Impact of real and nominal factors on long run equilibrium in Real Effective Exchange Rate (REER) in Pakistan

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Abstract

This paper focused on the hypothesis that nominal shocks such as monetary policy have only temporary impact on long run equilibrium real exchange rate and the consequent misalignment. To do so we utilized two approaches to tackle this issue. The first approach to find out long run real exchange rate is through investigation a long run relation between real exchange rate and its theoretical determinants. The variables that have a long run relationship with the real exchange rate include the terms of trade, real interest rate differential, government spending, and tradable to nontradable ratio. We found that monetary shocks have little impact in long run. Second approach used was the structural vector autoregression by imposing long run restrictions in line with the Blanchard and Quah (1989). Again, this approach has confirmed above results that only real shocks have lasting effects on long run real exchange rate. Nominal shocks only influence the equilibrium exchange rate temporarily in short run. The consequent misalignments measured through two approaches are then compared and policy implications are drawn. Although moving in the similar direction, there magnitudes are different. One important implication for this result is that policy makers' reliance on any one measure of to judge misalignment would be give inaccurate results.

1.1: Introduction

Any change in the real effective exchange rate (REER) should be considered as the change in the competitiveness of the country. Edwards (1988) points out that these changes could arise due to both real and nominal factors. Changes in REER due to real factors, such as productivity structure, terms of trade etc., are justified and represent equilibrium phenomenon and thus do not require any intervention by the policy makers. However, there are adjustments in REER that are not justified in accordance to the changes in fundamentals and represent a departure from long run equilibrium real effective exchange rate (LRER). These short run departures due to nominal factors such as changes in money supply etc. are known as misalignments of exchange rate from its true value. A useful survey of the literature include Edwards (1988), Williamson (1994), Hinkle and Montiel (1999) and Montiel (2003).

A vast amount of literature asserts that prolonged sterilization can have adverse consequences [Calvo (1991), Calvo et al (1993), Frankel (1994), Reinhart and Reinhart (1999)]. Failure to sterilize market interventions and the consequent increase in domestic liquidity can result in inflation as well as unwanted movement in exchange rate. These can have implications for the REER. Various studies regarding the behavior of the SBP indicate that it never sterilized the foreign exchange inflows completely [Qayyum and Khan (2003) for period 1982-2001 and Waheed (2010) for period 2001:1 to 2006:08]. That resulted in ample liquidity in the system, which in turn had implications for REER through changes in inflation, exchange rate, and interest rates in the economy. This is more relevant when we consider that the SBP has been following a regime of free floating exchange rate since 2000. Before that from 1982 to 2001, it had been managing the exchange rate through measured devaluation of its currency in nominal terms in accordance with the basket of trade weighted exchange rates of partner countries.

Motivation of this paper is to explore the hypothesis that nominal shocks such as monetary policy stance would have no consequence for the long run equilibrium of the REER in Pakistan. If true, this hypothesis would imply that monetary policy could only cause short run deviation, known as misalignment, from the equilibrium REER. The long term competitiveness will be determined by real factors called fundamentals. To investigate this hypothesis, we used two approaches namely the Johansen cointegration approach based on long run relationship between REER and its fundamental determinants and the Structural VAR approach to use Blanchard and Quah (BQ) decomposition of REER in to long run/permanent and transitory components.

We followed literature on behavioral real exchange rate (BEER) developed by Clark and MacDonald (1998) using Johansen cointegration technique. We identified the long run relationship between REER and its underlying fundamentals. The fundamental that were found to affect the REER included the terms of trade, changes in government expenditures as percentage of GDP representing fiscal policy stance, the Balassa-Samuelson effect (differential productivity growth in the tradable goods sector), and real interest rate differentials [Edwards (1988), Elbadawi (1994), Montiel (1998)]. Like REER, all fundamentals too were constructed in effective terms using the trade weights [Nilsson, K (2004)]. Trade weights are calculated using data on Direction of Trade statistics publication of IMF. We consider the real interest rate differentials as representing the relative monetary policy stance of Pakistan with respect to its trading partners. We found that all fundamentals explain significantly the long run relationship. Magnitude of the coefficient of real effective interest rate differentials is very small compared with the other fundamentals. However, it contributes significantly in the short run adjustment mechanism. That implies that the monetary policy shocks do contribute in deviation of REER from its long run equilibrium value in short run. We calculated the misalignment of REER from its long run equilibrium by evaluating the estimated long run relationship on the sustainable values of the underlying fundamentals, derived through the use of HP filter.

The other approach to calculate misalignment is the application of Bivariate Structural Vector Auto Regressive (SVAR) approach, using data on real effective exchange rate (REER) and nominal effective exchange rate (NEER), to decompose the REER in to permanent and transitory components based on Blanchard and Quah (1989) decomposition (BQ). Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and MacDonald (2001) used the permanent component of the real exchange rate as a measure of the equilibrium real exchange rate and the gap between the actual and permanent as the extent of misalignment. This structural VAR system was identified by imposing the long run restriction that the nominal shocks can influence nominal effective exchange rate in long run but not the real rate while real shocks can influence both real and nominal effective exchange rates in the long run.

The results from both techniques were interesting. We found that for the period 2001-Q1 to 2006-Q4, both measures of misalignment move very closely with correlation coefficient 0.85. In SVAR, we imposed the restriction that nominal shocks such as monetary policy can not impact the equilibrium REER in long run. The fact that the resulting misalignments closely correlate with the misalignment from the first procedure (based on fundamentals) in which we did not force such restriction, clearly suggests towards the conclusion that monetary shocks do not impact equilibrium REER in long run. These shocks can only influence REER in short run, thereby contribute to its misalignment. The policy implication is that changes in monetary policy stance can only be used in short run to adjust REER while to improve competitiveness in long run, policy makers have to tweak with the fundamentals.

1.2: Literature Review

Despite the vast literature on the issue, the equilibrium real exchange rate and the resulting exchange rate misalignments, however, are difficult to detect as there is no consensus on the methodology to estimate the equilibrium real exchange rate [Hinkle and Montiel (1999)]. Empirical research in this area is segmented in to developed and developing countries. For industrial countries, researchers largely focused on the test of purchasing power parity (PPP) using single equation methodology. The building block of this methodology is the relative PPP. In relative form, PPP holds that nominal exchange rate is proportional to the ratio of the domestic and foreign price levels expressed by following equation.

$$s = k\left(\frac{P^d}{P^f}\right)$$

Where s is spot exchange rate and is domestic currency price of one unit of foreign currency, P^d *and* P^f are domestic and foreign price levels, and k is a constant of proportionality. Rearranging equation, we get

$$k = s * \frac{P^f}{P^d}$$

$$k = RER$$

This essentially means that real exchange rate (external) is a constant. Since it is clear that actual real exchange rate is a unique number, therefore the question is whether or not the fluctuation in actual real rate represents the transitory movements away from a well behaved long run equilibrium. This hypothesis can be expressed as an equation

$$s = \alpha + (p^d - p^f) + \varepsilon$$

In this formulation real exchange rate is given by $s + p^f - p^d$, and the long run equilibrium real exchange rate is given by α. Thus movement in actual real exchange rate is indeed viewed as transitory departure from well defined constant value of long run equilibrium exchange rate. This can only happen if the domestic and foreign prices are cointegrated.

Significant contributions following this line are by Hakkio (1984), Mark (1990) and Rogoff (1994). However, empirical literature, in general, shows that purchasing power parity (PPP) is not an appropriate model for the determination of the equilibrium real exchange rate, because of the slow mean reversion of real exchange rates to a constant level (long run equilibrium implied by the PPP assumption). Lately, considering the fact that real exchange rate deviates substantially from the value predicted by PPP; the role of non-stationary fundamentals is also considered to explain these sustained deviations. Frequently used indicators for these fundamentals include nominal and real effective exchange rates, productivity and other competitiveness measures, terms of trade, current external account and balance of payments outlook, interest rate differentials, and parallel market exchange rates [Rogoff (1996), De Gregorio and wolf (1994), McDonalds (1997)]. Another strand of research on this topic for developed countries used structural models (partial as well as general equilibrium) for estimation of equilibrium exchange rate. A useful survey on the issue is given in Hinkle and Montiel (1999).

Another string of research for developed countries is to decompose the real effective exchange rate in to permanent and transitory components using structural Vector Auto-Regressive (VAR) techniques. Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and MacDonald (2001) use the permanent component of the real exchange rate as a measure of the equilibrium real exchange rate and the gap between the actual and permanent is the extent of misalignment.

The research in developing countries had recognized the role of fundamentals in deriving the long run equilibrium real exchange rate much earlier than it was realized for developed countries. Both traditional and cointegration approaches have been used towards this goal. Edwards (1988 a, b, 1994) seminal work was the first substantial endeavor to build an equilibrium exchange rate specifically for developing countries based on reduced-form single equation approach. He found that only real (fundamental) variables influence the equilibrium real exchange rate in the long run but in the short run changes in monetary shocks can be important determinants. Edwards further investigates the impact of real exchange rate misalignment on economic performance, and concludes that countries whose real exchange rates are closer to equilibrium perform better than those with misaligned real exchange rates. Edwards's ground-breaking work inspired a number of studies on not only the determinants of the real exchange rate, but also on the effects of real exchange rate misalignment; the majority of them used cointegration tests rather than classical regressions. Elbadawi (1994), Elbadawi and Soto (1994,a,b), Montiel (1999) and Baffes et el, (1999), MacDonald and Ricci (2003), Tatsuyoshi (2003) used cointegration techniques to estimate the long run equilibrium exchange rate and the resulting misalignment. Montiel (1997) suggests that co-integration is a superior method of estimating the real exchange rate over the PPP methodology. Similar to developed countries, frequently used indicators for fundamentals include nominal and real effective exchange rates, productivity and other competitiveness measures, terms of trade, current external account and balance of payments outlook, interest rate differentials, government expenditure, investment share to GDP, commercial policy, and parallel market exchange rates.

There have been a few attempts by various economists to estimate equilibrium real exchange rate for Pakistan. However, none of the studies except Hyder and Mehboob (2006) have tried to quantify the degree of misalignment for Pakistan over the course of time [Chishiti and Hasan (1993), Afridi (1995), and Siddiqui, Afridi and Mahmood (1996)]. In addition, these studies also suffer from various weaknesses. For example, no study except Hyder and Mehboob (2006) has satisfied or checked the time series properties of data. Also these studies do not provide any evidence about exchange rate misalignment. Hyder and Mehboob (2006) tried to estimate the equilibrium real rate and subsequent misalignment using the Engle-Granger two-step co-integration approach for Pakistan using annual data from FY78 to FY05. A major shortcoming of their study was that although they used REER, calculated by IMF which is a multilateral real exchange rate, as a dependent variable; the independent variables are all bilateral with respect to USA. Also there is lot of criticism in literature on Engle-Granger two-step co-integration approach which assumes a single cointegrating vector. This procedure produces different results of cointegration relation with the different choice of variable selected for normalization. Also since it is two step procedure any error introduced by researcher in step 1 is carried to step 2.

1.3: Empirical Methodology:

The concept that real exchange rate can be explained by the economic fundaments is widely used for the literature regarding developing countries [Edwards (1988 a, b, 1994), Elbadawi (1994), Elbadawi and Soto (1994,a,b), Montiel (1998) and (1999), and Baffes et el, (1999), MacDonald and Ricci (2003), Tatsuyoshi (2003)]. We use here the methodology developed by Clark and MacDonald (1998) to assess the extent of misalignment. This approach assumes that behavior of REER depends on the underlying fundamentals. These fundamentals explain the REER in medium to long run. In addition, it is assumed that there are factors, who affect the REER in short run and their affect do not persist. These are called transitory factors. A simplified version of reduced form system is as following.

$$q_t = \alpha' F_t + \gamma' Tr_t + \varepsilon_t \qquad \text{(a)}$$

Where:

q_t = Real effective exchange rate(REER)

F_t = Vector of fundamentals that are expected to have long run relation with REER.

Tr_t = Vector of transitory factors affecting REER in short run.

α', γ'= Reduced form coefficients.

ε_t = Random error term

In equation (a) REER is explained by the set of fundamentals that explain the long run relation and the short run transitory factors. Given the current values of these fundamentals, equilibrium real exchange rate is given by

$$q_t' = \alpha' F_t \qquad \text{(b)}$$

So current misalignment is given by

$$m_t^c = q_t - q_t' = q_t - \alpha' F_t$$

$$m_t^c = q_t - q_t' = \gamma' Tr_t + \varepsilon_t \qquad \text{(c)}$$

However, the current value of fundamentals may also be away from their equilibrium value thereby magnifying the misalignment. To factor in this departure of fundamentals from their long run sustainable value, we may define total misalignment as

$$m_t^T = q_t - \alpha' \overline{F_t} \qquad \text{(d)}$$

By adding and subtracting q_t' from right hand side of (d), we get

$$m_t^T = (q_t - q_t') - \alpha' \overline{F_t} - \alpha' F_t$$

$$m_t^T = (q_t - q_t') + \alpha' (F_t - \overline{F_t}) \qquad \text{(e)}$$

From (e), it is clear that first component is current misalignment while second component explains the departure of fundamentals from their sustainable values.

To do the empirical estimation of the misalignment, first we would identify the long run relation between REER and its underlying fundamentals using Johanson cointegration technique. After identifying this relationship, we would be able to get the current equilibrium real exchange rate, i.e., equation (b). This would give us the current misalignment. However, to factor in the departure of fundamentals from their long run sustainable values, we would use HP filter to decompose their values in to permanent and transitory values. Total misalignment would be calculated by assessing long run equilibrium relationship at permanent components of fundamentals.

Second method to measure misalignment is the application of Bivariate Structural VAR approach using only data on real effective exchange rate and nominal effective exchange rate; to decompose the real exchange rate in to permanent/long run and transitory components. More specifically, it is assumed that nominal shocks can influence nominal effective exchange rate in long run but not the real rate. On the other hand, real shocks can influence both real and nominal effective exchange rates in long run [Blanchard and Quah (1989)]. Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and MacDonald (2001) use the permanent component of the real exchange rate as a measure of the equilibrium real exchange rate and the gap between the actual and permanent is the extent of misalignment. For empirical details of Johanson cointigration and the Bivariate structural VAR using Blanchard and Quah decomposition is discussed in ***appendix***.

1.4: Data and Definitions

In order to use Johansen multivariate cointegration procedure, the fundamentals must be identified. The fundamental variables that affect the real exchange rate may include the terms of trade, changes in fiscal policy, workers' remittances, changes in international financial conditions, the Balassa-Samuelson effect (differential productivity growth in the tradable goods sector), and changes in commercial policy. However, in final estimation we kept only those variables which remained significant. The definition and the theoretical impact of these variables on the real exchange rate are briefly discussed in next section.

Quarterly data from 1980Q1 to 2006Q4 is used. Where ever possible, variables are constructed in effective terms (multilateral terms). In order to calculate real effective exchange rate (REER), nominal effective exchange rate (NEER) and other variables, we used the data of 15 trading partner countries of Pakistan (Australia, Belgium, Canada, France, Germany, Italy, Japan, Korea, Netherlands, Singapore, Spain, Switzerland, Thailand, United Kingdom, and United States).[1]

REER is calculated as $q = \sum_{i=1}^{15} w_i \,.\ln\,(e_i.\,cpi_i/cpi_{dom})$ while

NEER is calculated as $nq = \sum_{i=1}^{15} w_i \,.\ln\; e_i$

where w_i is weight attached to country, e_i is bilateral nominal exchange rate vis-à-vis country i , cpi_i is consumer price index of country i, cpi_{dom} is consumer price index of Pakistan. Data is taken from IMF's International Financial Statistics Database. All variables are taken in natural log form.

Several weighing schemes are employed in literature. We, however, preferred to use the most simplest and the transparent way of using the share of total trade as country weights. Therefore weights are constructed using trade data from IMF's Direction of Trade Statistics database.

[1] Choice of countries is largely determined by the size of trade relations and the availability of data.

Pakistan's share of trade with these countries is taken as the weight. All weights are normalized so that there sum equals one.

In addition to above variables, following additional variables are used as fundamentals in the Johansen cointegration method. These are;

Effective terms of trade (tot) is computed as the ratio of Pakistan's term of trade to the effective foreign terms of trade, where later is obtained by weighing 15 countries terms of trade. The terms of trade is defined as the ratio of the price of a country's exports to the world price of imports. In other words, they are defined as the price of exportable in terms of importable. Data is taken from IMF's International Financial Statistics CD-ROM Database.The effective tot is constructed as

$$tot = \ln\left[\frac{tot_{Pak}}{\sum_{i=1}^{15} w_i tot_i}\right]$$

The effect of the terms of trade on the real exchange rate operates through import and export price variations. The impact of a change in the terms of trade on the real exchange rate is theoretically ambiguous. It depends on the relative strength of the income and substitution effects, which emerge from changes in the prices of both imports and exports. If the direct income effect dominates the indirect substitution effect following an increase in the price of exports relative to imports (an improvement in the terms of trade), the real exchange rate will appreciate. On the other hand, the indirect substitution effect may dominate the direct income effect leading to opposite terms of trade effect; an improvement in the terms of trade may lead to depreciation in the real exchange rate (Montiel, 1999: 286-7). Thus, a fall or rise in the terms of trade tends to stimulate a depreciation/appreciation of the real exchange rate when the income effect is stronger than the substitution effect. The opposite is true when the substitution effect dominates the income effect.

Tradable to non-tradable is defined as the ratio of wholesale price index (wpi) to consumer price index (cpi). An effective relative index (tnt) is measured as a ratio of Pakistan's relative price of tradable to non-tradable to the foreign relative price of tradable to non-tradable where later is weighted by trade weights calculated using trade data. Data on price indices is taken from IMF-IFS CD-rom.

$$tnt = ln\left[\frac{\left({}^{wpi}/_{cpi}\right)Pak}{\sum_{1=1}^{15} w_i \left({}^{wpi}/_{cpi}\right)i}\right]$$

It is used as a proxy for *Balassa-Samuelson* effect. Another proxy to represent this effect is to use differential in per capita income. However, quarterly data on national accounts are not available in Pakistan so we were unable to use per capita income differentials as proxy for *Balassa-Samuelson* effect. Therefore we used prices ratios as a proxy. This method is also used widely in the literature. This effect presupposes that productivity differences in the production of tradable goods across countries can introduce a bias into the overall real exchange rate. It is because productivity advances tend to be concentrated in the tradable goods sector; the possibility of such advances in the non-tradable goods sector is limited. If a country experiences an increase in the productivity of the tradable goods sector, relative to its trading partners and non-tradable goods sector, demand for labor in the tradable goods sector increases causing the non-tradable goods sector to release labor to the tradable goods sector. Higher wages in the tradable goods sector pull labor out of the non-tradable goods sector. At a given real exchange rate, the tradable goods sector, expands while the non-tradable goods sector contracts. The supply of non-tradable goods accordingly contracts creating excess demand in the sector and ultimately higher prices of non-tradable goods.

At the same time, the increase in the production of tradable goods and a decline in their relative price creates an incipient trade surplus, as more of the country's tradable goods output is demanded in the world markets. As in the previous case, a real appreciation of the exchange rate is also required for the restoration of external balance. Thus, an increase in differential productivity growth in the tradable goods sector creates an appreciation of the real exchange rate (Montiel, 1999: 284-5)

The log of the ratio of government consumption to GDP (g), used as a proxy for fiscal position. Historically, Pakistan has been enduring large fiscal deficits. It can also be considered as structural issue with the economy and represents a real factor. It can also proxy the risk premium as higher the government expenditure with respect to GDP, higher is the macroeconomic vulnerability. Data on government expenditure is taken from IMF's International Financial Statistics CD-ROM Database, while data on GDP is taken from State Bank of Pakistan's publications. Since the quarterly data on real GDP is not available, we transform the annual real GDP in to quarterly by using a procedure in RATS.

Real interest rate differentials is defined as the annualized interest rate in percent on long term bonds minus the percentage change in consumer price index over four quarters. So effective $rdiff$ is defined as Pakistan's real interest rate minus foreign effective real interest rates, where foreign real rates are weighted using the trade weights. This variable is assumed to represents the monetary conditions with respect to the trading partners. All data is taken from IMF-International Financial Statistics.

1.5: Empirical Estimation

1.5.1: Measure of Long run Equilibrium Real Effective Exchange Rate and Misalignment using Johansen Cointegration technique

Johanson cointegration technique used in this section presupposes that at least some variables entering in the relationship are non-stationary [Clark and MacDonald (1998)]. Cointegration has practical economic implications. Many time series are non-stationary individually, but move together over time, that is, there are some influences in the series which imply that the two series are bound by some relationship in the long-run [Asteriou (2006)]. A cointegrating relationship may also be seen as a long term or equilibrium phenomenon, since it is possible that cointegrating variables may deviate from the relationship in the short run, but their association would return in the long-run. This concept is particularly important in this study where we seek to identify and distinguish those variables that have a long term relationship with the real exchange rate.

The first step is to examine visual (**Figure 1.1**) and time series properties of the data. To do so, test for the presence of unit root is conducted. Test of unit root are shown in **Table 1.1**. All variables except $rdiff$ are $I(1)$. [2]

[2] All variables in Table 1 are $I(0)$ when first differenced.

Figure 1.1: Plot of Data

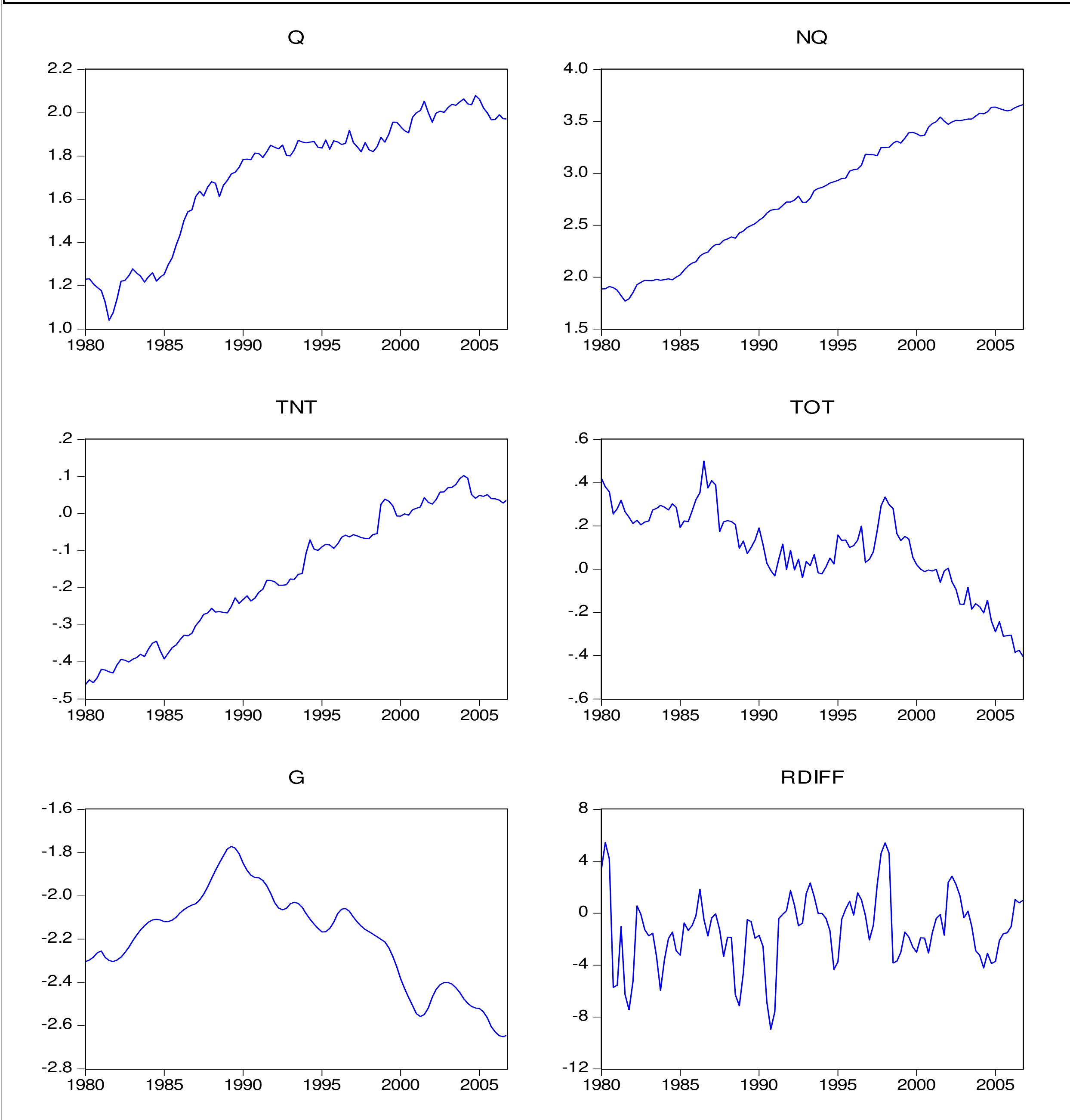


Table 1.1: Unit Root Test Results

	ADF(p)	[k]	DF(GLS)	[k]	Result
q	-0.8386	[0]	-1.0305	[0]	non-stationary
nq	-1.6742	[0]	-1.4320	[0]	non-stationary
tnt	-2.6164	[1]	-2.6164	[1]	non-stationary
tot	-2.4999	[0]	-2.5659	[0]	non-stationary
g	-1.9268	[6]	-0.8937	[6]	non-stationary
$rdiff$	-6.2776	[1]	-4.6117	[1]	stationary

Asymptotic critical values

1% level	-4.04693	-3.5728
5% level	-3.45276	-3.024
10% level	-3.15191	-2.734

Johansen (1991) test of cointegration is based on maximum likelihood estimation on a VAR system. However, before one proceeds to test, there are two issues that have to be attended to. The first is determining the appropriate lag order (k) of the VAR. Enders (2004: 363) argues that the Johansen test results can be quite sensitive to the lag length employed, thus it is crucial to attempt to select the lag length optimally. We used of multivariate versions of the information criteria, which includes the sequential modified likelihood ratio (LR), Akaike information criterion (AIC), Final prediction error (FPE) Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ) to determine the appropriate lag length. In our case, we found the different criterion do not emerge to a consensus. Therefore, we carried out the VAR on various lag lengths and found that lag length 5 is the appropriate one on the basis of diagnostics.[3]

The second issue is related to the choice of deterministic assumptions that the Johansen test require in testing for cointegration. Following Johansen (1995), we rely on the 'Pantula Principle' to find the most appropriate deterministic factors for each model. The Pantula principle can be summarized as follows. Starting from the most restrictive model, i.e. no deterministic components, the rank statistic is compared with the chosen quantile of the corresponding table. If the model is rejected, one continues to the model with a restricted constant in the cointegration space. If this model is rejected, one continues to the model with an unrestricted constant and trend. If this model is also rejected, the procedure is repeated for the

[3] Autocorrelation LM test, normality test and test for the homoscedasticity of error term was carried out. All test except normality test points to lag of 5 to be appropriate.

next rank. This is continued until the null hypothesis is accepted for the first time. The results of Pantula principle in our case suggest the selection of model 4 (**Table 1.2**).

Table 1.2: The Pantula Principle Test Result

	Model 2		Model 3		Model 4	
r	Trace Statistics	5 % critical value	Trace Statistics	5 % critical value	Trace Statistics	5 % critical value
0	120.667	76.973	101.255	69.819	110.650	88.804
1	67.652	54.079	51.392	47.856	59.043*	63.876
2	36.965	35.193	22.913	29.797	29.307	42.915
3	16.168	20.262	10.153	15.495	16.135	25.872
4	3.599	9.165	3.513	3.841	3.579	12.518

Note: * indicates the first time the null cannot be rejected.

Once the appropriate VAR order (k) and the deterministic trend assumption have been identified, the rank of the Π matrix can then be tested. We conduct the Johansen cointegration test using lag length 5 and using model 4 for deterministic assumption. Results in **Table 1.3** show that both the trace and max-eigenvalue test imply the presence of at most one cointegrating vector.

Table 1.3: Johansen Cointegration Test Results

Trend assumption: Linear deterministic trend (restricted)
Series: Q TOT TNT G RDIFF
Lags interval (in first differences): 1 to 5
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.397065	110.6497	88.8038	0.0006
At most 1	0.25288	59.04327	63.8761	0.1193
At most 2	0.121146	29.30729	42.91525	0.5435
At most 3	0.115827	16.13536	25.87211	0.4817
At most 4	0.034479	3.578956	12.51798	0.8018

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**

None *	0.397065	51.60641	38.33101	0.0009
At most 1	0.25288	29.73598	32.11832	0.095
At most 2	0.121146	13.17193	25.82321	0.7903
At most 3	0.115827	12.55641	19.38704	0.3651
At most 4	0.034479	3.578956	12.51798	0.8018

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The cointegrating equation is normalized on REER (q) and parameters estimates have plausible magnitude and signs as explained in next paragraph. **Table 1.4** reports the estimated parameters of resulting cointegration equation and the adjustment coefficients using Vector Error Correction Model (VECM).

Table 1.4: Estimated Coefficient in the Cointegration Vector and Adjustment Coefficients

Variable/Equation	$q/\Delta q$	$tot/\Delta tot$	$tnt/\Delta tnt$	$g/\Delta g$	$rdiff/\Delta rdiff$	$Intercept$	$trend$
Parameters of cointegrating vector	1.0000	0.2895	-1.3835	-0.6866	0.0222	-3.1901	-0.0044
		[2.356]	[-2.6274]	[-12.066]	[2.868]		
Adjustment coefficient	-0.0569	-0.1025	0.03602	0.0681	-7.9425		
	[-1.0237]	[-1.056]	[1.5545]	[5.5858]	[-2.7383]		

t-statistics in [ ]

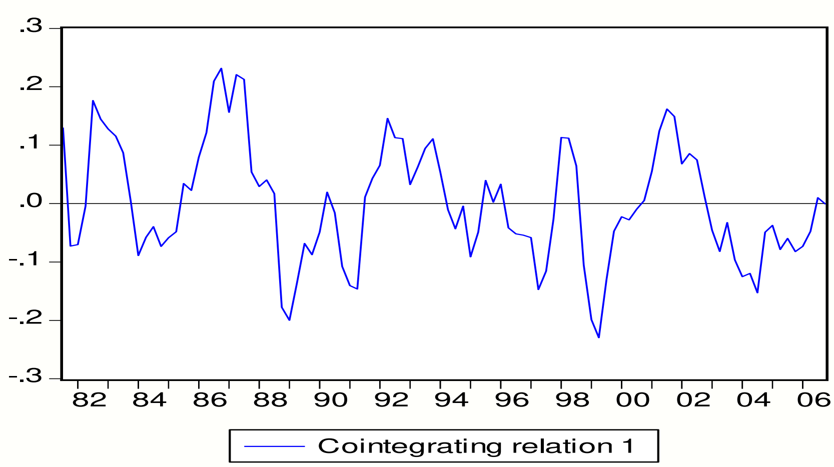
As mentioned above cointegrating vector is normalized on REER (q) so this parameter is unity. All parameters estimates of cointegrating equation carry expected sign and are highly significant. Considering steady state, a 1 percent improvement in relative terms of trade (tot) require a 0.29 percent decrease (appreciation) in REER (q) to restore equilibrium. As described in [Montiel (1999)], the impact of a change in the terms of trade on the real exchange rate is theoretically ambiguous. It depends on the relative strength of the income and substitution effects, which emerge from changes in the prices of both imports and exports. If the direct income effect dominates the indirect substitution effect following an increase in the price of exports relative to imports (an improvement in the terms of trade), the real exchange rate will appreciate.

Regarding the parameter of relative price of tradable to non-tradable (tnt), a 1 percent increase in productivity differential between Pakistan and its trading partners will require 1.38 percent increase (depreciation) in REER to restore equilibrium. In terms of Balassa-Samuelson effect, this reflects a relatively smaller productivity growth differential between tradable and nontradable sectors in Pakistan relative to its trading partners.

As regard to government expenditures to GDP ratio (g); an increase of 1 percent will require the REER to depreciate by 0.69 percent to restore equilibrium. This is because higher spending in economy jack up the prices thereby requiring exchange rate to depreciate to restore equilibrium in long run. The estimated parameter of relative real interest rate differential ($rdiff$) have the correct sign and statistically significant, albeit with a very small magnitude (0.02). Hence an increase in the $rdiff$ by 1 percent requires a 0.02 percent appreciation of REER (q). Therefore, we may assert that monetary policy shocks have little role in explaining the equilibrium real effective exchange rate in long run.

Figure 1.2 plot the cointegration relationship which looks stable.

Figure 1.2: Cointegrating Relationship



The adjustment coefficient shed light on dynamics of the adjustment process towards the equilibrium in the short run. It should be noted that the adjustment process is affected by both the adjustment coefficients and the short run dynamics of the factors in VECM. Consider a situation where error correction term is positive representing an undervalued exchange rate. With the statistically insignificant adjustment coefficient of -0.057 in real exchange rate equation, the error correction term in this equation contributes minimally in case of divergence of system from steady state. The real exchange rate thus has statistically little tendency to stabilize itself. In addition, the adjustment coefficient in relative terms of trade (tot) equation also turns out to be insignificant. In other words, short term focus on this factor is futile. The adjustment coefficients of tnt and g are statistically significant. That means that in case of any deviation of the system from steady state, both variables adjust to restore equilibrium. The adjustment coefficient in real relative interest rate differential ($rdiff$), is also negative and significant thus contributing to stabilizing the system in the short run. It also shows that monetary policy can play a role in restoring the competitiveness of the country in short run more effectively than it can do in long run.

Misalignment:

Because one of the focuses of this paper is to find out the extent of misalignment, we turn our focus on this issue in the following. To do so first step is to calculate the long run equilibrium exchange rate using the above estimated long run relation between actual REER and its fundamental determinants. As pointed out in Edwards (1988), equilibrium real exchange rate is not an absolute number. When there are changes in any of the variables that affect the real exchange rate, there will also be changes in the equilibrium exchange rate. Also there is not a single equilibrium exchange rate. Rather it is a path of equilibrium real exchange rates through time.

The above long-term relationships can be used to compute the equilibrium REERs by evaluating these coefficients at sustainable values of its fundamental determinants over the time. This is also pointed out in equation (e). The rationale of using sustainable economic fundamentals is to eliminate short run fluctuations in explanatory variables and only use long-term equilibrium values of the variables. Hodrick-Prescott (1979) filter is used to remove the short-term variations from the explanatory variables. This filter is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series.[4] The method was first used by Hodrick and Prescott to analyze postwar U.S. business cycles. Technically, the Hodrick-Prescott (HP) filter is a two-sided linear filter that computes the smoothed series (say s) of y by minimizing the variance of y around s, subject to a penalty that constrains the second difference of s. That is, the HP filter chooses to minimize:

$$Min\{s\}_{t=1}^{T}\{\sum_{t=1}^{T}(y_t - s_t)^2 + \lambda \sum_{t=2}^{T}((s_{t+1} - s_t) - (s_t - s_{t-1})^2\}$$

The penalty parameter λ controls the smoothness of the series variance. The larger the λ, the smoother the series. Usually λ is taken to be 1600 for quarterly data. We also followed this convention.

[4] We use the RATS procedure to apply HP filter. Since we are using quarterly data, we set the λ=1600.

Figure 1.3: Actual (q) vs Long Run Equilibrium (q^) Real Effective Exchange Rate

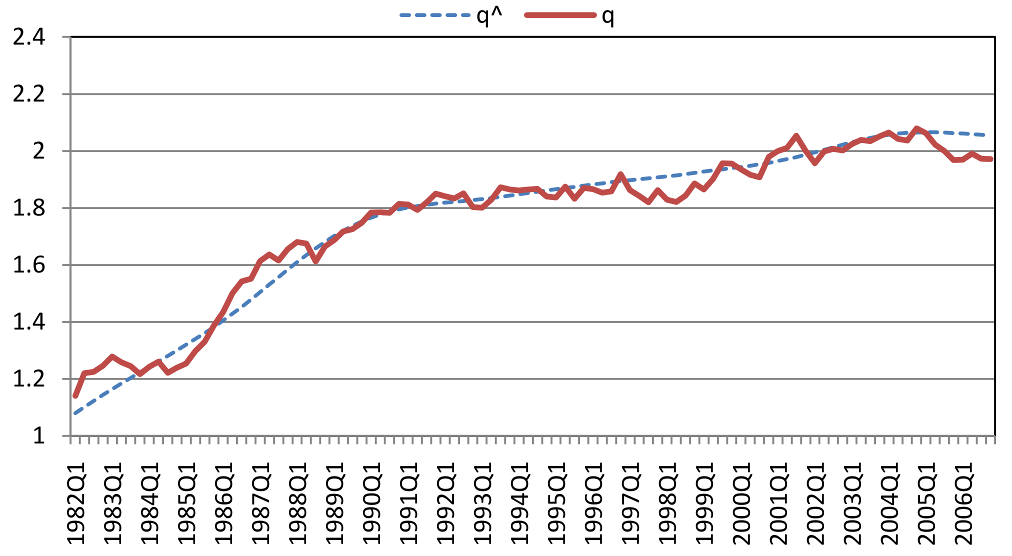
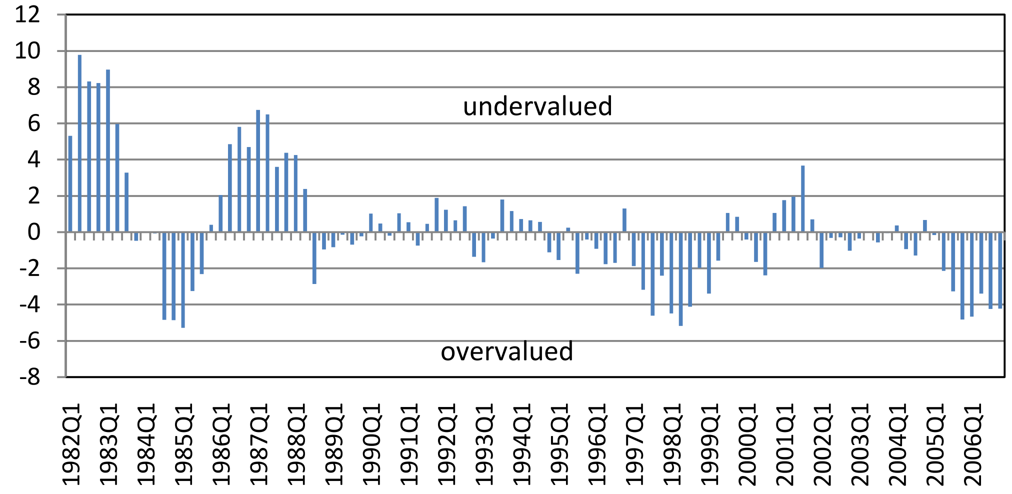


Figure 1.3 thus plots the equilibrium and actual real effective exchange rates. The Equilibrium REER $(\widehat{q})$ is calculated by evaluating the long run relation between REER and its determinants using *sustainable values* of the determinants. Although the actual real effective exchange rate tracks the equilibrium quite fairly well in the long run there are deviations in the short run which describes the misalignment of actual real exchange rates from the equilibrium real exchange rates.

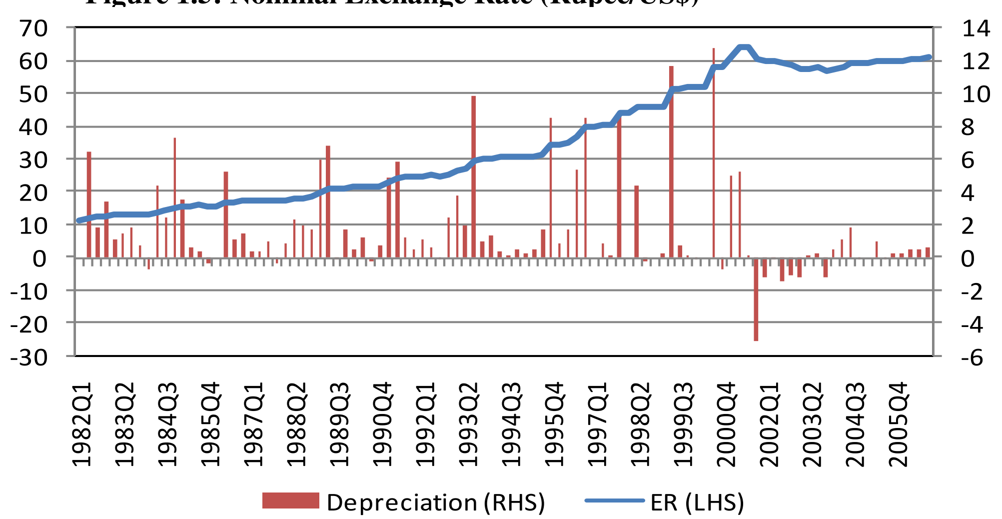
Figure 1.4 gives us a good visual of the extent of misalignment. It is evident that apart from a small period of 1984-85, the real effective exchange rate remained undervalued during 1980's. This was possibly the result of the managed float of Rupee against Dollar that was adopted in 1982 by the State Bank of Pakistan (SBP). Under this regime SBP carried out periodic adjustment of the nominal exchange rate to keep the REER undervalued. Also in this period Dollar appreciated against the other major currencies.

Figure 1.4: Misallignment (in percent)



This perhaps caused the undervaluation of real exchange rate during 1980's. Afterwards since 1989 to 1999, real exchange rate largely remained overvalued. This caused the loss in competitiveness and as a result exports stagnate. After the adoption of free floating exchange rate regime in 2001, Rupee depreciated sharply against the major currencies initially and this resulted in an undervalued real exchange rate for a brief period of a year. Since September 11, 2001, rupee started to gain against US $ due to increased foreign exchange inflows.

Figure 1.5: Nominal Exchange Rate (Rupee/US$)



Since late 2005 to end 2006, real exchange rate remained overvalued. There are possibly three major factors. First is the State Bank of Pakistan's policy of keeping the exchange rate stable by not allowing it to depreciate too much. Second is the resurgence of price pressures in the domestic economy. And third is the very expansionary monetary policy adopted in the time period. In this period although GDP grew, Pakistan's trade gap widened.

1.5.2: Measure of Long run Equilibrium Real Effective Exchange Rate and Misalignment using Structural VAR Technique

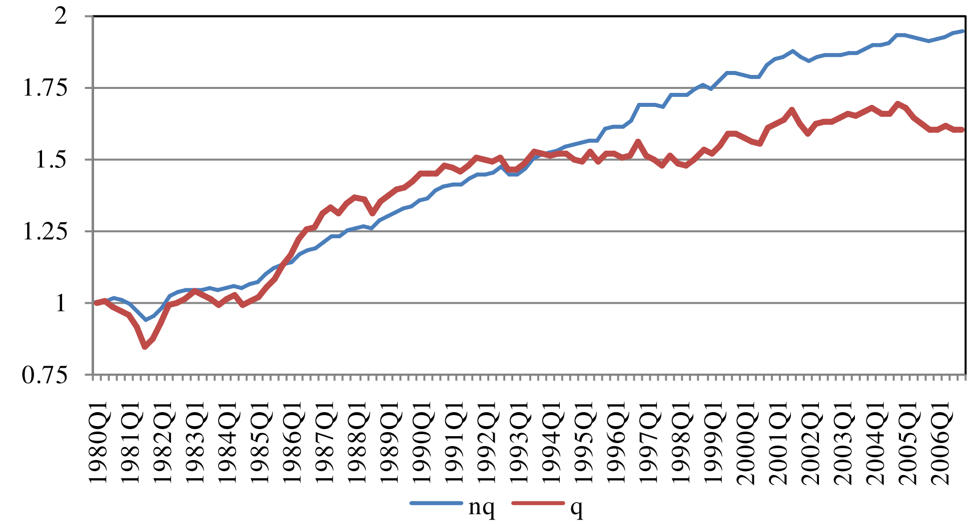
As seen in section 3.4, data is one issue which influenced the choice of proxies. These choices could have compromised the results derived through the particular estimation. To check the robustness of our results in section 1.5, we decided to estimate long run real effective exchange rate using structural VAR technique. Two factors were instrumental in this choice. First, in the structural vector autoregressive (SVAR) methodology, time series analysis is combined with the economic theory. The necessary restrictions on the estimated reduced form model, required for identification of the underlying structural model, can be provided by economic theory. These restrictions can be either contemporaneous or long-run in nature depending on whether the underlying disturbances are considered to be temporary or permanent in nature. Second, this technique is parsimonious in terms of data requirement. We would only be requiring data on REER and NEER.

In this paper, the SVAR methodology with long-run restrictions in line with Blanchard and Quah (1989) is used to obtain an estimate of equilibrium real effective exchange rate and its misalignment. Huizinga (1987), Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and MacDonalds (2001) use the permanent component of the real exchange rate as a measure of the equilibrium real exchange rate and the gap between the actual and permanent is the extent of misalignment. It is because of the fact that long run equilibrium is underlined by the sustainable values of the fundamentals, which can be identified by their permanent components. Therefore, rather than regressing real effective exchange rate on various other variables, this technique allows us to decompose historical real rate movements in to changes induced by real and nominal factors such as monetary policy changes. So by decomposing REER into permanent and transitory components we can have the extent of misalignment.

Stylized facts:

The construction of Real effective exchange rate (q) and the nominal Effective exchange rate (nq) is discussed in data section of previous section. Time series properties were also checked (**Table 1.1**). Both series turned out to be $I(1)$, i.e., non-stationary at level. **Figure 1.6** depicts the quarterly data on REER (q) and NEER (nq) from 1980:1 to 2006:4. Interestingly, both series move together with their turning points coincide closely. However, over time both series diverge from each other. As in Enders and Lee (1997), we assume that there are two type of shock present in the system. Among the two, one is real shock which affect both real and nominal rate effective exchange rate. This perhaps accounts for the similar turning points of the both series. A second type of shock which is called nominal shock, affects the two series differently; it impacts NEER in long run but has no influence on REER. This accounts for the divergence between the two series over the extended time period.

Figure 1.6: Real (q) and Nominal (nq) Effective Exchange Rate



It is therefore assumed that in long run only real shocks impact the real exchange rate. It is also assumed that nominal shock only temporarily impacts the real exchange rate. This assumption is used as identifying restriction in the Structural VAR analysis developed by Blanchard and Quah (1989); for the decomposition of real effective exchange rate. More specifically, it is asserted that nominal shocks can influence nominal effective exchange rate, but not the real rate. While real shocks can influence both real and nominal effective exchange rates. In the next section, we briefly discuss the Blanchard and Quah (1989) methodology in the context of our case in Annexure at end of this chapter.

Empirical Estimations:

An important issue relating to the estimation strategy consists of selecting the appropriate specification of the VAR. Specification entails deciding on whether the VAR should be estimated in pure differences or in levels. Statistically, the decision hinges crucially on the data temporal properties; that is, their unit root and cointegration properties. In particular, if the variables in a VAR are non-stationary and are not cointegrated then the VAR should be specified in pure differences. Sims (1980), and Sims, Stock and Watson (1990), however, recommend against differencing even if the variables contain a unit root. They argue that by way of differencing we trade loss of information for (statistical) efficiency. But since the goal of VAR analysis is to determine the interrelationships among the variables and not the parameters estimates, this trade is obviously unwarranted. We therefore, decide to use both variations i.e., VAR at levels and at first differenced form. The first step in estimation of VAR is to determine the appropriate lag length. We estimated two VAR systems. First is between $[q, nq]$, while the second is between$[\Delta q, \Delta nq]$. We used of multivariate versions of the information criteria, which includes the sequential modified likelihood ratio (LR), Akaike information criterion (AIC), Final prediction error (FPE) Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ) to determine the appropriate lag length. In our case, we found the different criterion do not emerge to a consensus (**Table 1.5**).

Table 1.5: VAR Lag Order Selection Criteria $[q, nq]$

Lag	LogL	LR	FPE	AIC	SC	HQ
0	14.76326	NA	0.002628	-0.265901	-0.212477	-0.244306
1	471.8995	885.7014	0.0000	-9.7062	-9.545967*	-9.6415
2	476.5564	8.8287	0.0000	-9.7199	-9.4528	-9.6120
3	483.5713	13.0069	0.0000	-9.7827	-9.4088	-9.6316
4	490.6663	12.8597	0.0000	-9.8472	-9.3664	-9.652862*
5	493.2138	4.5112	0.0000	-9.8170	-9.2293	-9.5794
6	499.1768	10.31106*	0.0000	-9.8579	-9.1633	-9.5771
7	504.4159	8.8410	1.76e-07*	-9.883665*	-9.0823	-9.5597
8	505.4334	1.6746	0.0000	-9.8215	-8.9133	-9.4544
9	507.6931	3.6248	0.0000	-9.7853	-8.7702	-9.3750
10	508.2860	0.9264	0.0000	-9.7143	-8.5924	-9.2608

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level) ,FPE: Final prediction error, AIC: Akaike information criterion
SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

However, after estimating the VAR $[q, nq]$ at various indicative criterions, we end up choosing the lag length 7, on the basis of various diagnostics tests.[5] Similarly, for the VAR $[\Delta q, \Delta nq]$ appropriate lag length turned out to be 6.

The forecast variance decomposition under the identifying restriction tha $B_{12} = 1$, and t $B_{22} = 0$ in the structural VAR allow us to gauge the relative contributions of the real and nominal shocks to real and nominal effective exchange rate series. **Table 1.6** presents the forecast variance decomposition accounted for by the real shocks.

Table 1.6 : Variance Decomposition(Percentage of forecast error variance accounted for by real shocks)

Model	**$[\Delta q, \Delta nq]$**		**$[q, nq]$**	
Variable	Δq	Δnq	q	nq
Horizon				
1	77.242	26.349	86.296	33.888
2	75.696	23.852	84.662	26.787
3	70.639	23.099	88.895	30.854
4	69.455	22.944	91.154	33.516
5	70.019	22.797	92.966	33.155
6	65.426	23.056	92.925	32.668
7	65.371	23.205	92.859	32.625
8	64.703	23.076	93.404	32.338

As can be seen in the **Table 1.6**, real shocks explain a very substantial portion of the forecast error variance of the real exchange rate (column 2 and 4). For example as column 4 indicate that real shock account for 93 percent forecast error variance in REER over eight quarter horizon. Similarly for the same horizon, real shock accounts for 32.4 percent forecast error variance in nominal rate. This also coincides with our stylized fact that real shocks not only impact real effective exchange rate (q) but also impact nominal effective exchange rates (nq). This fact was also evident by looking at the **Figure 1.6**, where turning points of both series coincide.

[5] [5] Autocorrelation LM test, normality test and test for the homoscedasticity of error term was carried out. All test except normality test points to lag of 7 to be appropriate.

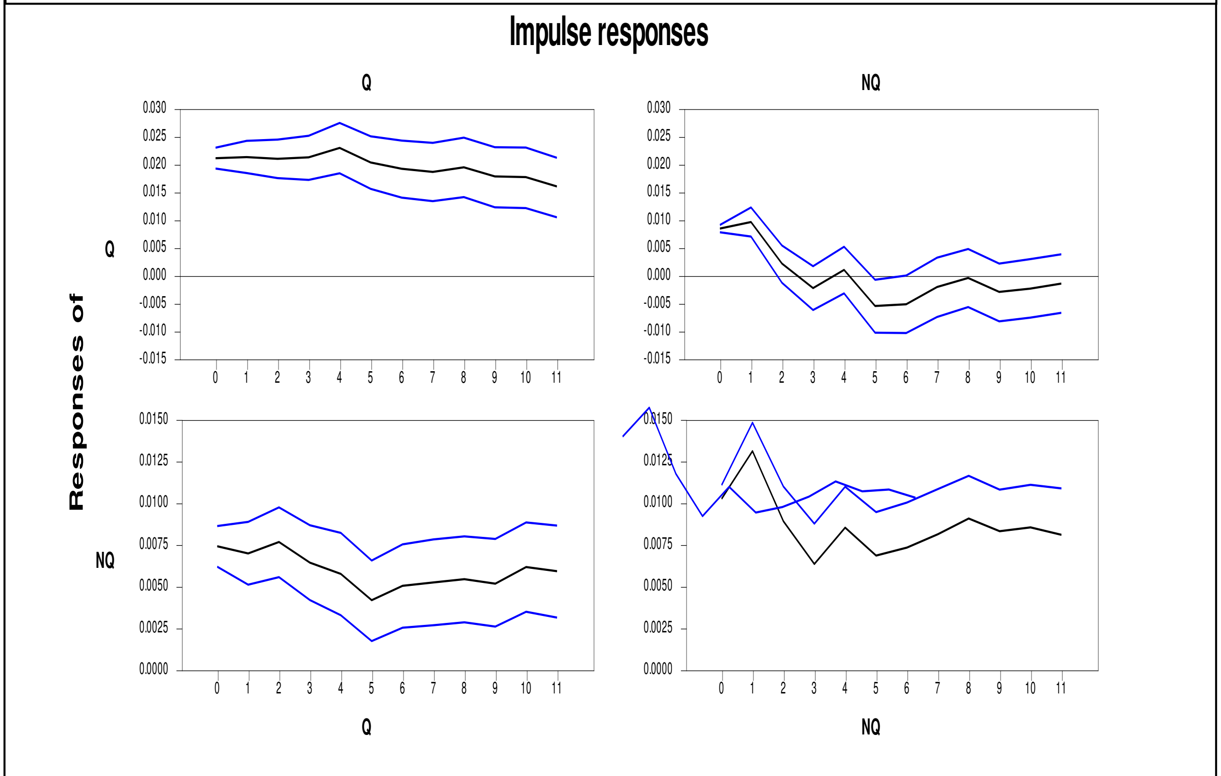
Table 1.7 represents the forecast error variance decomposition of series due to nominal shock. As can be seen in the table, nominal shocks explain a very substantial portion of the forecast error variance of the nominal effective exchange rate (column 3 and 5). This also coincides with our stylized fact that nominal shocks impact the nominal effective exchange rates (nq). This fact was also evident by looking at the **Figure 1.6**, where it can be seen that both series diverge over time.

Table 1.7: Variance Decomposition(percentage of forecast error variance accounted for by nominal shocks)

Model	$[\Delta \boldsymbol{q}, \Delta \boldsymbol{nq}]$		$[\boldsymbol{q}, \boldsymbol{n}]$	
Variable	Δq	Δnq	q	nq
Horizon				
1	22.758	73.651	13.704	66.112
2	24.304	76.148	15.338	73.213
3	29.361	76.901	11.105	69.146
4	30.545	77.056	8.846	66.484
5	29.981	77.203	7.034	66.845
6	34.574	76.944	7.075	67.332
7	34.629	76.795	7.141	67.375
8	35.297	76.924	6.596	67.662

Another way of looking at the dynamics of the model is impulse response functions. **Figure 1.7** shows the impulse response functions of REER and NEER to both types of shocks for the model $[q, nq]$. VAR with level data is used to have visual clarity of impulse response functions. Each plot shows the dynamic response of exchange rates to a standard deviation impulse in either the real shock or the nominal shock. A two standard error confidence interval indicates the precision of impulse response functions.

Figure 1.7: Response of Real and nominal effective exchange rates to real and nominal shocks



This standard error band is calculated by using the procedure in RATS based on Monte Carlo integration. The results are based on 2500 simulations and take into account the identifying restrictions.[6]

It can be seen from the **Figure 1.7**, that the real shock causes an immediate increase in both real and nominal effective exchange rates by 2.4 and 0.7 percent. This jump in real rate is greater than the jump in nominal effective exchange rate. Also these changes are of permanent nature. Both real and nominal effective exchange rates converge to their new long run levels in about 3 years time. This perhaps suggests that there are other factors in addition to nominal effective exchange rate that causes permanent changes in real effective exchange rate. In accordance with our restriction, the effect of nominal shocks on real exchange rate is temporary and dies down

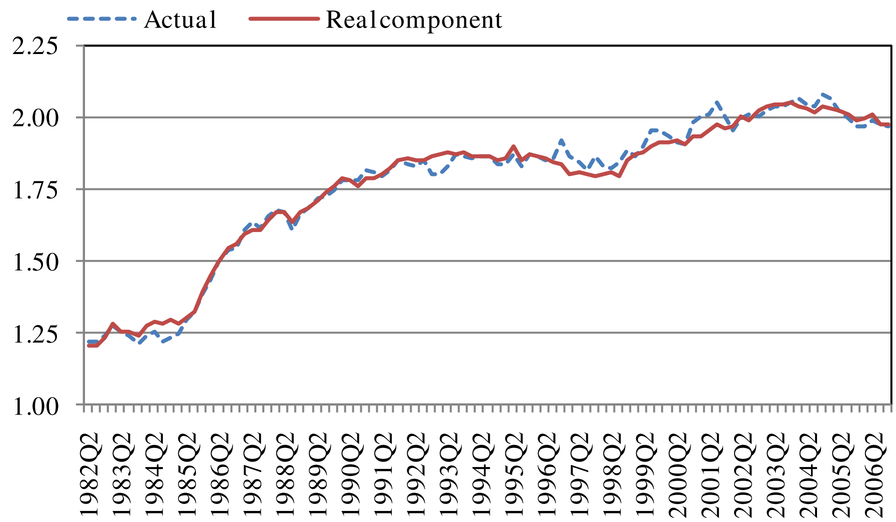
[6] We are grateful to Tom Maycock of RATS for providing the codes for estimating the standard error bands for impulse response functions using Monte Carlo Integration.

within three quarters in top right panel. The real effective exchange rate increases by 0.8 percent initially, however dies down in 3 quarters. Finally, there is a definitive overshooting response of the nominal effective exchange rate to a nominal shock. The effect of nominal shock on nominal effective exchange rate causes an immediate jump in the variable which settles within 3 quarters at 0.8 percent to its new equilibrium level. This also explains that a nominal shock can create a permanent divergence between real and nominal effective exchange rates. Looking at the impulse response functions, we can assert that our model explains the stylized facts about REER and NEER quite significantly. Therefore, we can use it to decompose REER in to its permanent and transitory components to find out the misalignment [Huizinga (1987), Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and MacDonalds (2001)].

Figure 1.8 shows the historical decomposition of REER (q). This decomposition is done using BQ factors (calculated by imposing long run restriction as discussed earlier).[7] It can be seen that real component closely follows the actual series. For visual clarity, the time path of the decomposition was presented in levels rather than in first difference. Real shocks almost fully interpret the REER (q) as both coincides very closely. In other words gap between two lines representing nominal shock is very small. This gives credence to our earlier analysis of variance decomposition of in which we saw that real shocks account for a large portion of forecast error variance decomposition. This result is in line with the studies focusing on the various determinants of real exchange rate, where there is broad consensus that in the long run only real factors determine the real exchange rate.

[7] RATS software is used to decompose REER into permanent and transitory components.

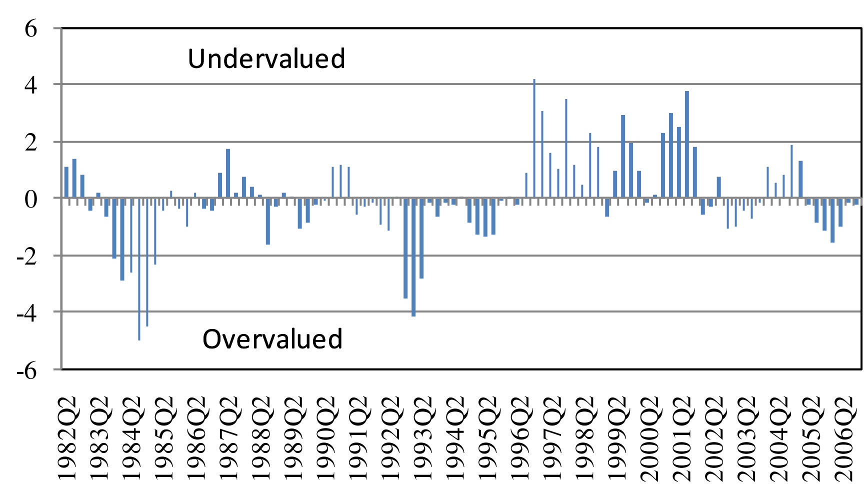
Figure 1.8: Historical decomposition of Log of REER



Misalignment:

Following Huizinga (1987), Lastrapes (1992), Clarida and Gali (1994), Enders and Lee (1997) and Hoffman and Macdonalds (2001), we consider the permanent component of the real exchange rate as a measure of the equilibrium real exchange rate and the gap between the actual and permanent is the extent of misalignment. **Figure 1.9** reveals the extent of misalignment using this technique.

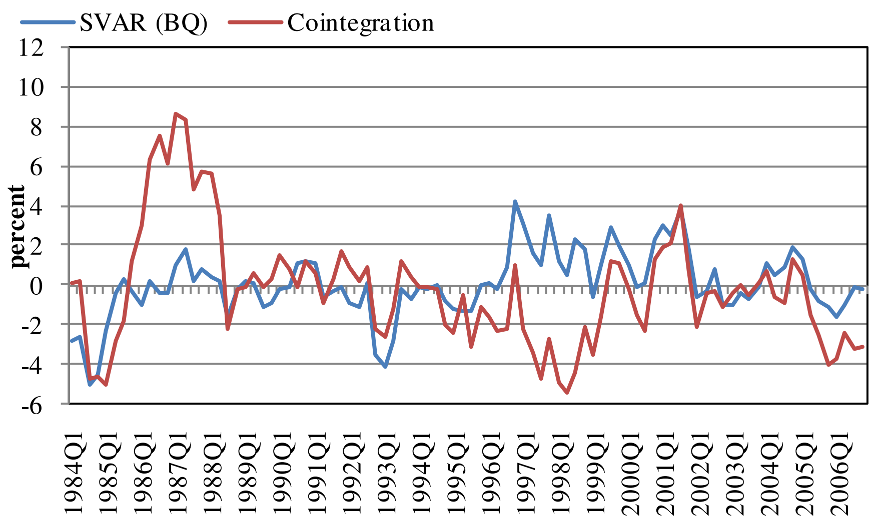
Figure 1.9: Misalignment (in percentage)



1.6: Comparison of Two Measures of Misalignment

Figure 1.10 compares the misalignment calculated from two different approaches used in this paper. Comparison reveals that the episodes of misalignment closely match, except for few periods see **Figure 1.10**.

Figure 1.10: Comparison of two measures of misalignment



Looking at **Table 3.8**, we can assert few points. First, both measures of misalignment move closely in most of the periods as depicted by the correlation coefficients. For instance, for the period 2000 to 2006, there is very high correlation between the two measures (r=0.85). This is also true for other periods yet the magnitude of correlation differs in all episodes. The high correlation between two periods during 2000-2006, when there was large foreign inflows which were only partially sterilized by the SBP, points towards the validation of the result that these deviations are the results of monetary shocks. It is because of the fact that in SVAR we decomposed REER into permanent/equilibrium and transitory/misalignment components by imposing the long run restriction in line with Blanchard and Quah (19889). These restrictions clearly entail that in long run REER can be impacted by real shock while in short run deviations from long run equilibrium are caused by nominal shocks such as monetary policy changes. Given the fact that this resulting misalignment closely correlated with the other measure of misalignment (where we did not impose such restrictions), validates such assumptions.

Another result is that although direction of movement is similar, the magnitude of misalignment is quite different. On average, SVAR approach gives lower mean than the other approach (**Table 1.8**). This differing magnitude of misalignments suggests that we can make a good judgment on the direction of misalignment, but deciding on magnitude of misalignment will be quite misleading by looking at any particular measures. On suggestion would be to use the average of both the measures of misalignment. This is because of the fact that larger magnitude of misalignment from first procedure may be the result of missing variable bias. On the other hand, in SVAR, we lumped together the real and nominal shocks together without further bifurcation, which may be useful in imposing restrictions but this could have resulted in lower magnitudes of misalignment. Future research agenda could be to improve the structural VAR estimation for allowing more than two types of shocks in the model in line with the Clarida and Gali (1994).

Table 1.8: Statistical Properties of two measures of misalignment

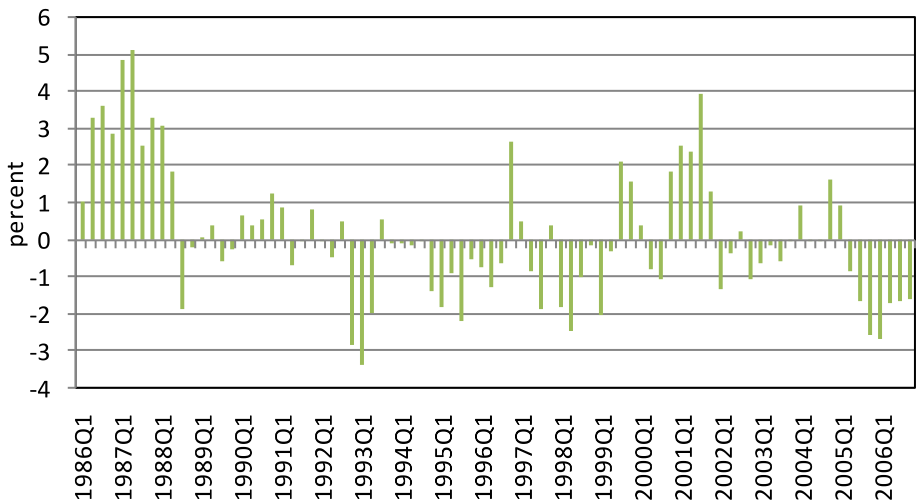
	SVAR (BQ)	Johansen cointegration	Average
Mean	0.029	0.229	0.129
Median	-0.124	-0.130	-0.127
Maximum	4.427	10.094	7.260
Minimum	-5.587	-5.464	-5.525
Std. Dev.	1.773	3.482	2.628
Skewness	-0.363	1.029	0.333
Kurtosis	4.243	3.807	4.025

Correlation between two measures of misalignment:

Period:	
1982-2006	0.27
1985-1988	0.79
1988-1996	0.45
1996-1999	0.46
2000-2006	**0.85**

In order to mitigate these issues, it may be prudent to use the average of the two measures **Figure 1.11**. However, there is a distinct advantage of using first approach that it enables us to identify the determinants of the equilibrium and therefore allows the policy makers' to adjust those variables; if possible.

Figure 1.11: Average misalignment



1.7: Conclusion

The first part of study analyzed the behavior of the real exchange rate, the relationship between the real effective exchange rate and its theoretical determinants. In order to determine the long run determinants of the real effective exchange rate, the Johansen cointegration technique was used. In the application of this methodology, we started by analyzing the time series properties of the data employing both informal and formal tests for stationarity. All variables except one $rdiff$ were first difference stationary. Johansen cointegration tests on alternative model specifications provided evidence that there is cointegration between the real exchange rate and its determinants. This finding, therefore, indicates that the real exchange rate is subject to permanent changes as a result of changes in its fundamentals. Evidence of cointegration allowed the estimation of VECMs, which simultaneously provided the parameter estimates for both the long and short run relationships. The variables that have a long run relationship with the real exchange rate include the relative effective terms of trade (tot), relative real interest rate differential ($rdiff$), government spending to GDP ratio (g), and effective relative ratio of tradable to nontradable (tnt). An improvement in the relative effective terms of trade and relative real interest differential would require an appreciation in the real exchange rate in the long run to restore equilibrium, while a effective relative ratio of tradable to nontradable (tnt) and government spending to GDP ratio are associated with a depreciation of REER. These results therefore, for the most part, support both the theoretical predictions and findings from previous research.

Taken together, the results of this part have a number of policy implications. First, the presence of long run relation (cointegration) between the REER and its determinants found in this study implies towards the effectiveness of targeting one of the determinants in influencing the long run equilibrium behavior of the REER. If this interpretation holds and given the significant long run relationship between the real exchange rate and the government spending then real exchange rate can be influenced using this variable.

Second, the real exchange rate is largely impacted by factors that are outside the direct control of monetary policy, such as relative effective terms of trade (tot), government spending to GDP ratio (g) which explain the significant component of the variation in the real exchange rate in this study. Given the very small coefficient of relative real interest rate differential ($rdiff$) in long run relation, which proxies the relative monetary policy stance, the policy implication is that the monetary authorities' ability to influence the movements in the real exchange rate in long run is quite limited. That mean, in the long run, relevant authorities should be utilizing policies to promote the diversification of traded goods and acting on other fundamentals to impact (tot) and (tnt) to achieve trade competitiveness. Looking at short run dynamics of the system, we found that REER has little tendency to stabilize itself. The adjustment coefficient in real relative interest rate differential ($rdiff$), was turned out to be significant and large thus contributing to stabilizing the system in the short run. It also showed that monetary policy could play a role in restoring the competitiveness of the country in short run more effectively than it can do in long run.

There are shortcomings as well to this methodology of finding cointegration between real rate and its determinants. Most important is the chances of missing variable bias. Second issue relates to the fact that these results actually are dependent on the specific data set we constructed and choice of proxies. There is a need for more research on the construction of proxies and the availability of real sector data.

In second part, we assessed the misalignment through evaluation of equilibrium rate based on Structural VAR. The main advantage with SVAR analysis is that the necessary restrictions on the estimated reduced form model, required for identification of the underlying structural model, was provided by economic theory. In this paper, the SVAR methodology with long-run restrictions on the lines of Blanchard and Quah (1989) was used to obtain an estimate of equilibrium real effective exchange rate and its misalignment. More specifically, it was assumed that nominal shocks can only influence nominal effective exchange rate but not the real rate in the long run. On the other hand, real shocks can influence both real and nominal effective exchange rates. However, this representation makes it impossible to differentiate between various types of real or nominal shocks. However, it was not too limiting shortcoming in our study, as we only focused on the equilibrium real effective exchange rate and the misalignment and assumed that nominal shocks largely are monetary policy shocks.

Historical decomposition of real effective exchange rate (q) series was done utilizing the above mentioned restrictions in line with the Blanchard and Quah (1989). The REER (q) is decomposed into permanent and transitory components. Following many studies, permanent component is perceived as the long run equilibrium real effective exchange rate while transitory component is considered as the short run deviation from the equilibrium. Results shows that real shock determine real exchange rate in long run. Nominal shocks have no lasting influence on real exchange rate. Using this we calculated the measure of misalignment in real effective exchange rate depicted in **Figure 1.9**.

Finally we compare the two measures of misalignments. The results from both techniques were interesting. We found that for the period 2001 to 2006—the period of large inflows with relatively loose monetary policy, both measures move very closely with correlation coefficient 0.85. It is important to note that in SVAR, we imposed the restriction that nominal shocks such as monetary policy can not impact the equilibrium REER in long run. The fact that the resulting misalignments closely correlate with the misalignment from the first procedure (based on long run relation between REER and its fundamentals) in which we did not force such restriction, clearly suggests towards the conclusion that monetary shocks do not impact equilibrium REER in long run. These shocks can only impact REER in short run, thereby contribute to the misalignment. The policy implication is that changes in monetary policy have affected the equilibrium REER in short run. However, to improve competitiveness in long run, policy makers have to tweak with the fundamentals.

Although moving in the similar direction, there magnitudes are different. The most important implication for this result is that for policy makers' reliance on one measure of misalignment would be a mistake. Looking at the statistical properties of the two measures it is evident that mean and variance of the first measure—calculated through estimating long run equilibrium rate through cointegrating techniques; are larger than the second measure. This perhaps is the result of missing variable bias. However, there is a distinct advantage of using first approach that it enables us to identify the determinants of the equilibrium and therefore allows the policy makers' to adjust those variables; if possible. It would perhaps be wise to be conservative about magnitude of misalignment using first method. Since direction of both measures is approximately same but only differs in magnitude therefore it would be appropriate to take an average of the both. Another implication would be to improve the structural VAR estimation for allowing more than two types of shocks in the model.

1.8: References

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