Inter-linkage between foreign exchange reserve and consumer price index: Evidence from Bangladesh

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Abstract- Unlike most developing countries Bangladesh has experienced a huge boost up in foreign exchange reserve, but with similarity in consumer price index. This paper aims at investigating the relationship between the consumer price index and foreign exchange reserve in the context of Bangladesh. A time series analysis has been done by using the monthly data from January 2007 to May 2018. All the data are non-stationary in their level form but stationary in their first differenced form. Applying Johansen cointegration and error correction technique, it is found that variables are cointegrated in the long-run for Bangladesh economy. To capture the short-run dynamics of variables towards long-run steady state condition, VECM has been applied. VECM estimates imply that any kind of deviation from the equilibrium will be corrected through adjustment in CPI by 2% (approx.) in every month. Granger causality shows that there exists a bidirectional relationship between variables at a 5% level of significance. This study can help the policymakers in formulating the monetary policy that can accommodate rising foreign exchange reserve and maintain price stability.

Keywords- Consumer Price Index (CPI), Foreign Exchange Reserve (FxR), Monetary Policy, Unit Root, Cointegration, VECM, Granger Causality, Bangladesh.

1 Introduction

Foreign Exchange reserve of a country is controlled by the central bank of that country. It is a component of capital account in a nation's balance of payments and also known as international reserve balance. Government or central bank has to take into consideration that how much foreign exchange reserve a country has while formulating both exchange rate policy and monetary policy. Sometimes foreign exchange reserve can be the savior of a nation in the crisis period. But it can cause inflation in an economy. Bangladesh is the third largest economy in South Asia and maintaining a GDP growth rate over 6% from 2004. It has the second highest foreign exchange reserve in South Asia after India. As we know Foreign exchange reserve is a key economic indicator of a country's financial strength. Like every other country, Bangladesh Bank, the central bank of Bangladesh, formulate and implement monetary policy twice in each fiscal year. Since the economy of Bangladesh growing consistently, monetary policy becomes more important to maintain equilibrium in the financial market as well as others market. Bangladesh bank holds foreign exchange in different forms like currency, deposits, securities or financial derivatives and gold. Sometimes the central bank uses this reserve for deficit financing to avoid risks associated with foreign currency. Foreign exchange reserve of Bangladesh in May 2018 was $32.158 billion which comes mostly from remittances and export earnings.

Another important reason for increased foreign exchange reserve is lower import payment. The increase in foreign exchange reserve is making our economy more dependable and resilient. Moreover, our currency has become stronger. But foreign exchange reserve behaves like a twin-devil.

On the one hand, it is making our currency stronger and on the other hand, to accommodate this huge foreign exchange reserve, the central bank has to print a lot of notes which in turns increases the money supply as well as increases the inflation rate. The average inflation rate is around 5.5%. On the contrary, if country's foreign exchange reserves are small, that country will have difficulty intervening in foreign exchange markets and equalizing the balance of payments, so reducing on its capability to deal with the influence of international capital and financial risk.

2 Literature Review

There are ample evidences throughout the world, both in developed and developing countries, which describe the inter-linkage between foreign exchange reserve and consumer price index through cross-country empirical studies.

Heller (1981) tried to explain the relationship between increased global holdings of international reserves, world money supply, and inflation throughout the world. He argued that there exists a direct causal relationship between international reserve holding to world money supply and further to the worldwide inflation rate. Rabin and Pratt (1981) argued that Heller's results cannot be generalized as

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his results are of a shorter time period in the 1970s. Abdullateef and Wahid (2010) used both OLS and vector error correction (VEC) methods while investigating the implications of external reserve holdings on inflation but no influence was found. But it is evident from the study by Hasan and Khan (1994) and Ahmed and Ram (1991) that internal price level changes significantly and gradually value of currency declines. Meiselman (1975) found in a study that there exists a direct relationship between changes in foreign exchange reserve and inflation rate. According to Utami and Inanga (2009), exchange rate volatility and interest rate differential are positively related. They found it while testing the Fisher effect by using yearly and quarterly data on inflation, a rate of interest and exchange rate for 2003-2008. According to Lin and Wang (2005), there is a positive relationship between the foreign exchange reserve and the inflation rate in the presence of strong trade effect. On the contrary, with the presence of strong monetary surprise effect, the relationship is negative. They have used the data of five East Asian countries. Steiner (2009) explained the consequences of monetary policy both on reserve accumulation and inflation rate. he tested the hypothesis of the quantity theory of money by using a panel data set and found a positive significant relationship between reserve accumulation and inflation. Khan (1979) explained that the accumulation of foreign exchange reserve is an important determinant of inflation under both fixed and floating exchange rate regimes in developing and industrialized countries. He also found the empirical evidence of quantity theory of money in his study.

Bangladesh's foreign exchange reserve has risen to $33.23 billion. The remittances from overseas working Bangladeshi and garment exports (RMG) are helping the country's foreign exchange reserve by more than $250 billion (Financial Tribune, 2017). Terada-Hagiwara (2000) analyzed that foreign exchange reserve grows quickly in Asia and h he pointed out that foreign exchange reserves growth influences the money supply and monetary policy. Bangladesh Bank plays a vital role in the financial sector management o for Bangladesh government which adopts the monetary policy to regulate the financial sector. "Creation of money, maintain the monetary base for money supply by using its operating instruments are the prime concern of Bangladesh Bank. Bangladesh's monetary policy maintains price stability gaining the highest sustainable output growth; inflation and output growth are the main policy targets. Bangladesh Bank uses the reserve money to achieve the target rate of GDP growth and inflation" (Annual Report: 20016-17, Bangladesh Bank).

3 Methodology

In this paper authors have used data from January 2007 to May 2018. To ensure robust estimation of the model, authors have selected a monthly frequency data of Consumer price index (CPI) and Foreign exchange reserve (FxR) to maximize the number of observation. All the CPI data are of base year 2005-2006. The data are collected from Bangladesh Bank, the central bank of Bangladesh. Both variables are converted into their logarithmic form, LogCPI & LogFxR, to normalize the data for analysis purpose. For data analysis, authors have used E-views software.

Since we are dealing with time series data, examining unit root of each variable is very essential. Non-stationary data may produce spurious regression with high R^2 which can mislead us in estimating the model. So it is important to check whether the data has unit root or not. The Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) can be used to check the stationarity of data. The ADF test runs the following regression equation with a constant and trend of the form:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta Y_{t-j} + \beta t + \omega_t \quad \text{.....(1)}$$

Where μ is the drift term, t denotes the time trend, and p is the largest lag length used.

Here, the null and alternative hypotheses are as follows:

H_0: Variable is non-stationary; H_1: Variable is stationary. If the null hypothesis is rejected, it will be meaning that the series is stationary.

The Phillips-Perron test runs the following regression equation:

$$\Delta Y_t = \pi Y_{t-1} + \beta_i D_{t-i} + e_t \quad \text{.....(2)}$$

Where, e_t is integrated of order zero with zero mean value and D_{t-i} is a deterministic trend component and the null hypothesis is, $H_0 : \pi = 0$.

Integration test can be carried out to check the presence of long run relationship among variables. To capture the possibility of multiple cointegrating relationships, we can use Johansen cointegration test if data series are integrated of same order (Johansen 1988, Johansen and Juselius 1990). We used maximum Eigenvalue and trace statistics to find out the number of cointegrating vectors.

Johansen cointegration test is based on the π matrix, where π is the long run coefficient matrix which can be represented as:

$$\pi = \alpha\beta' \quad \text{.....(3)}$$

β is the matrix for cointegrating vectors, while α denotes the amount of cointegrating vector that enters into the equation of the VECM.

The null hypothesis for Trace test is that the number of cointegrating vector is less than or equal to r. And the null hypothesis for Eigenvalue test is that the number of cointegrating vectors is r. Trace statistics and Eigenvalue statistics can be represented as follows:

$$\lambda_{Trace}(r) = -T \sum_{i=r+1}^{g} in(1-\hat{\lambda}_i) \quad \text{.....(4)}$$

$$\lambda_{Max}(r, r+1) = -T \ln(1-\hat{\lambda}_{r+1})$$

Where, $\hat{\lambda}_i$ is the estimated value for the i^{th} ordered Eigenvalue from the ıı matrix.

Existence of cointegration confirms a long run relationship among variables and we will go for vector error correction model (VECM) to present the short run dynamics.

To check whether any time series variable can cause another variable, we can use Granger Causality (Granger, 1987). Granger causality test indicates the direction of relationship among variables. Relationship among variables can be unidirectional, bidirectional or no relation. All the variables needed to be stationary to run the test.

4 Empirical Results

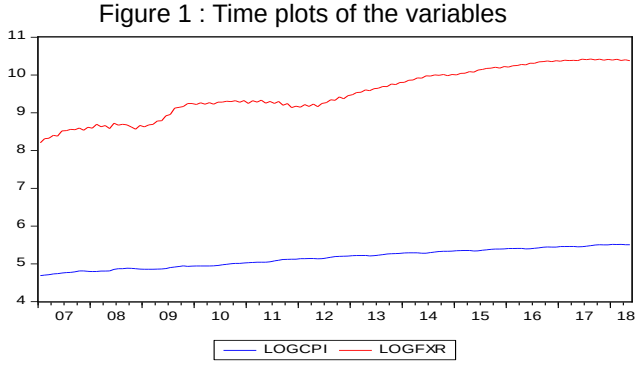
The main objective of this paper is to examine the relationship between foreign exchange reserve and consumer price index in a time series setting for Bangladesh. Before starting the time series analysis, authors want to give a overview on data used in this paper:

Table 1 : Summary statistics of the variables

Var.	Obs.	Mean	Std. Dev.	Min.	Max.
FxR	137	16461.38	9829.209	3665.52	33596.30
CPI	137	177.5703	41.93376	108.67	248.65

Time plots of the logarithms of the variables are shown in the following figure-1 which shows both variables exhibit an upward trend and they have a tendency to move together; implying that they are causally linked to each other.

Figure 1 : Time plots of the variables



4.1 Unit Root Test

The result of ADF and PP test for stationarity are given below in table 2:

Table 2: ADF and PP test results

Variables	ADF	PP
LogCPI	-0.6030 (0.9769)	-2.158639 (0.5083)
DLogCPI	-7.73965*** (0.0000)	-7.282714*** (0.0000)
LogFxR	-3.1994* (0.0894)	-2.701188 (0.2379)
DLogFxR	-4.078563***	-17.50275***
	(0.0015)	(0.0000)

Note: "D" is used as first difference operator. Both SIC and AIC are used. Trend and intercept are used in their level forms but only intercept in the first difference form. *, ** and *** indicates statistical significance at 10%, 5% and 1% level respectively. The values in the parentheses serve as p-value

The result of ADF and PP tests in the level form and in their first difference form are shown in the table to determine the stationarity and order of integration. We found that both LogCPI and LogFxr are non-stationary in their level form but stationary in their first difference form at 5% level of significance. So both variables are integrated of order one, i.e. I(1).

4.2 Johansen Co-integration test and Vector Error Correction Model (VECM):

As both variables are integrated of same order, i.e. I(1), we can use Johansen cointegration test to examine the long run relationship. But we need to select the number of lag to conduct Johansen test. Based on Schwarz information criterion (SIC) and Akaike information criterion (AIC), we have selected 14 lags which are justifiable for monthly data. Now Johansen cointegration test can be done and the results are in the following table-3:

Table-3: Johansen Cointegration Test

Maximum Eigen Value Test			Trace Test		
Null Hypoth-esis	Max-Eigen Statistic	Critical Values at 5% level	Null Hypot-hesis	Trace Statistic	Critical Values at 5% level
H0: r=0*	49.74732	14.26460	H0: r=0*	52.67133	15.49471
H0: r=1	2.924018	3.841466	H0: r≤1	2.924018	3.841466

Note: Maximum Eigen value test and Trace test indicate 1 co-integrating equation at the 5% level. * denotes rejection of null hypothesis at the 5% level

Both Maximum Eigen value statistics and trace statistics indicates only one cointegrating relationship or one stationary linear combination among variables at 5% level of significance.

Now VECM is applied to capture the short run dynamics of the variables. The coefficient of the lagged residual term is known as the error correction term which shows the speed of adjustment to the long run relationship if there is any kind of innovation or shocks. VECM estimates are shown in the table-4:

Table-4: Vector Error Correction Estimates

Cointegrating Equation	
LogCPI(-1)	1.000000
LogFxR(-1)	-0.432286
Standard Errors	(0.01979)
t-statistics	[-21.8466]

C	-1.032011	
Error Correction:	D(LogCPI)	D(LogFxR)
Speed of Adjustment	-0.024429	0.175929
Standard Errors	(0.01540)	(0.05836)
t-statistics	[-1.58583]	[3.01433]

It is evident from the cointegration equation that the coefficient of foreign exchange reserve is significant but the sign of the variable in the error correction term is not significant which indicates that foreign exchange reserve does not have a key role in maintain short run stability of the equation. But the error correction term for the first difference CPI is significant and it also indicates the mode of adjustment in CPI. Here, negative sign of first differenced CPI dictates a converging relationship among foreign exchange reserve and consumer price index. The coefficient of CPI in the error correction term is perfectly signed and less than 1 in absolute value. Any kind of deviation from the equilibrium will be corrected through adjustment in CPI by 2% (approx.) in every month.

4.3 Granger Causality Test

As there exist a short run relationship, we can proceed for Granger causality test to identify the direction of short run causality. The results are summarized in table-5

Table 5 : Granger causality test

Null Hypothesis:	F-Statistic	Prob.	Direction of Causality
H_0: DLogFxR does not Granger Cause DLogCPI	2.02575	0.0263	Reject H_0 (FxR causes CPI)
H_0: DLogCPI does not Granger Cause DLogFxR	2.14592	0.0178	Reject H_0 (CPI causes FxR)

We see that the p-values of the F-tests for both the cases are less than 0.05. This implies that there exists a bidirectional causal relationship between variables. The results suggest that the lagged values of foreign exchange reserve granger cause consumer price index and at the same time, the lagged values of consumer price index appear to cause foreign exchange reserve.

5 Conclusion

We can summarize this paper in a way that there is a positive significant relationship between foreign exchange reserve and consumer price index in Bangladesh which is compatible with existing literature. Increasing foreign exchange reserve of Bangladesh is increasing money supply which in turn increasing consumer price index. This study also assures us that there exist a stable long run relationship between CPI and foreign exchange reserve and CPI corrects the disequilibrium phenomena. This study will be helpful for government to prepare and implement monetary policy to have a stable consumer price index in Bangladesh.

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