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Equilibrium Exchange Rate, Current Account Deficits and Exchange Rate Misalignment in Bangladesh

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Abstract

The study aims to examine the equilibrium exchange rate in Bangladesh economy applying sustainable current account balance approach and behavioral equation approach during the period of 1980-81 to 2017-18. Using nominal exchange rate, current account balance, GDP and Terms of Trade data the study found that currently Bangladesh currency is overvalued compared to its equilibrium. In addition, the empirical results from the behavioral equation approach showed that the foreign aid and remittances have significant positive impacts on the real exchange rate. Besides, the study found that the investment to GDP, external sector resource and GDP have significant negative impacts on the exchange rate. The policy implications of the findings indicate that an increase in the investment to GDP and GDP itself causes the exchange rate to appreciate while the increase in external resource balance causes depreciation of the exchange rate.

Keywords: Equilibrium Exchange Rate, Current Account Deficits, Exchange Rate Misalignment

JEL Classification: F31, F41

1. Introduction

Exchange rate plays a vital role in a country's international trade and is considered as one of the most important measures of economic health of a country. Exchange rate affects the economy through its impact on the price of the tradable goods and services. It is well known that the performance of a country in terms of international trade, during a specified period is measured by the balance of payments. Current account balance is one of the most important parts of balance of payments. The larger current account deficit leads to the weaker exchange rate of a currency. The same is the true for the terms of trade: the higher ratio between export and import prices results in the improved current account balances. On the other hand, the more heated the economy, the larger the demand for imported goods and services and thus, the worse the current account balance.

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Therefore, the intention of this study is to estimate the equilibrium nominal exchange rate in Bangladesh and measure the exchange rate misalignment from its equilibrium.

Current account balances in Bangladesh had experienced an upward trend and according to the central bank's balance of payments data for July-May, FY18, the current account deficit stood at $9.37 billion compared to deficit of $2.21 billion in same period of the previous year. The current account deteriorated by USD 2.2 billion (-32%) during the months of April and May, FY18. Exports grew by USD 6.2 billion (+22.9%); remittance grew by USD 2.8 billion (+26.4%), but the steep rise in these two components were not enough to outweigh a robust USD 10.2 billion (+25.4%) rise in imports. This upward trend of current account deficit may create pressure on the exchange rate of the local currency.

In this situation, it is noteworthy to determine the sustainable equilibrium exchange rate or an optimal exchange rate that will help to achieve the sustainable economic growth of Bangladesh. However, it is quite challenging to determine the sustainable equilibrium exchange rate or an optimal exchange rate for an economy like Bangladesh. Existing literatures in Bangladesh and elsewhere mainly focus on the exchange rate misalignment. From the relevant literatures, it is observed that there are a number of empirical models based on economic fundamentals for estimating equilibrium exchange rate and some of these models were applied in Bangladesh for estimating equilibrium exchange rate of Taka/US Dollar and its misalignment. For example, Rahman and Bashar (2001), Hossain and Ahmed (2009), and Akhtaruzzaman and Begum (2015) conducted study on the exchange rate misalignment. However, there are no study in Bangladesh is found estimatinga sustainable equilibrium exchange rate or an optimal exchange rate of Taka/US Dollar.This study made an attempt to fill in the gap of the literature and estimate the sustainable equilibrium exchange rate or an optimal exchange rate for Bangladesh.In addition, this paper will also examine the long-run and short-run dynamics of the exchange rate of Bangladesh. The intention of this paper is to find a “Sustainable Equilibrium Exchange Rate” based on “Sustainable Current Account Balance” for Bangladesh following the study conducted by Mesquita (2016), Aristovnik (2006), Reisen (1998), and Wren-Lewis (2004). Reisen (1998) investigated current account deficits of four Latin American and four Asian economies and ascertained that sustainable current account deficits lied in the range of -1.6 to -3.8 percent of GDP. The current account deficit of transition economies in excess of 5 percent of GDP generally

poses external sustainability problems (Aristovnik, 2006). Summers (1996) developed a benchmark that current account deficits in excess of 5.0 per cent of GDP are excessive. Mesquita (2016) estimated sustainable equilibrium exchange rate for Latin America based on the sustainable current account balance, which is defined as the average of last 20 years' current account deficit.

This paper will magnify the dynamics in exchange rate of Tk/USD by encompassing wider time frame of data set. Thus, our paper is likely to come up with some unique outcome, which will be an improvement over the existing literatures explaining exchange rate behavior of Bangladesh.

2. Previous Studies

Patnaik and Pauly (2001) analyzed the structural changes of the Indian foreign exchange market and examined the equilibrium real exchange rate of the Rupee by using log linear regression model and data from 1993 to 1998. During the study period, they observed that bilateral exchange rate of Rupee to US Dollar appreciated.

Rahman and Basher (2001) estimates long run equilibrium real exchange rate in Bangladesh for the period 1977 to 1998 by using single equation approach and found that Taka was considerably overvalued until late 1980s. Macdonald (2000) discusses a critical overview of different concepts to calculate an equilibrium exchange rate for German mark (DM).

MacDonald and Ricci (2003) investigate equilibrium real exchange rate of South Africa for the period of 1970Q1 to 2002Q1 and found that real exchange rate (11.5 Rand/USD) was about 25 percent more depreciated with respect to the estimated equilibrium level, 8.8 Rand/USD in the first quarter of 2002.

Wren-Lewis (2004) calculates medium term exchange rates of Australian dollar (AUD) and New Zealand Dollar (NZD) conditional on assumptions for 'sustainable' current accounts. The review of the literature guided us to select the variables which are closely related with the exchange rate.

Wren-Lewis (2004) extend 'Five Area Bilateral Equilibrium Exchange Rate' (FABEER) model to include NZD and AUD. Using the model, the paper finds that the equilibrium values of both currencies has been declining for the last ten years and on

average, both currencies were near fair value during 2002. The paper estimated equilibrium exchange rates from 1991 to 2002. Kim and Korhonen (2005) attempts to estimate the real equilibrium exchange rates for advanced transition countries namely Poland, Hungary, the Czech Republic, Slovenia, and Slovakia. The paper finds that exchange rates in the Czech Republic, Poland, and Slovakia converging with real equilibrium exchange rates expressed in the US dollars except in the year 2002 particularly, the largest extent of misalignment took place in Hungarian currency.

Hyder and Mahboob (2005) tried to estimate equilibrium real effective exchange rate and exchange rate misalignment of Pakistan for the period from 1978 to 2005. Authors observed that during FY1978 to FY 2005 estimated exchange rate misalignment ranged -11.1 percent to 20.1 percent in Pakistan.

Koranchelian (2005) estimates a long-run real exchange rate path for Algeria. The data set for the study covered for the period from 1970 to 2003. The paper finds that the real exchange rate either moves progressively toward a new equilibrium level, or returns from its temporary deviation, to the initial equilibrium value depending on the cause of the gap. The paper finds that 50 percent of such a gap would be eliminated within nine months.

Alshehabi and Ding (2008) attempts to identify the possible exchange rate misalignment for Armenia and Georgia using behavioral equilibrium exchange rate approach. Hobdari (2008) assesses whether actual REER is line with the underlying REER for Tanzania. According to the equilibrium real effective exchange rate (EREER) approach, Tanzania's REER has been fluctuating since the early 1990s around its equilibrium value, and currently the REER is undervalued relative to its estimated equilibrium level. Hasan and Dridi (2008) evaluate the impact of oil-related income along with other economic fundamentals on EREER in Syria for the period of 1960 to 2006. The result of the paper shows that EREER of Syria appreciates with higher oil-related income, net foreign asset, and productivity, however, depreciates with higher government expenditures.

Hussain (2008) attempts to analyze the effects of economic fundamentals and associated sustainable levels to gauge the equilibrium real exchange rate and its misalignment in the case of Pakistan for the period of 1970 to 2007. Roudet et al. (2007) examine the long-run equilibrium paths of the real effective exchange rates of countries

(Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal, and Togo) in the West African Economic and Monetary Union (WAEMU) applying Fundamental Equilibrium Exchange Rate (FEER) approach for the period of 1970 to 2005.Tchaidze (2007) investigates the real exchange rate disequilibrium for Iceland. Author embraces three approaches: Macroeconomic Balance, Equilibrium Real Exchange Rate, and External Sustainability in the methodology of the paper. The result of the paper shows that all three approaches are suggesting different estimates of disequilibrium, but all advocates a depreciation of 10-20 percent under plausible assumption.Coudert and Couharde (2007) calculate real effective exchange rate consistent with the sustainable current account using FEER approach and find undervaluation of China's real exchange rate (RER) during 2002 and 2005 in effective terms against USD.

Imam and Minoiu (2011) have analyzed the equilibrium exchange rate of Muritian Rupee by using two structural models- the macroeconomic balance (MB) approach and the fundamental equilibrium exchange rate (FEER) approach in 2006–07. In the MB approach, the study found that the ERER by the equilibrium or sustainable current account balance. Under the MB approach the study estimate the long-run relationship between the current account balance and its determinants (overall fiscal balance as percent of GDP, net foreign asset position as percent of GDP, relative per capita GDP, per capita GDP growth and population growth) using a dataset for 140 countries over 1980–2005. Based on that relationship, the study projects the behavior of the current account for Mauritius in 2006–07 and over the medium run (until 2012). In FEER approach the study identified the long-run co-integrating relationships between the REER (which is measured based on the GDP deflator) and three variables: terms of trade of goods, trade openness, and government consumption using a time series dataset for the period of 1960-2007. The study found that the Mauritian rupee was aligned with its equilibrium value in 2006–07 and little adjustment appeared necessary over the medium run.

Iossifov and Loukoianova (2017) estimate the equilibrium exchange rate for Ghana by employing behavioral equilibrium exchange rate (BEER) and vector error correction model (VECM) econometric technique. Debowicz and Saeed (2014) assessed the exchange rate misalignment in Pakistan and its general equilibrium distributional implications for the period 1988 to 2010 by employing BEER approach. This study observed that the real exchange rate of Pakistan against the equilibrium real exchange

rate has been overvalued during the study period by large margins, contrasting with the real exchange rates of rapidly growing economies like India and China.

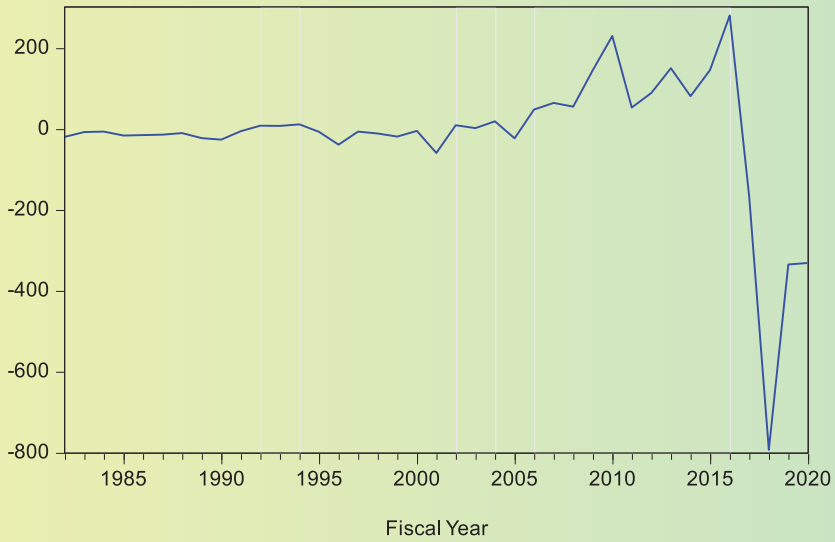
There are growing empirical studies on exploring equilibrium exchange rate and its determinants. There are few literatures available explaining equilibrium exchange rate of Tk/USD in Bangladesh. For instance, Akhtaruzzaman and Begum (2015) found in their study that exchange rate appreciated 16 percent to 21 percent in 1995 and 1996 while Rahman and Bashar (2001) found the rate broadly in equilibrium mid1990s. Hossain and Ahmed (2009) explored that real effective exchange rate (REER)has been overvalued on an average by 3 percent from second quarter of 2004 to 2008 in terms of the macroeconomic fundamentals in Bangladesh and identified the net foreign assets have a significant effect on the REER appreciation while terms of trade, real interest rate differential and government budget deficits were related to the depreciation of REER.All these three studies used Johansen Co-integration test for exploring long-run dynamics in real exchange rate of Bangladesh.

3. Data Analysis

This study includes some key macroeconomic variables such as current account balance, real GDP, exchange rate, terms of trade in pursuit of a sustainable equilibrium exchange rate for Bangladesh economy. Therefore, it would be worthwhile to investigate the trend analysis of the variables leading to useful information to understand the relationship among the variables.

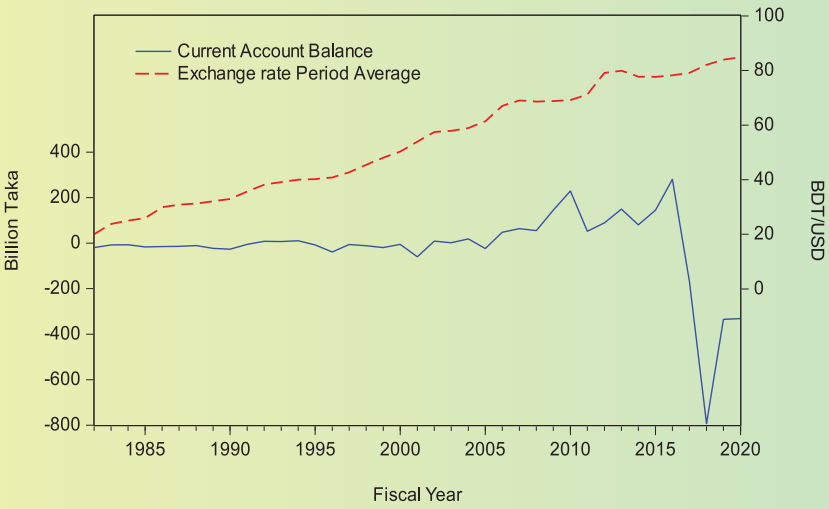
Graph 1 shows the current account balance of Bangladesh over the period of FY 1982 to FY 2020. The bigger picture of the graph allows us to comprehend that Bangladesh experienced mostly current account deficit until 2002 with an exception during FY 92-94. The shaded area shows the current account surplus periods of Bangladesh economy within the length of period considered for the analysis. Bangladesh enjoyed significant current account surplus from mid-2000s to mid-2010s, then the current account balance fell and became deficit, which was mainly contributed by the high import. However, current account deficit improved slightly in last two years though still far away from the surplus region.

Graph 1: Current Account Balance (Billion Taka)



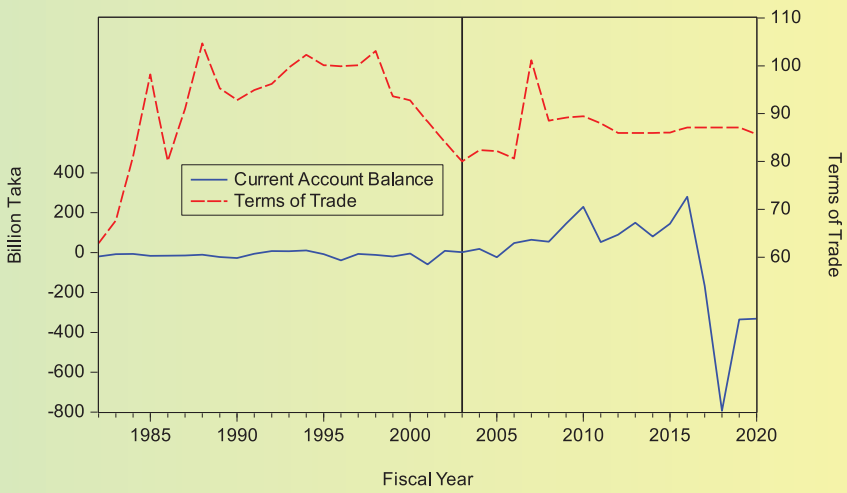
Graph 2 compares the trajectory of current account balance and period average exchange rate. Zoomed out sight of the graph shows that exchange rate of BDT/USD experienced gradual depreciation across the period we are considering here. However, we can easily draw a potential

Graph 2: Overtime trend of current account balance and exchange rate



relationship between current account balance and exchange rate. Closer look of the graph depicts that current account balance maintained same trend until 2006 with some ups and downs, and during the period, when exchange rate had smoother depreciation. However, from 2006 onwards, current account balance caught an upward trend with vivid fluctuations and the exchange rate seemed to respond to that by following less smooth path compared the previous period. The inter-relationship between current account balance and exchange rate makes us curious to dig the issue further through econometric analysis.

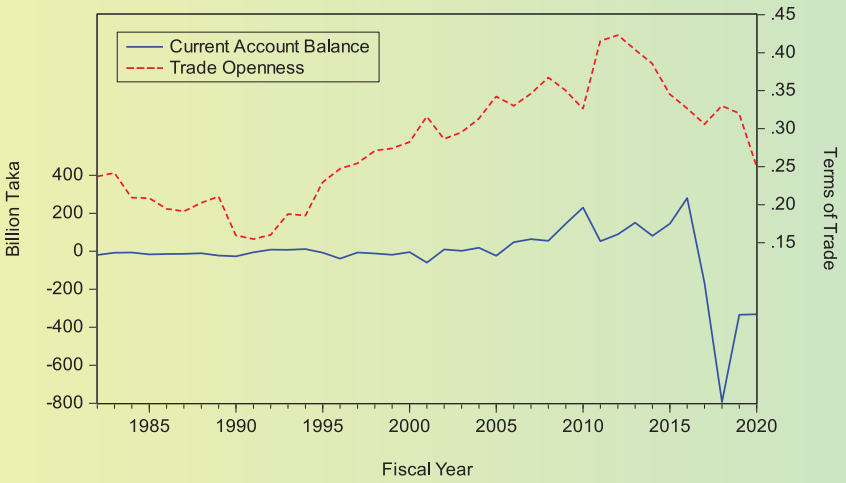
Graph 3: Overtime trend of current account balance and terms of trade



The comparative movement of current account balance and terms of trade presented in the graph 3. The vertical line in the graph shows 2003, the time of policy transformation of Bangladesh from fixed to floating exchange rate regime. Terms of trade maintained a turbulent trend until 2003, but since then, the path followed by terms of trade has been comparatively less fluctuating. Before 2003, it is difficult to find the resemblance between the trajectories of current account balance and terms of trade, but after the policy change, the two variables moved coherently compared the past except the co-movement of the variables in last year which could be a result of COVID-19 pandemic.

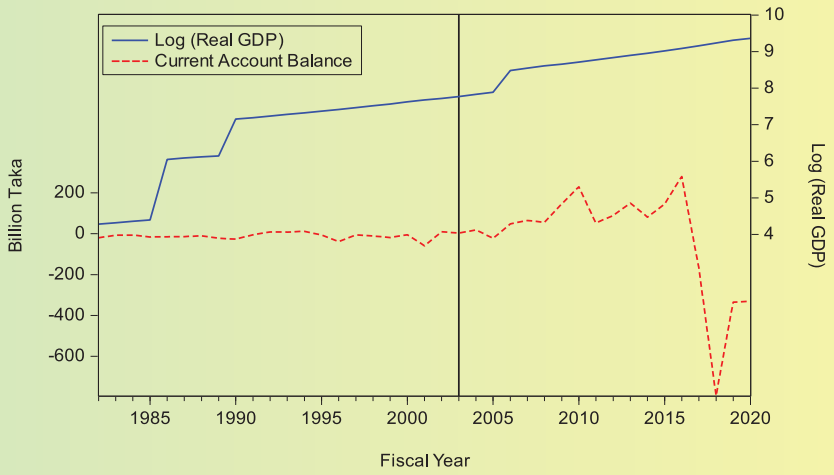
Trade openness is another variable, which is very important in our analysis. Therefore, here we will try to shed light on the course followed by the trade openness overtime (Graph 4). The plot is an evidence of rising openness of Bangladesh economy. Especially, Bangladesh economy has been embracing greater openness since early 1990s. The impact of openness on the current account balance is also noticeable from the graph 4 where we observe larger movement in the current account balance of Bangladesh with greater openness. This adumbrates potential correlation between trade openness and current account balance of Bangladesh. Slight improvement following sharp fall of current account balance in FY18 accompanied by sharp fall in trade openness is identifiable from the graph which can be an outcome of the COVID-19 outbreak.

Graph 4: Trade openness and current account balance trend over time



Another important variable of our study is real GDP, which represents overall activities of the economy. In order to magnifying the fluctuations in real GDP, we are using natural log of the variable to plot it. Graph 5 delineates the overtime movement of real GDP and compares it with the movement of current account balance.

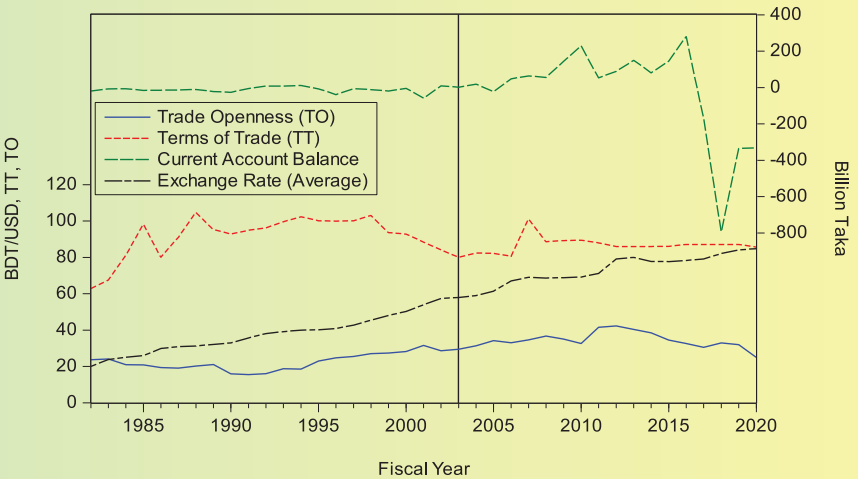
Graph 5: Overtime dynamics of Log(Real GDP) and current account balance



The macro picture of the real GDP shows an increasing trend for Bangladesh. As the economy becomes larger in terms of the real GDP, we can observer greater turbulence in the travel route of current account balance, especially last two years. So, we can perceive that higher real GDP in the future may be accompanied with higher fluctuation in the current account balance until Bangladesh becomes a sustainably developed economy.

Graph 6 encompasses four major variables: Trade openness, terms of trade, current account balance and exchange rate. The plot enables us to explore all four variables in the same canvas. The vertical line indicates the exchange rate policy regime change as the previous graphs. The graph allows us to capture the dynamics in the individual variable and the juxtaposed presentation shows inter play among the variables. Taking the movement of real GDP

Graph 6: Overtime interaction among four key variables



(Graph 4) into consideration, we may make this analysis more informative. Here, current account balance became more volatile as the exchange rate depreciated faster in floating exchange rate regime. However, terms of trade became more stable with increasing openness in new policy regime. We can also observe faster economic growth in the new policy regime. The overall picture of the variables helps us believe that a sustainable current account balance can potentially affect exchange rate and consequently, other macroeconomic variables. This takeaway encourages us further to find a sustainable equilibrium exchange rate based on sustainable current account balance for Bangladesh.

4. Methodology of the Study

The objective of this paper is to estimate the equilibrium exchange rate of Taka/US Dollar based on the sustainable current account balance in Bangladesh with application of latest econometric technique.The study covers annual data for the sample period of1981-82 to 2017-18. In the study the sources of data are Bangladesh Bank, Bangladesh Bureau of Statistics (BBS) and Bangladesh Economic Review.The reason for using sustainable current account deficits approach is mainly because the recent trend of current account balance shows that Bangladesh is experiencing higher currentaccount deficits due to higher imports. The higher the imports the weaker the currency.Although there is no unique definition for sustainable current account balance, literature suggest that if a current account balance remains between 3 to 5 percent of GDPis considered as a sustainable current account deficits. On the other hand, Statistics department of Bangladesh Bank calculates overall balance position for Bangladesh following classification of IMF's Balance of Payments and International Investment Position Manual (BPM). There are several editions of BPM. So, the data calculated based on various editions of BPM are different from each other. Balance of Payment items of Bangladesh for 1981-82 to 1996-97, 1997-98 to 2010-11, and 2011-12 to 2016-17 were calculated following BPM4, BPM5, and BPM6 respectively. So, the overall balance of Bangladesh for 1981-82 to 2016-17 under uniform definition is not available. Here, we tried to derive the overall balance of Bangladesh from the summation of the balances of current account, capital account, and financial account for the period of 1981-82 to 2017-18 to approximate the actual overall balance of Bangladesh.

As mentioned earlier in this study for estimating equilibrium exchange rate, we follow the sustainable current account balance approach developed by Mario Mesquita, 2016. For obtaining equilibrium exchange rate, we started by estimating the annual

current account balance (CAB) as a function of the exchange rate (ER), terms of trade (TOT), and economic activity measured by GDP, i.e.,

$$CAB = f(ER, TOT, GDP)$$

Applying basic economics intuition to the above relationship, depreciation in exchange rate is likely to encourage export and discourage import leading to improved current account status. As terms of trade is the ratio of export price index to the import price index, the rise in TOT is likely to improve CAB. GDP increase may affect current account balance negatively as the increased GDP can raise the demand for import which will eventually exacerbate current account balance of Bangladesh. Now, we may rewrite the above functional form as the following equation,

$$CAB_t = \beta_0 + \beta_1 ER_t + \beta_2 TOT_t + \beta_3 GDP_t \ldots\ldots\ldots (1)$$

Here, we will apply Ordinary Least Square (OLS) method to estimate the coefficients of equation (1) if all the classical assumptions are satisfied. The expected sign of the coefficients β_1 and β_2 are positive, and β_3 is negative. Then by using the estimated coefficients of equation (1), we obtain exchange rate as a function of terms of trade, economic activity, and current account balance. Therefore, the equation of exchange rate would be as follows-

$$ER_t = -\alpha_0 - \alpha_1 TOT_t - \alpha_2 GDP_t + \alpha_3 CAB_t \ldots\ldots\ldots (2)$$

Where,

$$\alpha_0 = \frac{\beta_0}{\beta_1}, \qquad \alpha_1 = \frac{\beta_2}{\beta_1}, \qquad \alpha_2 = \frac{\beta_3}{\beta_1}, \qquad \alpha_3 = \frac{1}{\beta_1}$$

For a given level of terms of trade equation (2) produces an equilibrium exchange rate when both the current account balance and the economy maintain equilibrium state. In addition to the above methodology, our research will look into both long-run and short-run dynamics among the variables. To do this analysis, we will check if the variables are stationary, then we will use Johansen Likelihood Ratio test of cointegration to examine the long-run relationship. Our investigation of long-run relation will also give us an idea of misalignment of the exchange rate from its sustainable level for Bangladesh. Finally,

we will employ Vector Error Correction Model (VECM) technique to find the short-run dynamics among the variables.

Therefore, the plan of the study is as follows after stating introduction and background of the paper in section-I, we will discuss the literature review in Section-II, theoretical background and data analysis in section III followed by the methodology of the study in Section IV. In section V will analyze the empirical results; finally conclusion and recommendation in section VI.

5. Model Specification, Model variables and Data Analysis

An empirical estimation has been done based on equation 1, and 2 using the annual data from 1981-82 to 2017-18. The data on nominal exchange rate, current account balance, terms of trade, openness and nominal GDP are used to estimate the model. The ordinary least square (OLS) method is used to get the coefficients of the variables to calculate the equilibrium exchange rate.The result of estimated coefficients of equation-1 and equation-2 is shown in the following table.

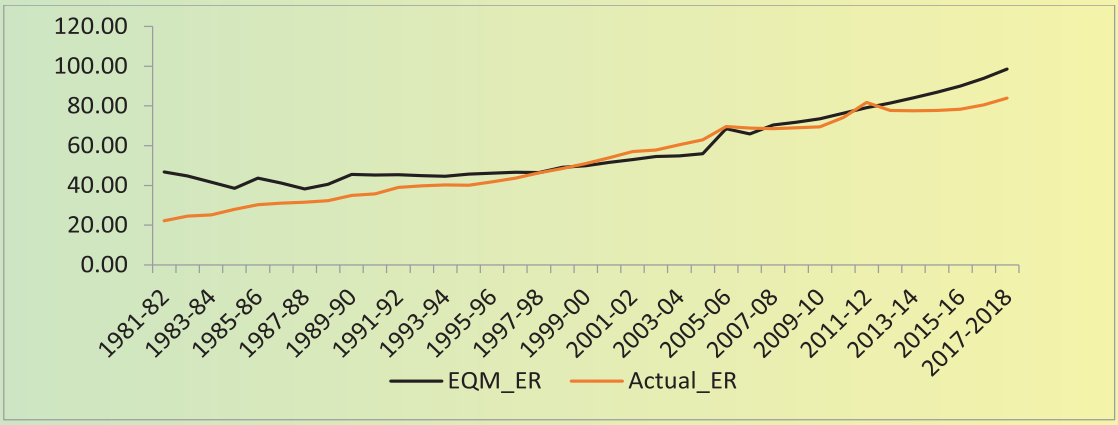
Table-1: Estimated coefficients of equation-1 and equation-2.

Equation-1		Equation-2	
Coefficients	Estimated value	Coefficients	Estimated value
β_0	1044.909	$\alpha_0 = \frac{\beta_0}{\beta_1}$	-58.861
β_1	-17.752	$\alpha_1 = \frac{\beta_2}{\beta_1}$	0.224
β_2	-3.969	$\alpha_2 = \frac{\beta_3}{\beta_1}$	-0.006
β_3	0.102	$\alpha_3 = \frac{1}{\beta_1}$	-0.056

Source: Authors' Calculation.

Based on the value of estimated coefficients of equation-2, we calculate the equilibrium exchange rate for each fiscal year and plotted against the actual exchange rate in graph-7.

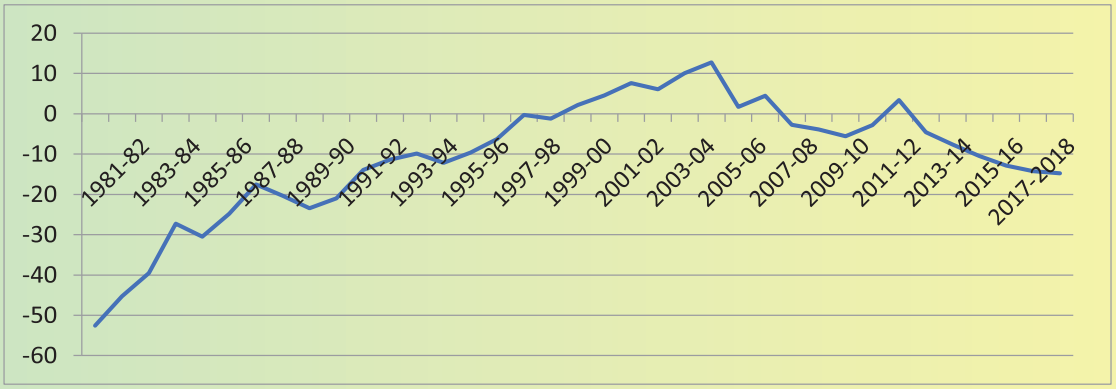
Graph-7: The Trends of Actual Exchange Rate and the Equilibrium Exchange Rate: Sustainable Current Account approach



Data Source: Bangladesh Bank, BBS, Bangladesh Economic Review.

From Graph-7,it is evident that the nominal exchange rate and the equilibrium exchange rate was almost equilibrium for throughout the period particularly at the end of 1990-91 to 2011-12. The exchange rate was overvalued for almost two decades though gradually declining from the beginning of 1980's to 2000. Again, it became overvalued from 2013-14 and remain there until 2017-18.

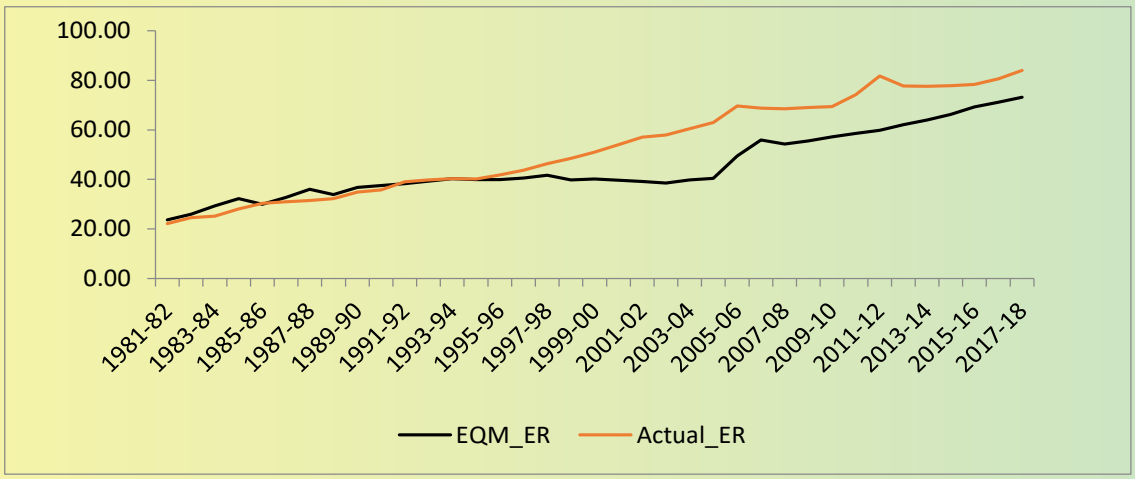
Graph-8: Overvaluation/Undervaluation of the Exchange rate: Exchange rate



Source: Authors' Calculation.

From Graph-8, it reveals that the percentage change of nominal exchange rate deviation from its equilibrium was much higher during the periods from 1980s which reversed during the periods of 2000sand remain there until 2007-08 and became overvalued thereafter.

Graph-9: The Trends of Actual Exchange Rate and the Equilibrium Exchange Rate: Using Overall Balance



Source: Authors' Calculation.

Although, according to the current account balance approach the nominal exchange rate of Bangladesh shows overvalued compared with the equilibrium on the other hand, using overall balance approach the exchange rate appears undervalued. However, it could be mentioned here that we tried to derive the overall balance of Bangladesh from the summation of the balances of current account, capital account, and financial account for the period of 1981-82 to 2017-18 to approximate the actual overall balance of Bangladesh due to non-availability of data.

Alternative Approach

Equilibrium exchange rate is an unobservable variable. Therefore, macroeconomic variables which have close relationship with the exchange rate are used to examine the

relationship between the exchange rate and other closely related macroeconomic variables.

To see the robustness of the model this study used the model used by Montiel (1999), Rahman and Basher (2001).The exchange rate misalignment is calculated. The following equation is used to calculate the exchange rate misalignment in Bangladesh.

Model $_A$ (real exchange rate) =f (external resource balance, terms of trade, investment to GDP, govt. con to total consumption, GDP, debt service to export ratio)

Model$_A$: LRER= LCONGOV, LINVGDP, LTOT, LRESB, LDSEX, LGDP)

As an external sector resource balances, the foreign aid and remittances are used; all the variables are in log linear form.

Preliminary Data Analysis

Before using the data in the estimation, we need to know time series properties of all the variables. Accordingly, a series of unit root tests[2], such as Augmented Dickey-Fuller (ADF, 1981), Phillips-Perron (PP, 1988), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992) are used to determine the order of integration for each series. The results of unit root tests as reported in Table-1 indicate that all the variables are I(1) i.e., except for terms of trade variable. It implies the external sector resource balance as proxies by the remittances and foreign aid, government consumption to total consumption, investment to GDP, debt service to export and GDP are non-stationary and contain unit-roots I (1).

[2] Note that ADF and PP tests are based on the null of unit-roots while KPSS test assumes the null of stationary are also performed. However, the conclusion doesn't change.

Table-2
Results of Unit-Root Tests

Unit Root Test (Augmented Dicky-Fuller Test)			
Variables	**Level**	**First Difference**	**Order of Integration**
LRER	-2.22	-5.83	I(1)
	(0.20)	(0.00)	
LRESB	0.81	-6.04	I(1)
	(0.99)	(0.00)	
LTOT	-4.08	-	I(0)
	(0.0031)		
LINVGDP	-0.53	-4.12	I(1)
	(0.87)	(0.01)	
LCONGDP	-1.23	-6.41	I(1)
	(0.65)	(0.00)	
LDSEX	-0.28	-4.28	I(1)
	(0.92)	-0.01	
LGDP	0.95	-0.64	I(1)
	(0.99)	(0.00)	

Source: Authors' Calculation.

Engle and Granger (1987) pointed out that a VAR model would be mis-specified if the all non-stationary variables of the model are co-integrated. Therefore, estimating a VAR model with I(1) series are not appropriate if they are co-integrated. The results show three co-integrated relations among the variables imply that there are long run relationships among the co-integrated variables. If a series of non-stationary variables are co-integrated they form the basis for estimating the model using Vector Error Correction approach (VEC).

Estimation Results of Co-integration

In our empirical estimation we have applied the Johansen (1991 and 1995) and Johansen and Juselius (1990, 1992) multivariate co-integrating methodology which jointly

determine empirically the number of *r* (maximum *k-1*) co-integrating vectors from a vector of *k* endogenous variables in the model along with coefficients of the variables and the adjustment parameters to a third order VAR (with maximum lag three) to test for co-integration. In our deterministic trend component specification in co-integrating equations we choose case-4 (linear trend assumption) that is, we assumed that the level series of endogenous variables have linear deterministic trends but the co-integrating equations have only intercepts (constants). The results are based on the assumptions of a constant and a linear trend in the data with optimal lag length 3. Akaike's Information Criteria (AIC) and Likelihood Ratio (LR) test are used to decide the optimal lag length that makes all the residuals White Noise. The results are presented in Tables-2

Table-3: Co-integration Test

Null Hypothesis	Alternative Hypothesis	Trace Test			Maximum Eigen Value Test		
		Statistics	95% Critical Value	Probability	Statistics	95% Criti	Probability
r=0	r=0	154.97*	95.75	0.00	69.89*	40.08	0.00
r≤1	r=1	85.08*	69.82	0.00	35.56*	33.88	0.03
r≤2	r=2	49.52*	47.86	0.03	28.57*	27.58	0.03

*Both Trace test and Max-eigenvalue test indicate 3 cointegrating equation(s) at 5%

Source: Authors' Calculation

In all the bi-variate co-integrating relationships, the critical values of the maximal eigen-value statistics and trace statistics strongly reject the null hypothesis of four (zero) co-integrating vector in favor of three co-integrating vectors both at the 1% and 5 % levels. Several important remarks could be developed from the results of co-integrating equation.

Table-4: Standardized Co-integrating Coefficients of Co-integrating Equation(s)

1 Cointegrating Equation					
LRER	**LRESB**	**LINVGDP**	**LGDP**	**LDSEX**	**LCONGOV**
1.00	-0.695	0.921	3.834	0.240	13.404
	(-9.07)	(1.98)	(15.63)	(1.71)	(11.63)
2 Cointegrating Equations					
LRER	**LRESB**	**LINVGDP**	**LGDP**	**LDSEX**	**LCONGOV**
1.00	0.00	0.55	0.80	-0.22	13.01
		(0.46)	(2.07)	(-0.62)	(4.57)
0.00	1.00	-0.53	-4.36	-0.67	-0.56
		(-0.34)	(-8.69)	(-1.43)	(-0.16)
3 Cointegrating Equations					
LRER	**LRESB**	**LINVGDP**	**LGDP**	**LDSEX**	**LCONGOV**
1.00	0.00	0.00	0.70	-0.43	12.47
			(1.79)	(-2.24)	(6.78)
0.00	1.00	0.00	-4.26	-0.47	-0.04
			(-8.73)	(-1.92)	(-0.02)
0.00	0.00	1.00	0.19	0.38	0.99
			(2.41)	(9.81)	(2.70)

Source: Authors' Calculation

Since we are interested to examine the relationships with the real exchange rate first co-integrating equation for the real exchange rate show that the long run equilibrium relationship exists among the log of real exchange rate, the log of investment to GDP, the log of external resource balance and the log of real GDP.

Vector Error Correction (VEC) Models

A vector error correction (VEC) model is used to see the short run dynamics since the variable are co-integrated. VEC is a restricted VAR representation. The co-integrating relationships reveal the presence of long-run equilibrium relationships among the variables of the model. However, in the short run, deviations from these relations could occur as a result of shocks to any of the relevant endogenous variables. Thus, after testing for co-integration, a VECM is estimated. The VECM is conditional on co-integrating vectors and thus, specified as to regress the first (time) difference of each non-stationary endogenous variable at time-t on one period lag (at time -1) of the co-integrating equation/vector (s) and the lagged (at time-t-i) first (time) differences of all of the endogenous variables in the system. In fact, when we impose number of co-integrating vectors as restrictions among the endogenous variables in the VAR, we move to VEC model whose general form is:

$$\Delta x_{t=} c_o + \sum_{i=0}^{p-1} \gamma_i \, \Delta x_{t-i} + \delta_i ECT_{t-i} + \omega_t$$

In our case the form of VECs will be as follows:

$$\text{Model:}\Delta \ln(rer)_t = c_0 + \sum_{i=0}^{p-1} \gamma 1 \, \Delta lnresb_{t-i} + \sum_{i=0}^{p-1} \gamma 2 \, \Delta ln(invgdp)_{t-i} + \sum_{i=0}^{p-1} \gamma 3 \, \Delta lncongov_{t-i} + \sum_{i=0}^{p-1} \gamma 4 \, \Delta lnGDP_{t-i} + \sum_{i=0}^{p-1} \gamma 5 \ln(dsex)_{t-i} + \sum_{i=0}^{p-1} \gamma 6 \ln(tot)_{t-i} + \delta_i ECTy_{t-i} + \omega 1_t$$

The Vector Error Correction Model (VECM) results

$$\Delta lner_t = 0.02 - \underset{(-2.21)}{1.24}\Delta \ln invgdp_{t-1} + \underset{(-0.94)}{0.02}\Delta lncongov_{t-1} - \underset{(1.17)}{0.18}\Delta lndebt_{t-1} - \underset{(10.23)}{3.64}\Delta \ln gdp_{t-1} + \underset{(2.64)}{0.53}\Delta \ln resb_{t-i} - \underset{(9.27)}{1.05} ECT_{t-1}$$

t-values are in the bracket.

The estimated results from VEC provide same results as in the long run co-integrating relations. The above dynamic estimate suggests that the log of investment GDP, external sector resource and the log of real GDP have significant impact on the exchange rate. The increases in the log of investment to GDP and also the log of GDP have significant negative impact on the exchange rate. In other words increase in the investment to GDP and GDP itself causes the exchange rate to appreciate while the increase in external resource balance causes depreciation of the exchange rate in the short run. The coefficient of ECT_{t-1} is negative and significant, which implies that the model converges. The parameter δ is the speed of adjustment (in case of short run imbalances) in bringing about the equilibrium that is, removing the deviation. In the VEC all the variables in the model are endogenously determined and the parameter δ is the speed of adjustment or the parameter of error correction. From our VEC model estimation results, we can draw several important conclusions; first, the error correction term is significant (at the 1-percent error level) in our specification as implied by the Granger representation theorem. The optimal lags of VECM stands at three as confirmed by the Log likelihood test, Akaike Information Criteria and also by Final Prediction Error. The error correction term found negative and significant for D(rer).

In more general terms, the significance of EC term implies that the error-correction mechanism work effectively to reduce the disequilibrium between the exchange rate and the fundamental variable to adjust to the new equilibrium. However, there are several features to be analyzed. Some of the adjustment coefficients of lagged values of explanatory variables were not significant. The value of adjusted R^2 is reasonably good which0.82.

A negative sign of EC term (coefficient of co-integrating vector) means that if the level of real output is distorted away from long run equilibrium then the distortion was automatically removed by appropriate change of fundamental variables used in the model to estimate the equilibrium exchange rate. The statistically significant error-correction terms implied that lagged values of the invgdp, res, gdp can be used as a guideline for present or future policy direction of equilibrium adjustment. The coefficient on the error correction term is high indicating that prices adjust rapidly to its long-run equilibrium. In VEC specification the estimated coefficient of the EC term is 1.05 implies a more rapid adjustment mechanism at work in correcting the exchange rate disequilibrium.

6. Conclusions and Recommendation

The study used annual data from 1980-81 to 2017-18 to estimate the equilibrium exchange rate and the deviation of the exchange rate from its equilibrium by applying sustainable current account balance approach and behavioral equation. Using nominal exchange rate, current account balance and GDP the study found that currently Bangladeshi currency is overvalued compared to its equilibrium. This implies that the export and the GDP growth might get affected negatively. Therefore, the policy implications of the study would be that Bangladesh needs to adjust its exchange rate slowly with the equilibrium value. The study also examined the impact of the some determinates on the exchange rate and found that external resource balance as proxy by the foreign aid and remittance have significant positive impact implying that an increase of these resource will depreciate the currency. On the other hand, the increases in the log of investment to GDP and also the log of GDP have significant negative impact on the exchange rate. This implies that increase in the investment to GDP and GDP itself causes the exchange rate to appreciate while the increase in external resource balance causes depreciation of the exchange rate in the short run

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