

Interaction of Inflation, Interest Rate and Remittance with Exchange Rate in Bangladesh

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Abstract: *This paper deals with the interaction of inflation rate, interest rate, and remittance with exchange rate in Bangladesh. The study is confined to Bangladesh and study period is from January 2004 to December 2013. Regression and correlation analysis are done with the help of Statistical Package for Social Science (SPSS) to analyze whether the exchange rate is influenced by the changing pattern of inflation rate, interest rate, and remittance or not. Here exchange rate is considered as a dependent variable and inflation rate, interest rate, and remittance are as independent variables. N-way analysis is conducted to find out whether the relationship is strong or not. Causal research approach is used to accomplish this analysis and MS Excel, Equation are used for processing and analyzing the data. Three-month FDR is used as interest rate to find out the relationship with exchange rate. The result shows the strong and positive relationship of interest rate and remittance with exchange rate. Inflation rate also shows positive but weak relationship with exchange rate because if inflation changes, exchange rate does not change by the same changing pattern.*

Keywords: Inflation; Interest Rate; Remittance; Exchange Rate; Interaction

1. Introduction

Exchange rate is the current market price for which one currency can be exchanged for another. As exchange rate plays important role in a country's competitiveness level, currency exchange rates are among the most analyzed and forecasted indicators in the world. The exchange rate is determined by the level of supply and demand for currency in the international markets. However, changes in foreign exchange market rates are often difficult to understand and to predict because the market is very large and volatile. The demand and supply of currency is influenced by the interest rate, inflation rate, and remittance. So these are called the influencing factors of exchange rate. Other significant factors that persuade the exchange rate are speculation, change in competitiveness, relative strength of other currency, balance of payments, government debt, government intervention, and economic growth or recession. The motive of this paper is to analyze the interaction of inflation, interest rate, remittance with exchange rate in Bangladesh. Inflation is the rate at which the general level of prices for goods and services is rising and, subsequently, the purchasing power is falling. Bangladesh Bank attempts to stop severe inflation, along with severe deflation, in an attempt to keep the excessive growth

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of prices to a minimum. Most countries' central banks try to sustain an inflation rate of 2-3%. But the inflation rate on January 2014 is 7.50% and February is 7.44% in Bangladesh (Bangladesh Bureau of Statistics, 2014). On the other hand, interest rate is the rate at which a debtor pays interest for the use of money that he borrows from the creditor (Investor words 2014). It is a vital tool of monetary policy and is taken into account when dealing with variables like investment, inflation and unemployment. Remittance is a transfer of money sent by a foreign worker to a home country, which is playing an important role in the economy of many developing and low-income countries and it has significant impact on country's exchange rate. Here the analysis is done to find out whether the exchange rate is changing for per unit changing of inflation, interest and remittance and whether the relationship is positive or not.

2. Objective of the study

Exchange rate is changing over time based on some factors. Interest rate affects the foreign investment, which control the demand and supply of currency and therefore influence the exchange rate. Inflation and remittance also affect the currency demand and supply. It reveals that they are correlated. The general objective of this analysis is to quantify the interaction of inflation rate, interest rate, remittance with exchange rate in Bangladesh. Based on the general objective the specific objectives are:

- To find out the relationship between inflation rate and exchange rate.
- To quantify the relationship between interest rate and exchange rate.
- To find out the relationship between remittance and exchange rate.
- To make out the nature of relationship among those variables.

3. Methodology of the study:

3.1 Research Approach

For the convenience of the study, causal research approach is applied to conduct the study and presented the result so obtained.

3.2 Sampling

The period of this study is 10 years begins from January 2004 to December 2013.

3.3 Research design

The decisive part of this analysis is to find out the relationship between dependent variable and independent variables. Regression analysis is performed to analyze the relationship because it is easy and more appropriate to find out the average probable change in dependent variable given a certain amount of change in independent variable with the help of regression. Exchange rate is used as a dependent variable in this report. On the other hand, the independent variables are inflation rate, interest rate, and remittance. Here the relationship among these variables is analyzed.

3.4 Data collection

To quantify the relationship between dependent variable and independent variable, data was collected by using different procedures. Among the independent variables, monthly inflation rate was collected from Bangladesh economic indicator published by Bureau of Statistics of the Bangladesh. Then the monthly data was annualized. Monthly interest rate of three- month fixed deposit of Uttara Bank was collected and analyzed after annualizing. The sources of annual remittance collection of Bangladesh are Business Report of The Daily Star published on Tuesday, January 3, 2012 and remittance of 2013 and Monthly exchange rates were collected from the reports of Bangladesh Bank (BB 2014). Different researchers use t- bill rate to analyze the relationship between interest rate and the exchange rate. As 91-day t-bill rate of 10 years is unavailable, three month FDR is used as a surrogate instead of t-bill rate. BDT / USD quote is used and other exchange rate quotes are ignored.

3.5 Measurement of variables

- **Dependent variable**

Exchange rate is the dependent variable. Monthly exchange rate changes are considered and to annualize it the following formula of arithmetic mean is used:

$$A = \frac{1}{n} \times \sum_{i=1}^n x_i$$

Where, A is average (or arithmetic mean), n is the number of terms (e.g., the number of items) and x_i is the value of each individual item in the list of numbers being averaged.

- **Independent variable**

Inflation: Monthly inflation rate is annualized through the arithmetic mean.

Interest Rate: Interest rate fluctuates monthly for this reason to annualize it arithmetic mean is used. When monthly data were not available, then total of highest and lowest rate is divided by two to derive the yearly average interest rate.

Remittance: Monthly remittances are summed up to calculate annual remittance.

- **Regression Model**

To analyze the relationship between the dependent variable and independent variable, the multiple regression equation is used which is as follows:

	Y = a + b₁X + b₂Z + b₃R	
Where	a=Constant	b ₁ = Beta coefficient/ slope of X
	X=Inflation	b ₂ = beta coefficient/ slope of Z
	Z = Interest rate	b ₃ = beta coefficient/ slope of R
	R = Remittance	Y =Exchange rate

3.6 Software used

MS Excel and SPSS-16.0 were used for processing and analyzing the data.

3.7 Procedure of Data analysis

Several statistical tools were used to analyze and evaluate the data. Data was mostly collected from secondary sources. Especially mean and regression are used as basic tools of analysis and evaluation. To quantify the relationship of inflation rate, interest rate, remittance and exchange rate regression analysis is conducted. Correlation coefficient measures the strength and direction of relationship among variables. Through the coefficient of determination, it is revealed that the proportion of change of dependent variable can be predicted from the change of independent variables. N-way ANOVA is used for regression analysis. t-test is worked out to know whether the relationship is strong or weak among the variables. Graphical presentation of partial regression plot is used to show the relationship graphically.

3.8 Hypothesis

Three hypotheses are developed to analyze the relationship between dependent variable and independent variables. The hypotheses of this study are:

H₁: There is no significant relationship between Inflation and exchange rate.

H₂: There is no significant relationship between interest rate and exchange rate.

H₃: There is no significant relationship between remittance and exchange rate.

5. Literature Review

Wellington Madesha, Clainos Chidoko and James Zivanomoyo conducted research to find out the empirical relationship between exchange rate and inflation in Zimbabwe during the period 1980 to 2007. Using Granger Causality test estimated results revealed that both the exchange rate and inflation have long run relationship. On the other hand, inflation and exchange rate are found to Granger-cause each other during the period under consideration (Wellington *et al.* 2013).

Francis Danjuma, Shuaibu, Yunusa Sa'id analyzed the impact of exchange rate volatility on inflation in Nigeria economy. Annual time series data from 1986 to 2010 were employed for their study. They employed different model in their study includes; VECM model (Vector Error Correction Mechanism), impulse response function, variance decomposition were the major tools of analysis. Their studied results indicated a negative shock between exchange rate and inflation that is a one percent increase in inflation rate leads to about 42 percent decrease in exchange rate. The major findings from their analysis showed the presence of volatility and the volatility is persistent (Francis *et al.* 2013).

Shalishali, Maurice K. Ho, Johnny C. (2002) conducted a test of international fisher effect for eight selected industrialized nations namely: Canada, France, Germany, Japan, The Netherlands, Sweden, Switzerland, and the United Kingdom. The results were mixed. While the theory holds for some countries, it does not hold for others. The theory holds when some countries were used as home country but was refuted when they were used as foreign countries. This suggests that there may be some impediments to foreign trade that may affect exchange rate adjustment apart from interest and inflation rates differentials.

Gazi M. Hassan and Mark J. Holmes (2012) analyzed the relationship between remittances and the real effective exchange rate which examined the long-run relationship between remittances and the real exchange rate for less developed countries using a panel co-integration approach. They employed an innovative method for the measurement of the multilateral real effective exchange rate and focused on high remittance economies. The study revealed a small inelastic, but significant, long run relationship, which confirms a “Dutch disease” type effect.

5.1 Proposition

Based on the analysis of different researchers, which is discussed above, following statement are produced:

- 1) There is a significant relationship amid inflation and exchange rate but sometimes it is meandering.
- 2) There is a remarkable relationship between interest rate and exchange rate.
- 3) There is a noteworthy relationship between remittance and exchange rate but sometimes it reveals small inelasticity.

6. Result and Discussion

N-way Analysis of Inflation, Interest rate, Remittance and Exchange rate

Descriptive Statistics: Descriptive statistics represents the mean and standard deviation of the dependent and independent variables. Here exchange rate is the dependent variable shows mean and standard deviations of 10-year period are BDT. 70.1567 and 6.51154. Independent variables are inflation, interest rate and remittance, which represent mean for the sampling period are 7.9910, 8.7708 and 9,078.4470 correspondingly. Standard deviation for inflation, interest and remittance are 1.38783, 2.00736 and 3,903.61266.

Table 1. Descriptive Statistics

Particulars	Mean	Std. Deviation	N
Exchange rate	BDT. 70.1567	\$6.51154	10
Inflation	7.9910	1.38783	10
Interest	8.7708	2.00736	10
Remittance	\$9,078.4470	\$3,903.61266	10

Correlation of variables

Table 2. Correlations

		Exchange rate	Inflation	Interest	Remittance
Pearson Correlation	Exchange rate	1.000	0.362	0.910	0.900
	Inflation	0.362	1.000	0.320	0.300
	Interest	0.910	0.320	1.000	0.850
	Remittance	0.900	0.300	0.850	1.000

Sig. (1-tailed)	Exchange rate		0.152	0.000	0.000
	Inflation	0.152	.	0.184	0.200
	Interest	0.000	0.184	.	0.001
	Remittance	0.000	0.200	0.001	.
N	Exchange rate	10	10	10	10
	Inflation	10	10	10	10
	Interest	10	10	10	10
	Remittance	10	10	10	10

The correlation matrix indicates the linear relationship between two variables. Pearson correlation measures the strength and direction of relation between two or more variable. The correlation between inflation and exchange rate shows positive relation that means if inflation change exchange rate also change. Nevertheless, the relationship is weak because the correlation between inflation and exchange is 0.362, which is less than 0.50³. Linear relationship of interest rate and exchange rate is strong and positive. The linearity between interest and exchange rate is 0.91, which is greater than 0.80^{3*}. Remittance and exchange rate also shows strong and positive relation because the correlation between the variable is 0.90. If one-unit changes in remittance, the exchange rate changes by 0.90. One tailed significance level is used to analyze the cause and effect relation between dependent variable and independent variable.

Regression Analysis: Model Details

Table 3. Variables Entered/Removed

Model	Variables Entered	Variables Removed	Method
1	Remittance, Inflation, Interest ^a	.	Enter
a. All requested variables entered.			
b. Dependent Variable: Exchange rate			

Model Summary

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.943 ^a	0.889	0.834	\$2.65236
a. Predictors: (Constant), Remittance, Inflation, Interest				
b. Dependent Variable: Exchange rate				

³ A correlation greater than 0.8 is generally described as strong and less than 0.50 is weak. Available at <http://mathbits.com>.

The table presents R that means linear correlation coefficient, which measures the strength and the direction of a linear relationship between variables⁴. The correlation coefficient in the table is 0.943, which is greater than 0.80. Therefore, correlation coefficient reveals the strapping relationship of inflation, interest rate and remittance with exchange rate. On the other hand, the coefficient of determination that means R squared gives the proportion of variance of one variable that is predictable from other variable. Here R squared is 0.889; the result is highly positively correlated that means 89% of the total variation in exchange rate can be explained by the linear relationship among inflation, interest rate, remittance and exchange rate. The other 11% of total variation in exchange rate remains unexplained. And the adjusted R squared represents the proportion of the variation in the dependent variable accounted by the explanatory variables.

Analysis of Variance

Null hypothesis: The model is not adequate ($\beta_1 = \beta_2 = \beta_3 = 0$)

Alternative hypothesis: The model is adequate ($\beta_1 = \beta_2 = \beta_3 \neq 0$)

Table 5. ANOVA^b

Model	Sum of Squares	df	Mean Square	F	Sig.
1					
Regression	339.391	3	113.130	16.081	0.003 ^a
Residual	42.210	6	7.035		
Total	381.601	9			
a. Predictors: (Constant), Remittance, Inflation, Interest					
b. Dependent Variable: Exchange rate					

The Regression Sum of Squares is the difference between the Total Sum of Squares and the Residual Sum of Squares. Since the total sum of squares is the total amount of variability in the response and the residual sum of squares that still cannot be accounted for after the regression model is fitted, the regression sum of squares is the amount of variability in the response that is accounted for by the regression model. The SPSS output for ANOVA shows that the F value is 16.081, which are greater than the table value that means 4.346. On the other hand, the level of significance determines is 0.003, which is less than the acceptable level of significance 0.05. So the null hypothesis is rejected and alternative hypothesis is accepted. This indicates that if interest rate and remittance increase, then exchange rate will also increases because of positive relationship and inflation rate slightly affects exchange rate.

⁴ The linear correlation coefficient sometimes referred to as the Pearson product moment correlation coefficient in honor of its developer Karl Pearson. S.P Gupta, M. P. Gupta, Business Statistics, New Edition, New Delhi: Sultan Chand & Sons, Page-212

T-test

Null hypothesis: The variable X, Z & R are not affecting Y ($\beta_1=\beta_2=\beta_3=0$)

Alternative hypothesis: The variable X, Z & R are affecting Y ($\beta_1=\beta_2=\beta_3 \neq 0$)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	46.507	6.229		7.466	.000
	Inflation	0.307	0.673	0.065	0.456	0.665
	Interest	1.637	0.844	0.505	1.940	0.101
	Remittance	0.001	0.000	0.452	1.747	0.131
a. Dependent Variable: Exchange rate						

The table results that the constant is 46.507. The beta coefficient of inflation, interest and remittance are 0.065, 0.505 and 0.452 respectively, which indicates a positive relationship with exchange rate. Therefore, the analysis shows that the exchange rate will increase if inflation, interest rate and remittance increase. However, there exists a positive relationship of inflation, interest, remittance with exchange rate based on beta coefficient. Nevertheless, the computed t value of inflation and remittance, which are 0.456, 1.747 is smaller than table value 1.86 except interest rate 1.940 at .05 level of significant. The t-test based on t value shows some anomaly of relationship among the variables. Comparing the computed t value with the table value indicates interest rate has relationship with exchange rate but inflation and remittance shows no relationship with the exchange rate. To get more appropriate result; hypotheses are tested through Fisher's z- transformation. At first p- value i.e. probability is calculated based on the t- value of each variable and degrees of freedom such as 0.330 (Inflation), 0.044 (Interest Rate) and 0.059 (Remittance). Then r that means multiple correlation coefficients (0.943) and p-value are transferred into z value by

$$z = \frac{1}{2} \log_e \frac{1+r}{1-r}$$

Where \log_e indicates natural logarithm. Common logarithm may be shifted to natural logarithm by multiplying by the factor 2.3026.

$\log_e X = 2.3026 \log_{10} X$ Here X is a positive integer.

Since $\frac{1}{2} (2.3026) = 1.1513$, the correlation transformation formula is used as:

$$z = 1.1513 \log_{10} \frac{1+r}{1-r} = 1.1513 \log_{10} \frac{1+0.943}{1-0.943} = 1.7645$$

Now to convert p- value of inflation into z_p value the formula is

$$z_p = \frac{1}{2} \log_e \frac{1+p}{1-p} = 1.1513 \log_{10} \frac{1+p}{1-p} = 1.1513 \log_{10} \frac{1+0.330}{1-0.330} = 0.3428$$

And standard deviation

$$\sigma_z = \frac{1}{\sqrt{n}} - 3 \quad \text{Where, } n = \text{sample size}$$

$$\sigma_z = \frac{1}{\sqrt{10}} - 3 = 0.3779$$

Therefore to test the hypothesis of inflation, the statistic is

$$z = \frac{(z - z_p)}{\sigma_z} = \frac{(1.7645 - 0.3428)}{0.3779} = 3.76$$

Conversion of p- value of interest into z_p value

$$z_p = \frac{1}{2} \log_e \frac{1+p}{1-p} = 1.1513 \log_{10} \frac{1+0.044}{1-0.044} = 0.0441$$

Then the test statistic of interest rate is

$$z = \frac{(1.7645 - 0.0441)}{0.3779} = 4.55$$

Conversion of p- value of remittance into z_p

$$z_p = 1.1513 \log_{10} \frac{1+0.059}{1-0.059} = 0.0591$$

Then the test statistic of remittance is

$$z = \frac{(1.7645 - 0.059)}{0.3779} = 4.51$$

Since the calculated value of z is greater than the table value at 0.05 level of significance, that means calculated values of inflation, interest rate and remittance are 3.76, 4.55, 4.51 respectively, and the table value is 0.302, so the null hypothesis is rejected and alternative hypothesis is accepted. There exists a relationship between dependent variable and independent variables, which implies exchange rate is influenced by the inflation, interest rate and remittance.

7. Graphical Presentation

Graphical appearance helps to visualize the perceptible relationship between the variables. Here the relationship of inflation rate, interest rate, and remittance with exchange rate is presented graphically. The graphs present the scatter plots of residual of each independent variable and the residual of dependent variable when both variables are

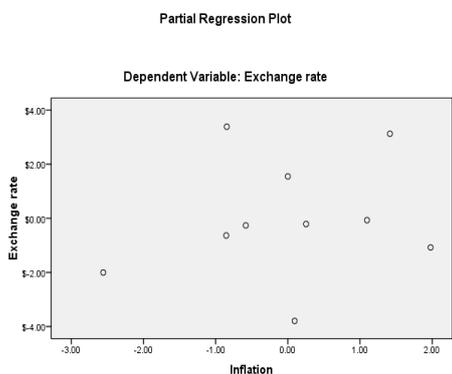


Fig. 1. Relationship between inflation rate,

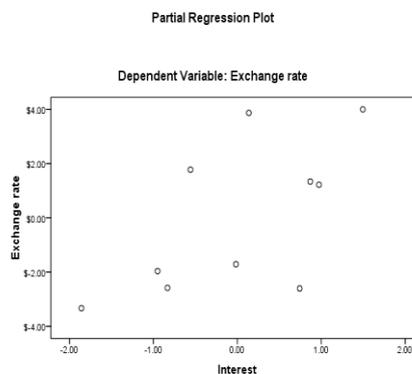


Fig. 2. Relationship between interest rate and exchange rate and exchange rate

regressed separately on the rest of the independent variables. Here the motive is to determine whether the inflation rate, interest rate and remittance are linearly related with exchange rate. If the points in a residual plot are randomly dispersed around the horizontal axis, a linear regression model is appropriate for the data; otherwise, a non-linear model is more appropriate. Figure-1 represents the linearity between inflation and exchange rate. In graph, the residual plot shows random pattern. The first two residuals are negative, next residual of exchange rate is positive but in case of exchange rate, it is negative. The fourth is negative and the remaining residual plots are presented randomly. This random pattern indicates a good fit for a linear model. The plots suggest that there is increasing relationship between inflation and exchange rate but sometimes it falls. On the other hand the increasing relationship is weak because if one unit change in independent variable, the dependent variable also change but in minor pattern. Relationship between interest and exchange rate, which are presented in figure-2, also shows the random pattern of residual plots. It suggests the increasing relationship between interest and exchange rate except seventh point. So it can be supposed that strong relationship exist between interest rate and exchange rate. Partial regression plot of remittance and exchange rate in figure-3 also shows the linearity.

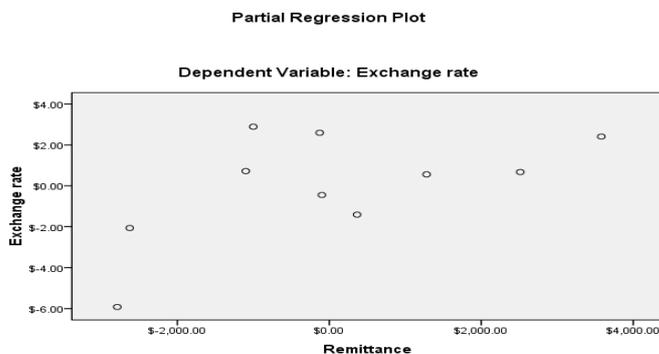


Fig. 3. Relationship between remittance and exchange rate

In addition, the plot suggests the increasing relationship between the variables. After analyzing the figure- 3, it is lucid enough that strong affiliation exists between the remittance and exchange rate. The reason is that if one unit change in remittance, the exchange rate also changes in superior pattern.

8. Findings of the Study

After analysis, there are some findings, which are as follows

1. Positive and strong relationship between the interest rate and exchange rate where $\beta = 0.91$ for interest and 0.90 for remittance which is greater than 0.80.
2. Positive but weak relationship between inflation rate and exchange rate where $\beta = 0.362$ which is less than 0.50.
3. Remittance also holds significant relationship with the exchange rate.
4. Purchasing disparity exist between Bangladesh and USA.

9. Conclusion

After analyzing the relationship between the variables, it is lucid enough that inflation, interest, and remittance influence the exchange rate. Between inflation and exchange rate, there exists positive but weak relationship. If inflation changes, the exchange rate changes are not properly offset by the same changing unit. For this reason purchasing disparity exist between Bangladesh and USA. On the other hand, interest rate and exchange rate have positive relationship but in general sense it should have negative relationship. Hence, the interest rate increase at that time in Bangladesh, consequently exchange rate also increases between the two countries. Remittance also shows the strong relationship with the exchange rate. Significant relationship of inflation, interest, and remittance is initiated with exchange rate.

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