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Forecasting Some Key Macroeconomic Variables in Bangladesh

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Forecasting Some Key Macroeconomic Variables in Bangladesh [1]

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Abstract

This paper uses three alternative forecasting models, namely, Box-Jenkins's Auto-regressive Integrated Moving Average (ARIMA) model, unrestricted Vector Autoregression (VAR) model and Hsiao's Final Prediction Error (FPE) criteria to forecast some of the key macroeconomic variables such as, output, inflation, exchange rate, money and credit growth in Bangladesh based on quarterly data during 1990:1-2006:4. This paper also compares these forecasting techniques to see which technique suits better in forecasting each of the macroeconomic variables used in the study rather than the forecasted outcome itself. Based on the lowest MSE and RMSE, it has been found that Hsiao's Final Prediction Error (FPE) Criteria appears to be relatively better technique followed by Box-Jenkins's ARIMA model (BJ) and unrestricted VAR model in forecasting the selected macroeconomic variables in Bangladesh. Among the three forecasting techniques, the FPE criteria generates best forecasted outcome for real GDP, industrial production index, narrow money and domestic credit. While UVAR produces best forecasted outcome for inflation and exchange rate, ARIMA (BJ) model produces best forecast for broad money and private sector credit based on the lowest MSE and RMSE. Based on the best technique, the point estimates for selected variables indicate that real GDP growth is expected to be 6.5 percent and 7.0 percent respectively in FY07 and FY08. According to the forecasted estimates of the current study, on the other hand, the rate of inflation in Bangladesh is expected to be 7.24 percent and 7.70 percent respectively in June 2007 and in June 2008.

Keywords: Forecasting, Output, Inflation, Exchange Rate, Money and Credit

JEL Classification: C53, E27, E37, E47

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Forecasting Some Key Macroeconomic Variables in Bangladesh

1. Introduction

Economic forecasting is a rapidly developing field with wide applicability in business and government. The increasing complexity of markets is fueling the demand for professionals who possess an understanding of the forecasting needs of organizations, the econometric tools to solve forecasting problems, and the necessary computer skills to generate optimal forecasts. Successful implementation and persuasion of monetary policy largely depends on the efficiency and accuracy of forecasting major macroeconomic events like inflation and output. Decision makers of most of the top-notched central banks in the world use forecasts of economic growth and inflation in making plans and implementing policies to combat dynamics of the world economic scenario. Keeping stable inflation and exchange rate along with its international competitiveness supportive to higher real GDP growth are the premier objectives of the Bangladesh Bank. Given typical time lags, monetary policy needs to be concerned with future inflation.

With a view to maintaining intended rate of future inflation within the desired limits, the monetary authority of the Bangladesh Bank programs the required rate of money supply growth for a given real output growth. Current inflation levels, however, which are themselves the result of past policies, provide insufficient information to the policy makers. The practice of forecasting in Bangladesh is 'ad hoc' in nature and is not based on any fundamental macroeconomic model. Forecasting some key macroeconomic variables based on a number of sophisticated econometric models that link future and current macroeconomic developments can play a crucial role in providing some guidelines for the existing practice of forecasting in Bangladesh.

Econometric forecasting models usually comprise of systems of relationships between variables of interest where the relations are estimated from available data, mainly aggregate time-series. In practice, however, it has been observed that reasonably good forecasts can be made using simple rules of thumb which are extrapolations of a single data series. Including too many variables makes a model unwieldy while not including enough can increase forecast error. Keeping this in mind the current paper attempts to use quite a few forecasting models, namely, Box-Jenkins's ARIMA model, unrestricted

Vector Autoregression (VAR) model and Hsiao's Final Prediction Error (FPE) criteria to forecast some of the key macroeconomic variables namely, inflation, exchange rate, growth in money, domestic credit, industrial production index and real GDP in Bangladesh based on quarterly data during 1990:1-2006:4. This paper also makes a comparison of these forecasting techniques to see which suits better in forecasting each of the macroeconomic variables used in the study. Based on the best technique, a table of forecasted values of the selected macroeconomic variables for FY08 will be produced. The remainder of the paper is organized as follows. Section 2 briefly surveys literature on forecasting macroeconomic variables. Section 3 describes the model variables and methodology. Section 4 and 5 respectively presents the preliminary data analysis of the forecasting models and empirical results. While Section 6 contains the analysis of near-term outlook of the paper, Section 7 draws the conclusion.

2. Literature Review

Like other central banks, one of the main responsibilities of the central bank of Bangladesh has been to conduct monetary policy with a view to regulating the issue of currency and keeping of reserves and managing the monetary and credit system of Bangladesh. Recently Bangladesh Bank decided to release its *Monetary Policy Statement* (Bangladesh Bank 2006 and 2007) bi-annually with the primary objective of outlining the formulation and implementation of monetary policy of the Central Bank and conveying information in advance relating to internal and external developments of the macroeconomic variables, particularly monetary and inflationary situation to the stakeholders and the public at large, which may be seen as a move in the right direction warranting forecasting of macroeconomic variables as well. This ex-ante announcement of the monetary policy stance is intended to affix inflation expectations of the market participants and the general public in the prevailing market based interest rate and exchange rate regime for Taka.

It may be noted that any study based on forecasting macroeconomic variables in Bangladesh using econometric techniques is virtually non-existent. This paper makes an attempt to fill the gap in the literature of forecasting macroeconomic variables in Bangladesh. Bokil and Axel (2005) argue that although forecasting macroeconomic variables based on quantitative techniques may provide useful information on future

developments on the variables, sometimes qualitative judgment combined with further analysis going beyond econometrical relationships which requires understanding of the actual developments of the variables. They use three empirical approaches to forecasting inflation for Pakistan based on monthly data for the sample period from 1998 to 2004. A leading indicator model (LIM), a univariate ARIMA model and an unrestricted VAR model are used in their study. Two variants of a leading indicator model are used that performed well in ex-post forecasting in case of Pakistan. The univariate approach also resulted in a reasonably acceptable forecasting model, though the ARIMA's forecasting accuracy was much less than the LIMs. The model-based VAR approach yielded the least satisfactory forecasting model.

Tao Sun (2004) developed an approach for forecasting core inflation in Thailand using monthly data from May 1995 to October 2003. The seasonally adjusted, monthly percent changes in Thailand's consumer price index after removing its raw food and energy components is used as the dependent variable. A group of potential explanatory variables available at monthly frequency have been selected for the estimation. These include commodity and asset prices, indicators of cost pressures in product or labor market (such as industry selling price indexes, wages, unit labor costs, and import prices), and measures of pressure on the demand side (such as the money supply and other financial indicators).

Three main issues emerge from Tao (2004)'s estimation. First, this paper implements an empirical statistical model to identify short-run factors that may be useful in forecasting Thailand's core inflation—with clear implications for the conduct of monetary policy in the inflation-targeting regime. Second, the paper makes use of an equilibrium-correction term to catch the long-run effect of the main economic determinants of Thailand's consumer price index. Combining the short and the long-run analysis, Tao (2004) obtained a forecasting model with out-of-sample predictive accuracy regarding core inflation—10, 24, and 55 months ahead. The results suggest that several indicators available at a monthly frequency contain information that helps forecasting core inflation in Thailand. Third, the paper illustrates that the combination of the general-to-specific approach, principal component analysis, and equilibrium correction modeling is a promising way to forecast Thailand's core inflation.

Ramakrishnan and Vamvakidis (2002) estimate a multivariate model for Indonesia to identify the leading indicators that have predictive information on future inflation using quarterly data from 1980 to 2000. Using Granger Causality tests their study identifies that the exchange rate, foreign inflation and monetary growth have significant predictive power for inflation in Indonesia.

Hafer and Hein (2005) compare the relative efficiency of the widely used interest rate based forecasting model and univariate time series model based on monthly data from the United States, Belgium, Canada, England, France and Germany for the sample period from 1978 to 1986. Using monthly data on the Euro rates and the consumer price index (CPI) their results indicate that time series forecast of inflation model produces equal or lower forecast errors and has unbiased predictions than the interest rate based forecasts. They also find that the best inflation forecast is the one that combined information in both the time-series and interest-rate models. Cornell (1978), on other hand, also examines whether variations in the nominal interest rate contain information on inflation expectations using data form Canada, Britain, and the United States and finds that nominal interest rate on the short-term and long term interest rates varies due to inflation expectations.

Smyth and Ash (1975) examine the accuracy of the forecasting values of three major variables – GNP, price and the balance of payments – of the major OECD countries, namely, the U.S.A, Canada, Japan, France, Germany, Italy and the United Kingdom in accordance to their importance in policy making. The finding of the study indicate that in most of the cases forecasting based on complex methods as reported in the publication '*OECD Outlook*' were less close with the actual compared to alternative naive methods used by authors.

Gavin and Kevin (2006), using Stock and Watson's (2005 and 1999) Dynamic Factor Models (DFM) forecast inflation and output with three alternative processes: a benchmark autoregressive model; a random walk; and a constant that presumes a fixed rate of growth of prices and output over the forecast horizon 3, 12 and 24 months with the monthly data from January 1978 to December 1996. Gavin and Kevin (2006) compare forecasts of four price indexes—the CPI, the CPI excluding food and energy, the Personal Consumption Expenditure (PCE) chain price index and the PCE measure

excluding food and energy. They find that the accuracy of the forecasts is sensitive to time horizon and the type model used in forecasting.

Callen and Chang (1999) forecast inflationary trends in India by estimating two models that describe the inflationary process in India – one is based on a monetary approach and the other on output gap model. Besides, they use a series of vector auto-regressions models (VARs) to identify the indicators that contain predictive information about future inflation in India. Quarterly data of Wholesale Price Index (WPI) is used as measure of inflation. A set of explanatory variables have been used for sample period from 1982:Q2 to 1998:Q2 to asses which variables contain significant information about future inflationary process in India. Callen and Chang (1999) find that two monetary aggregates (M1 and M3) contain best information about future inflation. The output gap model does not perform well on Indian data. They also find that in case of manufacturing sector prices, import prices, the exchange rate, stock prices, and the prices of primary products also provide useful information about future price developments.

3. Model Variables and Methodology

Quarterly data during 1990:Q1–2006:Q4 on narrow money, broad money, total domestic credit (private plus public) and domestic credit to the private sector from the banking system, consumer price index, exchange rate and industrial production index or real GDP for Bangladesh have been used in the study. Depending on the various alternative combinations of the selected variables four different models have been used in forecasting. The four alternative models are as follows:

Model 1: Narrow money (m1), exchange rate (er), consumer price index (cpi) and industrial production index (ipi) or real GDP (y).

Model 2: Broad money (m2), exchange rate (er), consumer price index (cpi) and industrial production index (ipi) or real GDP (y).

Model 3: Private sector credit (pc), exchange rate (er), consumer price index (cpi) and industrial production index (ipi) or real GDP (y).

Model 4: Domestic credit (dc), exchange rate (er), consumer price index (cpi) and industrial production index (ipi) or real GDP (y).

The literature on forecasting technique is one of the fastest growing areas in econometrics in terms of both volume and sophistication. Among the broad spectrum of forecasting techniques, the current study uses three techniques, such as Box-Jenkins's ARIMA model, Unrestricted Vector Autoregressions (UVARs) model and Hsiao's Final Prediction Error (FPE) criteria to forecast some of the key macroeconomic variables in Bangladesh. With view to introducing these forecasting techniques each of them is briefly discussed below.

1. Box-Jenkins's ARIMA Model: The Box-Jenkins (BJ) approach to modeling Auto-regressive Integrated Moving Average (ARIMA) processes was described in a highly influential book by statisticians Box and Jenkins (1970). An ARIMA process is a mathematical model used for forecasting. Box-Jenkins modeling involves identifying an appropriate ARIMA process, fitting it to the data, and then using the fitted model for forecasting. One of the attractive features of the Box-Jenkins approach to forecasting is that ARIMA processes are a very rich class of possible models and it is usually possible to find a process which provides an adequate description to the data. An ARIMA model includes three types of parameters: the autoregressive parameters (*p*), the number of differencing passes (*d*), and moving average parameters (*q*). In the notation introduced by Box and Jenkins, models are summarized as ARIMA (*p, d, q*). An ARIMA model predicts a value in a response time series as a linear combination of its own past values, past errors (also called shocks or innovations), and current and past values of other time series. The ARIMA procedure provides a comprehensive set of tools for univariate time series analysis that involves three stages: model identification, parameter estimation and forecasting.

2. Vector Autoregressions (VARs) Model: Structural macro-econometric models, such as Klein interwar model, the Brooking model, the St. Louis macroeconomic model and the Taylor model are based on hundreds of equations and variables. In addition to the estimation difficulties, the problems of identification and endogeneity are commonly associated with these giant structural macroeconomic models. Sims's (1980) seminal work introduces unrestricted vector autoregression (UVAR) that allows feedback and dynamic interrelationship across all the variables in the system and appears to be highly competitive with the large-scale

macro-econometric models in forecasting and policy analysis. The unrestricted VARs model assumes that each and every variable in the system is endogenous and does not impose any *a priori* restrictions. The vector autoregressions (VARs) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

3. Hsiao's Final Prediction Error (FPE) Criteria: The FPE criteria are based on minimizing the expected prediction error variance due to forecasting or due to incorrect estimation of the prediction coefficients. Although VARs is widely used procedures for forecasting, there are some basic issues that make the use of unrestricted VARs less and less attractive. The unrestricted VARs model assumes that each and every variable in the system is endogenous and does not impose any *a priori* restrictions. Because it does not impose any *a priori* restrictions and is based on reduced form equations, it is difficult to reconcile VARs with economic theory and to provide any meaningful interpretations of the estimated parameters. A problem most of the applications of unrestricted VARs encounter is, therefore, the high number of parameters required that lead to degrees-of-freedom problems by imposing a common lag structure for each of the variables in model. This problem may easily be handled by applying Hsiao's procedure based on Akaike's Final Prediction Error (FPE) criterion, a procedure that does not impose common lag-structure on the model but allows exogenous variable as well as the lag-lengths to differ for each variable in each equation (Hsiao 1981).

4. Preliminary Data Analysis

The forecasting models, as described above, require all variables to be identified properly so that all the residuals are white noise. A series of unit root tests, such as Augmented Dickey-Fuller (DF 1981), Phillips-Perron (PP 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS 1992) are used to determine the order of integration (*d*) for each series. In order to decide the autoregressive parameters (*p*) and moving average parameters (*q*), autocorrelation and partial autocorrelation functions are used. The lag lengths of the

unrestricted VARs are decided based on Schwarz Information Criterion (SIC) criteria that are sufficient to make all residuals white noise. The identification results of each variable are reported in Table-1.

Table 1

The Results of Identification

Name of the Variable (all in natural logarithmic form)	Identified as ARIMA (*p, d, q*)
1. Narrow money (lm1)	lm1 = ARIMA(4,1,1)
2. Broad money (lm2)	lm2 = ARIMA(1,1,0)
3. Domestic credit to the private sector (lpc)	lpc = ARIMA(1,1,1)
4. Total domestic credit (private plus public) (ldc)	ldc = ARIMA(1,1,1)
5. Exchange rate (ler)	ler = ARIMA(1,1,0)
6. Consumer price index (lcpi)	lcpi = ARIMA(6,1,0)
7. Industrial production index (lipi)	lipi = ARIMA(3,1,0)
8. Real GDP (ly)	ly = ARIMA(3,1,3)

5. Empirical Results

The Time Series Forecasting System (TSFS) provides a variety of tools for identifying potential forecasting models and for choosing the best fitting model. As a standard practice, in making the forecasting outcomes comparable among the various techniques, mean square error (MSE) as well as root mean square error (RMSE) are used as model selection criteria to identify the best performing technique in forecasting selected macroeconomic variables in Bangladesh. Table 2 and 3 depict all MSEs and RMSEs under all three forecasting techniques, namely Box-Jenkins's ARIMA model (BJ), unrestricted Vector Autoregression (UVAR) model and Hsiao's Final Prediction Error (FPE) criteria for various alternative combinations of variables.

It has been observed from Tables 2 and 3 that none of the models produces best forecast outcome for all the variables. As reported in Table 4, various forecasting techniques are assigned to forecast various variables based on the lowest MSE and RMSE. It has been observed from Table 4 that some models are better in forecasting money while others are better in forecasting exchange rate or price or output. For example, FPE produces best outcome for narrow money, domestic credit, industrial production index and for real GDP

growth. While BJ technique generates best outcome for broad money and private sector credit, UVAR model produces best outcome for exchange rate and inflation.

Table 2

Means Square Error (MSE) and Root Means Square Error (RMSE) when Industrial Production Index (IPI) is used

		Variables and Model Selection Criteria							
		M1		**ER**		**CPI**		**IPI**	
		MSE	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**
Model 1	**BJ 1**	**0.0026**	**0.0515**	0.0010	0.0317	0.0007	0.0269	0.0046	0.0677
	UVAR 1	0.0111	0.1055	0.0018	0.0426	0.0010	0.0315	0.0121	0.1099
	FPE 1	0.0034	0.0584	**0.0006**	**0.0239**	**0.0004**	**0.0195**	**0.0044**	**0.0666**
		M2		**ER**		**CPI**		**IPI**	
		MSE	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**
Model 2	**BJ 2**	**0.0003**	**0.0177**	0.0010	0.0317	0.0007	0.0269	0.0045	0.0677
	UVAR 2	0.0056	0.0747	0.0023	0.0481	0.0006	0.0244	0.0056	0.0749
	FPE 2	0.0007	0.0259	**0.0006**	**0.0251**	**0.0003**	**0.0179**	**0.0027**	**0.0517**
		PC		**ER**		**CPI**		**IPI**	
		MSE	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**
Model 3	**BJ 3**	**0.0006**	**0.0251**	0.0010	0.0317	0.0007	0.0269	**0.0046**	**0.0677**
	UVAR 3	0.0030	0.0551	0.0015	0.0382	0.0012	0.0347	0.0152	0.1232
	FPE 3	0.0012	0.0344	**0.0005**	**0.0225**	**0.0004**	**0.0192**	0.0054	0.0733
		DC		**ER**		**CPI**		**IPI**	
		MSE	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**	**MSE**	**RMSE**
Model 4	**BJ 4**	0.0047	0.0683	0.0010	0.0317	0.0007	0.0269	0.0046	0.0677
	UVAR 4	0.0060	0.0774	0.0015	0.0384	0.0013	0.0358	0.0155	0.1246
	FPE 4	**0.0016**	**0.0396**	**0.0006**	**0.0244**	**0.0004**	**0.0191**	**0.0042**	**0.0645**
Best Model (Min. MSE/RMSE)		**BJ 2** **0.0003**	**BJ 2** **0.0177**	**FPE 3** **0.0005**	**FPE 3** **0.0225**	**FPE 2** **0.0003**	**FPE 2** **0.0179**	**FPE 2** **0.0027**	**FPE 2** **0.0517**

Notes:

1. *The above figures are generated through RATS Programming. Please consult RATS 'Programming Manual, 2003' by Walter Enders for more details.*
2. *The optimal lag length for VAR is chosen to be 1(one) based on minimum Schwarz Information Criterion (SIC).*

Table 3

Means Square Error (MSE) and Root Means Square Error (RMSE) when Real GDP (y) is used

		Variables and Model Selection Criteria							
		M1		ER		CPI		y	
		MSE	RMSE	MSE	RMSE	MSE	RMSE	MSE	RMSE
Model 1	BJ 1	0.0026	0.0515	0.0010	0.0317	0.0007	0.0269	0.0003	0.0185
	UVAR 1	0.0101	0.1004	**0.0003**	**0.0172**	**0.0001**	**0.0117**	0.0003	0.0161
	FPE 1	**0.0020**	**0.0445**	0.0006	0.0235	0.0002	0.0151	**0.0001**	**0.0100**
		M2		ER		CPI		y	
		MSE	RMSE	MSE	RMSE	MSE	RMSE	MSE	RMSE
Model 2	BJ 2	**0.0003**	**0.0177**	0.0010	0.0317	0.0007	0.0269	0.0003	0.0185
	UVAR 2	0.0029	0.0537	0.0019	0.0432	**0.0002**	**0.0127**	0.0005	0.0216
	FPE 2	0.0006	0.0241	**0.0006**	**0.0235**	0.0002	0.0148	**0.0001**	**0.0100**
		PC		ER		CPI		y	
		MSE	RMSE	MSE	RMSE	MSE	RMSE	MSE	RMSE
Model 3	BJ 3	**0.0006**	**0.0251**	0.0010	0.0317	0.0007	0.0269	0.0003	0.0185
	UVAR 3	0.0105	0.1025	0.0028	0.0525	**0.0001**	**0.0102**	0.0004	0.0201
	FPE 3	0.0010	0.0320	**0.0006**	**0.0243**	0.0005	0.0230	**0.0001**	**0.0010**
		DC		ER		CPI		y	
		MSE	RMSE	MSE	RMSE	MSE	RMSE	MSE	RMSE
Model 4	BJ 4	0.0047	0.0683	0.0010	0.0317	0.0007	0.0269	0.0003	0.0185
	UVAR 4	0.0024	0.0491	0.0031	0.0553	**0.0001**	**0.0112**	0.0004	0.0210
	FPE 4	**0.0001**	**0.0081**	**0.0005**	**0.0214**	0.0002	0.0140	**0.0001**	**0.0100**
Best Model (Min. MSE/RMSE)		**FPE4 0.0001**	**FPE4 0.0081**	**UVAR1 0.0003**	**UVAR1 0.0172**	**UVAR3 0.0001**	**UVAR3 0.0102**	**FPE 3 0.0001**	**FPE 3 0.0010**

Notes:

1. *The above figures are generated through RATS Programming. Please consult RATS 'Programming Manual, 2003' by Walter Enders for more details.*
2. *The optimal lag length for VAR is chosen to be 4(four) based on minimum Schwarz Information Criterion (SIC).*

Before presenting the forecasted outcome, it is worthwhile to discuss briefly the recent development of the selected macroeconomic variables. The uncertain political environment and the accompanying transport and other logistical disruptions during the first half of FY07 impacted on the overall economic activities. Given the lower-than-expected production in agriculture and normal growth in industry and services sectors, the overall output growth is likely be close to the bottom of the range of the earlier

prediction of 6.6-7.1 percent by the PAU in FY07 as against 6.7 percent growth in FY06.[2]

Monetary and price developments early in FY06 as well as pressure in the foreign exchange market in the latter half of FY06 prompted BB to continue with the tightening bias which had started in Q2 of FY05. Despite the cautious monetary policy stance, narrow money, broad money, total domestic credit and private sector credit registered an increase of 22 percent, 19.9 percent, 18.7 percent and 17.3 percent respectively in February 2007 over February 2006.

Due to some supply side bottlenecks, recent adjustment in the oil prices and price hike in the international commodity market the rate of inflation on point to point basis increased to 7.28 percent in February from 5.94 percent in January 2007 reflecting an increase of 12 basis points in the annual average inflation (6.84 percent February 2007 from 6.72 percent in January 2007) during the period. In the backdrop of a healthy inflow of workers' remittances and exports earnings the exchange rate of Taka per US dollar declined to Tk. 68.81 at the end of March 2007 from Tk. 69.67 at the end of June 2006 indicating about 1.25 percent appreciation of Taka during the period.

Table 4

Best Technique Based on Minimum Means Square Error (MSE) and Root Means Square Error (RMSE) for All Variables

Name of the Variable (all in natural logarithmic form)	Selected Technique	Reported Minimum	
		MSE	RMSE
1. Narrow money (lm1)	FPE with real GDP	0.0020	0.0445
2. Broad money (lm2)	BJ	0.0003	0.0177
3. Domestic private sector credit (lpc)	BJ	0.0006	0.0251
4. Total domestic credit (ldc)	FPE with real GDP	0.0001	0.0081
5. Exchange rate (ler)	UVAR with real GDP	0.0003	0.0172
6. Consumer price index (lcpi)	UVAR with real GDP	0.0001	0.0102
7. Industrial production index (lipi)	FPE with IPI	0.0027	0.0517
8. Real GDP (ly)	FPE with real GDP	0.0001	0.0010

Having considered all of the forecasting outcomes, it may noteworthy to mention that Hsiao's Final Prediction Error (FPE) Criteria is the best technique followed by Box-Jenkins's ARIMA model (BJ) and unrestricted VAR model in forecasting selected

[2] A 6.5 percent GDP growth for FY07 is also predicted by the BBS

macroeconomic variables in Bangladesh. The forecasted outcomes during FY05-FY08, based on the lowest MSE and RMSE, are shown in Figures 1-7.

Based on the best outcome of all of the three forecasting techniques an attempt has been made to forecast exchange rate & inflation as well as annualized growth in M1, M2, private sector credit, total domestic credit and industrial production index for FY07-FY08. Forecasted points estimates by making necessary adjustments based on the available information for the selected macroeconomic variables are reported in Table 5.

Table 5

Forecasted Point Estimates under Various Techniques Based on Minimum MSE and RMSE

Name of the Variable	Selected Technique	Actual	Forecast		
		FY06	FY07	FY08	
		Q4	Q4	Q2	Q4
1. Real GDP Growth	FPE with real GDP	6.70	6.50	--	7.00
2. Exchange rate	UVAR with real GDP	69.67	69.90	72.14	74.26
3. Inflation	UVAR with real GDP	7.54	7.24	7.95	7.70
Annual Growth (in percent):					
4. Narrow money (m1)	FPE	21.32	16.62	17.98	19.33
5. Broad money (m2)	BJ	19.51	17.82	17.82	17.82
6. Private sector credit	BJ	18.27	16.11	16.11	16.11
7. Domestic credit	FPE with real GDP	20.45	16.79	16.77	17.06
8. Industrial production index	FPE with IPI	15.70	12.48	11.76	11.92

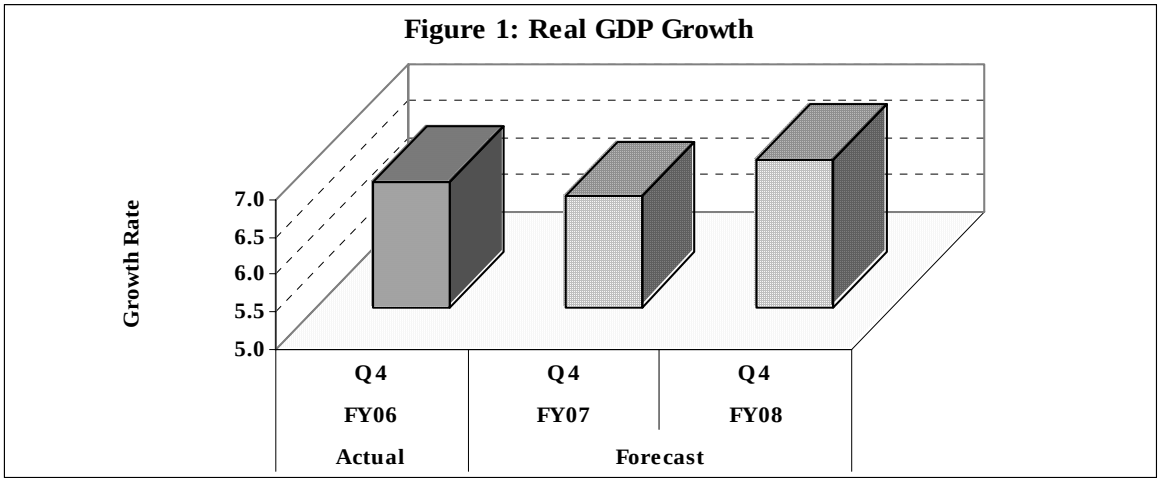
Notes

1. *All the point estimates are of end-of-period and adjusted based on the deviation from the last available actual data except real GDP growth.*
2. *The forecasted outcome as reported in the above table is a baseline scenario which is produced by various forecasting models given the fact that the tight monetary policy stance during FY05-FY06 will continue and there would be no policy changes in near future.*
3. *All of the above figures are generated through RATS Programming. Please consult RATS 'Programming Manual, 2003' by Walter Enders for more details.*

6. Near-Term Outlook

The growth momentum evidenced over the last several years is expected to continue during FY07-FY08. While agricultural growth is expected to be slower, available data for manufacturing production and service sector indicators including financial, telecommunication, computer and internet, education and health care segments all point to robust overall growth for the economy in FY07. The sectoral output projections carried out in the latest *Monetary Policy Review* (Bangladesh Bank, October 2006) lead to an estimated GDP growth of 6.6 to 7.1 percent for FY07. In view of the slower growth of agriculture and a more modest decline in manufacturing, the overall real output growth for FY07 is predicted to be close to 6.5 percent, the bottom of the range predicted earlier. Overall GDP growth forecast for FY08, however, is expected to regain its momentum and expected grow at about 7.0 percent per annum (Figure 1 and Table 5). The industrial production index, on the other hand, is expected to grow at 12.48 percent, 11.76 percent and 11.92 percent respectively in June 2007, December 2007 and June 2008 as against actual growth of 15.70 percent in June 2006.

Figure 1: Real GDP Growth



Because of the recent energy price adjustment, supply side bottlenecks and international commodity price hike bring the issue of projected inflation in Bangladesh for FY07 and FY08 under active debate. Given these factors, based on a recent study, ERG expected double digit inflation figure in near future. The forecasted outcome for inflation of the current study, however, indicate that the rate of inflation will be well below the ERG forecasted figure and will be at about 7.24 percent, 7.95 percent and 7.70 percent respectively in June 2007, December 2007 and June 2008 as against 7.54 percent in June

2006 that are, however, substantially higher than the predicted inflation as shown in the medium term macroeconomic framework (Ministry of Finance, 2007). The predicted exchange rate, on the other hand, will experience a depreciating pressure during forecast horizon (FY07-08) as the Taka-dollar exchange rates appear to be Taka 69.90 in June 2007, Taka 72.14 in December 2007 and Taka 74.26 percent in June 2008 respectively indicating about 6.2 percent depreciation over June 2006-June 2008 (Figures 2 and 3 and Table 5).

Figure 2: Inflation

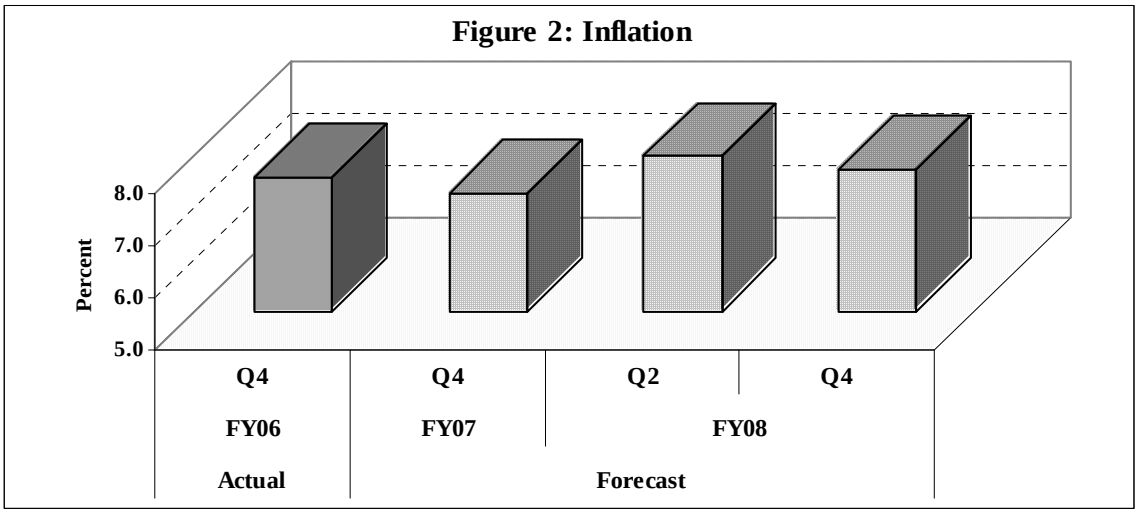
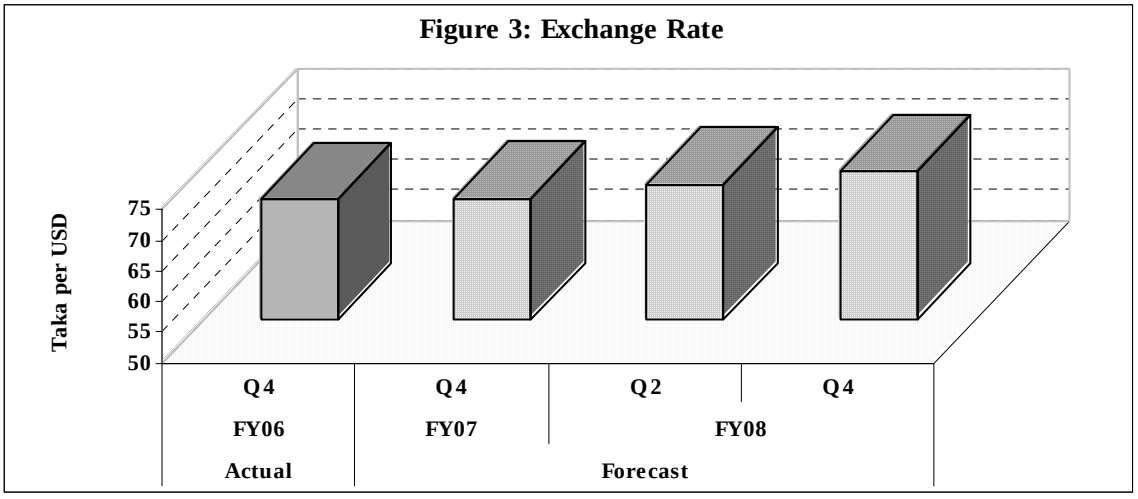


Figure 3: Exchange Rate



According to the policy framework of BB monetary policy is designed around a projected real GDP growth and a moderate level of CPI inflation rate attainable/sustainable without unduly depressing output. Monetary policy pursued by the BB, as noted earlier, aims at supporting the highest sustainable output growth while maintaining price stability, adjusting smoothly to the internal and external shocks faced by the economy from time to

time. Repo, reverse repo rates, among others, are the routinely employed policy instruments for influencing financial and real sector prices towards the targeted path for inflation. Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR) for banks are less frequently used instruments that directly influence available volumes of credit. Annual monetary programs based on the projected real GDP growth and targeted inflation rate employ Reserve Money (RM) and Broad Money (M2) as intermediate targets, while also tracking other asset and liability side sub-aggregates. On year-on-year basis, disbursements of total domestic credit as well as credit to private sector from the banking system also registered an increase of around 20 percent which reflected high credit demand from the public as well as private sectors. Given the tightened policy stance of the monetary authority, narrow money, broad money, total domestic credit and credit to the private sector are projected to grow by 16.62 percent, 17.82 percent, 16.79 percent and 16.11 percent respectively in June 2007 and respectively 19.33 percent, 17.82 percent, 17.06 percent and 16.11 percent in June 2008 as against the actual growth of 21.32 percent, 19.51 percent, 20.45 percent and 18.27 percent respectively in June 2006 (Table 5).

7. Concluding Remarks

Econometric forecasting models usually comprise systems of relationships between variables of interest where the relations are estimated from available data, mainly aggregate time-series. In practice, it has been observed, however, that reasonably good forecasts can be made with simple rules of thumb that are extrapolations of a single data series. Including too many variables makes a model unwieldy, while not including enough can increase forecast error. Keeping this in mind the current paper has attempted to use quite a few forecasting models namely Box-Jenkins's ARIMA model, unrestricted Vector Autoregression (VAR) model and Hsiao's Final Prediction Error (FPE) criteria to forecast some of the key macroeconomic variables namely, inflation, exchange rate, growth in money, domestic credit, industrial production index and real GDP in Bangladesh based on quarterly data during 1990:1-2006:4. This paper would also compare these forecasting techniques to see which technique suits better in forecasting each of the macroeconomic variables used in the study rather than the forecasted outcome itself. Based on the lowest MSE and RMSE, having considered all of the forecasting outcomes, it may noteworthy to mention that Hsiao's Final Prediction Error (FPE)

Criteria appears to be relatively better technique followed by Box-Jenkins's ARIMA model (BJ) and unrestricted VAR model in forecasting selected macroeconomic variables in Bangladesh. Among the three forecasting techniques, the FPE criteria appears to be the most appropriate as it generates best forecasted outcome for real GDP, industrial production index, narrow money and domestic credit. While UVAR produces best forecasted outcome for inflation and exchange rate, ARIMA (BJ) model produces best forecast for broad money and private sector credit based on the lowest MSE and RMSE. Based on the best technique, the point estimates for selected variables indicate that real GDP growth will be 6.5 percent and 7.0 percent respectively in FY07 and FY08. According to the forecasted estimates of the current study, on the other hand, inflation is expected to be 7.24 percent and 7.70 percent respectively in June 2007 and in June 2008. As the studies on forecasting macroeconomic variables in Bangladesh rarely exist, further investigations are needed before using any single technique in forecasting any macroeconomic variables in Bangladesh.

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