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Foreign Exchange Market Structure and Exchange Rate Volatility in Bangladesh

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Abstract

Foreign exchange rate volatility is an important factor involved in the decision making of investors and policymakers. This study attempts to measures the volatility behavior in terms of exchange rate returns and volume of daily transactions in foreign exchange market of Bangladesh ranging from July 2014 to June 2018, applying GARCH family models (i.e. PARCH, EGARCH, and IGARCH). The results show that the presence of volatility clustering in foreign exchange rate returns as the volatility of risk is responsive to past shocks and the past volatility influences the current volatility of exchange rate returns. Moreover, the return is positively related to its volatility. The existence of leverage effect is also evidenced in the Bangladesh foreign exchange market because positive past shocks increase volatility more than the negative past shocks of the same magnitude. Thus, the appreciation and the depreciation of Bangladesh Taka against USD do not necessarily cause symmetric variation in the exchange rate returns.

Keywords: Exchange rate, Volatility, ARCH, GARCH

JEL Classification: C52, C58, E44, F31

Introduction

Analyzing foreign exchange rate volatility i.e. fluctuation of the exchange rate with respect to time is essential for corporate decision-makers because such unpredictable movement presents exchange rate risk and uncertainty in the operational environment and increases profit uncertainty. The policymakers, on the other hand, keep an eye on the foreign exchange rate volatility for making economic decisions as it has effects on capital flows and international trade that are crucial for the balance of payments of a country. In addition, FX rate volatility adversely affects the long-term decisions by stirring the volume of global marketing and decisions to allocate resources for investment, sales and procurement policies of governments as investor's confidence to invest in a particular country is inversely related

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to high volatilities in the exchange rate. Because of its important economic and financial implications, monitoring the exchange rate volatility is gaining greater attention in developing countries like Bangladesh.

Kemal (2005) observes that in the medium term, FX rate can influence the balance of payments and level of the overall economic activity while affecting the local consumers and traders in the short run. With significant trade and financial account openness in the last two decades, Bangladesh economy has become considerably more integrated with the global economy. Despite the dominance of domestic demand, the role of foreign flows in conditioning the growth process in Bangladesh has become important over time. The domestic economy now reflects global economic developments reasonably quickly. The deceleration in Bangladesh's growth associated with the current global slowdown is also testimony to the increased global integration of the domestic economy. Recent global developments have significantly transformed the environment in which monetary policy operates. As a consequence, in addition to the usual economic challenges, monetary policy today is faced with the following key challenges like:

- transmission of the uncertainty of global environment into the domestic economy;
- transmission of the volatility of exchange rate and the corresponding adverse impact through the trade, financial, commodity price, and business confidence channels.

The unprecedented momentum in global financial integration in the last two decades has led to an ever-increasing interest among researchers to understand the linkages between exchange rate volatility and monetary policy. In order to curb exchange rate volatility, policymakers and researchers employ quantitative models to determine which macroeconomic and financial factors have important influences on exchange rate volatility.

In line with the above consideration, the objectives of the study are to:

a) analyze how exchange rate volatility behavior is associated with the foreign exchange market structure in Bangladesh and the market behavior as well as the responses of exchange rates with changes of major macroeconomic variables and
b) measure the volatility of exchange rate returns and volatility of transactions in Bangladesh and compare these to India as the neighboring country has multidimensional channels of influences on the Bangladesh economy.

In the era of the financial globalization process, monetary policy authorities have given a high weight to reduce the negative consequences of exchange rate fluctuations on inflation dynamics. To the best of our knowledge, ample studies have been done on the developed markets FX volatility but a few studies have been conducted on Bangladesh. So, this study will also further contribute to a literature on Bangladesh FX market volatility. Moreover, this study differs from the studies conducted earlier on Bangladesh as this study uses updated data along with contemporary econometric tools and techniques to overcome some methodological limitations of the earlier studies on exchange rate volatility. Different GARCH family models have been used in the study to capture the main characteristics of the time series, such as volatility clustering and leverage effect. Moreover, most of the studies on Bangladesh only focus on exchange rate volatility rather than the overall market activities such as transaction volume. The issue of transaction volume is important because unexpected events may affect the transaction volume which has an impact on exchange rate volatility especially reflected on market demand and supply. Accordingly, this study considers the transaction of the FX market and volatilities together instead of considering them separately.

Rest of the study is organized as follows. Following the introduction in section 1, Section 2 reviews some relevant literature on the exchange rate volatility. Section 3 discusses the features of the foreign exchange market structure and operations in Bangladesh. Section 4 specifies data and methodology used in the study and section 5 highlights the results of the models. Finally, section 6 offers the conclusions.

2. Review of the Literature

In the modern integrated world, the exchange rate plays a vital role not only in foreign trade but also in domestic price stability. Chongcheul Cheong, et al (2006) examine the dynamic interrelations between exchange rate uncertainty, international trade, and trading competitiveness in prices, using UK data. The empirical results derived from vector autoregressive (VAR) models show that a shock to exchange rate volatility negatively affects trade volumes, and such negative effects are greater than the effects on trade price levels. Bhanumurthy (2006) finds that a majority of the dealers feel short-term changes in the Indian rupee/US dollar market are basically influenced by the micro variables such as information flow, market movement, speculation, central bank intervention, etc. Khullar and Sethi (2011) measure the volatility of FX market in India found that the exchange rate of EURO is much more volatile than the YEN and US Dollar in the Indian foreign exchange market when comparing their daily volatilities. For all the 3 currencies under this study, they found generally an increasing trend in volatility when volatility is compared along the different time span taken into consideration such as from daily to weekly to monthly.

Among the articles on Bangladesh, Ahmed (2009) analyzes the relationship between exchange rate volatility and international trade growth in Bangladesh. The result shows that the exchange rate volatility has a negative and major effect on trade both in short run and long run with Western European and North American countries. Alam and Rahman (2012) Using GARCH type models,they measured the volatility of exchange rate using daily data for the period of July 2006-April 2012 find that the past volatility of exchange rate significantly influences current volatility. However, in this study limitations like excess skewness and kurtosis issues were detected but not properly addressed. Moreover, the lag specification of the mean equation was not properly addressed in their paper. Estimation with these may show misleading findings.

Younus (2014) finds that Bangladesh's export to India is sensitive to India's Rupee depreciation and Bangladesh's imports are very sensitive to the relative price level changes. Rahman &Ghosh (2013) detect that the forecasted exchange rates have not been exactly convergent to the market exchange rates and the volatility has been mounting. Hossain & Ahmed, (2009) conclude that expansionary monetary policy has a high exchange rate pass-through with high market pressure. Moreover, lowering the REER volatility has positive impact on overall exports.

Kamal Uddin et al (2013) investigate the fluctuation in the exchange rate of Bangladesh observes that stock of money and increase in debt service burden results in a real depreciation of currency while increasing foreign exchange reserve results in a real appreciation of the currency. Moreover, political instability has a significant negative effect on the value of the domestic currency. Another study by Abdullah et al (2017) examine exchange rate volatility using daily exchange rates for 7 years (January 1, 2008 - April 30, 2015) found that, in contrast with the normal distribution, the application of Student's t-distribution for errors helped the models satisfy the diagnostic tests and show improved forecasting accuracy. This study has also limitations since only the AR process is used in the mean equation but ARMA process may be more appropriate.

Our approach differs from the current literature that we measure the volatility of exchange rate using GARCH type models including GARCH in Mean equation with the objectives of measuring Foreign exchange rate volatility and also examining the foreign exchange market structure in Bangladesh. We not only measure the volatility of the exchange rate but also the volatility of transactions volume. Moreover, in this study, we compare the foreign exchange market of Bangladesh with that of India, a major trade partner.

3. Features of the FX Market: Structure and Operations

3.1 Volume of Transactions is increasing over time: All types of current transactions (excluding interbank) such as export earnings, import payment, remittance earnings are transected by the authorized dealer banks deal with customers increased over time (chart-1).
At present 57 scheduled banks with 1010 branches and 225 money changers are doing their FX businesses in Bangladesh. Mainly two types of transactions take place in Bangladesh FX market namely interbank and other than interbank. Authorized dealer banks are engaged in interbank transactions while both banks and money changers are engaged in transactions with the customers. In addition to the formal markets such as banks and money changers, there are some informal transactions which are called curb market transactions. In spite of major transactions occurred in USD, the interbank market is divided into 'US Dollar' and 'Non-Dollar' segment (includes all currencies other than USD, but calculated in equivalent USD units).

Among the typical foreign exchange instruments such as Spot, Forward and SWAP; the SWAP remained the dominant trading instrument during our sample period in Bangladesh foreign exchange market (chart-2). During FY18 the percentage share of SWAP, Spot and Forward transactions were 88%, 9% and 3% respectively while during FY17 the percentage share of SWAP, Spot and Forward transactions were 75%, 19% and 6% respectively. Decline in transaction of Spot and Forward as reflected in the percentage share of their transactions in FY18 compared to FY17 may be attributable to the higher weighted average exchange rate in FY18 than that of in FY17 (chart-3). So, a relationship between the exchange rate and the transaction type is also observed in Bangladesh FX market.

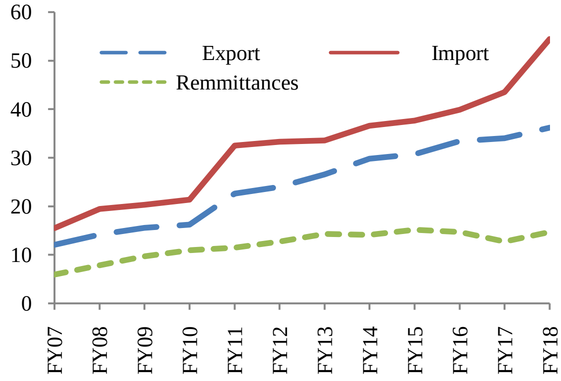


Chart-1: Trends in Exports, Imports & Remittances (billion USD)

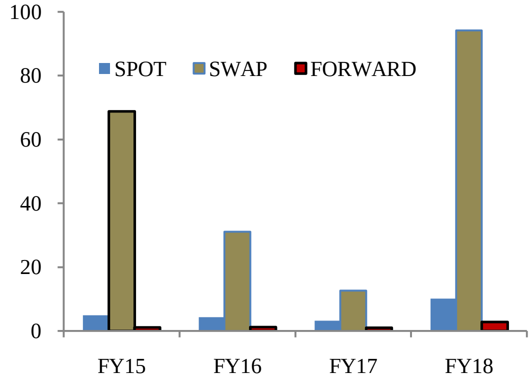


Chart-2: Interbank Foreign Exchange Transaction (billion USD)

3.2 Exchange rate and transaction volume have the opposite relationship: The exchange rate is broadly determined by the market forces such as the interactions of demand for and supply of the foreign currencies. However, Bangladesh Bank (BB) for the purpose of monetary management oversees the FX market movements vis-a-vis the exchange rate and occasionally intervenes in the market to ensure liquidity and stability of the exchange rate thereby helps build the confidence of the market. In the interbank foreign exchange market the transaction volume has fallen sharply since October 2015, when Taka–USD exchange rate shot up and the transaction further declined after another pick up in the exchange rate since mid-2018. The dominance of the market forces reflected in the negative relationship between the weighted average exchange rate and the volume of interbank foreign transaction is shown in the chart-4. The degree of correlation between them is 0.26 which is statistically significant at the 1% level.

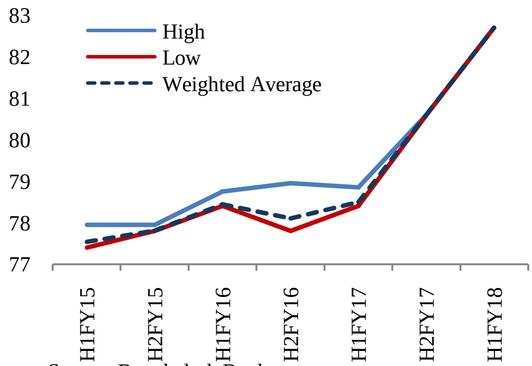


Chart 3: Interbank USD-BDT Exchange Rate BDT per USD

Source: Bangladesh Bank.

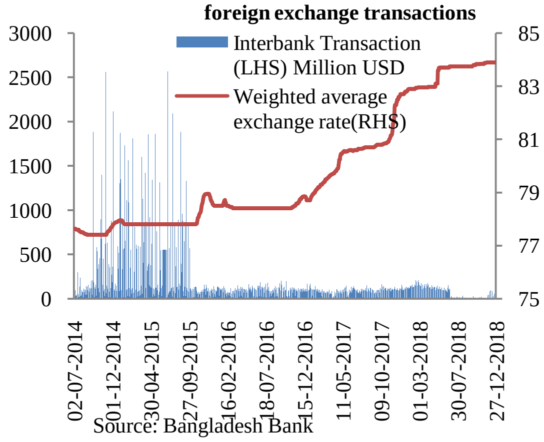


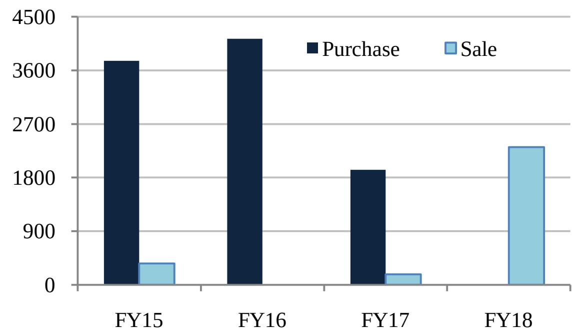
Chart 4: Exchange rate movements and daily turnover foreign exchange transactions

Source: Bangladesh Bank

During FY15-FY16 supply of foreign exchange in the market was adequate putting appreciation pressure on the taka (chart-3) as a result BB purchased US dollar 3,758.45 million, 4,131 million, and 1,931 million during FY15, FY16 and FY17 respectively. On the other hand, from the second half of FY17, it was observed that demand of foreign exchange in the market goes beyond the supply creating depreciation pressure on taka, as a result, BB sold US dollar 175 million and 2311 million during the second half of FY17 and FY18 respectively (chart-5).

3.3 FX market of Bangladesh follows economic fundamentals: The correlation matrix in table-1 shows that the nominal exchange rate is negatively correlated with current account balance and the degree of correlation is 0.60 which is statistically significant at 1% level.

Chart 5: Foreign Currency Purchase and Sale by BB (million USD)



Source: Bangladesh Bank.

Table:1 The Correlation Matrix

Correlation t-Statistic Probability	Exchange rate	Current account balance	Growth in private sector foreign debt	Domestic interest rate
Nominal Exchange rate	1.00			
Current account balance	-0.60 -3.43 0.003	1.00		
Growth in private sector foreign borrowings	-0.08 -0.39 0.70	0.23 1.08 0.29	1.00	
Domestic interest rate	-0.27 -1.28 0.21	0.44 2.27 0.03	0.44 2.22 0.04	1.00

Private foreign borrowing has an off-putting effect on the exchange rate as the data in correlation matrix support this argument. Accordingly, exchange rate shows an expected negative relationship with the domestic interest rate as the interest rate differential moves along with the movement of the domestic interest rate. The business and enterprises increase their borrowing from abroad instead of domestic financial institutes when the domestic interest rate is relatively high. The degree of negative correlation between the exchange rate and the growth of private sector foreign borrowings is 0.08 quietly not remarkable and also statistically insignificant even at the 10% level.

The relationship between the domestic interest rate and the exchange rate is indirect as the high-interest rate attracts more capital inflow which turns down the exchange rate by mounting the supply of foreign currency. Data used in the correlation matrix rightly demonstrates a negative correspondence with exchange rate by 0.27 degree of association but is statistically insignificant even at the 10% level.

4. Data and Methodology

To explore the volatility in the Bangladesh foreign exchange market, the daily foreign exchange rate of BDT per USD and daily transaction volume for the period of 2nd July 2014 to 27th June 2018 with 979 observations has been collected for the study from Bangladesh Bank. A the same time, to examine the influence of different economic variables on the volume of interbank foreign exchange transaction, yearly data on export, import, remittance, private sector foreign debt, current account balance, the domestic interest rate has been collected from BB website. To compare the volatility of Bangladesh foreign exchange market with neighboring India, data on Indian rupee-USD exchange and daily transaction volume has been collected from Reserve Bank of India (RBI) on a daily basis. Because of the nonstationary property of exchange rate series, the study converted the exchange rate series into the rate of return on the exchange rate by the following logarithmic transformation due to Alam and Rahman (2012) and Abdullah et al (2017) and uses the transformed series in our analysis. The adopted the logarithmic transformation to make the daily returns series stationary by using the following formula:

$$R_t = log\left(\frac{ER_t}{ER_{t-1}}\right) * 100$$

Here, R_t is the return on the exchange rate at period t; ER_t and ER_{t-1} are the exchange of the BDT per USD at period t and $(t-1)$. This formula for return has already been used by other authors for example, Kamal et al (2011) and Ece Oral (2012).

4.1 Model Specification:

4.1.1 GARCH models: GARCH models are assumed to be appropriate for understanding the dynamic behavior of exchange rate variables and derive variance series for volatility. Volatility is the common feature of the most financial series. To model volatility, Engle (1982) first introduced the autoregressive conditional heteroskedastic (ARCH) model. To predict volatility the model requires estimating a large number of parameters. To solve the problem Bollerslev(1986) proposed the generalized autoregressive conditional heteroskedastic (GARCH) model which reduces the number of required lags.

Appropriate specification of the mean equation plays an important role in the GARCH model. Any misspecification of the model will not be able to detect the autocorrelation problem in volatility model. So, the study uses three different models for mean equations where the first equation contains only constant, second equation includes *p* order autoregressive term with a constant and third equation follow an ARMA (p, q) process. Mean Equations are as follows:

$$R_t = \omega + \varepsilon_t \ldots\ldots \quad (1)$$

$$R_t = \omega + \varphi_1 R_{t-1} + \ldots\ldots\ldots + \varphi_p R_{t-p} + \varepsilon_t \ldots\ldots \quad (2)$$

$$R_t = \omega + \varphi_1 R_{t-1} + \varphi_2 R_{t-2} + \ldots\ldots + \varphi_p R_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} \ldots + \theta_q \varepsilon_{t-q} \quad (3)$$

GARCH_M (1, 1): $R_t = \omega + \lambda e_t + w_t$ where $w_t = e_t \eta_t$ (4)

The general form for the variance equation: $e_t = \sqrt{w_t}\, z_t$ where $z_t \sim iid(0,1)$

Based on the specification of w_t in variance equation several possible models within the GARCH family can be done as different models have aimed to capture different feature of volatility. To specify the variance equation to model volatility presence in the exchange rate returns, following models of the GARCH family have been used to measure volatility in exchange rate returns.

GARCH (1, 1): $w_t = \theta + \propto e_{t-1}^2 + \beta w_{t-1}$ $\theta > 0, \propto \geq 0, \beta \geq 0$ and $\propto + \beta \leq 1$

PARCH (1, 1): $w_t^\rho = \theta + \propto (|e_{t-1}| - \mu e_{t-1})^\rho + \beta w_{t-1}^\rho$ $\rho > 0,\ |\mu| \leq 1$

EGARCH (1, 1): $lnw_t = \theta + \propto \left|\frac{e_{t-1}}{\sqrt{w_{t-1}}}\right| + \mu \left(\frac{e_{t-1}}{\sqrt{w_{t-1}}}\right) + \beta lnw_{t-1}$

IGARCH (1, 1): $w_t = \propto e_{t-1}^2 + (1 - \propto) w_{t-1}$ $\{\alpha + (1 - \alpha)\} = 1$ and $0 < \alpha < 1$.

$\propto$ is the coefficient that measures the extent to which a volatility shock today feeds through the next period volatility, while $\propto + \beta$ is usually considered to be a measure of the persistence of volatility shock and it measures the rate at which this effect dies over time.

The PARCH model is an extension of GARCH with an extra term added to account for possible asymmetries or leverage effect. In the above PARCH model, ρ denotes the power parameter that requires condition $\rho > 0$, and μ is the parameter capturing asymmetry or leverage effect, which requires the condition $|\mu| \leq 1$.

A typical feature of financial data is that negative shocks generate more volatility compared to positive shocks. It has been shown that the symmetric GARCH models may not capture some important features of the data since they assume symmetric response of volatility to positive and negative shocks. The EGARCH is an asymmetric model that specifies the logarithm of the conditional volatility and avoids the need for any parameters constraints. In the EGARCH specification, μ is the asymmetry parameter measuring leverage effect, $\propto$ is the size parameter measuring the magnitude of shocks, and β is the persistency parameter.

5. Results and Discussion

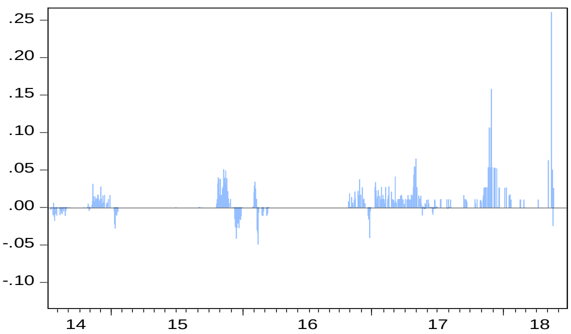
5.1 Measuring Exchange Rate and Transaction Volatility:

5.1.1 Estimation Output Taka-USD Exchange rate: Prior to measuring the volatility of exchange rate return the study estimates the summary statistics and test the stationary of the exchange rate returns. The average rate of return is 0.00335 with a standard deviation of 0.015 which indicates the exchange rate return is highly volatile (table-2). This conclusion is also evident from chart-6.

Table-2: Summary Statistics Taka-USD Exchange rate

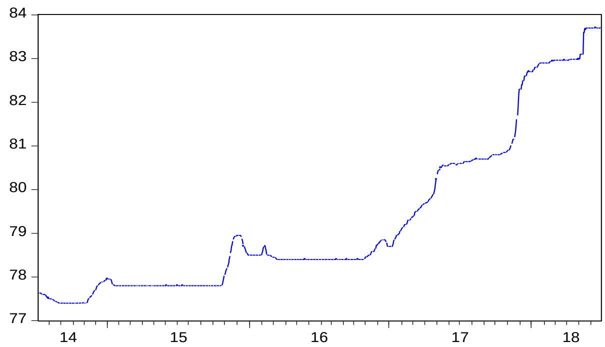
Average	Std. Deviation	Kurtosis	Skewness	JB test	P-value
0.003351	0.014966	108.6001	7.637428	464401.4	0.003

Chart-6
Exchange rate returns



Source: Bangladesh Bank.

Chart-7
Exchange rate



Source: Bangladesh Bank.

Table-3: Unit root test

	Level				First difference			
	ADF test		PP test		ADF test		PP test	
Series name	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend
Exchange rate	1.349	-1.110	1.871	-0.901	-7.994*	-8.268*	-27.174*	-27.095*
Exchange rate return	-7.933*		-26.858*					

* Indicates significant at 1% level

Table-3 shows the exchange rate of taka/USD is non-stationary at level but becomes stationary at first difference (chart-7). The series of exchange rate return is stationary at level as revealed from ADF and PP unit root test.

In Table-4 the result of the mean equation with five GARCH models has been summarized. Mean equation indicates that the exchange rate return series follow an ARMA(1,1) process with constant. Both AR(1) and MA(1) terms are statistically significant at 1% level, which indicates that the past day exchange rate return and past day shocks significantly affect current day exchange rate returns. Since higher-order ARMA terms are not statistically significant the mean equation was not augmented with further ARMA terms. To measure the effect of volatility on return of exchange rate we estimate the GARCH_M model. The value of the coefficient λ=0.415 which indicates that return is positively related to its volatility and the coefficient is statistically significant. The F-statistic of the model is significant which indicates the presence of ARCH effect in the exchange rate return series. The existence of volatility is also evident from residual series in chart-8.

Table-4: GARCH Models

Dependent variable R_t

Variables/Coefficients	Mean equation		Model-1	Model-2	Model-3	Model-4
	ARMA	GARCH_M	GARCH	PARCH	EGARCH	IGARCH
ω	0.003 (0.003)		0.003 (0.002)	0.003 (0.002)	0.001* (8.40E-05)	0.006* (0.001)
R_{t-1}	0.901* (0.014)	0.675* (0.087)	0.926* (0.038)	0.930* (0.028)	0.992* (0.001)	0.905* (0.015)
ε_{t-1}	- 0.673* (0.019)	-0.515* (0.131)	-0.528* (0.065)	-0.588* (0.053)	-0.977* (0.001)	-0.194* (0.020)
λ		0.415* (0.031)				
θ			3.24E-06* (1.77E-07)	1.11E-11 (3.05E-11)	-1.011* (0.033)	
$\propto$			0.457* (0.041)	0.393* (0.061)	0.928* (0.037)	0.056* (0.0001)
ρ				4.314* (0.499)		
μ				-0.090* (0.035)	-0.147* (0.028)	
β			0.710* (0.0124)	0.558* (0.0356)	0.954* (0.003)	0.943* (0.0001)
Inverted AR roots	0.90	0.68	0.93	0.93	0.99	0.91
Inverted MA roots	0.67	0.51	0.53	0.59	0.98	0.19
F-statistic	5.385**		0.005	0.009	0.022	3.455**
P-value	0.021		0.943	0.926	0.882	0.063

* Indicates significant at 1% level, ** Indicates significant at 5% level

To capture variance dynamics GARCH (1,1) model has been estimated with the normal error distribution assumption. The Coefficients of the model are ($\propto = 0.457$ and $\beta = 0.710$) statistically significant which imply that the volatility of risk is responsive to past shocks and the past volatility is influencing the current volatility of exchange rate returns by 71%. Since the sum of the coefficients is greater than one (1), the residuals of the model are non-stationary.

To test the presence of asymmetric volatility effects PARCH (1,1) model has been estimated. The coefficients of $\propto$ and β are found to be statistically significant. The coefficient μ is statistically significant which indicates the presence of leverage effect. The negative value of μ implies the existence of a leverage effect where positive past values of e_t increase volatility more than the negative past values of the same magnitude. That is, appreciation and depreciation of taka against USD do not necessarily cause symmetric variation in the exchange rate returns.

Chart-8

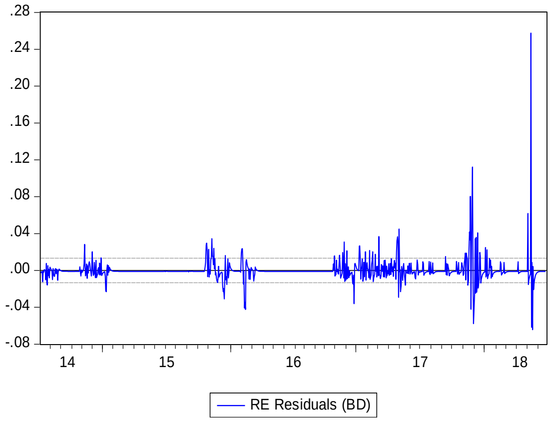
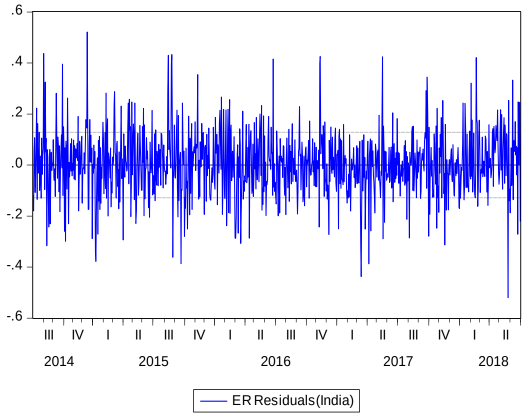


Chart-9



In the variance equation, the constant term of PARCH model is significantly different from zero. Thus the non-negativity restriction does not hold. To solve the problem of non-negativity restrictions, we use the EGARCH model. The ARMA(1,1) terms are statistically significant in EGARCH. In the variance equation, μ is significant which implies the presence of asymmetric behavior on volatility. Since EGARCH supports the PARCH result of the asymmetric behavior of volatility, the study did not estimate the TGARCH model.

In all models, the F-statistic shows that there is no ARCH effect which means no autocorrelation in the residuals.

The sum of GARCH parameters is greater than one in model-2 implies that the variance may not be well behaved. To model volatility by imposing restrictions that the sum of GARCH parameters is one leads to IGARCH specification. The result of the model shows that the restriction is valid and the model overcomes all of the diagnostic tests.

The inverted roots of the AR and MA terms are less than one in all models which imply the stability of the models.

5.1.2 Estimation Output Rupee-USD Exchange rate: Table-5 shows the exchange rate of Indian rupee/USD is non-stationary at level, but becomes stationary at first difference. The series of exchange rate return is stationary at level as revealed from ADF and PP unit root test.

Table-5: Unit root test for Rupee/USD

Series name	Level				First difference			
	ADF test		PP test		ADF test		PP test	
	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend
Exchange rate	-1.852	-1.900	-1.877	-1.939	-30.261*	-30.253*	-30.262*	-30.253*
Exchange rate returns	-30.217*		-30.220*					

* Indicates significant at 1% level

Table-6: GARCH Models

Dependent variable R_t

Variables/Coefficients	Mean equation	Model-1	Model-3
	ARMA	GARCH	EGARCH
ω		0.004 (0.004)	0.005 (0.004)
R_{t-1}	-0.887* (0.102)	0.345 (2.161)	0.328 (2.702)
e_{t-1}	0.914* (0.090)	-0.357 (2.148)	-0.338 (2.692)
θ		0.008* (0.003)	-1.575* (0.397)
∝		0.118* (0.032)	0.226* (0.046)
μ			0.114* (0.031)
β		0.398* (0.182)	0.661* (0.094)
Inverted AR roots	-0.89	0.34	0.33
Inverted MA roots	-0.91	0.36	0.34
F-statistic	17.50*	0.448	3.50
P-value	0.00	0.503	0.062

* Indicates significant at 1% level, ** Indicates significant at 5% level

In Table-6 the result of the mean equation with GARCH models of foreign exchange returns of Indian Rupee with USD has been summarized.

Mean Equation indicates that the exchange rate return series follow an ARMA(1,1) process with no constant. Both AR(1) and MA(1) terms are statistically significant at 1% level, which indicates that the past day exchange rate return and past day shocks significantly affect current day exchange rate returns. Since higher-order ARMA terms are not statistically significant the mean equation was not augmented with further ARMA terms. The F-statistic of the model is significant which indicates the presence of ARCH effect in the exchange rate return series. The existence of volatility is also evident from residual series in chart-9.

To capture variance dynamics GARCH (1,1) model has been estimated. The Coefficients of the model for India are ($\propto = 0.118$ and $\beta = 0.398$) statistically significant which imply that the volatility of risk is responsive to past shocks and the past volatility is influencing the current volatility of exchange rate returns by almost 40%. Since the sum of the coefficients is less than one (1), the residuals of the model are stationary.

To overcome the problem of non-negativity restrictions, we use the EGARCH model. In the variance equation, μ is significant which implies the presence of asymmetric behavior on volatility. That is, appreciation and depreciation of the Indian Rupee against USD do not necessarily cause symmetric variation in the exchange rate return.

In both models, the F-statistic shows that there is no ARCH effect which means no autocorrelation in the residuals. Since the sum of GARCH parameters is less than one, the study does not estimate the IGARCH model. The inverted roots of the AR and MA terms are less than one in all models which imply the stability of the models.

5.2 Transaction Volatility for Bangladesh and India

Table-7 shows the unit root test results of the daily turnover of foreign exchange transactions both in Bangladesh and India. The result indicates that the daily turnover of foreign exchange is stationary at level in both countries as revealed from ADF and PP unit root test.

Table-7: Unit root test for Daily turnover

Series name	Bangladesh				India			
	ADF test		PP test		ADF test		PP test	
	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend	Intercept	Intercept &trend
Daily Turnover	-3.920*	-5.095*	-32.54*	-31.234*	-23.97*	-24.261*	-25.94*	-25.78*

* Indicates significant at 1% level

In Table-8, the result of the mean equation with GARCH models of daily turnover of foreign exchange has been summarized. Mean Equation indicates that the transaction volume series follow an ARMA(1,1) process with no constant in case of Bangladesh and with a constant in case of India. Both AR(1) and MA(1) terms are statistically significant at the 1% level, which indicates that the past day turnover and past day shocks significantly affect current daily turnover. The existence of volatility is evident from residual series in chart-10 and 11.

To capture variance dynamics GARCH(1,1) model has been estimated. The Coefficients of the model for Bangladesh are ($\propto = 0.0745$ and $\beta = 0.8929$) statistically significant which imply that the volatility of risk is responsive to past shocks and the past volatility is influencing the current volatility of daily turnover by almost 90%. The sum of the coefficients is 0.96 shows the persistence of volatility shocks. Since it is less than one (1), the residuals of the model are stationary.

Table-8: GARCH Models

Dependent variable: Daily Turnover

	Bangladesh		India	
	Mean equation	Variance Equation	Mean equation	Variance Equation
Variables/Coefficients	ARMA	GARCH	ARMA	GARCH
ω	139.52 (202.35)	84.089* (3.397)	54806.8* (870.38)	51932.3* (645.92)
R_{t-1}	0.997* (0.0016)	0.952 (0.0203)	0.660* (0.072)	0.383* (0.095)
e_{t-1}	-0.957* (0.0077)	-0.905* (0.0336)	-0.452* (0.076)	-0.1031* (0.120)
θ		207.68* (58.83)		824078.62* (61607.34)
∝		0.0745* (0.020)		0.468* (0.067)
β		0.8929* (0.0198)		0.2433* (0.042)
Inverted AR roots	0.99	0.95	0.66	0.38
Inverted MA roots	0.96	0.91	0.45	0.10

* Indicates significant at 1% level, ** Indicates significant at 5% level

Chart-10

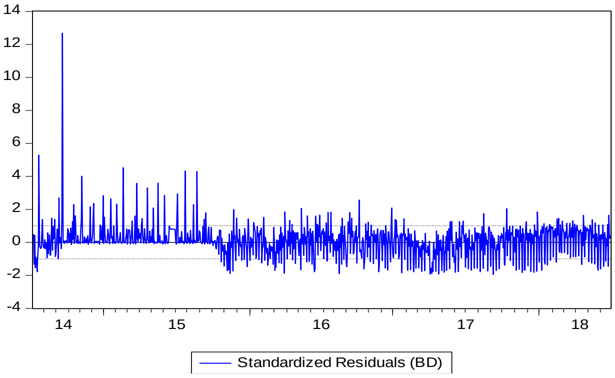
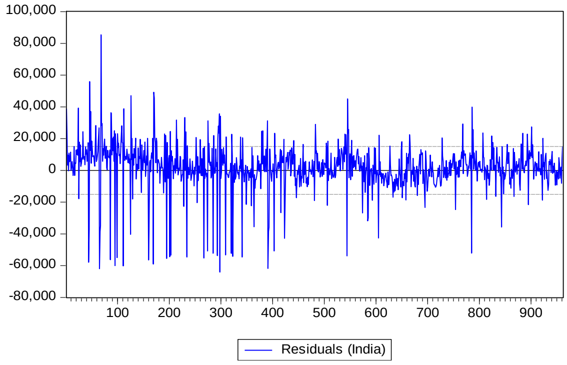


Chart-11



The Coefficients of the GARCH(1,1) model for India are ($\propto = 0.468$ and $\beta = 0.243$) statistically significant which imply that the volatility of risk is responsive to past shocks and the past volatility is influencing the current volatility of exchange rate returns by almost 71%. The sum of the coefficients is 0.711 shows the persistence of volatility shocks. Since it is less than one (1), the residuals of the model are stationary. So, it can conclude that the volume of daily foreign exchange turnover of the Indian foreign exchange market is more volatile than that of the Bangladesh foreign exchange market.

6. Conclusion and Recommendations

The size of the foreign exchange market in Bangladesh is small in terms of volume of transactions and the use of instruments. However, the size of the market is increasing over time. There is a negative relationship between exchange rate movement and the current account balance. This phenomenon indicates that Bangladesh foreign exchange market follows the economic fundamental of the country. The negative relationship between the exchange rate and the growth of private sector foreign borrowing is low and statistically insignificant. Moreover, the relationship between the nominal exchange rate and the domestic interest rate shows a weak and statistically insignificant that indicates a more indirect relationship between the variables as capital flows are not entirely open in Bangladesh.

The first order auto-regressive behavior of foreign exchange rate returns was evidenced in ARMA process while GARCH (1,1) model support the presence of volatility clustering i.e. the volatility of risk is responsive to past shocks and the past volatility is influencing the current volatility of exchange rate returns. The PARCH (1,1) model confirms the existence of leverage effect i.e. the positive past shocks increase volatility more than the negative past shocks of the same magnitude so the appreciation and depreciation of BDT against USD do not necessarily cause symmetric variation in the exchange rate return. The existence of volatility clustering and the leverage effect in the foreign exchange market of Bangladesh indicates the weak form of efficiency of the market. To make the foreign exchange market more dynamic, vibrant and competitive market size should be expanded with proper management in place.

This study reveals that high importance should be given to both monetary and non-monetary factors in the open-economy framework to detect the possible impacts on trade and capital flows. The empirical findings of this study would guide the monetary authority in formulating and conducting monetary policy and help achieve the ultimate goal of monetary policy.

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