3.0 REPORT PART

3.1 LITERATURE REVIEWS

The exchange rate between two countries is the price at which residents of those countries trade with each other. In economics, there are two kinds of exchange rates: nominal exchange rate and real exchange rate.

3.1.2 Nominal exchange rate:

The nominal exchange rate is the relative price of the currencies of two countries. For example, if the exchange rate between the U.S. dollar and the Bangladeshi taka is 80 taka per dollar, then exchange one dollar for 80 taka in world markets for foreign currency. A Bangladeshi who wants to obtain dollars would pay 80 taka for each dollar he bought. An American who wants to obtain taka would get 80 taka for each dollar he paid. When we refer to *"the exchange rate''* between two countries, we usually mean the nominal exchange rate.

An exchange rate can be reported in two ways. If one dollar buys 80 taka[2], then one taka buys 0.0125 dollar. We can say the exchange rate is 80 taka per dollar, or we can say the exchange rate is 0.0125 dollar per taka. Because 0.0125 equals 1/80, these two ways of expressing the exchange rate are equivalent.

3.1.3 Real Exchange rate:

The real exchange rate is the relative price of the goods of two countries. That is, the real exchange rate tells us the rate at which we can trade the goods of one country for the goods of another. The real exchange rate is sometimes called the *terms of trade. Generally,* The real exchange rate between two countries is computed from the nominal exchange rate and the price levels in the two countries.

$$\text{Real Exchange Rate} = \frac{\text{Nominal Exchange Rate} * \text{Price of Domestic Good}}{\text{Price of Foreign Good}}$$

$$= \text{Nominal exchange rate} * \text{Ratio of price Levels } (P/P^*)$$

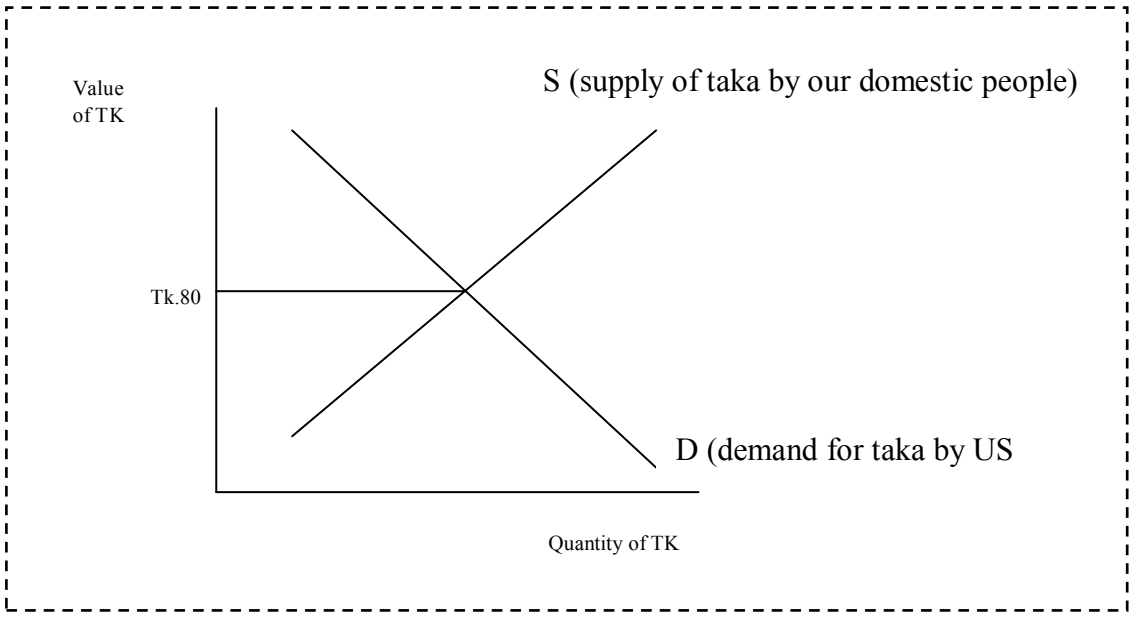
[2] In this report, exchange rate of our country represents how much taka we need to buy one dollar.

3.1.4 Equilibrium Nominal exchange rate:

The demand and supply schedules of one currency against other currency determine the equilibrium exchange rate. Here, the equilibrium exchange rate of USD to BDT is used to explain equilibrium exchange rate.

Demand for our currency (taka) is downward sloping because U.S. corporation will be encouraged to purchase more Bangladeshi taka when the taka I worth less, as it will take fewer dollars to obtain the desired amount of taka.

On the other hand, it is also important to consider the demand for U.S. dollars to us. This can be referred as our supply of taka for sale. So our supply of taka is upward sloping and when the value of taka is high, we are more likely to hold U.S. dollar to purchase foreign goods, and vice versa.



Factors that influence Exchange rate

- Change in the differential between inflation between two countries
- Change in the differential between the interest of the two countries
- Change in the differential between the two countries' income level
- Change in the expectation of future exchange rate
- Change in government controls

3.2 EMPIRICAL STUDIES

There have been several works done previously on the determinants of exchange rate throughout the world, but not a few on USDBDT exchange rates. Here I give some findings of those researches done around the world on different exchange rates, as these might help me to find specific explanatory variables for my research.

Macroeconomic fundamentals play an important role in explaining the behavior of exchange rates.[3] For example, "with flexible exchange rate regimes, changes in balance of payments equilibrium depend upon changes in exchange rates which in turn are determined by monetary policy".[4]

There has been a rating given by the Consensus economics to some economic factors which have significant influences over exchange rate (higher rating indicates higher effects),

CONSENSUS RANKING OF EXCHANGE RATE DETERMINANTS			
Exchange Rates	Inflation Differential	**Trade/Current Account**	**Interest Rate Differentials**
Euro	5.3	**4.3**	**7.3 (5.7)**
Japanese Yen	5.5	**4.8**	**7.8 (7.0)**
UK Pound	5	**5**	**7.7 (6.0)**
Swiss Franc*	3.3	**4.3**	**6.7 (4.7)**
Australian $	4.5	**4.3**	**7.8 (6.3)**
New Zealand $	4.5	**4.3**	**8.5 (6.0)**
Singapore Dollar	4	**6.5**	**6.5 (5.0)**

Table 3.2.1: Consensus ranking of exchange Rate Determination[5]

A common feature of models that adopt this approach is the assumption that an increase in the price of foreign exchange implies an increase in the relative price of a country's imports in terms

[3] Structural Factors Affecting Exchange Rate Volatility: A Cross-Section Study - Prepared by Jorge Canales-Kriljenko and Karl Habermeier1 in August 2004

[4] Are Exchange Rates Determined By Macroeconomic Factors? (1998) - by Geoffrey Williams , Ashok Parikh , David Bailey

http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.41.6549

[5] ECONOMIC FACTORS AFFECTING EXCHANGE RATES, by - Consensus Economics, on 2th February 2012, http://www.consensuseconomics.com/download/Foreign_Exchange_Rate_Forecasts.htm

of its exports and (provided certain elasticity conditions are satisfied) an increase in the net inflow of foreign exchange arising from current account transactions.[6]

Interest Rate Parity, exchange rates were influenced by changes in monetary policy. The rise of the home interest rate is usually followed by the appreciation of the home currency, and a fall in the home interest rate is followed by a depreciation of the home currency. The interest rate parity condition was developed by Keynes (1923), as what is called interest rate parity nowadays, to link the exchange rate, interest rate and inflation.[7]

According to Showbhik Kalra, determinants of the Nominal Exchange Rates are,[8]

1. Trade Balance
2. Relative Purchasing Power Parity
3. Relative Interest Rates
4. Relative Price Changes
5. Speculators, Traders and Financial Instruments
6. Political and Psychological Factors

So it can be seen that there have been several study over the determinants of the exchange rate by not much over the specific USDBDT exchange rate.

[6] This assumption is made in the standard **flow** model of the foreign exchange market that is described in virtually every textbook on international economics. The elasticity condition that is required to ensure stability of the foreign exchange market is sometimes the Marshall-Lerner condition and sometimes the more complicated **Robinson-Metzler-Bickerdike** condition.

[7] Existing Theories of Exchange Rate Determination by ADB institute, http://www.adbi.org/book/2006/05/16/1819.renminbi.exchange.rate/

[8] Note on Determinants of Foreign Exchange Rates by SHOWBHIK KALRA on December 13, 2005.

3.3 ANALYSIS OF THE VARIABLES USED IN THE MODEL

All the variables used in this model are macro-economic factors and the data collected on them are from the economy of Bangladesh. As we all know this report is based on what factors influence the USDBDT exchange rate in our economy. So our dependent variable is the weighted average exchange rate (USDBDT).

3.3.1 Dependent Variable: Weighted average exchange rate (USD to BDT):

We see that the average monthly exchange rate of USD was more or less stable from July 2007 to July 2010. After that it was seen an upward trend. That means the value of our currency depreciates rapidly against US dollar after mid-2010. In the later part of this report I will try to find out the factors that affect the exchange rate to increase.

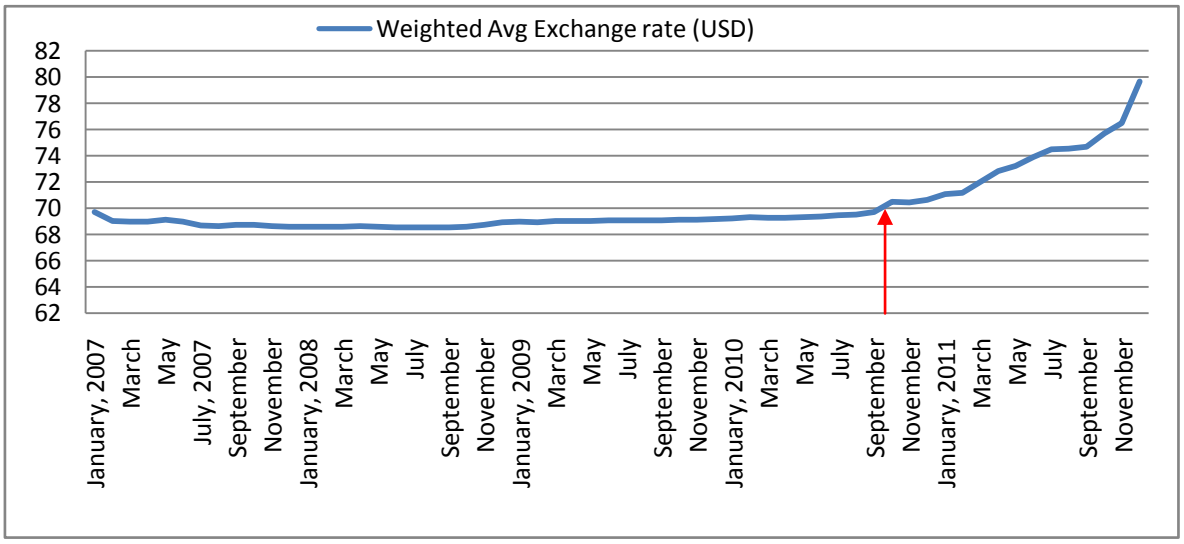


Figure 1: Weighted Avg Exchange Rate (USDBDT)

3.3.2 Independent Variable: Trade Balance (Export minus Import):

Export is very important variable which determine the exchange rate. When exports of our country increase, the demand of BDT to foreign countries also increases. Foreign currency inflow also increases at the same time. Thus theoretically export is negatively related with exchange rate of an economy. Our domestic currency appreciates against the foreign currency as

exports increase. But government always uses exchange rate policy to increase the export. As exchange rate of USD increases, the value of exported goods in terms of foreign currency falls. So the demand for our domestic products in foreign market (USA) increases. In this point of view exchange rate and export are positively related.

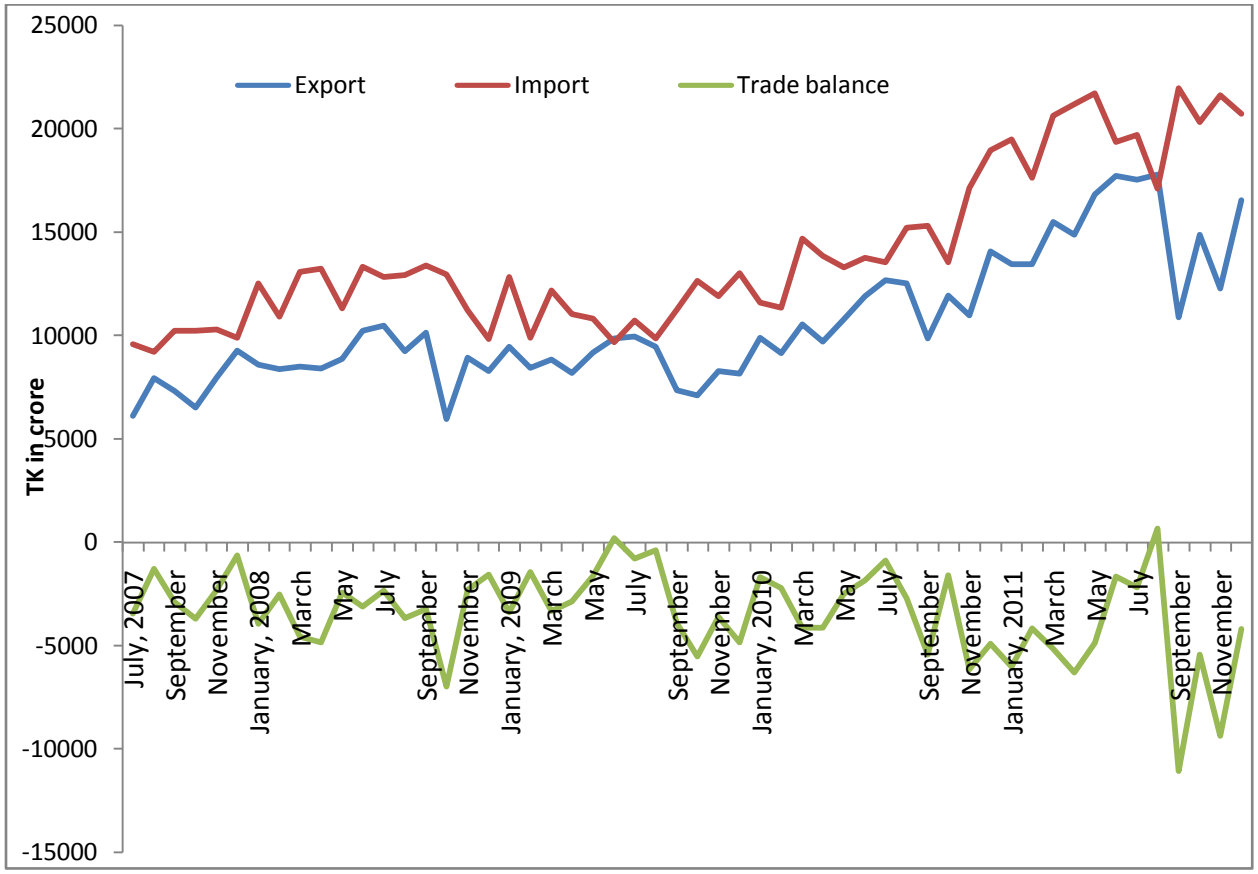


Figure 2: Trade Balance

Imports and exchange rates are also highly correlated. If the exchange rate of our increases, our local buyer would have to spend more money to buy the imported goods as they need more money to buy foreign currency before. On the other hand, if we continuously increase our import, the demand for foreign currency in our country will increase that will increase the exchange rate.

As we can see from the above graph from mid 2007 till mid 2010 national export amount of Bangladesh were around 8,000 to 10,000 but from September 2010 onward it started to increase at a higher rate, same as what we have seen in case of exchange rate. We also can see that the amount dramatically fall on October 2008 by around 4000, this is due to the global financial

crisis. On the other hand the imports of our country also have seen an upward trend during the period of 2009 to 2011. But the rate of imports increased at a faster rate from November, 2010 that what we have seen in our exchange rate in this period.

3.3.3 Independent Variable: Foreign direct investment:

Foreign Direct Investment (FDI) is an international flow of capital that provides a parent company or multinational organization with control over foreign affiliates. Exchange rates can influence both the total amount of foreign direct investment that takes place and the allocation of this investment spending across a range of countries. When a currency depreciates, meaning that its value declines relative to the value of another currency, this exchange rate movement has two potential implications for FDI. First, it reduces that country's wages and production costs relative to those of its foreign counterparts. All else equal, the country experiencing real currency depreciation has enhanced "location advantage" or attractiveness as a location for receiving productive capacity investments. By this "relative wage" channel, the exchange rate depreciation improves the overall rate of return to foreigners contemplating an overseas investment project in this country.

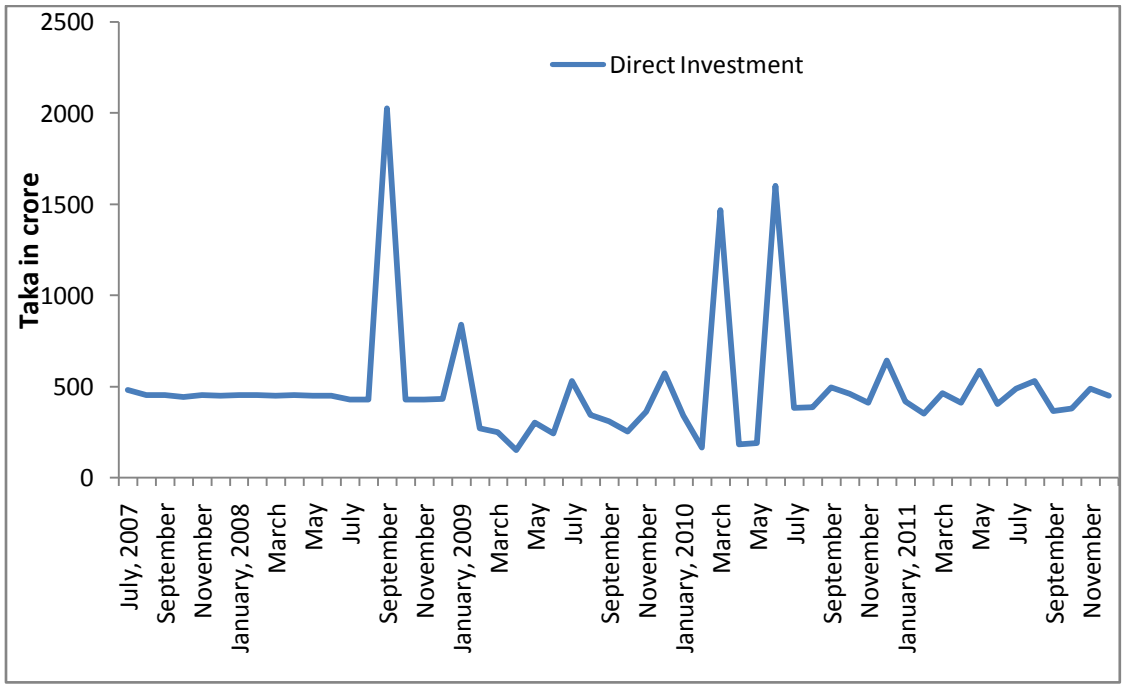


Figure 3: Foreign Direct Investment

We can see from the above figure that the FDI in Bangladesh was fluctuating between five hundred crore to six hundred crore from July, 2007 to December, 2011, but some sharp raises were also seen in the later part of the year 2008 and the first half of the year 2010.

3.3.4 Independent Variable: Remittance:

Remittance is another vital factor for our economic development. It is considered as capital inflow to our country. As remittance increases, the supply of foreign currency also increases that helps to appreciate our currency value against foreign currency.

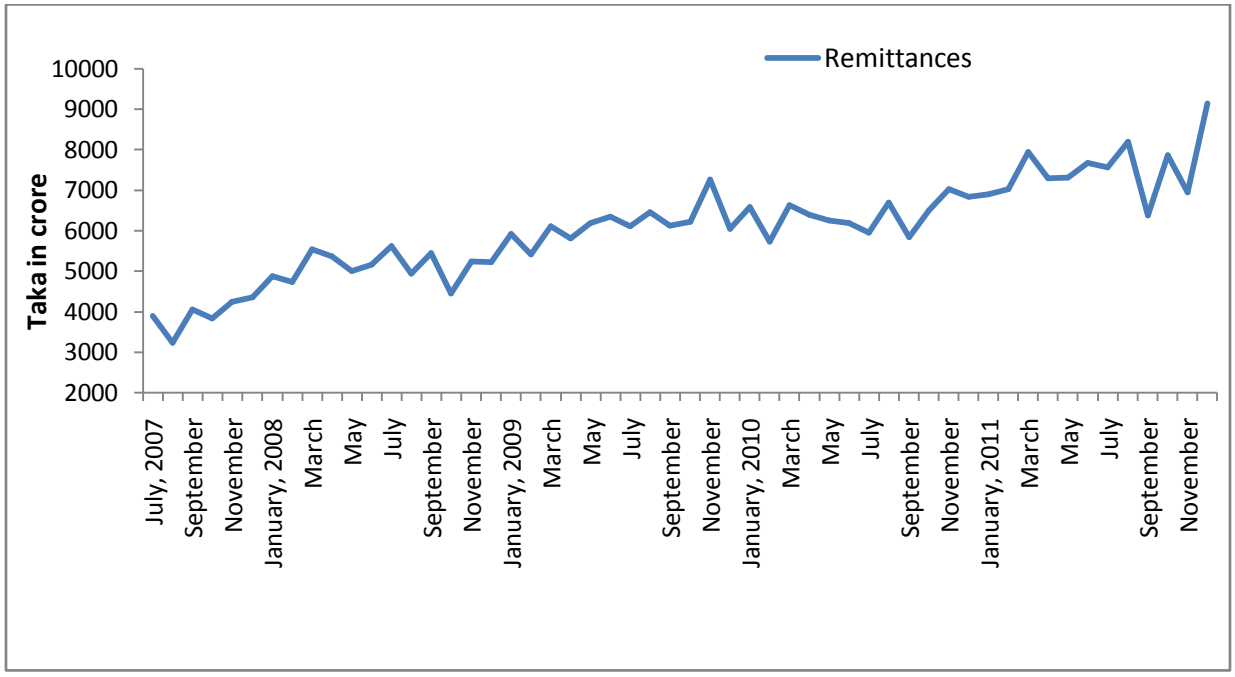


Figure 4: Remittances

We can see from the above graph that the remittance of our country had increased around 43% from July, 2007 to December, 2011. We can also see that the remittances are seen to have an upward trend through the whole period.

3.3.5 Independent Variable: Relative Purchasing Power Parity:

Relative purchasing power parity[9] is an economic theory that describes the relationship between two different currencies over time. Relative purchasing power captures the relative relationship by comparing the rate of change in price levels that contribute to inflation. Calculating the relative purchasing power parity between two different currencies makes it possible to evaluate over time whether a country's currency increased or decreased in value relative to another country's currency, or if the currencies achieved parity. As we know that inflation increases the price levels and that reduces our international competitiveness. As consequence, the foreign demands of our exports fall that reduces the inflow of foreign currency to our country. So the relative inflation rate is a crucial factor of exchange rate.

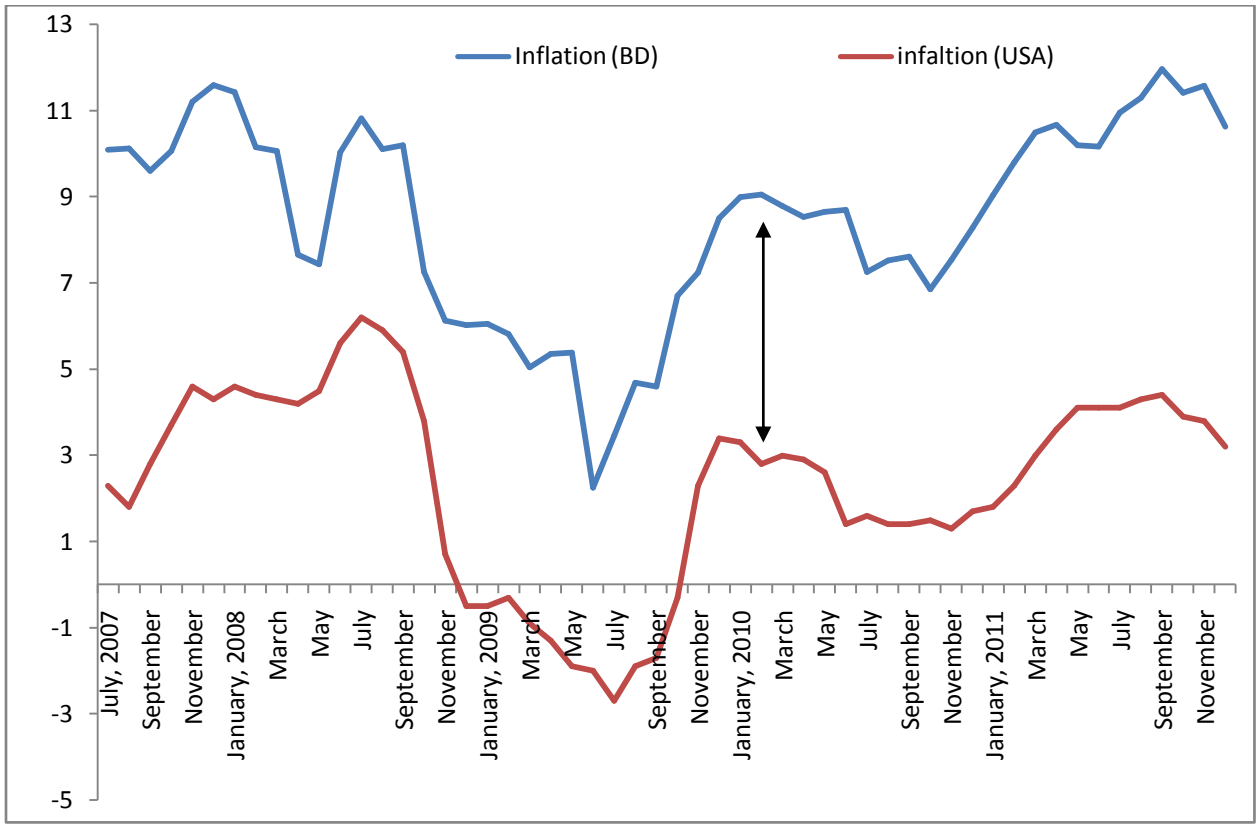


Figure 5: Inflation comparison

[9] Relative PPP = $(1 + inflation_{BD}) / (1 + inflation_{USD})$

We can see from the above graph that inflation rates of both countries were seen a downward trend from the mid 2007 to mid 2009. We have seen that exchange rate was stable at that point in time. Moreover we can see inflation rate of BD also started to increase relatively faster rate from the year 2011 than US. That is why the exchange rate had been increasing rapidly after that period.

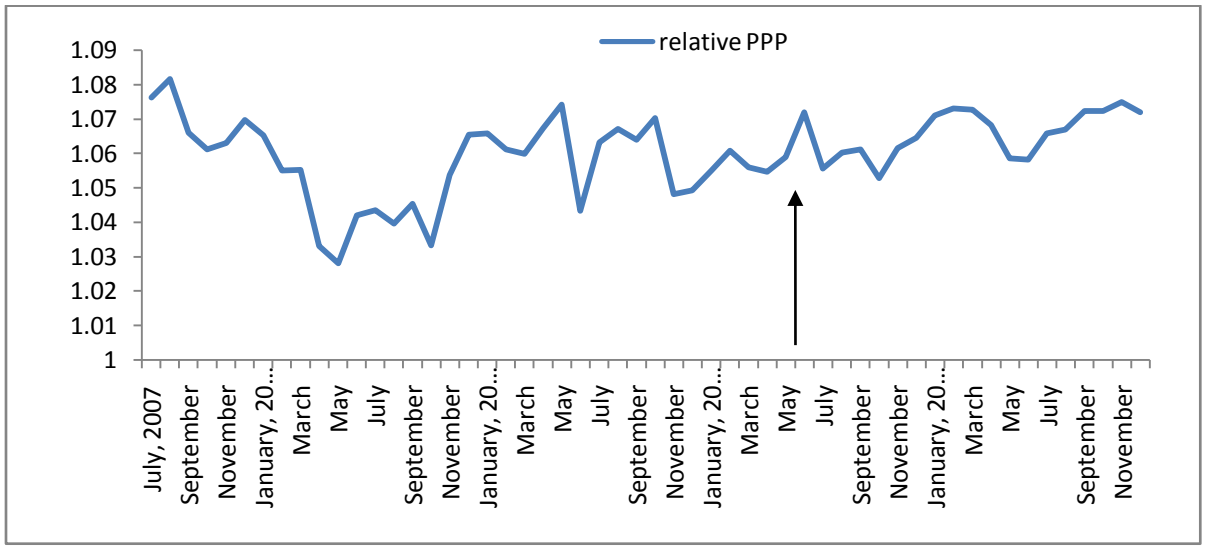


Figure 6: Relative Purchasing Power Parity

We can see that, there was a 108 percent differential between the relative purchasing power of these two countries in July 2007. In this cases, the U.S. dollar's relative purchasing power increased by 108 percent relative to the taka, while the taka's relative purchasing power decreased by 108 percent relative to the dollar. From the above graph we can see that the purchasing power parity of Bangladesh had improved up to 2008. Our relative purchasing power decreased at a faster rate after 2010 so as the exchanged rate.

3.3.6 Independent Variable: Relative interest rate:

Commercial deposit rate and exchange rates are highly correlated. Relatively higher interest rate encourages the foreigner investors to deposit currency in commercial bank that makes more foreign currency inflow in Bangladesh. Higher deposit rate will look more attractive to foreign investors with excess cash; the supply of dollar for sale by US investors would increase as they establish more bank deposits in our country. Due to the outward shift in the supply of dollars, the

equilibrium exchange rate of USD to BDT would decrease. That means the value of our currency would increase against dollar.

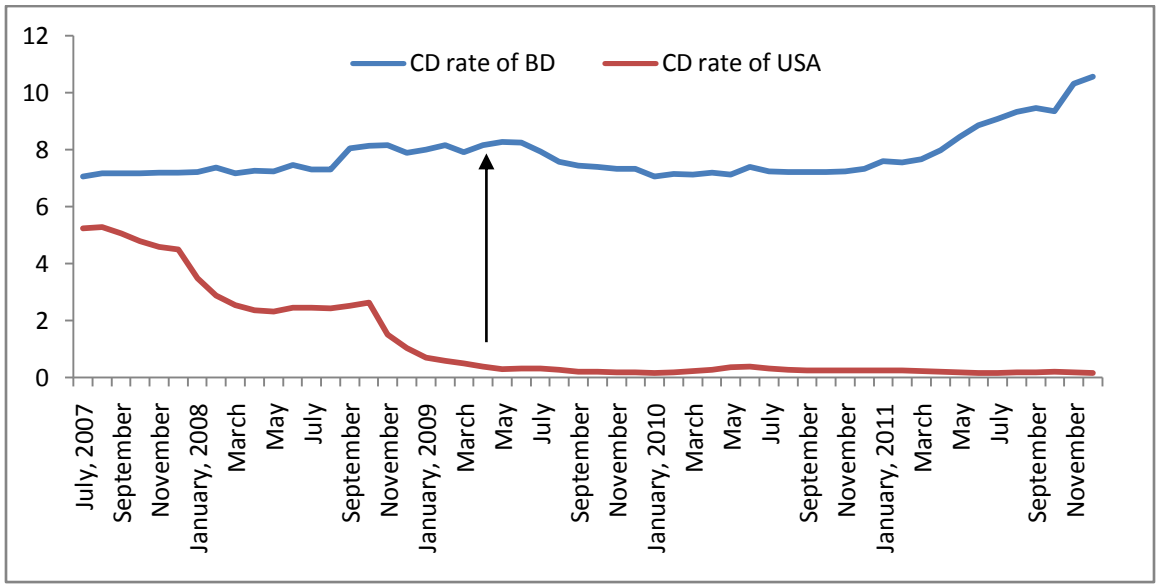


Figure 7: Interest Rate of Bangladesh & USA

As we see from the above figure commercial deposit rates were more or less stable up to July 2008 and it increased by a huge amount around in September –October 2008 due to global financial crisis, so most of the banks were in short of money. After that it had been increasing at a faster rate since the year 2011. This was because the high inflation rate at that period. On the other hand commercial deposit rate of US had been falling since 2007 to 2009. Then it was quite stable during the period of 2009 to 2011. That is why the relative interest rate of our country to America has been raising always. But more interesting thing is, the relative interest started to rise at a faster rate after the later part of the year 2008[10].

[10] World has been suffering recession since 2008

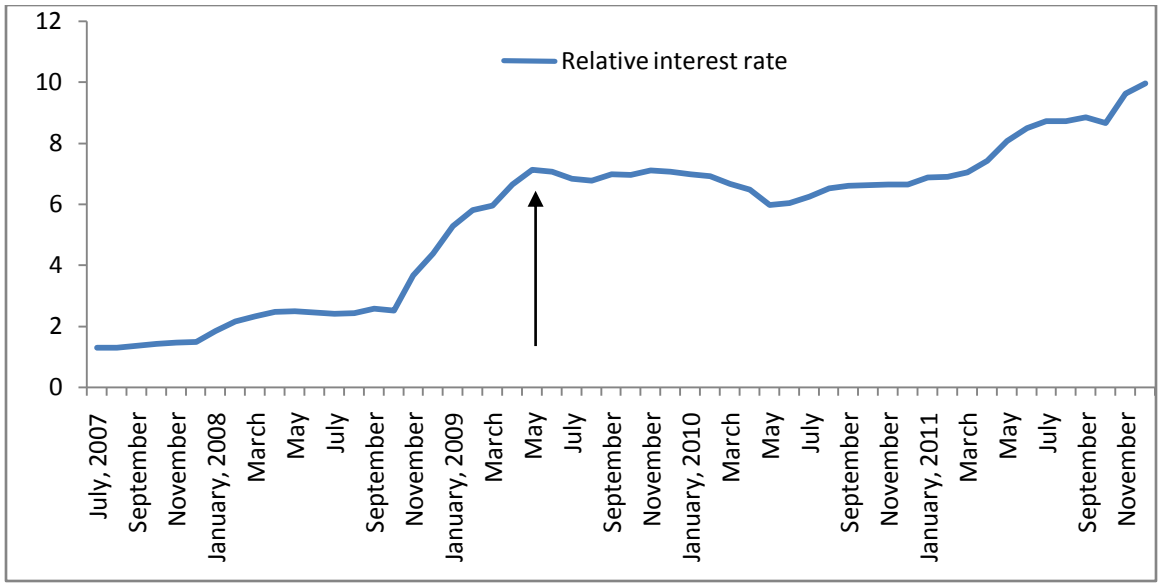


Figure 8: Relative Interest Rate

The effect of this higher interest on the exchange rate of USD to BDT is surprising. We have seen the exchange rate increased sharply after 2011, this was not likely to happen according to the prediction of our economic theory. The reason behind this might be our deposit rate was not high enough to motivate US investors for the higher inflation rate. Higher interest rates give the signal of higher inflation that discourages the foreign investors.

3.3.7 Independent Variable: Non Resident Foreign Currency Deposit rate:

NFCD (Non Resident Foreign Currency Deposit) Account is an interest bearing time deposit account for Non Resident Bangladeshis which can be opened with foreign exchange for a period of 1/3/6/12 months. As the NFCD rate increases it attracts more foreign currency deposits and increases the supply of foreign currency to our country that help to appreciate our currency value against foreign currency.

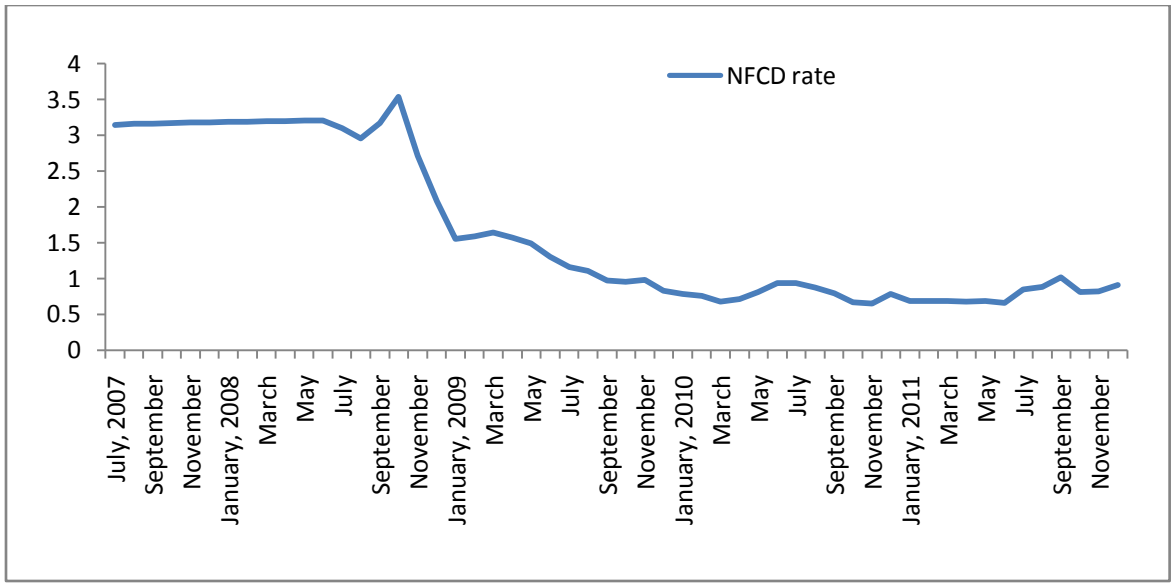


Figure 9 Non Resident Foreign Currency Deposit

As we can see from the above graph that the NFCD rates of our country had been falling since July, 2007 to December, 2009. After that it was more or less stable. The lower NFCD rate was reflected with higher exchange rate of USD to BDT during the period of 2010 to 2011.

3.3.8 Independent Variable: Gold Price at international market:

Historically it has been seen that Gold price and USDBDT exchange rate has strong positive relationship. This is because general people usually use these two types of instruments (Gold and US dollar) for their investment. So they generally move together and have strong effect on each other.

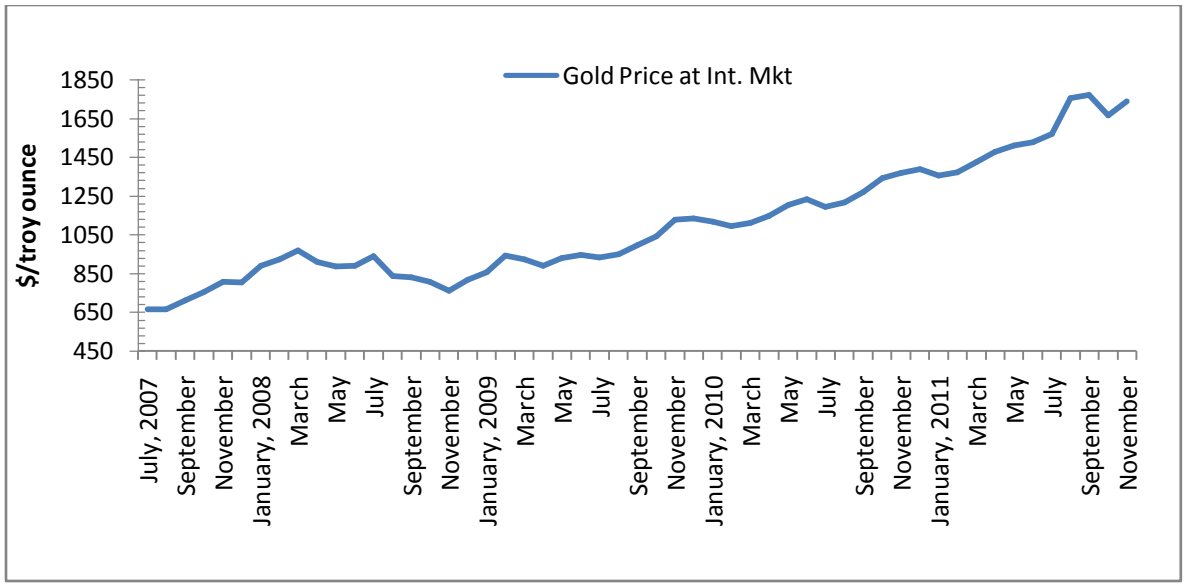


Figure 10 Gold Price at international market

Same behavior can be seen as the previous one. A dramatic downfall can be noticed at around October-November 2008 due to global financial crisis. But afterwards it started increasing constantly in the international market. That is why general people usually use gold as a safe investment instrument.

3.3.9 Independent Variable: Foreign exchange reserve:

Foreign currency reserve means the deposits of foreign currency held by the central bank. They are usually in the form of bills and bonds of foreign states, which allow these reserves to bear interest. Holding the currencies of other countries as assets allow governments to keep their currencies stable and reduce the effect of economic shocks. Foreign currency reserves are used as a monetary tool to control the exchange rate. In order to make a domestic currency more stable and stronger a nation can spend a Foreign exchange reserve to purchase its own domestic banknotes. For sure, such activity will increase the demand for this currency which will lead to higher valuation rates. Or a country can use such a strong reserve to buy foreign banknotes in order to reduce the value of its domestic currency. So the foreign currency reserve and exchange rate are positively correlated.

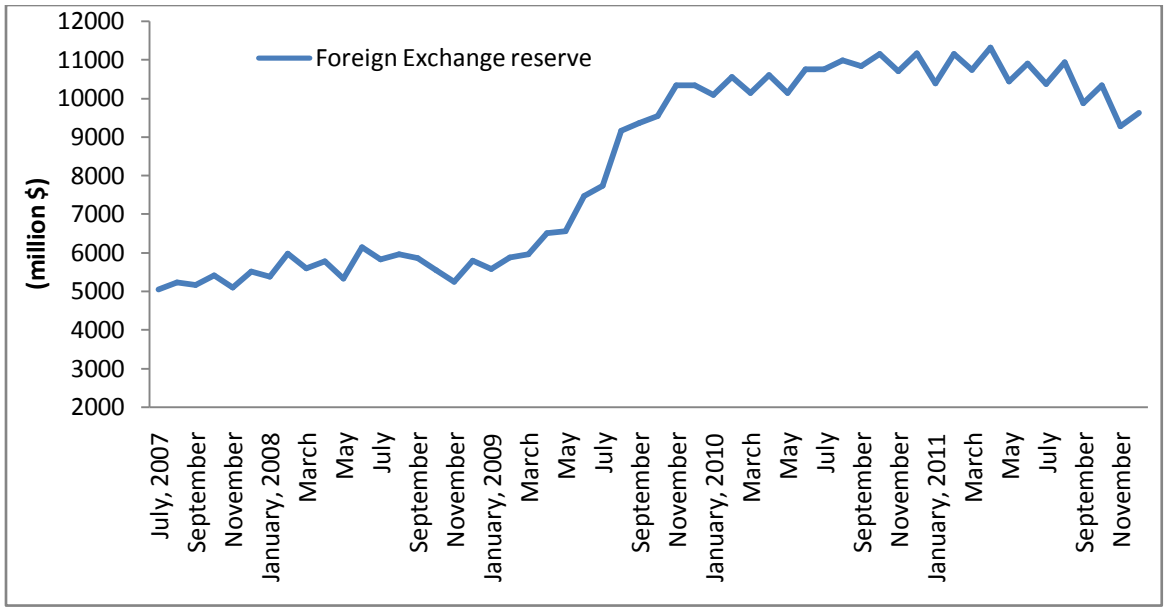


Figure 11: Foreign Exchange Reserve

We can see from the above figure that our foreign exchange reserve showed an upward trend after 2009. The main purpose of increasing foreign exchange reserve is to keep our currency value against foreign currency to boost our exports. Moreover it creates market confidence toward the national currency and show that the country has the resources to withstand a financial shock.

3.4 MODEL SELECTION CRITERION

At first I will test each of the variables significance. Then I will test their joint significance by the F test. I will also find out whether there are any problems of multicollinearity, Heteroscedasticity, and autocorrelation. I will also test the functional form of regression model by MWD test.

- Adjusted R-square:

After running the regression with the new independent variable in the model, I have compared the new adjusted R-square with the previous selected model's adjusted R-square. If the new adjusted R-square is higher than it shows a positive sign towards selection of the new model.

- Analysis of Variance (Anova):

Analysis of variance identity: SS (T) = SS (R) +SS (E): Total Sum of Squares equals to Regression sum of squares and Error sum of squares. Anova explains the existence of linear relationship between the dependent and independent variables.

- Akaike Information Criterion (AIC) and *Bayesian Information Criterion* (BIC):

These techniques are used to compare between two models. Model having the lower AIC or BIC will be considered as a better model than the other. The accuracy of BIC for selecting the best overall model consistently improves as sample size increases and as R^2 increases. But accuracy declines as the total number of predictors (p) increases, same goes for AIC.

3.5 MODELING AND ANALYSIS

I am going to use the backward elimination process for selecting the appropriate model from my listed variables. At first I will run a regression using all those variables and test for the individual partial regression and least significant variables will be dropped at each step.

In this report I have used STATA 11 to find out statistical outputs of those variables.

3.5.1.1 Model 1:

$Er = \beta_0 + \beta_1 rppp + \beta_2 expt + \beta_3 impts + \beta_4 fer + \beta_5 fdi + \beta_6 cdrate + \beta_7 rem + \beta_8 gold + \beta_9 nfcdrate + \beta_{10} M_3$

Here,

Er = Exchange rate of usd to bdt

rppp= Relative purchasing power parity

exprt= Exports (taka in crore),

impts= Imports (taka in crore),

fer= Foreign exchange resurve (Million US $),

fdi= Fixed direct investment (in million US$),

rinterest= Relative interest rate

rem= Remittances (Taka in crore),

gold= Gold price at international market (US $/ Troy Ounce),

nfcdrate= Nonresident foreign currency deposit rate,

M_3= broad money

$\beta_1, \beta_2, \beta_3, \beta_4\ \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}$ are the coefficient of those variables respectively and β_0 is the intercept of the vertical axis.

```
. tsset month,month
        time variable:  month, Jul 2007 to Dec 2011
                delta:  1 month

. reg erusd relativeppp export import fer fdi relativecdrate remittances goldpri
> ce nfcdrate broadmoneym3
```

Source	SS	df	MS	Number of obs =	54
Model	301.400584	10	30.1400584	F(10, 43) =	66.01
Residual	19.6345702	43	.456617912	Prob > F =	0.0000
				R-squared =	0.9388
				Adj R-squared =	0.9246
Total	321.035154	53	6.05726706	Root MSE =	.67574

erusd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
relativeppp	37.29769	10.00097	3.73	0.001	17.12882	57.46656
export	.000033	.0000758	0.44	0.665	-.0001199	.0001859
import	-.000047	.0000737	-0.64	0.527	-.0001957	.0001016
fer	-.0002946	.0001631	-1.81	0.078	-.0006236	.0000344
fdi	-.0002076	.0003038	-0.68	0.498	-.0008203	.0004051
relativecd~e	.4787364	.2052791	2.33	0.024	.0647516	.8927211
remittances	.0002026	.0002576	0.79	0.436	-.000317	.0007222
goldprice	.0042993	.0015829	2.72	0.009	.001107	.0074915
nfcdrate	1.752046	.5127917	3.42	0.001	.7179031	2.786189
broadmoneym3	.0000177	8.31e-06	2.14	0.038	9.94e-07	.0000345
_cons	15.10129	11.83525	1.28	0.209	-8.766781	38.96935

```
. estimates store AIC

. estimates stats *
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
AIC	54	-124.752	-49.30699	11	120.614	142.4928

Table 1: Regression Findings

3.5.1.2 Testing Individual Partial Regression Coefficient Test:

Decision rule: reject null hypothesis if the $t_{cal} > |t_{critical\ (\frac{\alpha}{2},df)}|$ or if the p value of the calculated t value is significantly low (p value < level of significance, α)

- $H_0 : \beta_1 = 0$
  $H_1 : \beta_1 \neq 0$

The null hypothesis states that, with all other variables (except inflation rate) held constant, relative PPP has no linear influence on exchange rate and the alternative hypothesis states that, relative PPP has linear influence on exchange rate.

Here, $t_{cal} = 3.73$ & $t_{0.025,42} = 2.021$

As, calculated t value 3.73 is greater than the critical t value 2.021 we can reject the null hypothesis that is relative PPP has no linear influence on exchange rate. So this test of the coefficient is statistically significant.

P value: The p value of this test is 0.001. It means that if the null hypothesis were true the probability of obtaining a t value as much as 4.28 or greater (in absolute term) is only 0.001 or 0.01%. So we can reject the null hypothesis.

- $H_0 : \beta_2 = 0$
  $H_1 : \beta_2 \neq 0$

The null hypothesis states that, with all other variables held constant, export has no linear influence on exchange rate and the alternative hypothesis states that, export has linear influence on exchange rate.

Here, $t_{cal} = 0.44$ & $t_{0.025,42} = 2.021$

As, calculated t value 0.44 (in absolute term) is less than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.665. It means that if the null hypothesis were true the probability of obtaining a t value as much as 1.78 (in absolute term) is 0.665 or 66.5%. This is

not a small probability and it is greater than our level of significance. So cannot reject the null hypothesis that means there is no linear exist of export on exchange rate.

- $H_0 : \beta_3 = 0$
  $H_1 : \beta_3 \neq 0$

The null hypothesis states that, with all other variables held constant, import has no linear influence on exchange rate and the alternative hypothesis states that, import has linear influence on exchange rate.

Here, $t_{cal} = -0.640$ & $t_{0.025,42} = -2.021$

As, calculated t value 0.64 (absolute term) is less than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.527. It means that if the null hypothesis were true the probability of obtaining a t value as much as 0.64 (in absolute term) is 0.527 or 52.7%. This is not a small probability and it is greater than our level of significance. So cannot reject the null hypothesis that means import has no linear influence on exchange rate.

- $H_0 : \beta_4 = 0$
  $H_1 : \beta_4 \neq 0$

The null hypothesis states that, with all other variables held constant, foreign exchange reserve has no linear influence on exchange rate and the alternative hypothesis states that, foreign exchange reserve has linear influence on exchange rate.

Here, $t_{cal} = -1.81$ & $t_{0.025,42} = -2.021$

As, calculated t value 1.81 (in absolute term) is less than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.078. It means that if the null hypothesis were true the probability of obtaining a t value as much as 1.81 (in absolute term) is 0.078 or 7.8%. This is not a small probability and it is greater than our level of significance. So cannot reject the null hypothesis that means foreign exchange reserve has no linear influence on exchange rate.

- $H_0 : \beta_5 = 0$

  $H_1 : \beta_5 \neq 0$

The null hypothesis states that, with all other variables held constant, foreign direct investment has no linear influence on exchange rate and the alternative hypothesis states that, foreign direct investment has linear influence on exchange rate.

Here, $t_{cal} = -0.68$ & $t_{0.025,42} = -2.021$

As, calculated t value 0.68 (in absolute term) is less than the critical t value 2.021 we can reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.498. It means that if the null hypothesis were true the probability of obtaining a t value as much as 0.68 (in absolute term) is 0.498 or 49.8%. This is not a small probability and it is greater than our level of significance (5%). So we can not reject the null hypothesis.

- $H_0 : \beta_6 = 0$

  $H_1 : \beta_6 \neq 0$

The null hypothesis states that, with all other variables held constant, relative interest rate has no linear influence on exchange rate and the alternative hypothesis states that, relative interest rate has linear influence on exchange rate.

Here, $t_{cal} = 2.33$ & $t_{0.025,42} = 2.021$

As, calculated t value 2.33 is greater than the critical t value 2.021 we can reject the null hypothesis that is relative interest rate has no linear influence on exchange rate. So this test of the coefficient is statistically significant.

P value: The p value of this test is 0.024. It means that if the null hypothesis were true the probability of obtaining a t value as much as 2.33 or greater (in absolute term) is only 0.024 or 2.4%. So we can reject the null hypothesis.

- $H_0 : \beta_7 = 0$

  $H_1 : \beta_7 \neq 0$

The null hypothesis states that, with all other variables held constant, remittance has no linear influence on exchange rate and the alternative hypothesis states that, remittance deposit rate has linear influence on exchange rate.

Here, $t_{cal} = 0.79$ & $t_{0.025,42} = 2.021$

As, calculated t value 0.79 (in absolute term) is less than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.436. It means that if the null hypothesis were true the probability of obtaining a t value as much as 0.79 is 0.436 or 43.6%. This is not a small probability and it is greater than our level of significance. So cannot reject the null hypothesis that means foreign exchange reserve has no linear influence on exchange rate.

- $H_0 : \beta_8 = 0$

  $H_1 : \beta_8 \neq 0$

The null hypothesis states that, with all other variables held constant, gold price has no linear influence on exchange rate and the alternative hypothesis states that, gold price has linear influence on exchange rate.

Here, $t_{cal} = 1.99$ & $t_{0.025,42} = 2.021$

As, calculated t value 2.72 (in absolute term) is lrdd than the critical t value 2.021 we can reject the null hypothesis. So this test of the coefficient is statistically significant.

P value: The p value of this test is 0.009. It means that if the null hypothesis were true the probability of obtaining a t value as much as 2.72 (in absolute term) is 0.009 or 0.9%. This is a small probability and it is less than our level of significance. So can reject the null hypothesis that means gold price has linear influence on exchange rate.

- $H_0 : \beta_9 = 0$

  $H_1 : \beta_9 \neq 0$

The null hypothesis states that, with all other variables held constant, NFCD rate has no linear influence on exchange rate and the alternative hypothesis states that, NFCD rate has linear influence on exchange rate.

Here, $t_{cal} = 3.42$ & $t_{0.025,42} = 2.021$

As, calculated t value 3.42 (in absolute term) is greater than the critical t value 2.021 we can reject the null hypothesis. So this test of the coefficient is statistically significant.

P value: The p value of this test is 0.001. It means that if the null hypothesis were true the probability of obtaining a t value as much as 3.42 (in absolute term) is 0.001 or 0.1%. So can reject the null hypothesis that means NFCD rate has linear influence on exchange rate.

- $H_0 : \beta_{10} = 0$

  $H_1 : \beta_{10} \neq 0$

The null hypothesis states that, with all other variables held constant, broad money M_3 has no linear influence on exchange rate and the alternative hypothesis states that, broad money M_3 has linear influence on exchange rate.

Here, $t_{cal} = 2.14$ & $t_{0.025,42} = 2.021$

As, calculated t value 2.14 (in absolute term) is less than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.038. It means that if the null hypothesis were true the probability of obtaining a t value as much as 2.14 (in absolute term) is 0.038 or 3.8%. This is a small probability and it is less than our level of significance. So can reject the null hypothesis that means broad money has linear influence on exchange rate.

- $H_0 : \beta_0 = 0$

  $H_1 : \beta_0 \neq 0$

The null hypothesis states that, with all other variables held constant, our model does not have any intercept of dependent variable and the alternative hypothesis states that, our model has an intercept.

Here, t_{cal} = 1.28 & $t_{0.025,42}$ = 2.021

As, calculated t value 1.28 (in absolute term) is greater than the critical t value 2.021 we cannot reject the null hypothesis. So this test of the coefficient is statistically insignificant.

P value: The p value of this test is 0.209. It means that if the null hypothesis were true the probability of obtaining a t value as much as 1.28 (in absolute term) is 0.209 or 20.9%. This is not a small probability and it is greater than our level of significance. So we can not reject the null hypothesis that means our model has no intercept term.

3.5.1.3 Testing Overall Significance of the Sample Regression

- $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = 0$

  $H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 = \beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq 0$

This joint null hypothesis states that coefficients of all independent variables are jointly or simultaneously equal to zero and the alternative hypothesis is that all those coefficients are not simultaneously equal to zero.

Decision rule: If calculated F is greater than $F_\alpha(k-1, n-k)$, reject null hypothesis otherwise we do not reject it where $F_\alpha(k-1, n-k)$ is the critical F value at the=5% level of significance and (k-1) numerator df and (n-k) denominator df.

Alternatively if the p value of F is sufficiently low we can reject H_0

Here,

Calculated F = 66.01 & critical F = 2.08

As calculated F is greater than critical F value we can reject the null hypothesis. Moreover the p value is 0.000 that means there is 0% probability of obtaining the null hypothesis. So we can

reject the null. That means all the slopes of the coefficients are non zero and have their effects on exchange rate.

Explanation of R square:

This model or in other words the variability of dependent variables can explain 93.88% variability of Exchange rate. In simple words 93.88% movement in exchange rate can be explained by movements of our selected variables.

3.5.1.4 Multicollinearity Test:

We have found some insignificant coefficient from our individual partial coefficient test, while the joint test of those coefficients was statistically significant. Moreover we found extremely high R square value. That means our model has multicollinearity problem.

```
. correlate export import fer fdi remittances goldprice nfcdrate broadmoneym3 re
> lativeppp relativecdrate
(obs=54)
```

	export	import	fer	fdi	remitt~s	goldpr~e	nfcdrate
export	1.0000						
import	0.8212	1.0000					
fer	0.6616	0.6475	1.0000				
fdi	0.0950	0.0771	-0.0116	1.0000			
remittances	0.8064	0.7433	0.7889	-0.0138	1.0000		
goldprice	0.8396	0.8987	0.8013	-0.0299	0.8613	1.0000	
nfcdrate	-0.5859	-0.5476	-0.9080	0.0862	-0.8172	-0.7334	1.0000
broadmoneym3	0.8411	0.8719	0.8728	-0.0084	0.8844	0.9669	-0.8366
relativeppp	0.2502	0.2544	0.2491	-0.0662	0.2047	0.3131	-0.3680
relativecd~e	0.6484	0.6363	0.8149	-0.1172	0.8910	0.8222	-0.9311

	broadm~3	relati~p	relati~e
broadmoneym3	1.0000		
relativeppp	0.3408	1.0000	
relativecd~e	0.8844	0.3364	1.0000

Table 2 Correlation Matrix

From the above table we can see the most of the variables are highly correlated. So the VIF of those variables would also very high.

```
. vif
```

Variable	VIF	1/VIF
broadmoneym3	62.12	0.016097
nfcdrate	34.74	0.028783
relativecd~e	31.65	0.031597
goldprice	28.20	0.035464
fer	17.70	0.056501
remittances	11.07	0.090296
import	9.31	0.107365
export	6.31	0.158441
relativeppp	1.60	0.625784
fdi	1.13	0.884188
Mean VIF	20.38	

Table 3 Variance Inflating Factor

As we know that the VIF shows how the variance of an estimator is inflated by the presence of multicollinearity. From the above table we found that the variance inflating factors of those variables are extremely high for most of the cases. So, presence of multicollinearity has been found in this model.

3.5.1.5 Auxiliary regressions

In this section we will run another regression among those independent variables which are highly correlated. What we have found from table 3 is import, remittance, gold price, remittance, and relative interest rates are highly correlated.Now we will run the regression of export with remittance and gold price.

```
. reg export goldprice remittances
```

Source	SS	df	MS	Number of obs =	54
Model	366798873	2	183399436	F(2, 51) =	69.55
Residual	134475269	51	2636769.98	Prob > F =	0.0000
				R-squared =	0.7317
Total	501274142	53	9458002.67	Adj R-squared =	0.7212
				Root MSE =	1623.8

export	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
goldprice	5.549728	1.409828	3.94	0.000	2.719379	8.380076
remittances	.8270108	.3661562	2.26	0.028	.0919215	1.5621
_cons	-605.5685	1192.151	-0.51	0.614	-2998.911	1787.775

Table 4 Auxiliary regression

Here, our calculated F = 54, and critical $F_{0.05}(k-2, n-k+1)$= 4 and the p value of the test is highly significant at our chosen level of significance.

So it means that gold price and remittance have linear relation with export.

3.5.1.6 Heteroscedasticity Test:

In this test, we will observe whether the error variances of this model are constant or it varies with observation. This problem occurs when the Gauss Markov assumption that the residual variance is constant across all observations in the data set so that $E(u_i^2/X_i) \neq \sigma^2 \forall i$

(In practice, this means the spread of observations around any given value of X will not now be constant)

Consequences of Heteroscedasticity

OLS estimates of coefficients remains unbiased

$$Y_i = \beta_0 + \beta_1 X_i + u_I$$

$$\beta_1 = \frac{COV(X,Y)}{Var(X)} = \beta_1 + \frac{COV(X,u)}{Var(X)}$$

and heteroscedasticity assumption does not affect Cov(X,u) = 0 needed to prove unbiasedness, so OLS estimate of **coefficients** remains unbiased in presence of heteroscedasticity.

Residuals plots

In absence of Heteroscedasticity there should be no obvious pattern to the spread of the squared residuals. In the figure below, squared residuals are plotted against estimated exchange rate values ($\widehat{Yi}$) to find out whether the estimated mean value of Y is systematically related with squared residuals. It might seem that the first corner view of figure indicates a short of quadratic relationship between squared residuals and predicted exchange rate value, but grossly we cannot find any kind of exact relation between them. Moreover, we cannot predict any increases or decreases in the size of the residual from the figure below where I plotted squared residuals in the vertical axis and estimated y at horizontal axis. So, there is no heteroscedasticity problem in this model, at least not severe otherwise.

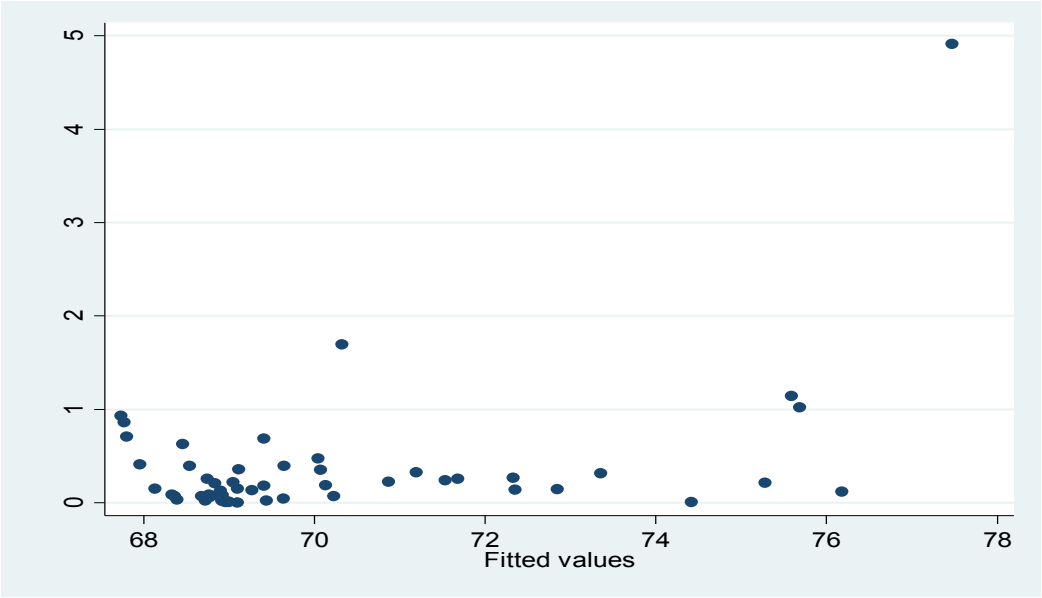


Figure 12 Squared residual against estimated values of exchange rate

The graph below shows the **residual** by fitted (predicted) value of exchange rate. The variability of the residuals is high for fitted value from 68 to 71 and for the value 75 and higher. So it can be said there is mild heteroscedasticity problem in this model. It could be more clear if consider the avplots[11] (deviations of each variables from actual mean)

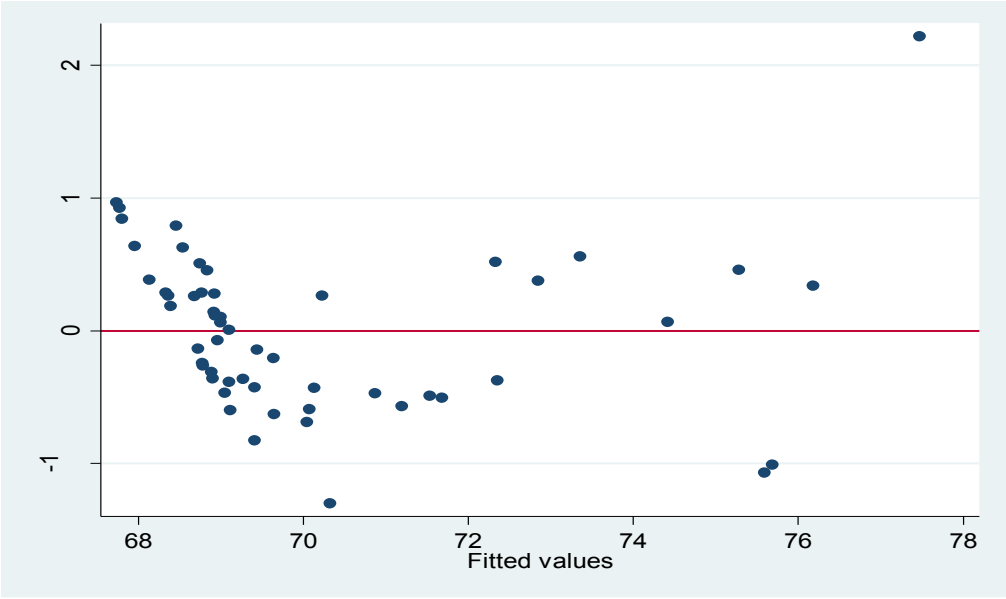


Figure 13 Residuals against estimated exchange rate

[11] See appendix-2, figure-1

White's General Heteroscedasticity test

```
. estat imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(53)     =     54.00
         Prob > chi2  =    0.4360

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	54.00	53	0.4360
Skewness	21.19	10	0.0198
Kurtosis	0.82	1	0.3643
Total	76.01	64	0.1446

Table 5 White's test

Here, $calculated\ \chi^2 = 54.00$ and, $critical\ \chi^2_{(0.05,53)} = 67.50$

As we can see that $calculated\ \chi^2$ is less than the $critical(5\%, 53df)\ \chi^2$ there is no heteroscedasticity problem in this model. Moreover, the probability of the null hypothesis is very high, so we cannot reject the null hypothesis that means heteroscedasticity problem is not present in this model.

3.5.1.7 Autocorrelation test

Graphical Method

Here I will try to figure out the pattern of residuals over time. Therefore, I have plotted the residuals, deviation of estimated exchange rate to actual, on the vertical axis and month (time variable) on the horizontal axis. In the figure below, the residuals are, seen to move more or less in the same relation, showing a weak positive autocorrelation.

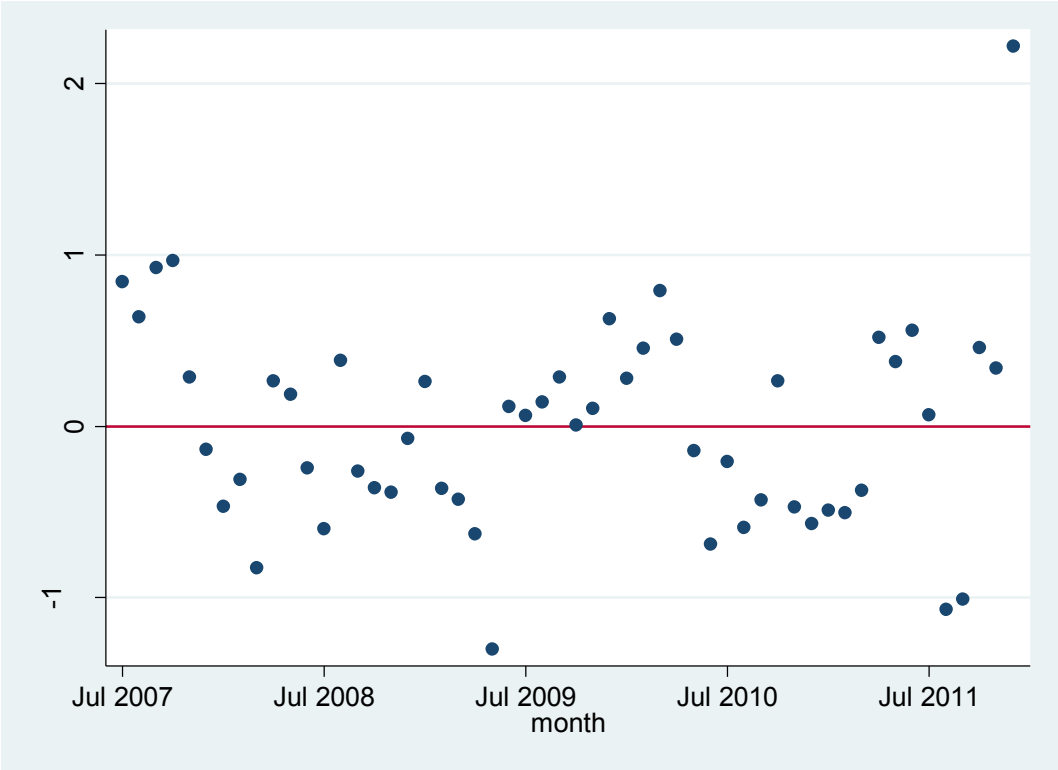


Figure 14: Residuals against time variables

Durbin-Watson test for autocorrelation

H_0 : No positive autocorrelation

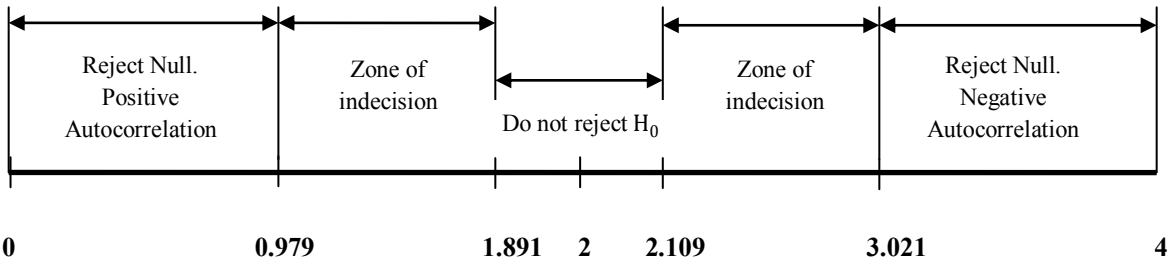
H^*_0: No negative autocorrelation

```
. dwstat

Durbin-Watson d-statistic( 11,    54) =  .9256459
```

From Tables given sample size N =54 and k = 11 (number of parameters) at 5% significance level, d_L = 0.979, and d_U = 1.891

(From Durbin-Watson statistical table, "*Models with an intercept (from Savin and White)*")



Since the computed d of 0.9256459 lies below d_L, we can reject null hypothesis that there is positive serial correlations in the residuals.

In addition, we can examine the residuals to find out the autocorrelation. From the graph below it is obvious that autocorrelation exist at different lags.

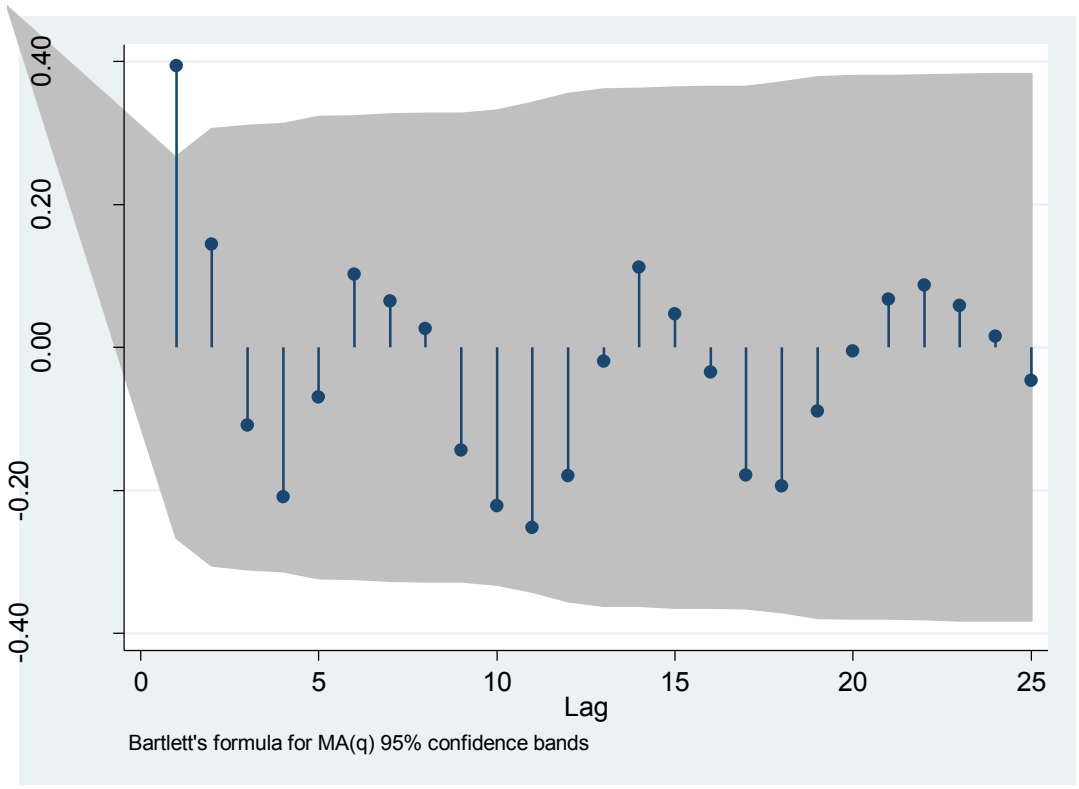


Figure 15: autocorrelations of residuals

3.5.2 Remedial Measures

Solving Multicollinearity- We know that our data is over the period data that means time serious data. Time series data sometimes suffered for high multicollinearity because they might change in the same direction over time. As for example, in recession every economic activity tends to decrease while in recovery or boom period economic activities tends to move upward.

So, I will change my model to remove the multicollinearity among those variables considering following points-

- In our original model[12] we found several insignificant t statistics while in our auxiliary regression[13] of remittance and gold price on export, we found statistically significant t statistics. Moreover, the goodness of fit of the auxiliary model was quite high around 73 percent. Therefore, we could get the impact of those variables from export. In addition, we have also found high correlation among import, export, and broad money. We found statistically significant individual coefficients (t test) as well as their joint significant of the regression[14] of broad money and export on import.
- NFCD (nonresident foreign commercial deposit) tends to move in the same way as with the US commercial deposit rate. In our relative interest we have already considered it.
- The correlation[15] between foreign direct investment and the exchange rate of USD to BDT is -0.0531, which is very low. This is one the reasons behind getting insignificant t statistics of FDI in our first regression.

Therefore, we can drop those variables (remittance, gold price, broad money, NFCD, and FDI) from our original model except export and import as they are considered in the earlier works of exchange determination. Our new regression model, after dropping those variables, is given below-

[12] Table 01
[13] Table 04
[14] Appendix-table 01
[15] Appendix- table 02

```
. reg erusd export import fer relativeppp relativecdrate
```

Source	SS	df	MS	Number of obs =	54
Model	267.060606	5	53.4121211	F(5, 48) =	47.50
Residual	53.9745487	48	1.12446976	Prob > F =	0.0000
				R-squared =	0.8319
				Adj R-squared =	0.8144
Total	321.035154	53	6.05726706	Root MSE =	1.0604

erusd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
export	.000215	.0000876	2.46	0.018	.0000389	.0003911
import	.0003596	.0000689	5.22	0.000	.000221	.0004981
fer	-.000462	.0001111	-4.16	0.000	-.0006854	-.0002385
relativeppp	27.86613	13.23379	2.11	0.040	1.257808	54.47446
relativecd~e	.4682353	.1050118	4.46	0.000	.257095	.6793756
_cons	34.55957	13.92838	2.48	0.017	6.554687	62.56445

```
. estimates store AIC

. estimates stats *
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
AIC	54	-124.752	-76.60995	6	165.2199	177.1538

Table 6: Solving multicollinearity

We can see from the above table that the t statistics of the all individual slope coefficients are highly significant as well as their joint statistics is also significant at our chosen level of significance. So it can be said that this model has no multicollinearity problem. The variance inflating factor of those variables are given below-

```
. vif
```

Variable	VIF	1/VIF
export	3.42	0.292435
relativecd~e	3.36	0.297339
fer	3.33	0.299934
import	3.31	0.302477
relativeppp	1.14	0.880105
Mean VIF	2.91	

Table 7 Variance inflating factor

We can see from the above graph that the VIF of those variables is quite acceptable. So the model is now free from multicollinearity problem.

Solving Heteroscedasticity-

```
. imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(20)     =     41.27
         Prob > chi2  =    0.0034

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	41.27	20	0.0034
Skewness	10.42	5	0.0641
Kurtosis	0.98	1	0.3230
Total	52.67	26	0.0015

Table 8: White Test

Here, $calculated\ \chi^2 = 41.27$ and, $critical\ \chi^2{}_{(0.05,53)} = 31.41$.We can see that, $calculated\ \chi^2$ is greater than the $critical(5\%, 20df)\ \chi^2$ there is heteroscedasticity problem in this model. Moreover, the probability of the null hypothesis is very low, so we can reject the null hypothesis that means heteroscedasticity problem is present in this model.

In the presence of heteroscedasticity the standard errors, t statistics etc are biased. One the other hand if residuals of the new model are plotted against the fitted (estimated) values of exchange rate, any kind of precise direction could not be found (from the figure below). Moreover our sample size is quite large, so we can take the white standard error (robust error) to correct the Heteroscedasticity problem.

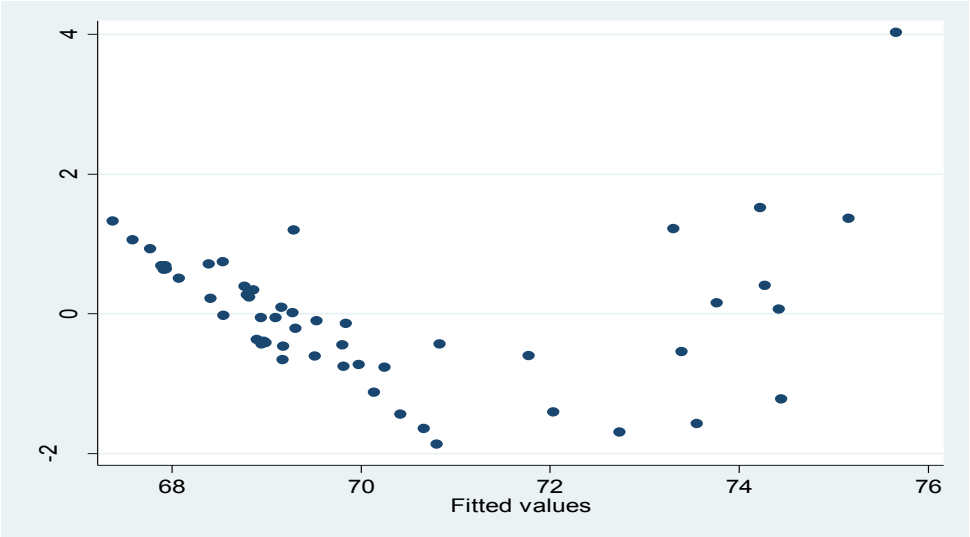


Figure 16: residuals against estimated values

The regression of robust standard error is given below[16]-

```
. reg erusd export import fer relativeppp relativecdrate, robust

Linear regression                                      Number of obs =      54
                                                       F(  5,    48) =   24.64
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.8319
                                                       Root MSE      =  1.0604
```

erusd	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
export	.000215	.000078	2.76	0.008	.0000581	.000372
import	.0003596	.0000593	6.06	0.000	.0002403	.0004788
fer	-.000462	.0001578	-2.93	0.005	-.0007792	-.0001448
relativeppp	27.86613	9.860749	2.83	0.007	8.039768	47.6925
relativecd~e	.4682353	.1398436	3.35	0.002	.1870609	.7494097
_cons	34.55957	10.32478	3.35	0.002	13.80021	55.31893

Table 9 Regression of Robust error

Solving autocorrelation -

H_0 : No positive autocorrelation

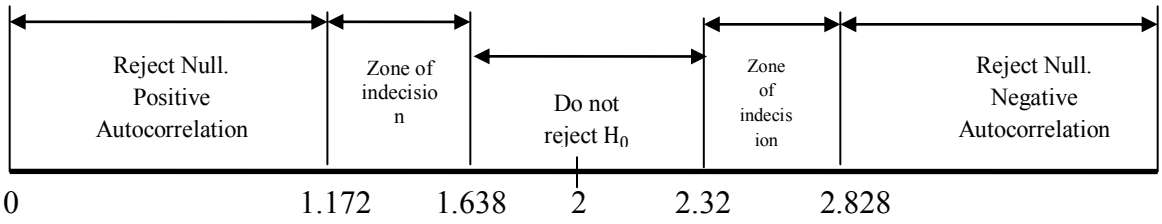
H^*_0: No negative autocorrelation

```
. dwstat

Durbin-Watson d-statistic(  6,    54) =  .8479032
```

From Tables given sample size N =54 and k = 6 (number of parameters) at 5% significance level, $d_L = 1.172$, and $d_U = 1.638$

(From Durbin-Watson statistical table, "*Models with an intercept (from Savin and White)*")



[16] Note that the OLS coefficients are unchanged, only the standard errors and t values change.

Since the computed d of 0.8479032 lies below d_L, we can reject null hypothesis that there is positive serial correlations in the residuals.

We found that our new model is free from multicollinearity problem, but the estimated d value is highly significant. So we need some other things to consider.

We all know that the variance of financial time series data varies over time. So we need to test the **auto regressive conditional heteroscedasticity** whether the present is the cause of autocorrelation or not.

```
. archlm
LM test for autoregressive conditional heteroskedasticity (ARCH)
```

lags(*p*)	chi2	df	Prob > chi2
1	1.810	1	0.1785

H0: no ARCH effects *vs.* H1: ARCH(*p*) disturbance

Table 10: Testing for ARCH

Here the probability for getting our null hypothesis is 17.85 percent which is quite enough to accept our null hypothesis that autoregressive conditional heteroscedasticity is not present in this model.

So it is important to test the specification error test of our model to find out whether the autocorrelation that exist in this model is pure or it is for misspecification of the model.

```
. ovtest

Ramsey RESET test using powers of the fitted values of erusd
       Ho:  model has no omitted variables
                  F(3, 45) =     51.46
                  Prob > F =      0.0000
```

Table 11 specification error test

Here the p value is 0 percent, so can reject the null hypothesis that means our model is mis-specified.

3.5.3 Model2:

$$Y = \beta_0 + \beta_1\, tbl1 + \beta_2 fer + \beta_3 lremittanceL1 + \beta_4 goldprice + \beta_5 relativecdrate + \beta_6 derusdL1$$

Here,

Y= ln(exchange rate – relative purchasing power parity)
Tb = trade balance (Net export)
lremittanceL1 = ln(remittance), & L1 means Lag period one
derusdL1 = First difference of erusd $(\text{erusd}_t - \text{erusd}_{t-1})$ at lag period one

Rational of this model

- Relative purchasing power parity has some direct influence on relative commercial rate[17]. So, we take the adjusted exchange rate after deducting relative ppp.
- From our theoretical analysis, we know that export helps to appreciate our currency while import depreciates our currency. What we found in our earlier analysis is that both export and import have been seen an upward trend during the time period. So if we take their difference (export-import) that will help to get precious effect of them on exchange rate.
- Our empirical theory suggests taking speculation as an independent variable. In order to get the speculation motive of investors, we need two or three month forward exchange rate of USD to BDT. But, forward exchange rate data is not available. So we take the first difference of the exchange rate to get the immediate market trend.

[17] We know that if inflation goes up, nominal interest will also adjust to that extend.

```
. tsset month,month
        time variable:  month, Jul 2007 to Dec 2011
                delta:  1 month

. reg Y l.tb fer l.lremittance goldprice relativecdrate l.derusd
```

Source	SS	df	MS		
Model	.058466781	6	.009744463	Number of obs =	52
Residual	.003177311	45	.000070607	F(6, 45) =	138.01
				Prob > F =	0.0000
				R-squared =	0.9485
				Adj R-squared =	0.9416
Total	.061644092	51	.001208708	Root MSE =	.0084

Y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tb						
L1.	-1.34e-06	5.85e-07	-2.29	0.027	-2.52e-06	-1.60e-07
fer	-7.22e-06	9.78e-07	-7.38	0.000	-9.19e-06	-5.25e-06
lremittances						
L1.	-.0393145	.0137707	-2.85	0.006	-.0670501	-.0115789
goldprice	.0001236	9.18e-06	13.47	0.000	.0001052	.0001421
relativecd~e	.0047257	.0011081	4.26	0.000	.0024938	.0069575
derusd						
L1.	.0147798	.0061654	2.40	0.021	.002362	.0271977
_cons	4.464458	.1124654	39.70	0.000	4.237941	4.690975

```
. estimates store AIC

. estimates stats *
```

Model	Obs	ll(null)	ll(model)	df	AIC	BIC
AIC	52	101.3934	178.4923	7	-342.9845	-329.3258

Table 11: New regression

3.5.3.1 Testing Individual Partial Regression Coefficient Test

H_o: That the independent variables do not have any significant impact on the exchange rate

H_A: That the independent variables have significant impact on the exchange rate

- As P-value of β_0 or coefficient of intercept is 0.000, so H_o: $\beta_0 = 0$ is rejected, implying that the model has an intercept.
- As P-value of β_1 or coefficient of trade balance is 0.027, so H_o: $\beta_1 = 0$ is rejected, implying that the coefficient of trade balance β_1 is significant.
- As P-value of β_2 or coefficient of foreign exchange reserve is 0.000 so H_o: $\beta_2 = 0$ is rejected, implying that the coefficient of foreign exchange reserve β_2 is significant.

- As P-value of β_3 or coefficient of remittance is 0.006 so H_o: $\beta_3 = 0$ is rejected, implying that the coefficient of remittance is significant.
- As P-value of β_4 or coefficient of gold price is 0.000 so H_o: $\beta_4 = 0$ is rejected, implying that the coefficient of gold price is significant.
- As P-value of β_5 or coefficient of relative commercial deposit rate is 0.000 so H_o: $\beta_5 = 0$ is rejected, implying that the coefficient of commercial deposit rate is significant.
- As P-value of β_6 or coefficient of first difference of exchange rate is 0.021 so H_o: $\beta_6 = 0$ is rejected, implying that the coefficient of squared first difference exchange rate is significant.

3.5.3.2 Testing Overall Significance of the Sample Regression

- $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ (all slope coefficients are simultaneously zero)
  $H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 = \beta_6 \neq 0$ (not all slope coefficients are simultaneously zero)

Calculated F = 134.87 & critical F = 2.34

As calculated F is greater than critical F value we can reject the null hypothesis. Moreover the p value is 0.000 that means there is 0% probability of obtaining the null hypothesis. So we can reject the null. That means all the slopes of the coefficients are non zero and have their effects on exchange rate.

Interpretations of the coefficients:

Coefficient of the constant = 4.464458: It is the intercept of the model

Coefficient of trade balance = -0.00000134: this means if the trade balance increases by BDT one crore, then the value of our currency will be appreciated by 0.00000134% of one crore in the following month (holding other variables constant).

Coefficient of foreign exchange reserve = -0.00000722: as foreign exchange reserve increase by one million dollar then exchange rate will decrease by 0.00000722 times (holding other variables constant) that means our currency value will increase by that amount.

Coefficient of remittance = -0.0393145: if remittance increases by 1%, exchange rate will decrease by 0.039 %. The amount 0.039 also indicates the elasticity of the exchange rate with respect to remittance (holding other variables constant).

Coefficient of gold price rate = 0.0001236: if gold price at international market increases by hundred USD per troy ounce then exchange rate will also increase by 0.0001236% of that amount (holding other variables constant).

Coefficient of Commercial deposit rate = 0.0047257: if Commercial deposit rate increases by 1% point then the exchange rate will also increase by 0.0047257% (holding other variables constant).

Coefficient of first difference exchange rate = 0.0147798: the exchange rate will be increased by 0.014574% of its first difference rate (holding other variables constant). That means if the current exchange rate increases by one unit, then the next period exchange rate will also increase by 0.0147798% (holding other variables constant).

Explanation of 94.85% R square:

This model or in other words the variability of trade balance, foreign exchange reserve, remittance, gold price and Commercial Deposit Rate can explain 94.85% variability of Exchange rate. In simple words 94.85% movement in exchange rate can be explained by movements in trade balance, foreign exchange reserve, remittance, gold price and Commercial Deposit Rate.

3.5.3.3 Multicollinearity Test

```
. vif
```

Variable	VIF	1/VIF
goldprice	5.63	0.177714
relativecd~e	5.32	0.187823
lremittances L1.	5.27	0.189863
fer	3.83	0.260905
derusd L1.	2.13	0.468554
tb L1.	1.23	0.810985
Mean VIF	3.90	

Table 11: VIF

The variance inflating factors of the independent variables are not significantly. So we can say that our current model is not suffers for multicollinearity problem. It will be more clear if we plot the residuals obtained from this model against the time interval.

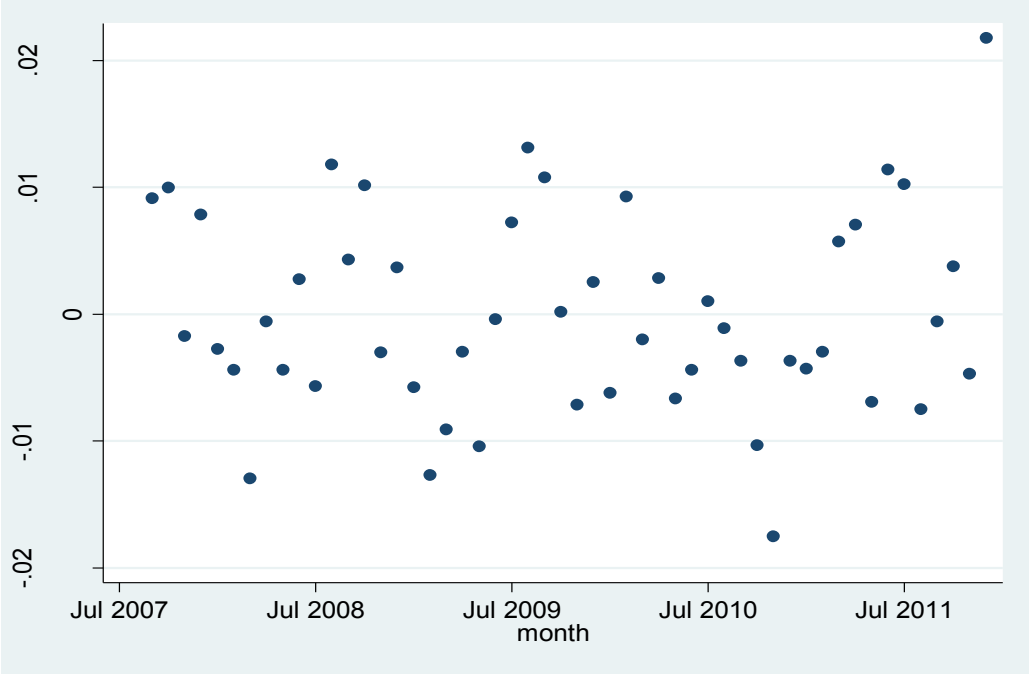


Figure 17: residuals against time interval

We can see form the residuals plots that the residuals are scatted and no observed pattern is found. So this model is free from multicollinearity problem.

Heteroscedasticity Test

```
. imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(27)     =     40.88
         Prob > chi2  =    0.0423

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	40.88	27	0.0423
Skewness	18.28	6	0.0056
Kurtosis	0.08	1	0.7828
Total	59.23	34	0.0047

Table 12: White test

The probability of the null hypothesis is not very high, so we can reject the null hypothesis that means heteroscedasticity problem is present in this model, but in this case it is not sever.

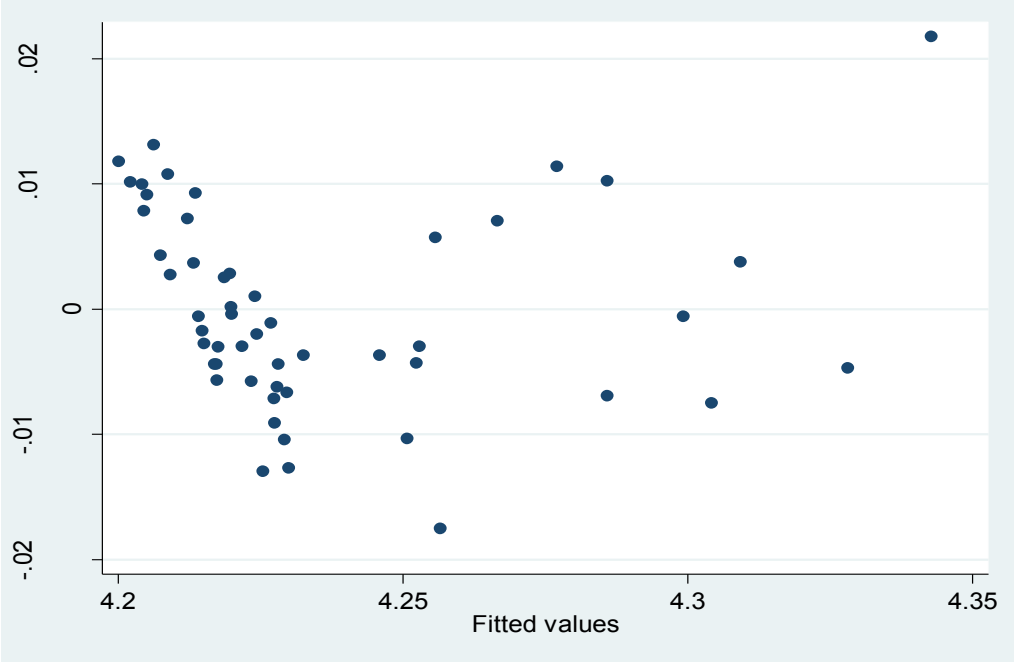


Figure 18: residuals against estimated values

It is obvious from the above graph that there are no precious relation between the residuals and the estimated value, though we can see a downward pattern at the left side of the graph. This is

mainly because of the structural change of that time that we will test in the letter part of this report. So we take robust standard error to solve this problem.

```
. reg Y l.tb fer l.lremittance goldprice relativecdrate l.derusd, robust

Linear regression                               Number of obs =      52
                                                F(  6,    45) =  107.28
                                                Prob > F      =  0.0000
                                                R-squared     =  0.9485
                                                Root MSE      =   .0084
```

Y	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
tb L1.	-1.34e-06	5.89e-07	-2.27	0.028	-2.52e-06	-1.52e-07
fer	-7.22e-06	1.11e-06	-6.52	0.000	-9.45e-06	-4.99e-06
lremittances L1.	-.0393145	.0149273	-2.63	0.012	-.0693796	-.0092494
goldprice	.0001236	8.48e-06	14.59	0.000	.0001066	.0001407
relativecd~e	.0047257	.001262	3.74	0.001	.0021838	.0072675
derusd L1.	.0147798	.0068673	2.15	0.037	.0009484	.0286112
_cons	4.464458	.1211117	36.86	0.000	4.220526	4.708389

Table 13: Robust std error

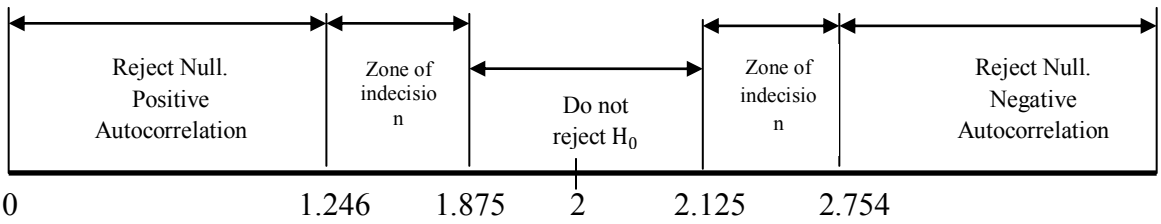
Autocorrelation test

```
. dwstat

Durbin-Watson d-statistic(  7,    52) =  1.471244
```

From Tables given sample size N =52 and k = 7 (number of parameters) at 5% significance level, $d_L = 1.34$, and $d_U = 1.685$

(From Durbin-Watson statistical table, "*Models with an intercept (from Savin and White)*")



Since the computed d of 1.471244 lies between d_L & d_U, we neither can reject nor accept null hypothesis.

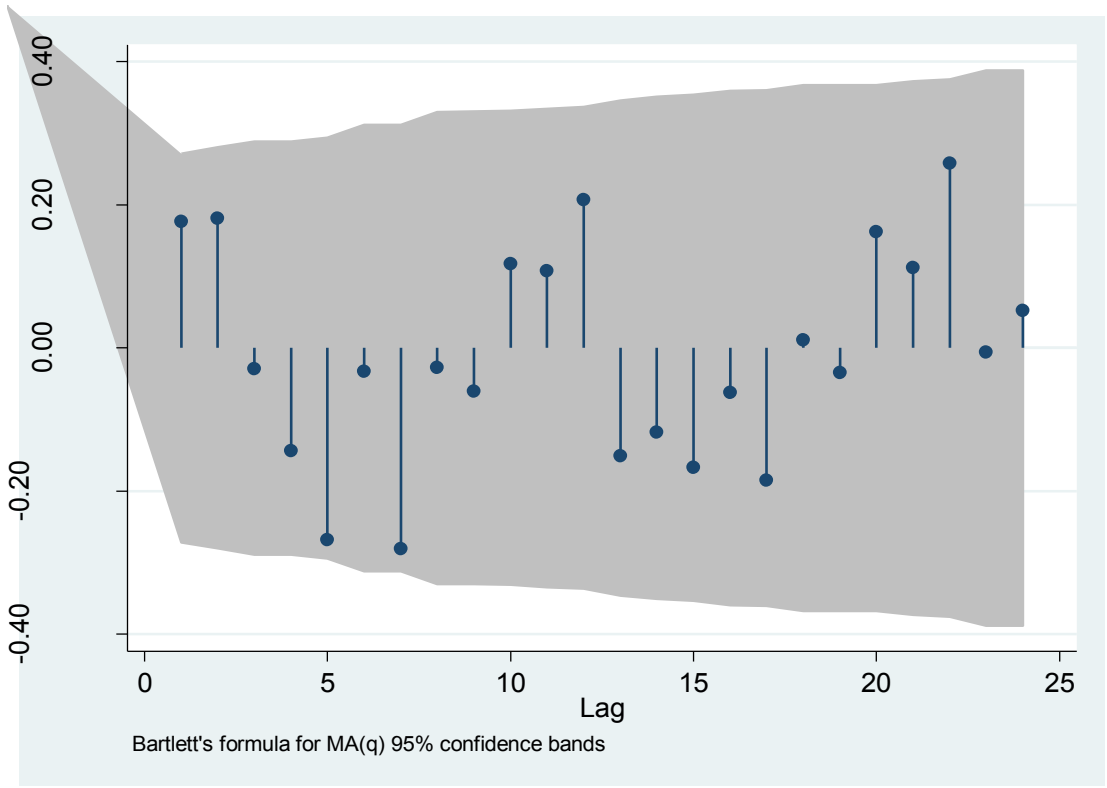


Figure 19: Autocorrelation of residuals

If we observe the correlogram of the residuals at different time lags, we will see some kind of correlation among them though it is not precise. But, this may happen because of not taking into consideration some crucial variables like speculation and political factors (dummy variables) in this model due to unavailability. Apart from this, our model is quite sound to get the other important factors for determining the exchange rate.

Choosing between the models

The adjusted R square of our current model is highest than earlier model, at the same the akaike information criterion (AIC) and *bayesian information criterion* (BIC) are the lowest for this. So we have to select the later model.

3.5.4 Normal Probability of Residuals

The normal probability plot is a graphical tool for comparing a data set with the normal distribution. We can also use it with the standardized residual of the linear regression model and see if the error term E is actually normally distributed. The data are plotted against theoretical distribution in such a way that the points should form an approximate straight line. Departure from this straight line will indicate departure from normality.

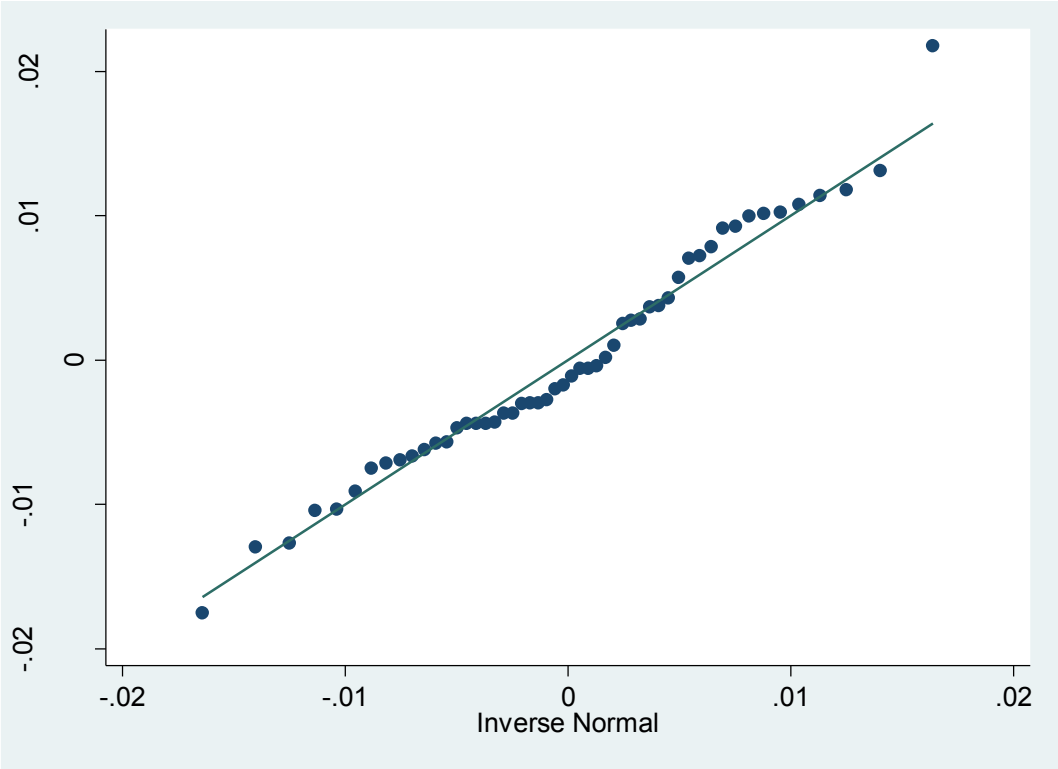


Figure 20: Normality test

The points on this plot form a nearly linear pattern, which indicates that the normal distribution is a good model for this data set.

Here we will see that how well our prediction fits with actual exchange rate during our time interval graphically-

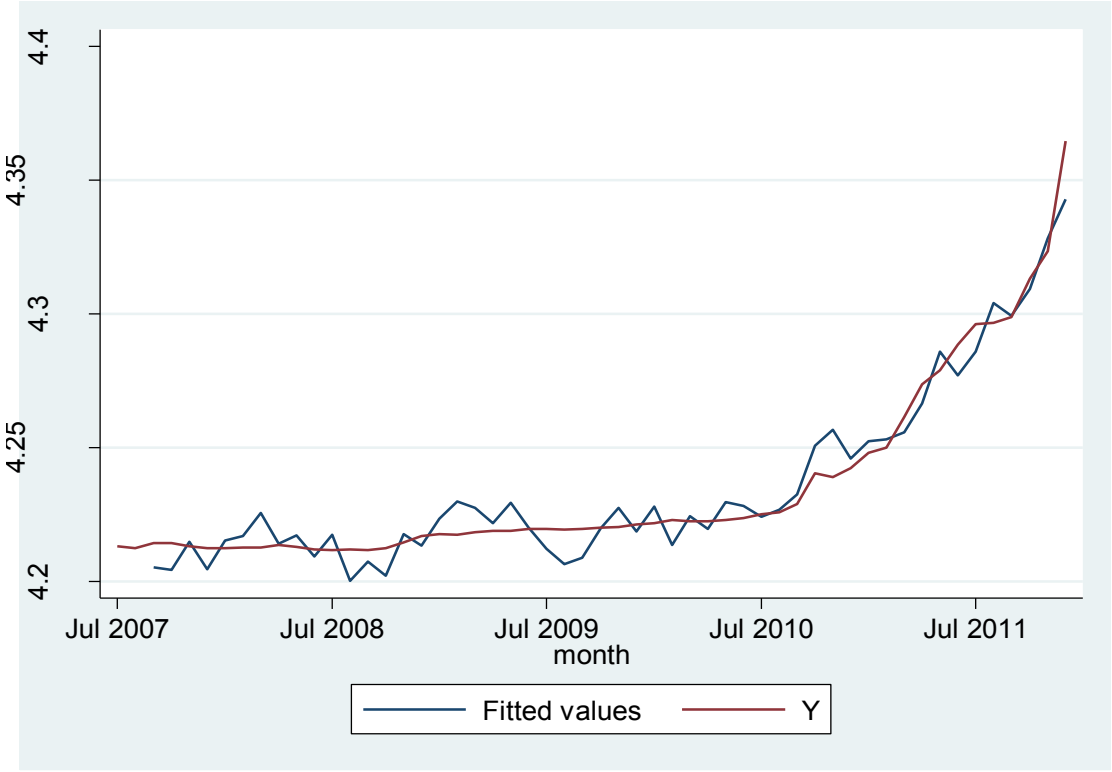


Figure 21: Estimated & actual Y

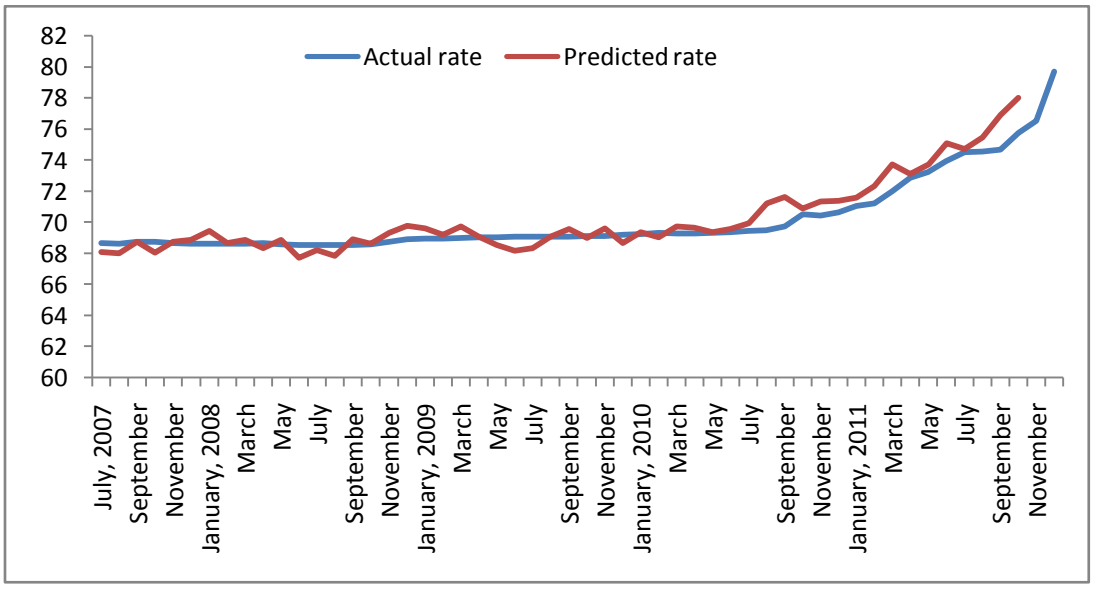


Figure 22: estimated & actual exchange rates

3.5.5 Chow Test: Testing structural stability

Structural breaks can occur in time series data or cross sectional data, when there is sudden change in the relationship being examined. We then need to decide whether to separate regression lines are more efficient than a single regression or not.

Here,We select three possible regressions:

- Time period July 2007- June 2009
- Time period July 2009-December 2011
- Time period July 2007- December 2011

H_0 : No structural change

H_1 : Structural change

```
. reg Y l.tb fer l.lremittance goldprice relativecdrate l.derusd if tin(2007m7,2
> 009m6)
```

Source	SS	df	MS		
Model	.000149743	6	.000024957	Number of obs	= 22
Residual	8.4030e-06	15	5.6020e-07	F(6, 15)	= 44.55
				Prob > F	= 0.0000
				R-squared	= 0.9469
				Adj R-squared	= 0.9256
Total	.000158146	21	7.5308e-06	Root MSE	= .00075

Y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tb						
L1.	1.24e-07	1.31e-07	0.95	0.357	-1.55e-07	4.04e-07
fer	2.88e-07	5.63e-07	0.51	0.616	-9.12e-07	1.49e-06
lremittances						
L1.	-.0063636	.0020759	-3.07	0.008	-.0107883	-.001939
goldprice	-1.18e-06	3.54e-06	-0.33	0.743	-8.72e-06	6.36e-06
relativecd~e	.0015047	.0001489	10.10	0.000	.0011872	.0018222
derusd						
L1.	.0071896	.0032058	2.24	0.040	.0003566	.0140226
_cons	4.263105	.0145633	292.73	0.000	4.232064	4.294146

Table 16 regression of time interval 1

Here, $RSS_1 = 5.6020e - 07 = 0.0000005602$

and, $n_1 = 22$

```
. reg Y l.tb fer l.lremittance goldprice relativecdrate l.derusd if tin(2009m7,2
> 011m12)
```

Source	SS	df	MS	Number of obs =	30
Model	.042756967	6	.007126161	F(6, 23) =	138.94
Residual	.001179621	23	.000051288	Prob > F =	0.0000
				R-squared =	0.9732
				Adj R-squared =	0.9661
Total	.043936588	29	.001515055	Root MSE =	.00716

Y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tb						
L1.	-1.55e-06	6.21e-07	-2.50	0.020	-2.83e-06	-2.66e-07
fer	-5.82e-06	2.74e-06	-2.13	0.044	-.0000115	-1.58e-07
lremittances						
L1.	-.0194001	.0217577	-0.89	0.382	-.0644094	.0256092
goldprice	.0000921	.0000139	6.63	0.000	.0000634	.0001209
relativecd~e	.0139336	.0032881	4.24	0.000	.0071316	.0207356
derusd						
L1.	.0072	.0056197	1.28	0.213	-.0044252	.0188252
_cons	4.250723	.182057	23.35	0.000	3.874109	4.627336

Table 17 regression of time interval 2

Here, $RSS_2 = 0.000051288$

and, $n_2 = 30$

$RSS_{UR} = RSS_1 + RSS_2$, with df=$(n_1 + n_2 - 2k)$

$= (0.0000005602 + 0.000051288)$

$=0.00005689,$

$$\mathbf{F} = \frac{(RSS_R + RSS_{UR})/K}{(RSS_{UR})/(n_1+n_2-2k)} \sim \mathrm{F}_{[k,(n_1+n_2-2k)]}$$

$= 18.8253$

On the other hand, critical F = 2.45[18]

As our calculated F value is greater than critical, therefore the probability for obtaining an F value as much or greater than18.825 will be smaller than 5%. So we can reject the null hypothesis that means structural change[19] occurred during this period.

[18] See F tables for 5 and 42 df with 5% level of significance
[19] September-October 2008, global economic recession

3.5.6 MWD test (Linear or log linear model)

H_0 : Linear model[y = f(tb)+f(fer)+f(remittance)+f(gold price) +f(relativecdrate)+fa(derusd)]

H_1 : Log-Linear model [lny = f(tb)+f(fer)+f{ln(remittance)}+f(gold price) +f(relativecdrate)+fa(derusd)]

New variable, Z1 = (lnYf – lnf)

Where, lnf = natural log of the estimated value of log-linear model and,

LnYf= natural log of the estimated value of linear model

```
. reg y l.tb fer l.remittances goldprice relativecdrate l.derusd Z1
```

Source	SS	df	MS		
Model	304.56371	7	43.5091014	Number of obs	= 52
Residual	10.170064	44	.231137817	F(7, 44)	= 188.24
				Prob > F	= 0.0000
				R-squared	= 0.9677
				Adj R-squared	= 0.9625
Total	314.733774	51	6.17125046	Root MSE	= .48077

y	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
tb						
L1.	-.0001457	.0000351	-4.15	0.000	-.0002164	-.000075
fer	-.0006197	.0000572	-10.83	0.000	-.0007351	-.0005044
remittances						
L1.	3.90e-06	.0001699	0.02	0.982	-.0003385	.0003463
goldprice	.0086809	.0005465	15.88	0.000	.0075795	.0097823
relativecd~e	.244203	.0635669	3.84	0.000	.1160924	.3723137
derusd						
L1.	.9511595	.3540892	2.69	0.010	.2375396	1.664779
Z1	-379.6387	63.81381	-5.95	0.000	-508.247	-251.0304
_cons	62.50883	.6122847	102.09	0.000	61.27485	63.74281

Table 18: Testing the functional form of the model

Here we found that coefficient of Z1 is highly statistically significant, so we can reject the null hypothesis and accept the log-linear model.

4.0 Conclusion

It is very important for a country to have clear idea on the movements of the exchange rate of its own currency with the most used and accepted foreign currency of the world. That was my main motive for doing this research, and at the end now this paper presents a model which actually explains about 94.85% of the movements of the exchange rate of Bangladesh Taka with US Dollar.

Explanatory Variables used in this model are Value of Net export by Bangladesh, Gold price in the international market, remittance, Commercial deposit rate, and first difference of exchange rate. Whereas the dependent variable was the weighted average USDBDT exchange rate.

As this model has used time series data it has the problem of autocorrelation which might be the cause of insufficiency of data and missing important variables like forward exchange rate[20], but don't have Multicollinearity. It also had problem of mild Heteroscedasticity but it has been solve through robust standard error. Structural instability has also been found in the model, this is mainly because of the global financial crisis of 2008. And it's also been confirmed through MWD test that this model follows a log-linear form.

One very new and important finding for Bangladesh's economy is that this USDBDT exchange rate has a significant positive relation with the movement of Gold price in the international market. It was expected before the research as we knew that Gold and USD has strong positive relation but it's just been proved for the USDBDT exchange rate in Bangladesh.

[20] Forward exchange rate helps to get the speculative motive which is an important variable as per our empirical study.