ARIMA Model and Forecasting of Exchange Rate of Bangladesh and Economic Dynamics

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Abstract

Background*:* This paper concentrates technical analysis to address stochastic and deterministic approach to forecast exchange rate of Bangladesh.

Methods*:* Using auto regressive integrated moving average (ARIMA) model.

Results: ARIMA model is useful to determine the exchange rate stochastically. Economic dynamics is discussed to achieve technology based higher sustainable GDP growth, which is the base for classical economy and forecasting. ARIMA (1,0,0) is followed for getting forecasted exchange rate with the help of Minitab software. Non seasonality in ARIMA predicted stable exchange rate for next six months (July-December, 2012), which is mostly close to actual rate.

Application*:* This exercise will help to forming rational expectation from quantitative point of view.

*Keywords***:** Central bank and policies**,** Exchange rate and forecasting and model application.

 JEL classification: E58, F31 and F47

1. Introduction

As the government has successfully achieved the macroeconomic stability, agent may rationally work for arriving and adjusting future time path using ARIMA. On the monetary frontier, the Nationalised Commercial Banks (NCBs) are hesitant to lend because of uncertainty resulting higher rate. At the same time, this approach to some extents contributes for excess liquidity in the economy. On the demand side, the current account surplus attributed higher growth in currency, advocating interest rates and money supply balancing. Solving the demand side issues it is likely to be less complicated in the short run absorbing liquidity through Reverse Repo and Bangladesh Bank Bill operation for maintaining interest rate and exchange rate. It is hoped that with collective actions taken by banks and BB we will be able to deal with the agency problems related to loans disbursement smoothing investment and mobilizing savings. Operationally, this is how rotten apples can be segregated from good ones (A.K.N. Ahmed, former Governor, IBB Journal, Dec.1997).

Time path in economics is crucial factor, which figure out summing the dots as a complete line. Canadian Securities Institute (CSI) books on "Derivatives Fundamental Course" (DFC) pointed that the market makers' establish the future exchange rate through an organized exchange. Forward exchange rate is decided through OTC. The loss or profit from the future and forward deal offset necessarily as it is zero sum game. Developed countries exchange rates appreciate or depreciate directly with respect to domestic interest rate. Bangladesh exchange rate is not fully convertible in all accounts of BOP. As a result, BB has role to smooth the exchange market from the macroeconomic and economic cycle perspective. Economic agents with different risk taking behaviour for example risk lover, risk neutral and risk averter along with technical analysis form rational expectation regarding exchange rate around the world. Predetermined forward exchange rates by the market makers are highly likely deviate considering actual path. At length, accounting book of the banks accommodates the exchange rate fluctuations with profit or loss.

Literature on balance of payments suggests that policy actions have ability to impact the interest and exchange rate of Bangladesh for determining inflation targeting monetary policy and productivity considering autonomy. These are influenced by opportunity cost, productivity and purchasing power parity to gain absolute and comparative advantage. This policy is crystal clear followed by bank of England and other central banks of the world calculating rates achieving real growth. Central bank in many cases deals with variable which is quadratic in nature

due to two roots. From economics literature we know that in the quadratic equation there are two roots. If the profit is maximum then the change of the slope will be negative. In case of cost minimization the slope will be positive. We always examine maximization and minimization following convexity and concavity of the yield curve. Considering residual in the system of equations mentioned next structural rigidity of Bangladesh and enabling environment for private sector, it is difficult to estimate by how much private investment would increase in response to a fall in lending rates. It is attributed from anecdotal evidence, surveys on banks and financial institution transactions, business expectations, and empirical evidence there is insightful correlation between investment and real interest rate [1]. Basically economic cycle, seasonality and time lag on policy actions have greater impact on mapping different rates including tradable and non-tradable. Demand and supply as economic fundamentals is crucial to understand causal effect termed as rates and price. Clearly demand and supply is the cause and rates are the effect quantifying the fundamental variables into constant.

In effect Bangladesh's link with the international trading system is tied to a single product, readymade garments 79 percent of total export. With the signing of the Uruguay GATT accord, the eventual dismantling of the quota system under the Multi-Fiber Arrangement (MFA) will pose most efficient garments sector. The global traditional garments industry has typically moved next generation ensuring style, fabrics and quality equating demand of the industrialized nations. Countries, including Bangladesh, to some extent offering only quota dispersion and not internationally competitive production, may lose out ("Impact of the GATT Accord on Developing Countries," Oxford Analytica, December 22,1993). Allowing trafficking considering export base, however, outflows of resident owned capital for investment abroad is restricted. Arriving exchange rate daily basis for international transaction BB announces a buying-selling rate band for the dollar against the Taka with authorised dealer (AD) banks. Avoiding interest rate arbitrage and encouraging domestic investment trends of the real effective exchange rate of Taka against a trade-weighted basket of currencies of major trade partners, as well as of other major external and internal indicators are analysed and calculated to monitor the competitiveness. ADs set own buying and selling rates for dollar and other currencies, based on cross rates in international markets (Exchange Arrangement and Exchange Restrictions-2003, IMF). Forward rates are calculated depending on demand and supply and technical analysis. Consequently, Bangladesh is moving towards capital account convertibility following inflation targeting international norms of banking satisfying national account indicators as policy agenda materializing empirical work.

2. Material and methods

Econometric analysis has been performed in this paper. Theoretical and practical issues with higher GDP growth are discussed to form rational expectation regarding exchange rate. Forecasting of exchange rate using ARIMA is the fundamental contribution of this paper.

3. Forecasting of volatility clustering exchange rate using ARIMA

After analyzing mentioned test in classical manner we performed forecasting incorporating seasonal and non-seasonal factors apart from VAR. Following exchange rate own pace observed from VAR the auto regressive integrated moving average (ARIMA) model can be deployed for forecasting. ARIMA (1,0,0) is followed for getting forecasted exchange rate with the help of Minitab software. Non seasonality in ARIMA predicted stable exchange rate (Figure 1) for next six months (July-December, 2012), which is mostly close to actual rate. Six months seasonality demonstrated that there is surge in exchange rate from November to December, 2012 (Figure 2). Non-seasonal and seasonal forecasted value can be found in Table 1 and Table 2 respectively. [2, 3] pointed out many forecasting research have shown that the behaviour of exchange rate series cannot be modelled solely by linear time series model (e.g. regression model, AR(p), ARIMA(p,q) and others) because exchange rate nature is most complex(non-linear) and volatile. Therefore, developing a model for forecasting requires an iterative process of knowledge discovery, system improvement through data mining as well as error and trial experimentation. However, Bangladesh's foreign exchange market is limited and experiencing low arbitrage and speculation. For that reason conventional variance decomposition has absolute effect among variables. SWAP transaction based on comparative advantage and currency affluence works for reducing the volatility clustering exchange rate of Bangladesh.

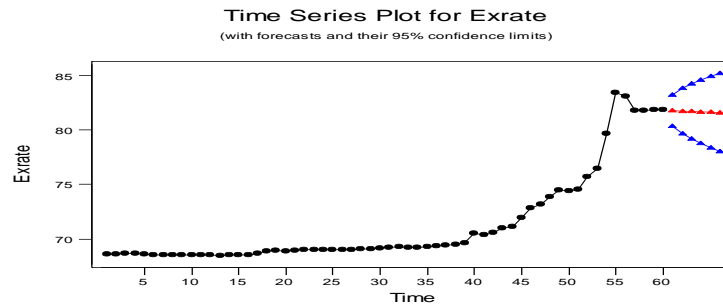*Figure 1. Non seasonal monthly (average) forecasted exchange rate plot using ARIMA*

Figure 2. Forecasted monthly (average) exchange rate plot using ARIMA with seasonal treatment
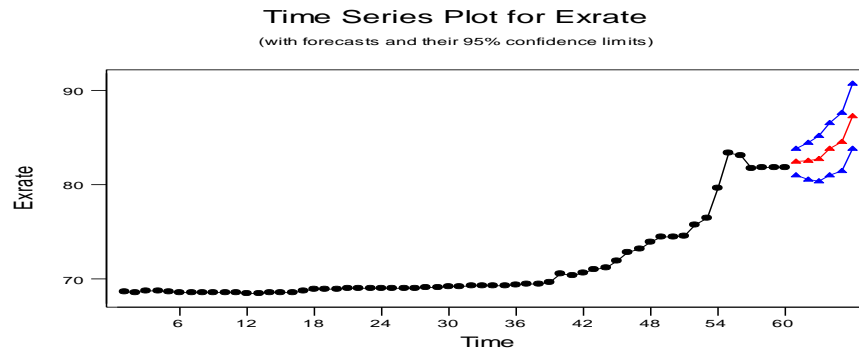

Table-1.   95% confidence level (without seasonality) (Taka/US$ exchange rate)

Month average	Forecast	Lower	Upper	Actual
July 12	81.7838	80.3281	83.2395	81.7715
August 12	81.7476	79.6894	83.8058	81.5160
September 12	81.7114	79.1912	84.2317	81.7286
October 12	81.6752	78.7658	84.5847	81.3123
November 12	81.6391	78.3869	84.8913	
December 12	81.6030	78.0412	85.1648	

Table 2.   95% confidence level (with seasonality) (Taka/US$ exchange rate)

Month average	Forecast	Lower	Upper	Actual
July 12	82.432	81.0529	83.8112	81.7715
August 12	82.5303	80.5743	84.4863	81.5160
September 12	82.7584	80.3559	85.1610	81.7286
October 12	83.8163	81.0340	86.5985	81.3123
November 12	84.5619	81.4422	87.6815	
December 12	87.2837	83.8563	90.7111	

BB's approach following ARIMA and economic aspects: In time series analysis in econometrics a linear stochastic process has a unit root if I(d) in certain order of differentiation is stationary. AR(1,2…n) is a auto regressive process showing different order of differentiation identifying unit root of the system of equation. AR(1) represents the data which is stationary in 1st order differentiation. AR(2) refers 2nd order differentiation which is required to make the data stationary. Auto regressive process has been followed to fit the data in linear form for forecasting and forming rational expectation. This order is stationary as it is reached to zero. In this case we can accept the hypothesis or reject the alternative. The hypothesis is Auto correlation function is different from zero after first difference. We reject the hypothesis and find the stationary of the AR process of the data. Complicated Auto Regressive Integrated Moving Average ARIMA (1,1,0) can be derived using this mechanism [3]. ARIMA has 3 components. Auto Regressive - AR(1) is stationary in 1st order differentiation. Integrated- I(1) refers to the co integrated process. Moving Average MA(0) is a statistical extrapolation, and treatment is not applied (0). ARIMA (1,0,0) is followed for getting forecasted exchange rate in our study. To deal with reserve money (RM) the ARIMA (1,1,1) may be deployed. RM is basically deterministic variable.

Virtually BB follows Auto Regressive (AR) methods reflecting Robert E. Lucas (ranked one of the 10th leading economists in the world) observation data speak itself as procedure. In most cases our findings suggest exchange rates data is stationary in first order i.e. AR (1) solving I(d). Virtually BB allows stochastic and deterministic approach with due trade weight and price index of the partner countries. Basically, monetary authority uses exchange rate as tools in tightening or loosening subject to liquidity in coordination with policy rates (repo and reverse repo rate) as bank rate is fixed in nature. Market experiences correction through open market operation (OMO) and debt management credit product treasury bills and bonds on regular basis addressing the norms of managed float. The outcome of BB's action is duly reflected in the yield curve of different maturities providing short run and long run rate preferably with buyback facility in bonds allowing variability in the yield curve (time path).

4. Policy analysis of CES production function to generate over 7 percent real GDP growth

Financial intermediaries channelize the savings into investment. Proper distribution of surplus to deficit with effective technology based investment can augment the economic growth and forming rational expectation in forecasting exchange rate. Monitoring of loan can channelizing assets between factors of production termed capital and labour reducing income inequalities for sustainable economic development. In economics, constant elasticity of substitution (CES) is an important property of production functions and utility functions. The constant distribution of profit will reduce the income inequalities in Bangladesh considering Gini coefficient (32.1%: in the year 2010, source: http://data.worldbank.org/indicator/SI.POV.GINI).   The benefit of economic growth is not realised if the income inequalities increase. As a result poverty will not reduce in a desired level. In Bangladesh 31% (in the year 2010, source: http://www.indexmundi.com/g/g.aspx?c=bg&v=69) people are living below poverty line. Introduction of technology with proportioned distribution of profit between labour and capital can ensure the benefit of CES following Euler's theorem.

In reference to the economics literature survey, the CES is a type of production function that displays constant elasticity of substitution in the factors of production maximizing input and output. In other words, the production technology has a constant percentage change in factor (e.g. labour and capital) proportions due to a percentage change in marginal rate of technical substitution. Considering the intensity of the economy labour and capital can be deployed. In case of Bangladesh labour intensive production function can be followed through productivity gain with the help of technology.

Marshallian demand functions can be derived when preferences are CES. Constant returns to scale exponent of Cobb-Douglas production functions reflects $\gamma+\beta=1$ as input factors maximise capital (C) and labour (L) in a production function. The underlying equation has the general form $Y = F(C,L) = AC^{\gamma}L^{\beta}$. Here F is total production and A is total factor productivity (technology) and γ and β are positive parameters showing the elasticises of production. For illustration we can figure out the equation for a particular year as $F(194,407)=1.05((194^\wedge.35)(407^\wedge.65)) \approx 329.73$. Factor productivity 1.05 = current year total production (105) divided by base year total production (100). $\gamma + \beta >1$ demonstrates increasing returns to scale. Considering this mode of production as developing country concern it is possible to augment the real GDP growth over 7 percent using technology maintaining increasing returns to scale. This technological base will enhance the economic capacity and will help to forecast stable interest rate, exchange rate and inflation in the country with balanced growth. Stability in GDP subject to uncertainty will help to address the calculated and uncalculated risk in forming rational expectation.

As productivity concern economic openness in South Asia, rapid growth in China and Malaysia, pose a challenge that our country is facing comparatively. Bangladesh is likely in intense competition for export market and foreign investment in the quota free era. Consequently, increase in technology can stimulate the capital and labour generating increasing returns to scale for Bangladesh economy. [4] suggests that RER helps diversify exports and raise technological intensity of exports. As a developing country Bangladesh can increase its GDP by a greater margin with a set amount of resources comparing developed countries. This is because the developed country is already operating with the highest level of technology and infrastructure. Any further improvements would have to come from more costly research and development, whereas the developing country like Bangladesh can implement existing technology to improve its situation. Exchange rate has positive effect on the foreign exchange reserves and this relationship is statistically significant [5]. This study covers yearly data from July 01, 1996 to June 30, 2005 and quarterly data from July 01, 2005 to June 30, 2012. Findings of this study show that out of the selected 16 factors affecting foreign exchange reserves, exchange rates occupy the first position.

Monetary and economic analysis of exchange rate: Exchange rate management is correlated with interest rate. Regarding monetary policy frontier Taylor rule based effective interest rate policy will balance the actual and potential output in Bangladesh maintaining optimum flexible inflation rate. Many studies reveal that higher output growth over 7 percent will reduce the poverty level in Bangladesh significantly. This economic dynamics is vital for the development of the country following desired exchange rate. Higher GDP growth will provide more stability in forming rational exchange rate considering structural break of the data and maintaining classical norms of the economy. As a result, following economic dynamics stable higher GDP growth with the stochastic exchange rate data ARIMA will provide better result in forecasting exchange rate in Bangladesh. In case of two-pillar monetary regime monetary and economic analysis are considered. Our monetary analysis related to exchange rate will help to economic analysis to target flexible inflation like Bank of Thailand and Bank Indonesia uplifting the country's economic position.

5. Conclusion

The asset bubble burst in the developed countries slows the pace of global economy. In spite of this, sincere hard work reducing asymmetric information and moral hazard along with stimulus financial package through forward motion will optimize mean variance of exchange rate deviations with desired economic path. Volatility of exchange rate is inherent due to economic cycle with arbitrage opportunity and speculation and we can define it as zero sum game. Managed float leads to fixed exchange rate in Bangladesh with particular solution. In our ARIMA models exercise we can forecast the monthly exchange rate autoregressive base in order to compare the deviation of real exchange rate. To forming rational expectation regarding exchange rate technology based higher GDP growth is essential.

6. Acknowledgements

7. References

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