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Equilibrium Exchange Rate Estimation for Taka – A Co integration Analysis

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Equilibrium Exchange Rate Estimation for Taka – A Co integration Analysis

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Abstract

Exchange rate is one of the key macroeconomic variables and efficient management of exchange rate is very crucial for continued performance of external sector competitiveness and openness. Like the experiences of many other countries considering gradual openness and increasingly integrated pace of Bangladesh economy into the global economy exchange rate policy has important role in macroeconomic management process. The estimation of equilibrium exchange rate gives a benchmark for assessing the actual development of the real exchange rate. During the financial crisis of 2008-09 when US dollar was losing its value, most of the currencies were appreciated, but Bangladesh's Taka against US dollar was stable. In recent years, foreign exchange reserve is piling up as results of robust remittance inflows and higher export growth along with slower import growth. BD Taka is gaining value against US dollar. Though exchange rate of neighboring trade competitive countries (like India and Pakistan) are gradually depreciating against US dollar. In these circumstances, Bangladesh Bank continues to buy dollar from the foreign exchange market to maintain external competitiveness. This paper is an attempt to know the equilibrium exchange rate of Taka to measure exchange rate misalignment. To estimate the equilibrium real exchange rate we use macroeconomic balance approach, which calculates the real exchange rate that is consistent with internal and external balance. Using Johansen (1995) cointegration method we were able to find a long run equilibrium relationship between exchange rate and fundamentals, which comprises of tot, openness, consgdp, remaid, dsex. Estimation of all of the macro fundamental variables entered in the cointegrating vector generates correct sign. The estimated result showed that taka was overvalued by almost 16.14 percent in FY14. Interbank exchange rates were kept lower than REER based exchange rate almost throughout the year in FY14. However, the differential between the two rates have been widened despite the demand side policy intervention of BB.

JEL Classification: F31 and F41

Keywords: Exchange rate policy, Equilibrium exchange rate, Misalignment

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1. Introduction

Exchange rate is one of the key macroeconomic variables. Like monetary policy, exchange rate policy is under the purview of the monetary authority. Bangladesh's exchange rate policy can be classified into three regimes since independence. During the period 1972-1979, BD followed fix pegged exchange rate regime. From 1979-2003 BD followed a flexible pegged exchange rate regime. During this period a new industrial policy had been introduced and the openness of the economy increased substantially. The current account was made convertible and the capital account was made partially convertible. Since May 2003 floating (managed) exchange rate policy has been in place. Though Bangladesh follows floating exchange rate regime, Bangladesh Bank keep an eye on the external value of taka and sometimes intervenes for smoothing the excessive volatility of taka. Like the experiences of many other countries considering gradual openness and increasingly integrated pace of Bangladesh economy into the global economy exchange rate policy has important role in macroeconomic management process (Isard 2007). Now-a-days, the central bank policy maker often faces a question regarding equilibrium exchange rate and or stability relating longer run period. This question is reasonable considering the observed fluctuation in exchange rates and BB's continued intervention in the foreign exchange market. The movements of the real exchange rates have important implications for economic activities. If the exchange rate is undervalued it will have inflationary effects on the economy and can create macroeconomic imbalances. On the other hand, overvalued currency creates balance of payment pressure, thus external sector imbalances. Overvalued currency had also created currency crisis in many countries (such as South East Asia, 1997; Mexico 1994; Kubota 2011)

The estimation of equilibrium exchange rate gives a benchmark for assessing the actual development of the real exchange rate. Real exchange rate (RER) misalignment, the deviation of RER from what it

should be at the equilibrium level in the steady state, could be used as a signal to detect a coming crisis. The literature on real exchange rate provides a large number of empirical studies on the equilibrium real exchange rate in developing countries. A few numbers of studies on equilibrium real exchange rate were done for Bangladesh Taka. Those studies were based on data collected upto 90s' and showed overvalued exchange rate prevailed for most of the period.

During the financial crisis of 2008-09 when US dollar was losing its value, most of the currencies were appreciated, but Bangladesh's Taka against US dollar was stable. In recent years, foreign exchange reserve is piling up as the results of robust remittance inflows and higher export growth along with slower import growth. BD Taka is gaining value against US dollar. Though exchange rate of neighboring trade competitive countries (like India and Pakistan) are gradually depreciating against US dollar Bangladesh's Taka is appreciating. Obviously Bangladesh is losing competitiveness in international trade. In these circumstances, Bangladesh Bank continues to buy dollar from the foreign exchange market to stabilize the exchange rate.

It is now important to know the equilibrium exchange rate of Taka to measure the misalignment for taking appropriate policies to avoid any crisis or macroeconomic imbalance. This paper is an attempt to estimate the equilibrium real exchange rate of Taka. A number of empirical models based on economic fundamentals try to estimate equilibrium exchange rate. One of the important models is the macroeconomic balance approach, which calculates the real exchange rate that is consistent with internal and external balance. This methodology has been popularized by Williamson (1994), who referred to the exchange rate computed in this manner as the Fundamental Equilibrium Exchange Rate (FEER). In this paper we use the internal-external balance model to calculate the equilibrium real exchange rate.

The remainder of the paper is organized as follows. Section II presents review of literature; Section III reviews evolution of exchange rate policy in Bangladesh ; Theory and measurement of RER are shown in section IV; Section V formulate empirical model to estimate equilibrium exchange rate for Bangladesh Taka; Section VI analyze methodology and collection of data; Section VII explains estimated results; an attempts to measure degree of exchange rate misalignment is presented in section VIII and finally some concluding remarks is made in section IX .

2. Literature Review

Chun E Sun (1998), , in a research paper (Chonnam National University) estimated equilibrium Korean won/dollar real exchange rate using multivariate co integration method of Johansen based on behavioral effective exchange rate (BEER) over the sample period 1986Q1 to 2003Q4. The study was able to find a long run equilibrium relationship between real exchange rate and a set of fundamental variables. Variance decomposition analysis demonstrated that the net foreign assets (NFA), productivity differential, measure of openness and house price index plays an important role in explaining the behavior of real exchange rate. The won was overvalued and undervalued for the period 1986-87 and 1988-89 respectively. From early 1991 to till currency crisis in 1997 the won was consistently overvalued.

Baffes, et all (1999) in their working paper used internal and external balance approach for estimating both the equilibrium real exchange rate and degree of misalignment. They illustrated the methodology using annual data for Cote d'Ivoire and Burkina Faso. They used government consumption to GDP ratio as a proxy for government spending for nontradable and total investment to GDP ratio as a proxy for government spending for tradable. The ratio of trade openness was used as a proxy for stance of trade policy. A crucial parameter in the estimation of the short run dynamic model is the coefficient of error

correction term which measures the speed of adjustment of the RER to its equilibrium level. The adjustment speed for Cote d'Ivoire is somewhat higher (-0.30) than that of Burkina Faso (-0.54). This finding suggests that smaller economies are more adaptive to shocks than the large ones.

Hossain (2000) estimates short run and long run model of real exchange rate of BD Taka using Edwards's model of the equilibrium real exchange rate within the general equilibrium framework. Estimating regression of short run equilibrium exchange rate he found that terms of trade, economic growth, and foreign capital inflows lead to an appreciation of the real exchange rate, while increase in investment leads to depreciation is effective in bringing about a short run depreciation of real exchange rate. The cost of exchange rate misalignment is poor economic performance through various channels. This study showed that a real exchange rate misalignment lowers the growth rate of output.

Rahman and Basher (2001) estimate long run equilibrium real exchange rate based on Monteil (1999) analytical model of equilibrium real exchange rate. It observed that trade liberalization and increase in debt service burden result in real depreciation of currency, while increase in capital inflow, improvement in terms of trade and increase in government consumption of non-tradable result in a real appreciation of currency. Nominal devaluation partly retained its effectiveness in having a real devaluation in the short run. The study revealed that currency was overvalued during the late seventies and eights, during nineties currency was broadly in equilibrium due to implementation of trade liberalization and economic reforms, pursued a policy of mini-devaluation as signaled by BBs' REER index and stable macroeconomic performances relative to previous decades.

Sahminan (2005) in a working paper estimated equilibrium real exchange rate of the Indonesian Rupiah using quarterly data from 1993Q1 to 2005Q2. The study showed that beside other variables terms of trade, inflation differential and interest rate differential are significant factors in determining

the long run equilibrium real exchange rate of Rupiah. The model showed that the exchange rate of the Rupiah overvalued substantially relative to equilibrium real exchange rate in the period shortly before the crisis.

Hossain and Ahmed (2009) investigated the exchange rate policy in Bangladesh for the period 2000-08. They found that BD follows a dirty float de facto exchange rate regime by occasional intervention in the foreign exchange market to keep the exchange rate within certain limits. But due to thin foreign exchange market and high pass- through depreciation affects output through a balance sheet effect. They showed BB may affect exchange rate by tightening/loosening (through interest rate) monetary policy. Since the interest rate channel of monetary policy transmission is almost ineffective, its leads to sterilized interventions that ultimately contributes to exchange rate shocks. They found net foreign assets have significant effect on the REER appreciation while terms of trade, real interest rate differential and government budget deficit are significant to REER depreciation. Although BD maintained average competitiveness throughout the period with depreciating REER, currency remained somewhat overvalued. They found that REER remained overvalued on an average 3 percent, which is very close to its equilibrium as warranted by economic fundamentals.

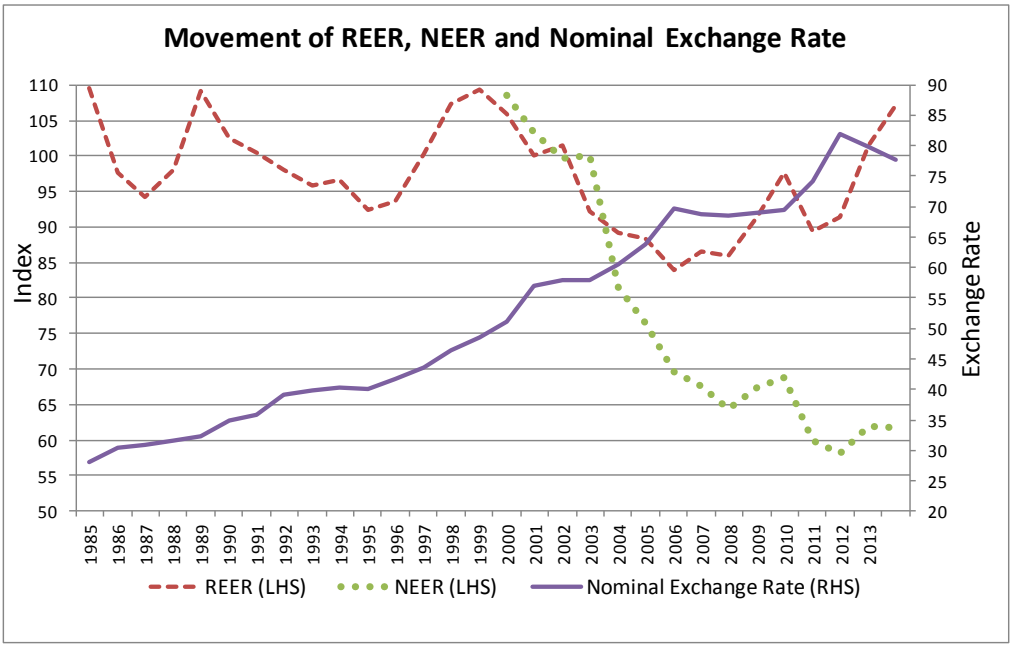
Hangsasuta (2011) in a research paper investigated the way in which RER misalignment relates Thai economy in financial crisis, capital control and export/import. The equilibrium RER is estimated using the BEER approach for data from year 1993Q1 to 2010Q4. The estimated result revealed that overvaluation prevailed in the period before 1997 Asian currency crisis and before US subprime crisis in 2008.

Khondker, et all (2012) made an attempt to examine the effect of exchange rate changes on BD's aggregate output (GDP) using the three market Keynesian Model. The study showed a long run

relationship between GDP and a vector of variable including terms of trade, government expenditure, credit to private sector and RER. Despite a steady rise in the nominal exchange rate, BD's real external competitiveness as measured by the real exchange rate has hardly changed since 1980s. Nominal devaluation have largely accounted for cancelling out the differential inflation rates of BD vis-à-vis trading partners. The movement in the real exchange rate does affect the overall output, and the effect is borne out even if other variables are controlled.

3. Evolution of Exchange Rate Policy in Bangladesh since Independence

Following the independence of Bangladesh, on 3 January 1972 the exchange rate of newly created currency (Taka) was fixed with the British Pound sterling at the rate of £1=t18.9677. During the early years of independence government adopted expansionary monetary and fiscal policies. These accelerated inflation to the level of about 50 percent per annum during the period of 1972-75. The incompatibility between expansionary monetary and fiscal policy and a fixed exchange rate system made the taka grossly overvalued. In May 1975 taka was devalued by about 85 percent, though the size of the devaluation was large, it was lagged adjustment of the exchange rate to high inflation over the past three years (Hossain,2000). In 1979 the government pegged the taka to a basket of currencies to its major trading partners with the Pound sterling as the intervening currency. This attempt did not make any difference to the real exchange rate of the taka. The taka remained overvalued with the US dollar, this created sustained large trade deficit. In 1983, pound sterling was replaced by the US dollar as the intervening currency. Throughout 80's government continued expansionary monetary and fiscal



Source: Bangladesh Bank

policy. Inflation remained at high roughly about 12 percent per annum and trade deficits were at about 13 percent of output (Hossain, 2000). In 1985, Bangladesh Bank introduced calculation of Real Effective Exchange Rate (REER) Index to measure international trade competitiveness. Based on the REER, nominal exchange rate continued to depreciate, but not to the extent that could have made the tradable goods sector competitive. The government undertook IMF-World Bank structural adjustment program but in selective areas.(Despite, depreciation of nominal exchange rate by almost 40 percent, real exchange rate appreciated by 5 percent during 1983- 1990).

During 90's structural adjustment program continued. Some improvements were made in the area of monetary and fiscal policy under this program. Few measures were taken to streamline the exchange rate arrangements. On 1 January 1992, the government unified the exchange rate regime by abolishing the secondary exchange market and made an improvement in current transactions by removing some exchange controls. In April 1994, the government made the current account convertible. Interbank foreign exchange market also developed. The removal of exchange controls increased inflows of

workers' remittances through the official channels. This lowered the level of current account deficit and boosted foreign exchange reserve. Monetization of reserve raised the prices of nontradables and thus appreciated the exchange rate. Mini devaluation of exchange rate was continued based on REER Index. In 90's inflation also decelerated to an annual average 5 percent. Exchange rate regime gradually shifts from fixed peg to flexible peg. The band width of exchange rate was made wider, so that the exchange rate could move more in line with market forces. In May 2003, in a balanced macroeconomic condition floating exchange rate policy was put in place, where exchange rate are free to determine by market forces. But Bangladesh Bank could intervene if necessary to avoid excessive volatility in the exchange rate.

4. The Long Run Equilibrium Real Exchange Rate: Theory and Measurement

4.1 Real Exchange Rate (RER)

Exchange rate is one of the core macroeconomic variables. In macroeconomic perspective, especially in open economies, exchange rate is rather significant. The exchange rate is defined as "the price of one currency in terms of another"(Mishkin,2004). The real exchange rate (RER) is the nominal exchange rate adjusted for the inflation differential among countries. It could be interpreted as the purchasing power of two currencies relative to one another. The RER is used to represent a country's' competitiveness in international trade. According to Montiel " The decentralization that characterizes market economies implies that decisions about what and how much produce, as well as about what and how much to consume, are made by individual agents, and relative prices are the signals and incentives that guide the decisions of these agent. In doing so, relative prices play a key role in allocating economic resources among competing uses".

$RER = NER. P^f/P^d$

Where, NER is nominal exchange rate, P^f foreign price level, P^d domestic price level.

Another definition of real exchange rate is prices of tradable to nontradable, $RER=P_T/P_N$

For small country $P_T = E\ P_T^{\ f}$, Therefore $RER = E\ P_T^{\ f} / P_N$

This definition of real exchange rate provides a measure of incentives that guide domestic resource allocation across tradable and nontradable goods sectors. It is also interpreted as an index for international competitiveness of tradable goods sector.

4.2 Concept of long Run Equilibrium Real Exchange Rate

Like other economic variable real exchange rate is in equilibrium if there is no tendency for it to change. Precisely, because the real exchange rate is an important part of the macroeconomic adjustment mechanism, it will tend to change whenever the economy is subjected to new shocks. Thus the equilibrium real exchange rate must refer to the value to which the real exchange rate would tend in the absence of new shocks. Equilibrium exchange rate is unobservable, but it is function of a set of sustainable values of policy and exogenous variables.

The real exchange rate at any moment is determined by the reduced form relationship:

$e = F(X_1, X_2)$

where, X_1 represents the sustainable values of a set of real exogenous and policy variables, and X_2 represents the current values of a set of predetermined macroeconomic variables (such as nominal wage, net international creditor position and capital stock in the traded and nontraded goods sector), whose values are fixed at any moment but change gradually overtime. Therefore, e is a short run equilibrium exchange rate. When the macroeconomic variables in X_2 stop changing i.e. when they reach at a long run equilibrium X^*_2, we have

$e^* = F(X_1, X_2^*)$

Where e*is the long run equilibrium real exchange rate. It depends on the sustainable values of the exogenous and policy variables.

4.3 Measuring Equilibrium Exchange Rate

With the objective of capturing other factors, beyond just monetary variable in determining movements of equilibrium exchange rate, the concept of fundamental equilibrium exchange rate (FEER) was developed by Williamsons (1994). A number of basic features of FEER are worth highlighting. Williamsons (1994) defined FEER as a real effective exchange rate that simultaneously secures internal and external balances for a given number of countries at the same time. Internal balance is reached when the economy is at full employment output and operating in a low inflation environment. External balance is characterized as a sustainable balance of payment position over a medium-term horizon, ensuring desired net flows of resources and external debt sustainability. A minimum criterion for external balance is that the current account balance has to be sustainable. The FEER approach focuses more on "economic fundamentals.

In this study we used a simplified model of internal and external balance, which is well covered by Montiel (1999) to illustrate the real exchange rate and sets of factors that determines real exchange rate.

Internal balance holds when the markets for labor and nontraded goods clear. This occur when

$$Y_N(e) = c_N + g_N = (1-\theta)ec + g_N \qquad (1)$$

Y_N is the supply of nontraded goods under full employment c_N is total private spending (measured in traded goods), θ is the share of this spending devoted to traded goods, and g_N is government spending on nontraded goods. Equation 1 is shown as the schedule IB in Chart- 1.

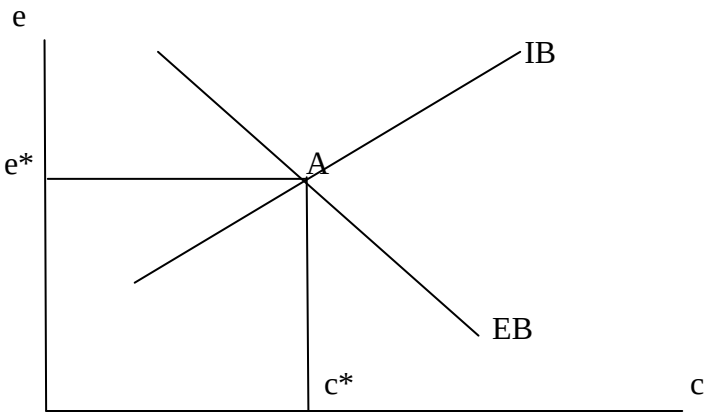
To define external balance, we begin with the current account surplus, which is given by

$f = b+z+rf=y_t(e)-(\theta+\tau)c+z+rf$ (2)

Where f is total net foreign assets, b is the trade balance, z is net foreign aid received by the Government and r is the real yield on foreign assets, measured in traded goods. The trade balance is the difference between domestic production of traded goods, y_T, and the sum of government (g) and private spending on these goods. Equation 2 is shown as the schedule EB in Chart- 1.

External balance holds when the country's net creditor position in world financial markets has reached steady state equilibrium. The equilibrium real exchange rate, is given by the intersection of the IB and EB curves, which occurs at point A in the Chart 1. The intersection of these loci determines the long run equilibrium value of the real exchange rate as well as private expenditure.

Chart 1- Internal Balance, External Balance and the Determination of the Long run equilibrium real Exchange Rate



Montiel (1999) identifies six sets of factors that determine real exchange rate. The first- is the changes in fiscal policy. The increase in government spending on traded goods creates an incipient trade deficit, which requires a real depreciation to maintain external balance. In contrast, changes in government spending on nontraded goods affect the internal balance locus IB. The increased demand for nontraded goods requires an increase in their relative price to maintain equilibrium in the nontraded goods market, the real appreciation required to clear the market for

nontraded goods would create an unsustainable deficit in the current account. Consequently, adjustment to the shock requires appreciation of real exchange rate. Second- Changes in the value of international transfer represent an addition to household incomes equal to transfer as well as external balance condition. There are no direct effects on the internal balance, so the real exchange rate undergoes an equilibrium real appreciation. Third- Changes in international financial condition-capital inflows and transfer-have in common impact that they influence towards an expansion of absorption relative to income in the short run. The two phenomena differ in two important respects. First, the volume of capital inflows is an endogenous variable that can result from a variety of changes in domestic and external economic conditions. The change in the long run real exchange rate associated with a particular episode of capital inflow depends on the source of the shock that triggers the inflow. Second, unlike transfer, capital inflows create an obligation of repayment in the long run which impact on supply-demand gap on foreign currency. These also affect the long run equilibrium exchange rate. Fourth-the Balassa-Samuelson effect that refers to productivity differential to the tradable and non tradable goods sectors. Exchange rate appreciates if relative productivity in the tradable sector increases because it creates excess demand in the non tradable sector as well as it improves trade balance. Fifth-Changes in the terms of trade results in contraction in the output of nontraded goods and resources shift into the production of exportable. As in the case of favorable productivity shock, the incipient improvement in the trade balance requires a real appreciation to keep the trade balance at a sustainable level. Sixth-Commercial policy could have important effect on equilibrium real exchange rate. Trade liberalization lowers support to import competing industries and reduce export subsidy thus channeled resources to nontraded goods sector which results in exchange rate depreciation.

5. Empirical Model for Equilibrium Real Exchange Rate of Bangladesh Taka

The theory developed in the previous section delivers a long run relationship between the real exchange rate and a set of macroeconomic fundamentals. The equilibrium real exchange rate is then defined as the steady state real exchange rate conditional on a vector of permanent values for the fundamentals. Liner relationship of long run equilibrium real exchange rate (log transformation) is expressed as:

$lne_t^* = \beta F_t^p$

Where $e_t^*$is the equilibrium real exchange rate, F_t^p is the vector of permanent or sustainable values of fundamentals, β is the vector of long run parameter of interest. The steady state is dynamically stable. The stochastic term (w_t) in the equation is stationary variable with a zero mean.

$lne_t^* = \beta F_t^p + w_t$

To estimate the long run equilibrium real exchange rate for Bangladesh selection of variables of fundamentals on the basis of availability and feasibility are describe as follows-

Data on government spending on tradable and nontradable are not available. Government consumption mostly includes nontradable (salary, payment and allowances). We have taken consumption-GDP as a proxy for spending on nontradable goods. Investment mostly contains importable goods (machineries, raw materials and intermediate goods); we have taken investment-GDP ratio as a proxy for government spending on tradable. To measure the effect of international transfer we use foreign remittance inflow and foreign aid. Such inflows directly increase household income thus appreciate real exchange rate by increasing prices of non tradable goods. Third, our capital account transaction is restricted till now. Furthermore, portfolio investment and foreign direct investment (FDI) is not yet very significant. Very recently, we have permitted commercial borrowing

from abroad in a limited scale. Therefore, considering very limited inflows of foreign financial resources with almost restricted outflows of financial resources due to the policy of inconvertible capital account policy, we did not take any variable for international financial condition. Fourth- we ignore productivity differential between tradable and nontradable goods to measure the impact of Balassa-Samuelson effect for lack of availability of data. Fifth- terms of trade measured as a ratio of export price index to import price index. Sixth-there is no composite index to measure trade policy. So to capture the impact of trade liberalization we use openness, which is a ratio of import plus export to GDP. Finally, debt service to export earnings ratio also used to see the impact of debt service burden on equilibrium real exchange rate.

Thus, the Real exchange rate model for Bangladesh is

RER = F(tot, open,remaid, consgdp, invgdp, dsex)

Where, tot stand for terms of trade, open for trade openness, remaid is for remittance plus foreign aid, consgdp for consumption to gdp ratio, invgdp for investment to gdp ratio, and dsex for debt service to total export earnings ratio.

6. Methodology and Data

To estimate equilibrium real exchange rate (RER) we have taken time series for the explanatory variables. The span of the time series used in the model is from 1979 to 2014. We have taken data from 1979 because since then a somewhat market driven exchange rate mechanism has been put in place by fixing the exchange rate of Taka pegged with a basket of currencies of its major trading partners. The variables of consgdp, invgdp, and dsex are collected from economic review publish by Ministry of Finance. Time series for remaid, tot and openness are collected from Economic Trends of Bangladesh Bank. Producer Price Index (PPI) of USA used to calculate RER index is collected from IFS.

Real exchange rate (RER) is defined as the nominal exchange rate adjusted with price differential (home country price and foreign price). All variables are taken in log linear form.

To get some idea on the dynamics of the variables used in the model, we plot each of the variables for the period 1979-2014 in levels and its first differences (annex). It is revealed from the chart that all of the variables have upward; downward or both trends in level. If we take

Table 1: Unit Root Test

Variables	Level (PP test Statistics)		First difference (PP test Statistics		Order of
	with trend	without trend	with trend	without trend	Integration
LRER	-2.08	-2.08	-4.73	-4.73	I(1)
	(0.53)	(0.25)	(0.00)	(0.00)	
LTOT	-2.61	-2.67	-4.76	-5	I(1)
	(0.28)	(0.09)	(0.00)	(0.00)	
LREMAID	-1.84	-1.88	-5.2	-5.28	I(1)
	(0.66)	(0.33)	(0.00)	(0.00)	
LOPEN	-2.18	-1.05	-6.68	-6.76	I(1)
	(0.48)	(0.72)	(0.00)	(0.00)	
LDSEX	-2.24	0.38	-6.58	-6.16	I(1)
	(0.45)	(0.97)	(0.00)	(0.00)	
LCONSGDP	-1.09		-5.41	-5.85	I(1)
	(0.24)		(0.00)	(0.00)	
LINVGDP	-1.82	-0.34	-5.29	-5.19	I(1)
	(0.67)	(0.91)	(0.00)	(0.00)	

Figures in the parenthesis indicate probability, * Has UR as per model C (without constant & trend)

All variables have unit root at level, but stationary at first difference.

the first difference of the variables these oscillate around the mean value. To test the nature of the series, whether they follow unit root, we have conducted Phillips Perron (PP) test as presented in Table-1. We use PP test because it is serial correlation and heteroskedasticity adjusted thus gives a good result for unit root test. The PP tests statistics have shown that all variables have unit root at level but stationary at first difference i.e. integrated of order one (I). Since the variables are I(1), these may be cointegrated. To see whether the variables are cointegrated we have conduct Johansen (1988) cointegration test. Table-2 shows cointegration results. Max-eighen value statistics and Trace statistics have confirmed that Model-1 and Model-2 have one long run co-integration relation. Therefore, these

variables have two long run relations. Thus, we have explored the following two alternative models of long run equilibrium real exchange rate.

Model1: lrer = ltot lremaid lopen lconsgdp ldsex

Model2: lrer = ltot lremaid lopen linvgdp @trend

Table2: Cointegration test

Model 1					
Null Hypothesis	Alternative Hypothesis	Test Statistics	5-percent Critical Value	Prob.	Conclusion
Trace Test					
r = 0	r> 0	115.45	95.75	0.0011	One
r ≤ 1	r> 1	68.02	69.82	0.069	Cointegration
r ≤ 2	r> 3	41.77	47.86	0.1652	Relation
Maximum Eigenvalue Test					
r = 0	r> 0	47.43	40.08	0.0063	One
r =1	r=2	26.24	33.88	0.3059	Cointegration
r = 2	r=3	23.85	27.58	0.1399	Relation
Model 2					
Null Hypothesis	Alternative Hypothesis	Test Statistics	5-percent Critical Value	Prob.	Conclusion
Trace Test					
r = 0	r> 0	118.12	117.71	0.0471	One
r ≤ 1	r> 1	80.85	88.8	0.1634	Cointegration
r ≤ 2	r> 3	53.78	63.87	0.2623	Relation
Maximum Eigenvalue Test					
r = 0	r> 0	37.27	44.49	0.2457	No
r = 1	r=2	27.06	38.33	0.5222	Cointegration
r = 2	r= 3	25.29	32.11	0.2694	Relation

7. Estimated Results

Table-3 shows the estimated long run parameters of explanatory variables and its short run error correction. Column 2 and column 3 show estimated results for model1 and model 2 respectively. In model 1 all of the long run parameters of explanatory variables are consistent with theory. The effects of the shock of terms of trade (ltot) are theoretically ambiguous. However, keeping consistency with most of the literature, the results here indicate that an improvement in the terms of trade appreciates the real exchange rate, suggesting that the spending effects of this variable dominate substitution

effects. Estimated elasticity of ltot is 0.51 i.e. 1 percent increase in tot will decrease exchange rate by 0.51 percent and it is statistically significant. An increase in foreign transfer (as proxied by remittance plus foreign aid i.e lremaid) appreciate exchange rate by increasing the demand for nontradable which is consistent with the theory but it is statistically insignificant. The elasticity of lremaid is 0.02 i.e, 1 percent increase in lremaid will decrease exchange rate by 0.02 percent. Increased government

Table 3: Vector Error Correction Estimates.

Variables	Model1	Model2
Dependent	LRER	LRER
Constant	13.15	6.17
Trend		0.05
Explanatory Variables		
LTOT	-0.51	-1.69
	(5.27)	(5.75)
LREMAID	-0.02	0.06
	(0.29)	(0.27)
LOPEN	0.12	-2.6
	(-1.09)	(5.09)
LDSEX	0.03	-0.43
	(-0.34)	(1.81)
LCONSGDP	-1.63	-
	(7.65)	
LINVGDP	-	0.53
		(-2.12)
Error correction		
D(LRER)	-0.119	-0.182
	(-0.87)	(-2.38)
D(LTOT)	-0.5	-0.262
	(-2.39)	(-2.45)
D(LREMAID)	0.352	-0.039
	(1.52)	(-0.33)
D(LOPEN)	-0.29	-0.169
	(-1.35)	(-1.64)
D(LDSEX)	-0.25	-0.033
	(-0.61)	(0.17)
D(LCONSGDP)	-0.31	-
	(-3.86)	
D(LINVGDP)		0.074
		(0.68)
AIC	-2.8292	-2.556
SBC	-2.47	-2.197
F-Statistics	0.82	1.38
Loglikelihood	56.1	51.47
Figures in the parenthesis indicates t-statistics		

spending on consumption which proxies for government spending on nontraded goods is consistent with theory and highly significant. Increase in government consumption will increase demand for nontradable. To bring equilibrium in the nontradable goods market price of nontradable will increase

thus appreciate the real exchange rate. The elasticity of lconsgdp is 1.63 i.e, 1 percent increase in government consumption will appreciate exchange rate by 1.63 percent. Furthermore, coefficient of openness (lopen) and debt service (ldsex) are positive, these are also consistent with the theory; however these estimated coefficients are statistically insignificant. Trade liberalization increase export and import but import volume is higher than export volume. Increase in openness will create excess demand for foreign currency thus will increase the exchange rate. Elasticity of openness is 0.12 i.e, 1 percent increase in openness depreciate exchange rate by 0.12 percent. Debt service burden also depreciate exchange rate. A permanent increase in debt service ratio will create pressure on current account balance, thus required to depreciate the exchange rate. The elasticity of debt service ratio is 0.03 i.e. 1 percent increase in debt service will increase exchange rate by 0.03 percent. In model 2 coefficients of long run variables are also consistent but two variables ltot and lopen are statistically significant.

In model 1, short run effects of the fundamentals are appreciable in size but only two variables ltot and lconsgdp are in the same direction as the long run effects and statistically significant. Any deviation from long run equilibrium is corrected in short run by two variables ltot and lconsgdp. In model 2 only ltot is in the same direction as the long run effects and statistically significant. RER itself makes the error correction in the short run.

Model selection criteria AIC and SBC show that model 1 perform better than model 2.

Hence, we will analyze long run equilibrium real exchange rate behavior and misalignment with the actual RER on the basis of model 1.

8. Measuring Exchange rate Misalignment

Exchange rate misalignment measures as the percentage difference between observed and equilibrium real exchange rate (Kubota 2013). Using the estimated parameters of the long run fundamentals we obtained the fitted or long run equilibrium real exchange rate (Table-4). From chart-2 the gap between these two series provides a measure of real exchange rate misalignment. The last column of the table shows the misalignment (overvaluation/undervaluation).The chart shows that fitted value of the real exchange rate is a good reflection of the well known currency overvaluation (undervaluation) phases in the macroeconomic history of Bangladesh. Taka was overvalued throughout the decades 80's upto mid 90's for expansionary monetary and fiscal policies. Misalignments were high and volatile in 80's due to high inflation and changes in economic policies (such as trade liberalization; Barajas 2010). During 1995 and 1996 taka were appreciated in the range of 16 percent to 21 percent due to sudden rise in foreign exchange reserve in substantial amount and foreign investment in the capital market for withdrawal of lock in provision in capital market. From late 90's misalignment were reduced as an effect of reform measures toward the market economy,

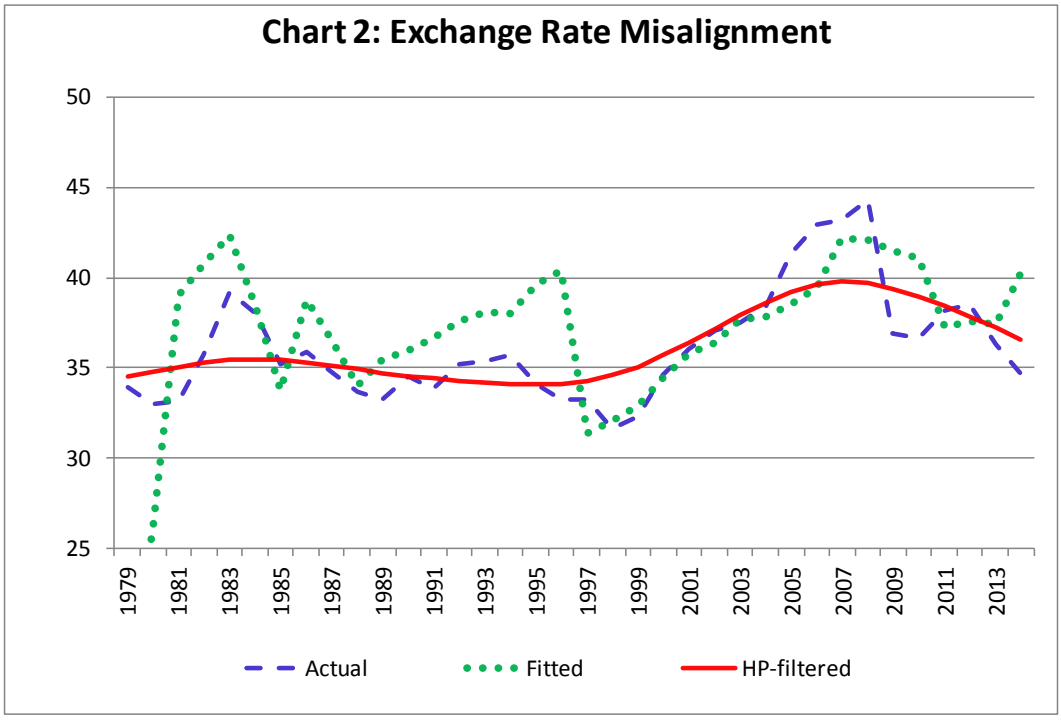
Table 4: Actual, Fitted and Overvaluation/Undervaluation of RER

year	Actual	Fitted	HP-filtered	3-Year MA	over/under valuation
1979	33.96	17.88	34.50		-47.35
1980	32.99	25.90	34.76		-21.50
1981	33.19	39.07	35.02	27.61	17.70
1982	35.72	40.77	35.25	35.25	14.14
1983	39.23	42.38	35.41	40.74	8.03
1984	38.05	38.34	35.47	40.50	0.76
1985	35.19	33.73	35.42	38.15	-4.15
1986	35.91	38.81	35.29	36.96	8.08
1987	34.80	36.55	35.11	36.37	5.03
1988	33.71	34.04	34.91	36.47	0.98
1989	33.26	35.45	34.71	35.35	6.59
1990	34.52	35.94	34.54	35.14	4.11
1991	33.87	36.64	34.39	36.01	8.17
1992	35.23	37.54	34.27	36.71	6.56
1993	35.39	38.13	34.17	37.44	7.73
1994	35.70	37.98	34.10	37.88	6.37
1995	34.10	39.63	34.07	38.58	16.19
1996	33.26	40.41	34.12	39.34	21.50
1997	33.27	31.37	34.29	37.14	-5.70
1998	31.65	32.07	34.60	34.62	1.34
1999	32.32	32.90	35.07	32.12	1.81
2000	34.58	34.44	35.68	33.14	-0.42
2001	36.06	35.78	36.40	34.37	-0.78
2002	37.06	36.36	37.17	35.53	-1.89
2003	37.47	37.63	37.93	36.59	0.43
2004	38.43	37.85	38.63	37.28	-1.52
2005	41.29	38.51	39.21	38.00	-6.72
2006	42.93	39.43	39.60	38.60	-8.14
2007	43.22	42.18	39.76	40.04	-2.42
2008	44.34	42.11	39.69	41.24	-5.04
2009	36.86	41.47	39.40	41.92	12.49
2010	36.68	41.10	38.97	41.56	12.05
2011	38.21	37.28	38.45	39.95	-2.44
2012	38.53	37.58	37.87	38.65	-2.47
2013	36.35	37.40	37.23	37.42	2.90
2014	34.65	40.25	36.58	38.41	16.14

Note: Overvaluation/undervaluation are calculated as percentage change of actua value from fitted value.

such as unification of exchange rate, removal of some exchange control, development of interbank foreign exchange market and current account made convertible for Taka. Since then mini depreciation

of taka were made to adjust the price differential for maintaining stable real exchange rate. During this period, under flexible peg exchange rate regime exchange rates were fluctuated within a band, gradually band width were making wider towards the market based determination of exchange rate. From 2000 actual and fitted values of real exchange rates became closer.



After floated in May 2003, exchange rate remained stable upto April 2004. Thereafter, exchange rate had begun to devalue. From mid 2004 to late 2008 taka were undervalued. As financial crisis started, exchange rate of taka appreciated as a result of price differential and US dollar became weaker against the other currencies. From late 2010 due to robust remittance inflows, moderate export growth with lower import growth reserve is being piled up. Which creates excess demand for domestic currency as a result BD Taka has started to appreciate. Moreover, our main trading partner countries (India, Pakistan) depreciated their currencies against US dollar, Thus bilateral exchange rate of Taka also appreciating. To keep external value of taka competitive Bangladesh Bank continues to buy US dollar

from the foreign exchange market. In FY13 and FY14 BB bought USD 4.54 billion and USD 5.15 billion respectively from the foreign exchange market. Despite the effort of central bank in bringing balance between the supply and demand of foreign exchange estimated value of misalignment shows 16.14% (taka was overvalued) in FY14.

9. Conclusion

In this paper we have estimated an internal-external balance approach based measure of the equilibrium real exchange rate for Bangladesh Taka against US Dollar. Using Johansen (1995) cointegration method we are able to find a long run equilibrium relationship between exchange rate and the relevant macroeconomic fundamentals, which comprises of tot, openness, consgdp, remaid, invgdp, dsex. All of the variables entered the cointegrating vector with the correct sign. The estimated results of this study are almost consistent with the results of other study (Kubota 2013, Limi 2006) on equilibrium exchange rate of Taka.

The study reveals that Taka was overvalued most of the time during eighties and nineties due to expansionary monetary and fiscal policy which created a space of incompatibility with fixed/flexible exchange rate regimes. Since late nineties currency became close to equilibrium rate as macroeconomic condition improved and inflation declined substantially. During this period, mini devaluation was made based on REER index calculated by Bangladesh Bank. According to the study immediately after adoption of floating exchange rate regime currency became undervalued and had been continued until 2008. In recent years, due to piling up of foreign exchange reserve Taka started to be overvalued. Our model based estimation value of scale of misalignment is 16.14 percent in FY14 which is consistent with the Bangladeshs' actual recent experience. This result is also consistent with the REER based exchange rate calculated by BB. During this period it is noticed that for long time

interbank exchange rates are lower than REER based exchange rate and gap between these two are being widen gradually. Thus it can be concluded that BB's policy is working in the right direction. However, lack of adequate sterilization process creates inflationary situation, which further appreciate the exchange rate. To check this immediate inflationary effect of sterilization BB also introduced BB-bill; this sterilization instrument proved to be inadequate and thus the policy effort could not be able to control inflation successfully.

Developed financial sector is a necessity for effective monetary policy transmission channel. BB should work hard in making the financial sector more competitive in order to ensure smooth transmission of monetary policy through the interest rate channel and enjoy the "low inflation benefit" of non-sterilized intervention. Moreover, to make actual exchange rate aligned to equilibrium rate monetary and fiscal policies must be consistent with exchange rate policy.

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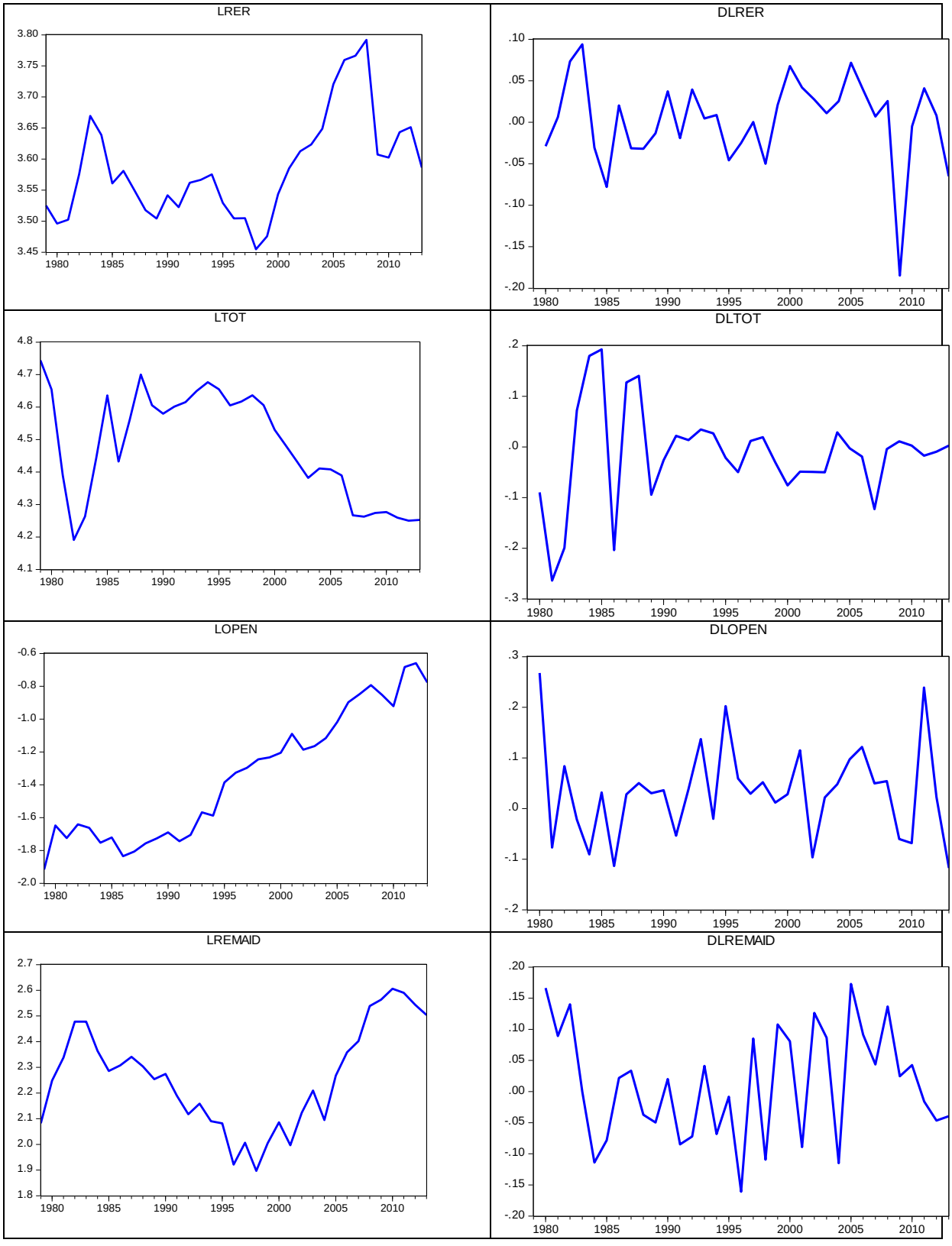
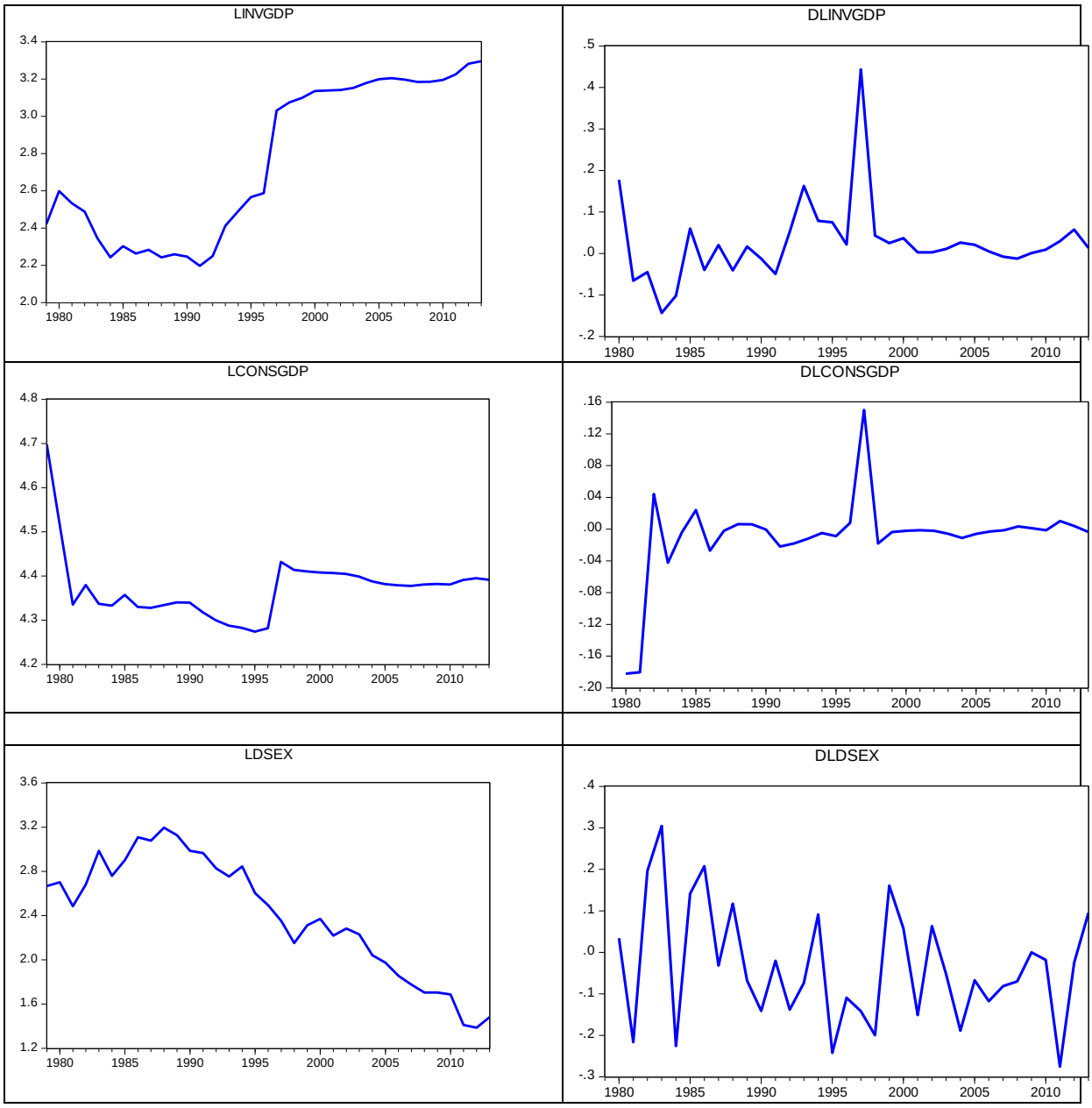
Annexure

Dynamics of variables and its first differences




LINVGDP
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1980
1985
1990
1995
2000
2005
2010
DLINVGDP
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1980
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LCONSGDP
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