (1978) developed a flexible price monetary model (FPMM) which is based on the assumption that prices are flexible and changes in the nominal interest rate reflect the changes in expected inflation rate. Moreover, demand for the domestic currency falls relative to the foreign currency leading to instant depreciation and the relationship between the exchange rate movements and differential in the nominal interest rates is positive. Moreover, due to flexible nature of prices, PPP holds continuously.

The main criticism on the FPMM is the assumption of PPP that does not hold continuously under flexible exchange rate especially. Dornbusch (1976) proposed a model of Sticky-Price Monetarist Model (SPMM) that explains large and prolonged departures from PPP. The basis of the model is that prices and wages are determined in the sticky-price markets and change only slowly over time in response to various shocks [Frankel (1979)]. According to Dornbusch (1976) an increase in money supply in the short run decreases the interest rate at given prices and exchange rate. The reduction in interest rate results in capital outflow and depreciation in the spot rate, while prices remain constant. The extent of depreciation is more than what it should be, i.e., exchange rate overshoots from the equilibrium level. In the long run prices starts moving upward and exchange rate appreciates and equilibrium is restored. Moreover, PPP is also achieved in the long run.[2]

Afridi (1995) examined the real exchange rate determinants and found that real exchange rate is explained by capital flows, excess domestic credit, openness and government consumption of non-tradable GDP but is not explained by terms of trade, investment, technological change. He also found that lagged dependent variable and nominal devaluation are highly significant in explaining the movements

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[2]Frankel (1979) modified the Dornbusch (1976) model by taking inflation expectation into account but overall the model and the results are the same.

in real exchange rate. Bhatti (2001) test the empirical validity of the traditional flow model (M-F model) of exchange rate and concludes that Pak Rupees is determined against the six industrial nations by differences in prices, income and interest rate differential. Bhatti (1997) focused on *ex ante* PPP and concluded that real exchange rate is a random walk and nominal exchange rate is determined by relative prices as well as expected real exchange rate. Choudhri and Khan (2002) found no evidence of a significant pass through of rupee depreciations to consumer prices in the short-run. This finding is consistent with recent theoretical analysis that suggests a weak short-run association between exchange rate changes and inflation. Moreover, Rogoff (1999); Mark and Choi (1997); Macdonald (1999); Obstfeld and Taylor (1997); Coleman (1995); O'Connel (1998) and Michael, *et al.* (1997) did not find strong evidence for PPP.

Other aspect of monetary model is the linkages between exchange rate and interest differential. Using annual data from 1971–2000 Alam, Butt and Iqbal (2001) concluded for 10 Asian countries including Pakistan that UIP holds continuously.[3] Meese and Rogoff (1988) did not find strong correspondence between exchange rates and interest differential and supported the random walk model of exchange rate forecasting. Baxter (1994) concluded that real interest differential is related only to temporary components of real exchange rate and the link between real exchange rate and real interest differentials is very weak. However, MacDonald (1999) concluded that fundamentals have clear role in the determining in-sample and out-of-sample performance of exchange rate models and Kemal (2004) concluded for UK exchange rate that after the adoption of inflation targeting regime (interest rate is the key monetary tool to control inflation in inflation targeting regime which both directly and indirectly affects the exchange rate) real exchange rate is not completely a random walk, it is affected by the short run changes in the real interest differential.[4]

Exchange rate is also adjusted due to improvements and deterioration of trade balance. Depreciation in exchange rate due to deterioration in trade balance makes domestic goods cheaper in foreign market, which helps in boosting exports and decline in imports and vice versa in case of improvement in trade balance. This result has also been shown by Kemal (2004a) that exchange rate significantly explained by the changes in trade balance. Furthermore he also concluded that exchange rate is also adjusted due to temporary shocks in exchange rate. Bokhari (2004) also stated that the pressure on the Rupee can be explained by the soaring trade deficits.

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[3]In most of the Asian countries the assumption of perfect capital mobility did not hold in the period which was taken for the analysis. Moreover, almost in all the developing countries which are taken, the free float exchange rate regime was adopted in the late nineties or even in 2000. Evidence of cointegration based on 30 annual observations could be misleading because the sample size should be large enough so that one can use generous number of lags to avoid specification error and making the model more reliable.

[4]For further reading on monetary model see Sarno and Taylor (2002).

Exchange rate is determined due to demand and supply of foreign exchange (forex) reserves under flexible exchange rate regime. It has been observed that due to inflow of foreign exchange the rupee highly appreciated against the Dollar. Kemal (1999) observed a significant negative relationship between exchange rate and foreign exchange reserves in case of Pakistan. (*Ibid*) also concluded that whenever reserves fall below the psychological barrier i.e. one billion dollar, there is a sort of panic in the foreign exchange market, i.e., open market exchange rate starts depreciating and the gap between official and open market exchange rate starts widening.[5]

III. DATA

Monthly data has been taken on the nominal exchange rate, interest rate (government bond yield and in some cases money market rate), money supply (money, quasi money, and in some cases direct M2), consumer price index (CPI) which are used as prices, exports, imports, and the foreign exchange (forex) reserves from the International Financial Statistics CD-Rom from July 2000 to August 2004 for Pakistan, USA, UK, Euro Area and Japan. For each country our total sample size is 49.

Data on the nominal exchange rates for all the four countries is available in terms of US Dollar. These were then converted in terms of Rupee against other currencies, i.e., Sterling, Euro and Yen. Government bond yield and in some cases money market rate is taken as the interest rate variable. Money supply variable is calculated by adding money and quasi money where direct data on M2 is not available. Consumer price index (CPI) has been taken as price variable for both the domestic and the foreign prices. Exports and imports are taken in Pakistani Rupees and then converted to corresponding country's currencies by dividing with their respective exchange rate. We do not have readily available data on the real exchange rates, nominal interest differential, nominal money differential, trade balance, real interest differentials, and the real money differentials. Therefore, we calculated it using the following equations (formulas).

$$RER = \frac{ER * CPI^*}{CPI} \qquad \text{(Real Exchange Rate)}$$

$$NID = I - I^* \qquad \text{(Nominal Interest Differential)}$$

$$RID = R - R^* \qquad \text{(Real Interest Differential)}$$

$$R = I - \pi \qquad \text{(Real Interest Rate)}$$

$$\pi = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \qquad \text{(Inflation Rate)}$$

[5]For more detailed analysis see Kemal (1999).

$$NMD = MI - MI^* \qquad \text{(Nominal Money Differential)}$$
$$RMD = RMI - RMI^* \qquad \text{(Real Money Differential)}$$

where *RER, ER, CPI, NID, RID, R, I, π, NMD, MI, RMD, RMI* represent real exchange rate, nominal exchange rate, consumer price index, nominal interest differential, real interest differential, real interest rate, nominal interest rate, inflation rate, nominal money differential, nominal money index,[6] real money differential, and real money index[7] respectively. Superscript* represents foreign country and subscript *t* and *t*–1 represent current and lag period. Moreover all the variables are taken in log form; however, there are certain values in different variables which are negative such as real or nominal interest rate differential so we add one before taking log of those variables.

IV. METHODOLOGY

Structural Vector Autoregressive (SVAR) approach[8] is used to check the exchange rate linkages with different variables taken in this analysis. The model is estimated by taking the log first difference of all the variables because if the variables are non-stationary and integrated of order one then VAR should be estimated by using first difference of the variables [Maddala and Kim (1998)]. Augmented Dickey-Fuller (ADF) test and Philip-Perron (PP) test are generally used to check the stationarity of the data. Though there are several shortcomings in using these tests (*Ibid*) but still these two tests are the most commonly used and other tests have their own shortcomings, therefore, we do the same. PP test is useful when there are structural breaks in the data otherwise ADF and PP give the same result. We employed both ADF and PP tests because exchange rate behaves differently in pre and post 9/11. AIC and SBC criteria are used to check for proper lag lengths.[9]

Dummy variable for the pre and post 9/11 and in certain cases dummy variable for the 5 months after 9/11 is used to capture the impact of pre 9/11 on exchange rates and transitional period of adjustment in exchange rates after 9/11 respectively. It has been observed that though the shock of 9/11 on exchange rate was too severe but it is absorbed after 5 months, which is due to the high level of existing reserves as well as continuous flow of foreign exchange which served as shock absorbers.

Impulse response function (IRF) is also estimated to check the time adjustment paths in response to the shock caused by either variable or any exogenous

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[6]Nominal money index is constructed by taking base July 2000 of nominal money supply.

[7]Real money index is constructed by taking base July 2000 of real money supply.

[8]VAR approach first developed by Sims in 1980 is an atheoretical approach, which relies on the previous information of the variables. Simple VAR can be expressed as $y_t = A(L)y_{t-1} + w_t$, while structural VAR take a form as $y_t = A_0 + A(L)y_{t-1} + w_t$. It is used to check the dynamic behaviour of economic variables and also provides some interesting insights and appears to bring certain benefits for forecasting [Greene (2003)].

[9]For further details on ADF and PP tests see Enders (1995) or Maddala and Kim (1998).

shock. The test is very sensitive to the frequency of the data, i.e., more frequent data gives better results and we are using monthly data in our analysis, therefore, the results are interpreted very cautiously.

Three separate models are estimated based on the theoretical background discussed in the Section II, i.e., Monetary Model (relationship between money differential, interest rate differential and exchange rate), Trade Model (relationship between exchange rate, exports and imports), and Forex Model (relationship between exchange rate and foreign exchange reserves). All the three models are used to check the linkages of both real and nominal exchange rate with their respective variables in each model.

V. DESCRIPTIVE ANALYSIS[10]

Pakistan had adopted free float exchange rate since 17 July 2000. It is evident that initially moving from fixed or managed float exchange rate system to free float exchange rate system the volatility of nominal exchange rate increases dramatically but usually other economic fundamentals remain the same. Theoretically, free float exchange rate eliminates the imbalances in balance of payments through automatic changes in exchange rate.[11] However, in Pakistan capital flows has not been liberalised so the transmission mechanism is not perfect to fix these imbalances. Moreover, the market conditions and transmission mechanism are imperfect and just changes in exchange rate do not eliminate the imbalances in current account balance and some other fiscal and monetary measures are used to fix these imbalances.

In early days of free float the exchange rate depreciated heavily at one and a half percent per month till September 11 (9/11) happened and it started appreciating after that. It is also observed that three months before the 9/11 the exchange remained stable and the main reason of this stability was increase in the forex reserves above the 2 Billion Dollars mark. However, it is usually noticed that after 9/11 event exchange rate appreciates against dollar at the rate of 0.06 percent but depreciates against other currencies. The depreciation rate in Pak-UK and Pak-Euro case was higher before 9/11 while higher after 9/11 in case of Pak-Japan. Initially discount rate (twice) and cash reserve requirement are used to contain depreciation of the Rupee [Janjua (2004)]. These tools are mainly used before 9/11 and after that sterilisation operations were used to contain excess appreciation and inflation.[12]

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[10]Results explained in this section are based on some calculations which can be obtained from the authors directly or from the earlier version of the paper which was presented at the 20th AGM and Conference of PSDE, 2005.

[11]The imbalances in balance of payments can be eliminated through inflows and outflows of capital which keeps exchange rate stable.

[12]In this pre 9/11 after floating regime, various restrictions were imposed on various transactions which are mainly related to the capital outflows. This shows that Pakistan did have strict capital controls, which is good to prevent the possibility of currency crisis as proven by the experience of Malaysia in the South East Asian financial crisis.

Prices in Pakistan grew at higher rate than the other four countries. Inflation was higher before 9/11 than pre 9/11. Japan has experienced negative inflation over the entire period, both in pre and post 9/11. Overall inflation in USA and UK were same and higher than the Euro Area. However, USA inflation was higher before 9/11, while UK and Euro Area inflation was lower before 9/11 than post 9/11.

Relative prices against all currencies have upward trend. However, in pre 9/11 era the relative prices of Pak-US had downward trend. It is very interesting to note that the growth rate of the relative prices of Pak-Japan was higher than the others but depreciation rate against Yen was lowest among the four currencies. More interestingly, after 9/11 the trend growth rate of the relative prices is 0.36 percent per month and depreciation rate per month is 0.40, which shows that Pak-Japan nominal exchange rate was adjusted according to the change in the relative prices. This implies that PPP might hold between Pakistan and Japan. However, other results do not favour the hypothesis of PPP.

It has also been observed that the gap between the real and the nominal exchange rate had started rising soon after 9/11 and after September 2003 it had widened more. Similar behaviour has been depicted with Pak-UK and Pak-Euro real and nominal exchange rates. The behaviour of Pak-Japan real and nominal exchange rates is totally different from the other three currencies. The gap between Pak-Japan real and nominal exchange rate had started rising well before 9/11 event in November 2000, however, the gap widened more in January 2002 and later the gap widened even further (after October 2003).

Prices in Pakistan remained more stable before 9/11 than post 9/11. The main reason of high volatility after 9/11 could be the recent increase in oil prices. Inflation in USA, UK, and Euro area was more or less of the same variation however, if we compare it between the two periods then the inflation was higher after 9/11 in these countries. Japan's inflation was quite stable over the two periods, though the oil price hike showed some impact on it as well. On the other hand, the relative prices were very stable before 9/11 but slightly increased after 9/11. In comparison volatility in the relative prices of Pak-Japan was higher than the other three. Variations in Pak-US nominal exchange rate were slightly higher before 9/11 than post-9/11, while variability of the nominal exchange rate against Sterling, Euro, and Yen was more stable before 9/11 and it became more volatile after 9/11. Opposite to the movements of nominal exchange rate, volatility in real exchange rate against all the four currencies was higher after 9/11 than pre 9/11. It is also evident that volatility in nominal exchange rate was higher than the real exchange rate except for Rupee per Dollar.

Correlation between the relative prices and the nominal exchange rate is not very strong which shows the departure from the PPP hypothesis. However, the correlation is still better in case of UK and Euro but correlation between the change in the relative prices and change in the nominal exchange rate is highly insignificant

and very small, which implies that the changes in the relative prices and the changes in the exchange rate has very weak link or in other words we can say that the short run movements between the two are not very significant and in short run PPP does not hold. Correlation between the nominal and the real exchange rate was higher before 9/11 than post 9/11, similarly, correlation between the changes in the nominal exchange rate and the changes in the real exchange rate was higher before 9/11.[13] This implies that the changes in both the variables are linked with each other, however, we can check the interlinkages through VAR structure which we did not check in this study but can be a part of future research. Correlation between the relative prices and the exchange rate shows that the changes in the real exchange rate are not highly correlated with the changes in the relative prices as PPP hypothesis stated.

We have also checked PPP hypothesis using OLS against all the four currencies, the results are reported in Table 1.[14] For both Pak-US and Pak-Japan, coefficient of both foreign and domestic prices are significant but R^2 is very small. On the other hand, for Pak-UK and Pak-Euro, coefficient of domestic prices for former and foreign prices for later is significant. Moreover, R^2 for both cases is high and significant. However, the null hypothesis formulated [see Moosa and Bhatti (1997)] shows that PPP does not hold for all the four cases.

Table 1

PPP Results

Variables	US	t-value	UK	t-value	Euro	t-value	Japan	t-value
β	1.24	0.67	–5.11	–3.49	–13.85	–6.46*	–41.51	–6.44*
α_0	–1.38	–2.67*	0.90	1.82***	0.87	1.46	1.36	6.53*
α_1	2.00	2.29*	1.17	1.51	2.99	2.96*	7.50	6.10*
R^2	0.15		0.81		0.85		0.49	
DW	0.28		0.79		0.63		0.73	
F-stat	4.16**		98.20*		134.54*		22.47*	
Null Hypothesis: $\alpha_0 = 1$ and $\alpha_1 = -1$								
F-statistic	18.04*		60.72*		97.80*		43.01*	
Chi-square	36.08*		121.44*		195.61*		86.02*	

Note: *, **, and *** indicate significance level at 1, 5 and 10 percent respectively.

[13]The correlation between the changes in the nominal and the real exchange rate of Japan was quite higher than the correlation between the two in the level form.

[14]The estimated equation is $s_t = \beta + \alpha_0 P_t + \alpha_1 P_t^* + \vartheta_t$.

When Pakistan adopted the flexible exchange rate the nominal interest rate was around 9 percent on average and now it has declined to less than 2 percent on average. In pre 9/11 era maximum nominal interest rate was 12.93 percent and minimum was 5.63 percent. However, in post 9/11 era initially it was as high as 10.41 percent in October 2001 and then it started declining. The minimum value of nominal interest rate was 0.74 percent in July 2003. The minimum value of real exchange rate before 9/11 was 5.84 percent when the nominal interest rate was 6.82 percent, the maximum real exchange rate was 12.04 percent when the nominal interest rate was 12.93 percent. Real interest rate was maximum at 9.90 percent after 9/11 while minimum value was –0.03 percent in March 2004.

Volatility of nominal interest differential was higher after 9/11 than pre 9/11. This is coherent with the statement of Janjua (2004) that after 9/11 the exchange rate is adjusted through changes in the interest rate. Except for Pak-US exchange rate other currencies were more volatile after 9/11. On the other hand volatility in the real interest differential shows different results than nominal interest differential. Pak-UK real interest differential was more volatile in pre 9/11 era than post 9/11, however, rest were more volatile after 9/11. Similar to the nominal exchange rate, real exchange rate was relatively more volatile after 9/11 than pre 9/11 except for Pak-US real exchange rate.

Correlation between the Pak-US nominal exchange rates and the nominal interest differential is positive in both pre and post 9/11. However, correlation between the Pak-UK, Pak-Euro Area, and Pak-Japan nominal exchange rates with the nominal interest differential respectively is negative after 9/11 but positive before 9/11 except for Euro Area. Correlation between the Pak-US real exchange rate and the real interest differential is positive in both pre and post 9/11, while it is negative in both pre and post between Pak-UK real interest differential and the real exchange rate. Correlation between Pak-Euro real exchange rate and the real interest differential and Pak-Japan real exchange rate and the real interest differential is positive overall but later has negative correlation before 9/11 and positive after 9/11 while former has positive correlation before 9/11 and negative after 9/11. Overall, the linkages between interest differential and exchange rate are not very significant. This could be due to lack of capital mobility between Pakistan and other countries or insensitivity of interest rate or there could be lagged adjustment in exchange rate due to change in interest rate.

Correlation between the nominal money differential and the nominal exchange rate shows positive correlation except for the Pak-US case because after 9/11 due to high inflow of foreign exchange, exchange rate started appreciating against the Dollar. The reason behind the appreciation against Dollar is the depreciation of Dollar itself against Sterling, Euro, Yen and other currencies. However, correlation between the nominal money differential and the nominal exchange rate was higher in post 9/11 era than before 9/11. On the other hand except

for Japan the correlation between the real money differential and the real exchange rate was quite high in both pre and post 9/11 but still it was higher after 9/11.

Nominal and real money supply of Pakistan has higher rate of growth than the other four countries. According to the monetary models, increase in money supply relative to the foreign country leads to exchange rate depreciation against that country's currency. Therefore there should be an upward trend in the exchange rate[15] if the money differential has upward trend. Especially in post 9/11 era the trend between Pak-US money differential and exchange rate is negative, while, in both Pak-UK and Pak-Euro Area money differential and exchange rate has upward movements. As discussed earlier that behaviour of nominal and real Pak-Japan exchange rate was different especially after post 9/11 when exchange rate started adjusting after heavy appreciation, positive trend is observed between the nominal money differential and the nominal exchange rate and the real exchange rate shows random behaviour.

Volatility of the money supply of Pakistan was higher than the other four countries. Volatility of Pakistan's nominal as well the real money supply increased by almost 4 times after 9/11 compared to pre 9/11. Variation in the nominal as well as the real money supply of all the four countries was higher after 9/11 compare to pre 9/11. Variation in the nominal as well as the real money supply of UK and Euro was lower before 9/11 than USA and higher after 9/11, however, variation in the real money supply of Japan was higher than the other three countries after 9/11. On the other hand, volatility in the money differential has enormously declined in post 9/11 era. Volatility in the nominal as well as the real money differential was higher before 9/11 compared to post 9/11, especially, the variations in the Pak-US and the Pak-UK nominal money differential were enormously declined after 9/11.

Lagged behaviour is observed between the changes in the nominal exchange rate and improvement and deterioration of the trade balance for all the four cases, i.e., deterioration of trade balance in January 2004 is responded by depreciation of nominal exchange rate in February 2004. Correlation between the trade balance and the change in the exchange rate depicts the same result that the correlation, though not very high but it is better when we measure it with legged behaviour. Similarly, the real exchange rate responds to the trade balance with one period lag and these movements responded more before 9/11 compared to post 9/11. On the other hand, we can say that trade balance is adjusted after one period lag due to changes in the nominal and the real exchange rate. Trade balance can only be adjusted spontaneously if imports respond to the changes in exchange rate because having existing deals with the foreign companies exporters do not respond so early to the changes in exchange rate.[16] Volatility in trade balance has increased in post 9/11 era

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[15]Exchange rate is taken as Rupee against Dollar and other currencies. Therefore, upward trend of exchange rate means depreciation.
[16]For more details see Kemal and Qadir (2003).

compared to pre 9/11. Average trade balance has been increased from -6.8 percent of total average trade[17] before 9/11 to –7.2 percent of total average trade after 9/11, which is not good news for the Government. However, average monthly imports after 9/11 were increased by 23.6 percent while average monthly exports grew by 22.7 percent.

In September 2001 the forex reserves were 2.15 Billion Dollar which soon after 9/11 went up to 3.1 billion Dollars in November 2001 and now around 11 Billion Dollars. It is also observed that small changes in the forex reserves lead to small changes in the Pak-US exchange rate. On the other hand, large ups and downs in the Pak-Britain, Pak-Euro and Pak-Japan exchange rate has been observed due to change in the forex reserves. The correlation between the Pak-US exchange rate and the forex reserves was high and negative while with other currencies it is high and positive. On the other hand, the correlation was positive for all the currencies in pre 9/11 era but lower than the post 9/11. The correlation between the changes in the forex reserves and the changes in the nominal and the real exchange rate was positive but not too high. Variations in the changes in the nominal exchange rate was higher in the post 9/11 compared to the pre 9/11. Variations in the changes in the real exchange rate was enormously high in Pak-UK and Pak-Euro case real exchange rate, while variation in the changes in the real exchange rate has declined after 9/11 in Pak-US and Pak-Japan real exchange rate.

VI. EMPIRICAL FINDINGS AND RESULTS

Three models are estimated for each real and nominal exchange rate as discussed in Section IV. This section elaborates the empirical findings of these models.

(1) Model 1: Monetary Model

Monthly changes in the real exchange rate are affected by the real money differential as well as the real interest differential for all the four countries (Table 2). However, Pak-Euro and Pak-Japan has more significant lagged values of the real money differential and the real interest differential than other two. This implies that the monetary model of the exchange rate determination holds especially for Pak-Euro and Pak-Japan case. Moreover, from the results it is clearly shown that real exchange rate is affected by 1st lag of both the real money differential and the real interest differential in Pak-Euro case, while 1st lag is insignificant of these variables in case of Pak-Japan case. This implies that real exchange rate is more explained by monetary model in case of Pak- Euro case than Pak-Japan. Results also show that the real exchange rate also responds to its own lags, which shows the random walk

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[17]Average is taken on monthly basis.

Table 2

Estimates of Monetary Model

Variables		Real Exchange Rate				Variables		Nominal Exchange Rate			
	Lags	Pak-US	Pak-UK	Pak-Euro	Pak-Japan		Lags	Pak-US	Pak-UK	Pak- Euro	Pak-Japan
Exchange Rate	1	–0.21	0.47	–0.52**	–0.58	Exchange Rate	1	0.10	0.05	–0.25	–0.08
Exchange Rate	2	–0.50	0.54	–0.96*	–1.41	Exchange Rate	2	0.17	–0.14	0.34	0.11
Exchange Rate	3	–0.34	–0.07	–0.61*	–1.47**	Exchange Rate	3	0.07	–0.11	–0.13	–0.17
Exchange Rate	4	–0.92	0.26	–0.14	–1.54*	Exchange Rate	4	–0.39	0.21	0.68	–0.41
Exchange Rate	5	0.16	1.36***	–0.32	–0.89	Exchange Rate	5	–0.60**	–0.28	0.21	–0.41
Exchange Rate	6	–0.26	–0.36	0.28	0.94	Exchange Rate	6	0.10	0.44	0.18	–0.17
Exchange Rate	9	–0.38	0.09	0.06	–0.53	Exchange Rate	12	0.03	–0.15	–0.60**	0.01
Exchange Rate	10	0.37	–0.40	–0.60*	–0.95**	Money Differential	1	–0.09	0.43	0.53	0.37
Exchange Rate	11	–0.22	1.97	0.38	–0.27	Money Differential	2	0.002	–0.35	–0.91**	0.12
Exchange Rate	12	–0.07	1.09	0.63**	0.45	Money Differential	3	–0.08	–0.11	0.31	–0.25
Money Differential	1	0.32	1.85	–1.68*	–0.19	Money Differential	4	–0.05	–0.65	–0.60	0.05
Money Differential	2	0.47	1.83	–2.51*	–1.95*	Money Differential	5	–0.11	0.40	1.11	–0.14
Money Differential	3	0.48	–0.08	–2.26*	–2.07*	Money Differential	6	–0.12	0.57	0.07	0.06
Money Differential	4	0.60	1.16	–2.50*	–1.55**	Money Differential	12	0.03	0.43	–0.24	–0.21
Money Differential	5	–1.00	0.19	–0.87*	1.09	Interest Differential	1	–0.0003	–0.01	–0.01	–0.003
Money Differential	6	–1.09	1.24*	0.01	1.27***	Interest Differential	2	–0.001	–0.01	0.01	–0.003
Money Differential	9	–0.51	0.89	–0.63***	0.39	Interest Differential	3	–0.003	–0.01	0.01	–0.01
Money Differential	10	–0.34	–1.26	–0.19	0.48	Interest Differential	4	–0.002	0.01	0.02	–0.01
Money Differential	11	–2.53	–1.52	–0.59	–0.70	Interest Differential	5	–0.002	0.005	0.01	–0.01
Money Differential	12	–2.01**	–1.13	–0.39	–1.36**	Interest Differential	6	0.0005	0.01	0.01	–0.002

Continued—

Table 2

		Real Exchange Rate						Nominal Exchange Rate			
Variables	Lags	Pak-US	Pak-UK	Pak-Euro	Pak-Japan	Variables	Lags	Pak-US	Pak-UK	Pak-Euro	Pak-Japan
Interest Differential	1	0.00002	–0.04	0.12*	–0.03	Interest Differential	12	–0.001	0.01	0.01***	0.002
Interest Differential	2	0.0047	0.01	0.29*	–0.05***	Relative Prices	1	–0.07	–1.85	–1.10	0.31
Interest Differential	3	0.003	–0.04	0.38*	–0.03	Relative Prices	2	–0.49	3.08	2.53	–0.37
Interest Differential	4	0.00004	–0.07	0.35*	–0.10**	Relative Prices	3	0.42	–0.50	–1.88	–0.98
Interest Differential	5	0.01	0.07	0.24*	–0.10*	Relative Prices	4	0.38	1.31	3.84	2.36
Interest Differential	6	0.003	0.13	0.15*	–0.07***	Relative Prices	5	0.51	0.02	–4.95***	–1.04
Interest Differential	9	0.003	–0.03	–0.06	0.11**	Relative Prices	6	–0.03	0.13	1.40	2.34***
Interest Differential	10	0.004	–0.18	–0.09**	0.09**	Relative Prices	12	0.21	4.35*	3.13***	1.31
Interest Differential	11	0.01**	–0.08	–0.11*	0.002	Constant		0.01***	–0.02	0.004	–0.03
Interest Differential	12	0.001	–0.06**	–0.04	–0.06*	Dummy–1		–0.003	–0.01	–0.07	
Constant		0.04*	–0.07***	0.12*	0.05**	Dummy–2					0.05*
Dummy–1		–0.09	0.45***	–0.11		R^2		0.83	0.76	0.88	0.87
Dummy–2			–0.01		0.13*						
R^2		0.88	0.79	0.97	0.95						

Table 2—(*Continued*)

Note: *, **, and *** indicate significance level at 1, 5 and 10 percent respectively.

behaviour of the real exchange rate. Results of IRF[18] show that the real exchange rate instantaneously adjusts to the shock but overshoots from the equilibrium level followed by appreciation to restore the long run equilibrium. Monthly changes in the nominal money differential and the nominal interest differential significantly explains the changes in the nominal exchange rate only in case of Pak-Euro. Results also show that exchange rate does not respond to the frequent changes in prices in either case. Exchange rate is affected by 5th and 6th month changes in prices in case of Pak-Euro and Pak-Japan respectively, while it takes one year in case of Pak-UK. Recent experience in Pakistan for the last few years shows that increase in money supply was not adjusted by prices even for three years.

(2) Model 2: Trade Model

Monthly changes in the real exchange rate are significantly explained by the changes in the imports and the changes in the exports as shown in Table 3. The linkages are more explained in case of Pak-US. However, the real exchange rate also responds to the frequent changes in exports and imports in case of Pak-Japan and Pak-UK but in case of Pak-Euro, linkages are not very strong. Moreover, real exchange rate also responds to its own lags especially in case of Pak-US and Pak-UK. Results of IRF show that the real exchange rate instantaneously adjusts but overshoots from the equilibrium level and then adjusts back towards long-run equilibrium. Opposite to the results of the real exchange rate, monthly changes in the nominal exchange rate are significantly explained by exports and imports especially in the case of Pak-Euro and Pak-Japan. It is interesting to note that frequent changes in exports are significantly responded by the nominal exchange rate but this is not the case with imports. Kemal and Qadir (2003) on the other hand shows that response of changes in exports is not frequent due to changes in exchange rate while it is frequent in case of imports. This shows opposite association of these variables if we take one variable independent and other dependent or vice versa.

(3) Model 3: Exchange Rate—Forex Relationship

Monthly changes in the real exchange rate are significantly explained by 1st month's lag of forex reserves in case of Pak-UK and Pak-Euro as shown in Table 4. However, 6 months lagged changes in forex reserves affect the real exchange rate in case of Pak-US which is quite strange because we have large number of reserves in Dollars (almost 90 percent or even more than that). Results of IRF show that real exchange rate overshoots initially but then appreciates to restore the equilibrium- Moreover, IRF also shows that shock caused by forex reserves spontaneously adjusts by exchange rate in case of Pak-US and Pak-Japan. On the other hand nominal

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[18]Graphs of IRF can be obtained directly from the authors or earlier version of this paper which was presented at the 20th AGM and Conference of PSDE, 2005.

Table 3
VAR Estimates of Trade Model

Variables	Lags	Real Exchange Rate				Nominal Exchange Rate			
		Pak-US	Pak-UK	Pak-Euro	Pak-Japan	Pak-US	Pak-UK	Pak-Euro	Pak-Japan
Exchange Rate	1	–0.29**	–1.08**	0.12	0.44	–0.15	–0.67	0.74*	0.09
Exchange Rate	2	–1.20*	–0.15	0.28	0.28	–0.37	–0.06	0.13	0.33
Exchange Rate	3	–0.52*	0.00	–0.20	–0.02	–0.50	–0.05	–0.24	0.19
Exchange Rate	4	–0.74*	–0.12	0.001***	–0.29	–0.66*	–0.004	0.08	–0.42***
Exchange Rate	5	0.01	0.11	–0.26	–0.27	0.52***	–0.32	–0.41	–0.30
Exchange Rate	6	–0.54*	–0.86*	–0.22	0.13	0.59*	–0.36	0.18	0.09
Exchange Rate	9	–0.17	–0.01	–0.22	–0.27	0.79	–0.18	0.01	–0.16
Exchange Rate	10	0.32*	–0.32	–0.27	–0.49**	0.30	–0.30	–0.48*	–0.39
Exchange Rate	11	–0.23	0.18	0.09	0.19	–0.07	0.08	0.36***	0.11
Exchange Rate	12	–0.36*	–0.14	–0.11	0.46**	0.03	–0.19	–0.19	0.38***
Imports	1	–0.05*	–0.03	–0.03	–0.16*	–0.02	–0.06	–0.16**	–0.17*
Imports	2	–0.07*	0.03	–0.01	–0.13	–0.04***	–0.11	–0.02	–0.17**
Imports	3	–0.004	–0.11	0.01	–0.01	–0.07**	–0.19	–0.03	–0.03
Imports	4	0.07*	0.07	0.20	0.23**	–0.02	–0.002	0.22**	0.26*
Imports	5	0.06**	0.15	0.10	0.10	0.03	0.13	0.01	0.21***
Imports	6	0.04*	0.16***	0.08	0.01	0.01	0.09	0.10	0.10
Imports	9	–0.03**	0.12**	0.10	–0.15	–0.01	0.15	0.19***	–0.07
Imports	10	–0.03	0.34*	–0.004**	–0.19	0.03	0.23	0.08	–0.05
Imports	11	–0.01	0.08	–0.08	–0.15	–0.04	0.02	0.04	–0.03

Continued—

Table 3

Imports	12	0.02	–0.01	–0.02	–0.07	–0.01	0.01	0.04	–0.0001
Exports	1	–0.09*	–0.01	–0.03	–0.07	0.02	0.07	0.02	–0.02
Exports	2	–0.10*	0.10***	0.08	–0.05	–0.01	0.14	0.07	0.01
Exports	3	–0.15*	0.16***	0.04	–0.11**	–0.03	0.15	–0.04	–0.11***
Exports	4	–0.12*	0.08	–0.01	–0.13**	–0.06***	0.02	–0.20***	–0.19*
Exports	5	–0.09*	0.06	0.08	–0.10	–0.03	–0.005	0.01	–0.13***
Exports	6	–0.05***	0.01	–0.13	–0.09***	0.04	0.01	–0.24*	–0.07
Exports	9	–0.03	–0.19*	–0.07	–0.13*	0.05	–0.13***	–0.17***	–0.13*
Exports	10	–0.03	–0.02	0.20	–0.03	0.03	0.05	0.14***	–0.05
Exports	11	–0.10*	0.26*	0.01	–0.06	0.03	0.18	–0.21***	–0.03
Exports	12	–0.15*	0.11	–0.12	–0.13*	–0.003	0.08	–0.08	–0.09
Constant		0.03*	–0.02*	–0.01	0.01***	0.0003	–0.02***	–0.005	0.003
Dummy-1		–0.11*						0.07	
Dummy-2			0.07	0.02	0.01*	0.04*	0.04		0.03
R^2		0.98	0.96	0.91	0.97	0.93	0.93	0.94	0.97

Table 3—(*Continued*)

Note: *, **, and *** indicate significance level ate 1, 5, and 10 percent respectively.

Table 4
Estimates of Forex Model

Variables	Lags	Real Exchange Rate				Nominal Exchange Rate			
		Pak-US	Pak-UK	Pak-Euro	Pak-Japan	Pak-US	Pak-UK	Pak-Euro	Pak-Japan
Exchange Rate	1	–0.15	–0.44***	–0.60*	–0.42	–0.50	–0.65*	–0.67*	–0.56***
Exchange Rate	2	–0.33	–0.73*	–0.09	–0.25	–1.06***	–0.92*	–0.23	–0.22
Exchange Rate	3	–0.38	–0.74*	–0.27	–0.14	–0.90*	–1.30*	–0.44**	–0.01
Exchange Rate	4	–0.37***	–0.56**	–0.24	–0.36	–0.70*	–1.09*	–0.53*	–0.32
Exchange Rate	5	–0.17	–0.51***	–0.13	–0.38	–1.24**	–0.95*	–0.31	–0.40
Exchange Rate	6	–0.17	–0.72*	–0.05	–0.18	–1.04***	–1.39*	–0.15	–0.20
Exchange Rate	7	–0.33	–0.72*	0.02	–0.41	–1.33**	–1.18*	–0.01	–0.70
Exchange Rate	8	–0.09	–0.38	0.10	–0.02	–0.99	–0.88*	0.25	–0.20
Exchange Rate	9	–0.05	–0.51***	0.25	0.20	–0.69	–0.75**	0.39	0.01
Exchange Rate	10	–0.25	–0.27	–0.08	–0.07	–0.61***	–0.43***	0.02	–0.24
Exchange Rate	11	–0.32***	–0.12	0.22	–0.09	–0.50***	–0.22	0.37***	–0.25
Exchange Rate	12	–0.17	0.06	0.49**	–0.18	–0.37	0.15	0.52***	–0.56
Forex Reserves	1	0.03	–0.19**	–0.24*	–0.13	0.09	–0.40*	–0.46*	0.09
Forex Reserves	2	0.07	0.14	0.16	0.02	0.10**	0.08	0.01	0.07
Forex Reserves	3	0.00	–0.18	–0.10	0.05	0.02	–0.28**	–0.09	0.12
Forex Reserves	4	0.00	–0.03	–0.10	0.06	–0.01	–0.07	–0.08	0.07
Forex Reserves	5	–0.05	0.08	–0.04	0.09	–0.02	0.16	0.12	0.01
forex Reserves	6	–0.06***	–0.05	–0.08	0.01	0.04***	0.07	0.06	–0.03
forex Reserves	7	–0.01	0.01	–0.14**	0.06	0.07***	0.12	–0.04	–0.04
forex Reserves	8	0.01	0.25*	0.13***	0.09	0.05**	0.41*	0.19*	0.02
forex Reserves	9	–0.01	0.10	0.05	–0.04	0.07***	0.28*	0.04	–0.01
forex Reserves	10	0.02	0.17***	–0.10	–0.04	0.05***	0.32*	–0.12	0.05
forex Reserves	11	0.04	0.07	–0.07	–0.05	0.07*	0.18**	–0.12	0.06
forex Reserves	12	0.02	0.02	0.04	–0.02	0.04**	0.12***	0.01	0.06
Constant		0.01**	–0.06*	0.01	0.00	0.00***	–0.14*	0.00	–0.04
Dummy-1		–0.08**				–0.20**	0.10	0.13***	–0.10
Dummy-2			0.09*	0.10*	0.04	–0.07***	0.15*	0.10*	0.06
R^2		0.79	0.82	0.81	0.67	0.89	0.86	0.82	0.76

Note: *, **, and *** indicate significance level ate 1, 5, and 10 percent respectively.

exchange rate frequently responds the changes in forex reserves in case of Pak-US and Pak-UK. Interestingly it is examined in both real and the nominal exchange rates the changes in the forex reserves either affect exchange rate with one or two period lags and then after 6, 7 or 8 months lag. Daily data in this regard could give better results which is not taken in the current analysis. The above analysis shows that changes in the forex reserves only change the face value of exchange rate in case of Pak-US, not the real exchange rate. This implies that appreciation in exchange rate due to high inflow of foreign exchange reserves in Pakistan does not make currency stronger in real terms, we can term it as overvalued exchange rate. Current appreciation is rather a temporary appreciation which can take U-turn if the forex reserves or remittances are stopped flowing into the country.

VII. SUMMARY AND CONCLUSIONS

We have analysed the behaviour of exchange rate, interest rate, interest differential, money supply, money differential, prices, relative prices, forex reserves, imports and exports. SVAR model is estimated to check the short-run impacts on both nominal and real exchange rate with respect to the movements in fundamentals.

Prices in Pakistan were more stable in pre 9/11 era than post 9/11 era, which could be due to recent oil price hike. As discussed by Janjua (2004) that interest rate is used as a main monetary tool to adjust exchange rate after 9/11, it has been found that volatility in interest differential was higher after 9/11. However, now when interest rates are quite low Pakistan should think thrice before changing the interest rate because frequent changes in a wrong direction can affect the fiscal debt and other variables including exchange rate. Moreover, it has also been observed, though not analysed, in this study that inflationary gap has widened in the last two years; therefore, there is a potential that inflation can increase at any time. Therefore, some policy should be adopted which can tackle the expected increase in inflation, and contain the current expected inflation.

The gap between the nominal and real exchange rate has widened after 9/11, which is the major concern for the policy-makers. Changes in the nominal exchange rate and real exchange rate are highly correlated and because relative prices are not significantly correlated with the nominal exchange rate, we might say that the nominal exchange rate variations cause real exchange rate variations. Exchange rate did not capture frequent changes in relative prices, which implies that PPP does not hold for the recent floating period. This result conforms to the theory and the facts that productivity growth and prices of traded and non-traded goods are not similar between Pakistan and other countries. PPP might hold in the long run but it is not analysed in this study due to sample restrictions.

Monetary model significantly explains the movements in the real exchange rate especially in case of Pak-Euro and Pak-Japan, while, movements in nominal exchange rate are not significantly explained by the monetary model for the three

countries except for Pak-Euro. It is concluded from the monetary model that exchange rate does not respond to the frequent changes in prices, which again show the departure of PPP hypothesis in the short run. The trade model explains the movements in the real exchange rate significantly for Pak-US, Pak-UK and Pak-Japan and the nominal exchange rate for Pak-Euro and Pak-Japan. It is concluded from the trade model that exchange rate frequently responds to the changes in exports but the response is not that frequent when there is an increase in imports. Changes in forex reserves are responded by Pak-Euro and Pak-UK real exchange rates. However, the Pak-US nominal exchange rate is affected by forex Reserves and not the real exchange rate.

The most important finding of this study is that real exchange rate always overshoots in response to some shock and then adjusts back to restore the equilibrium, although the adjustment process varies by country. The real exchange rate is not completely a random walk model and the movements are also explained by other fundamentals. This result coincides with the findings of MacDonald (1999) and MacDonald and Taylor (1994). In the flexible exchange rate regime and the rapid development of global financial system, monetary variables are expected to affect exchange rate more than any other variables. In this context, it has been found that movements of Pakistani currency is more linked to Euro Area and then with Japan.

The adjustment behaviour of exchange rate due to shock caused by forex reserves show that it adjusts and restores the equilibrium in case of Pak-US and Pak-Japan. Therefore, keeping reserves in dollars and yen is safer than any other currency. In the future research we can take daily data on forex reserves and exchange rates, weekly or fortnightly data on money, interest rate and prices. Long-term interest rate can be useful to take into account in order to get better results in monetary model.

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Comments

The authors have picked up a very interesting and timely topic and has attempted to provide a detailed analysis of the behaviour of Pakistan's exchange rate after the Sate Bank of Pakistan adopted a free float regime in July 2000. The analysis becomes even more important in view of the post-9/11 events and authors have looked into this by comparing the volatility of Pakistan rupee *vis-à-vis* other major currencies in the pre- and post-9/11 periods. The paper also investigates the movements in other macroeconomic variables such as interest rate, money supply, foreign exchange reserves and imports and exports. Monthly data from Pakistan, USA, UK, Euro Area and Japan are used for econometric analysis. The empirical evidence does not support the validity of short-run purchasing power parity under a free-float. Further, the results suggest that exchange rate in Pakistan is determined by the demand and supply conditions in the foreign exchange market. The empirical evidence also supports the view that the recent inflow of foreign exchange reserves helps the currency to appreciate whereas deterioration of trade balance leads to exchange rate depreciation.

The main focus of the paper, however, is the movement of exchange rate after the free-float. The authors argue that contrary to theoretical belief that a move to free-float exchange rate helps to reduce imbalances in the current account, due to prevailing imperfect market conditions and poor transmission mechanism in case of Pakistan, exchange rate policy alone cannot reduce or eliminate the current account imbalances. Therefore, it is suggested that a move to free-float has to be supported by fiscal and monetary policy measures. The empirical evidence provided in the paper suggests that the Pakistan rupee experience heavy depreciation after the switch to a free-float. However, significant increase in foreign exchange in the post-9/11 period helped the currency to slightly appreciate and then stabilise. The paper also finds that Pakistan rupee is closely linked to the Japanese yen. These are important findings. However, I have some comments to further improve this paper.

General Comments

No doubt that the issue raised and analysed in this paper is an interesting one and the authors have provided a very detailed analysis. However, such a detailed analysis is perhaps the main problem with this paper. The paper seems to be extracted from author's master thesis (author has recently completed his Masters in Economics from University of Warwick, UK). The main body of the paper has 35 pages including 19 tables while the appendix includes 60 figures. This is a very long paper by any conference standards. In fact, refereeing this paper was not an easy

task. My first suggestion for the authors are to substantially reduce the size of the paper to make it publishable in the proceedings.

Next, some of the econometric tests are used simply to test the established theory and the empirical findings are trivial. I think, the focus on free-float and a comparison of pre- and post-9/11 events on exchange rate is itself is very important and including other avenues in the same paper adversely affects the main focus of the paper. Further, the objective of any research is not to report the empirical results but to look into policy implications of the results obtained in line with the basic motivation for the research. The paper lacks to discuss the policy implications. For instance, authors rightly asserts that Pakistan rupee appreciated in the post-9/11 period. But this may not be directly related to a switch to free-float. It is widely believed (and I have been advocating this for the last two years) and the recent economic performance of Pakistan is partly due to economic planning but mostly due to international economic environment in the post-9/11 period. Being a coalition partner in the war on terror, in the aftermath of 9/11, Pakistan enjoyed softening of economic sanctions that were imposed by the US and the West in 1998. At the same time, increased uncertainty of Pakistanis investment in the US forced them to transfer their assets to Pakistan, resulting into large inflow of remittances. The result was a substantial increase in foreign exchange reserves which helped the currency, first, to slightly appreciate and then stabilise. This is exactly what the paper has found. As the result is due to external factors, these conditions could not prevail in the long run. The main question remains, what next. I did not expect the authors to thoroughly look into this broader question and suggest some policies for a long-run stability of the exchange rate. However, preliminary discussion as part of policy implication is needed.

I also have a couple of technical comments. The paper uses monthly data on exchange rates for empirical estimation. The authors would agree that exchange rate movements are extremely fast and at times it is difficult to capture these movements on a daily basis due to regional time differences. Use of monthly data to analyse the issue of exchange rate volatility seems to be incorrect and may provide misleading results. Some important information may have been lost with this aggregation. This poses even more problem when the paper is extended to investigate the impact of shocks on exchange rates using impulse response functions. Impulse responses for exchange rate are basically used to observe how long it would take the market to adjust to a shock. Usually, a shock is introduced and its impact is observed over a week to 10 days. Observing daily changes by using monthly averages is completely in appropriate. The authors should make use of high-frequency data such as daily observation on exchange rate to perform this analysis and obtain some meaningful results.

I also have a problem with the empirical test of PPP and the results reported in Table 8 and Table 9. Theoretically, spot rate should be equal to relative prices at abroad and home, if PPP holds. This would mean a restriction on α_0 and α_1 to be '+1' and '−1', respectively. This requires estimation of a restricted version of equation in footnote 15 (on page 11) with restrictions: $(s, p^*, p) = (1, -1, 1)$. With these restrictions imposed 'a priori', you can test residual of equation in footnote 15 for unit root. PPP holds if the process is stationary. Surprisingly, the paper talks about diagnostics tests but estimates a simple OLS to test the validity of PPP. A similar approach could be used for estimating equation for mean reversion (footnote 16 on page 12). This approach is superior to the one that the authors have used in this paper.

Finally, I appreciate the effort made in this paper and commend the authors for choosing an important area of research. I believe that the comments made in this report would help to improve the quality of paper. Some minor technical comments are directly communicated to the authors.

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