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**Recent Practices of Forecasting Real Gross Domestic Product (GDP) and Inflation in Bangladesh Bank**



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# Recent Practices of Forecasting Real Gross Domestic Product (GDP) and Inflation in Bangladesh Bank<sup>1</sup>

## *Abstract*

This paper attempts to analyze the recent forecasting practices in Bangladesh Bank regarding the projections on the growth rate of GDP and inflation which are provided regularly for the Monetary Policy Statement and other policy making purposes. Various methodology have been employed in the GDP growth forecasting practices such as model-based approach, sector-wise approach and nowcasting, where inflation projection includes model-based approach, univariate ARIMA model, unrestricted VAR, etc. The growth rate of GDP has been projected to remain between 6.10 to 6.68 percent, where model-based approach assumes the same to remain between 6.17 to 6.63 percent for the ongoing FY2021-22. Inflation has also been anticipated to stand between at 5.41 to 5.56 percent through ARIMA and VAR approach, and 5.51 to 5.82 percent under the model-based approach for FY2021-22. The analysis and inference of this paper will help the higher authority of Bangladesh Bank to formulate an accommodative and expansionary monetary policy with maintaining stable inflation rate in order to achieving the desired economic growth.

Key words: Forecasting, Economic Modeling, Monetary Policy.

*JEL Classification Code: C53, C51, E58.*

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<sup>1</sup> Views expressed in this paper are authors' own and do not necessarily reflect that of Bangladesh Bank. Comments and suggestions may be sent to sayera.younus@bb.org.bd.

## Section 1: Introduction

Forecasting is the process of making predictions of the future based on past and present data and most commonly by the analysis of economic modeling and trends. It is a decision making tool that helps economists, businessmen, statisticians to assess the future condition by examining the historical data. It also helps the Government and Central Bank take proper planning for the economy. Short-term, medium-term, and long-term plans to minimize unexpected situation for our economy could be taken through the forecasting practice. GDP and inflation are the two important core elements in our economy. Growth rate of GDP is directly related to employment, income, savings, and investment. If the growth rate of GDP rises, then all those variables rise as well as and vice-versa. The general price level is measured through inflation. Inflation indicates how much stable an economy is. The main function of country's central bank is to maintain inflation rate by taking appropriate 'Monetary Policy'. Due to the stated importance of GDP and inflation, governments, central banks, and various international organizations such as the International Monetary Fund, World Bank, and ADB forecast GDP and inflation to assess the economic condition relying on past and current data and trend analysis.

According to the Bangladesh Bank Order of 1972, the aim of monetary policy in Bangladesh is "to support highest sustainable output along with reasonable price stability". To achieve the said dual mandate, Bangladesh Bank (BB) conducts monetary policy through targeting broad money (M2) as an intermediate instrument while reserve money (RM) serves as an operating instrument. The RM is influenced by BB through indirect market-based instruments such as Cash Reserve Ratio (CRR), Statutory Liquidity Ratio (SLR), Repo, Reverse Repo (commonly known as the BB policy rates), open market operation, and moral suasion. The success of monetary policy in achieving its objectives critically depends on the degree of controllability of RM and M2 by BB. To achieve the objective of Monetary Policy, Economic Modeling and Forecasting Unit (EMFU), which is created in the Research Department in 2018, presents the forecast of major macroeconomic variables (particularly GDP Growth and Inflation regularly for the Monetary Policy Committee (MPC) of Bangladesh Bank.

## Section 2: Evolution of macroeconomic modeling and forecasting methods

The practice of forecasting various macroeconomic variables in Bangladesh was ‘ad hoc’ in nature and not based on any fundamental macroeconomic model earlier. Later on, among the broad spectrum of forecasting techniques, Bangladesh Bank used the following three techniques earlier such as, Box-Jenkins’s ARIMA model, Unrestricted Vector Auto regressions (UVARs) model, and Hsiao’s Final Prediction Error (FPE) criteria (Younus and Roy, 2016; Rahman and Younus, 2007), and also qualitative judgmental approach to forecast inflation, exchange rate, and output growth. With a view to introducing these forecasting techniques each of them is briefly discussed below.

- **Box-Jenkins’s ARIMA Model:** The Box-Jenkins (BJ) approach to modeling Auto-regressive Integrated Moving Average (ARIMA) process is described in a highly influential book by statisticians Box and Jenkins (1970, published by Holden-Day). An ARIMA process is a mathematical model used for the 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.

- **Vector Autoregressions (VARs) Model:** The problems of identification and endogeneity are commonly associated with the giant structural macroeconomic models. Sims’s (1980, *Econometrica*) 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 VAR model assumes that each and every variable in the system is endogenous and does not impose any priori restrictions. The VAR is commonly used for forecasting systems of interrelated time series equations 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 the endogenous variables in the system.

- **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. 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, *Journal of Monetary Economics*).

## Recent Practices of Forecasting GDP Growth in Bangladesh Bank

Economic growth forecast of Bangladesh for FY2021-22 has been done in three different approaches: Sector-wise forecast, Model-based forecast, and Nowcasting. Under the sector-wise forecast approach, growth forecasts of the fifteen sub-sectors of GDP have been estimated, while an output-gap model has been applied in case of the model-based forecast approach. Nowcasting is the estimate of the current state of the economy based on the very recent state of some selected economic indicators with high frequency data. The term is a contraction of ‘now’ and ‘forecasting’. The detailed methodology along with a summary of findings for FY2021-22 has been discussed in the following sections.

### Section 3: An Example of Forecasting GDP: based on sub-sectors

A comprehensive and accurate forecast of real economic variables is always a major concern for the policy makers. Thus, Bangladesh Bank strives to forecast the GDP based on the projection of various sub-sectors of GDP composition. In the Unit, forecasting GDP is done by using sector wise data and also using models to see the robustness of the results. Broadly, there are three main sectors such as agriculture, industry, and services to measure the GDP in Bangladesh economy. These major sectors are consisted of fifteen sub-sectors which are highlighted in Table 3.1.

Table 3.1: Major GDP Components in Bangladesh		
Agriculture	Industry	Services
1.Agriculture and forestry	3.Mining and quarrying	7.Wholesale and retail trade
2.Fishing	4.Manufacturing	8.Hotels and Restaurants
	5.Electricity, gas, water	9.Transport, Storage & Communication
	6.Construction	10.Financial Intermediations
		11.Real estate, Renting and Business Activities
		12.Public administration
		13.Education
		14.Health and Social Works
		15.Community, Social and Personal services

Source: Bangladesh Bureau of Statistics.

Bangladesh Bureau of Statistics (BBS) has published GDP data on fiscal year basis i.e. July-June period of each year. In this backdrop, the projection of GDP based on various sub-sectors leads Bangladesh Bank to get the deeper insights of economic activities in the economy. More specifically, GDP projection based on sectoral compositions i) provides an opportunity to understand the GDP movement of the economy from segregated information; and ii) helps central bank to incorporate necessary adjustment in GDP projection time to time .

### 3.1. Methodology

Time series data of fifteen sub-sectors have been collected from the BBS. Then, the growth rates of fifteen sub-sectors have been forecasted using the univariate-ARMA/ARIMA model. One of the important challenges in this framework is to find out an appropriate ARMA/ARIMA model satisfying all the statistical properties. Hence, the Box-Jenkins approach, a widely used framework, is considered to select the robust ARMA/ARIMA model.

The growth rate of three major sectors such as agriculture, industry, and service has been calculated by combining these sub-sectoral forecasted growth rates and their relative shares. Subsequently, the overall GDP growth rate has been projected comprising these three main sectors. The formula to calculate the GDP growth rate is given below:

$$GDP\ growth\ rate = \frac{\sum_{i=1}^k W_i X_i}{\sum_{i=1}^k W_i}$$

Where  $W_i$  = share of respective sectors in total GDP; and  $X_i$  represents three major sectors. The above GDP calculation is considered as the baseline scenario. Thus an alternative scenario of GDP growth rate has also been predicted incorporating the movements of the updated data of fifteen sub-sectors. The subjective judgments, and secondary news/data on contemporary economic performances are incorporated to the said baseline scenario to construct a more pragmatic and responsive alternative scenario.

### 3.2. An Example of Forecasting GDP for the Current Fiscal Year

The GDP forecast using sector-wise approach for FY2021-22 is summarized in the table 3.2 illustrated in the next page and detailed result of forecasting is given in the table-1 of Annex.

Table 3.2: Forecasted GDP Growth Rate for FY22		
Type of Forecast	Baseline	Alternative Scenario
Sector-wise forecast	6.10	6.68
<p>Note: <b>Sector-wise GDP forecast assumptions</b>  <b>Baseline scenario:</b> ARIMA (Autoregressive Integrated Moving Average) based forecast: No adjustment is done in the sector-wise growth forecasts.  <b>Alternative Scenario:</b> Judgmental approach is used to forecast the alternative scenario.</p>		

Source: Authors' calculation.

Out of the fifteen sub-sectors of GDP, some sub-sectors such as Manufacturing; Construction; Financial Intermediations; Real Estate, Renting and Business; and health are leading the recovery process in the period after the first wave of Covid-19 pandemic

compared to other sub-sectors. These sub-sectors represent about fifty percent of our GDP.

The manufacturing sub-sector which is mostly represented by Ready Made Garments (RMG) is showing rebounding sign based on RMG export prospect. RMG export represents about 8.46 percent of the nominal GDP of FY20.

Quantum Index of Medium and Large-Scale Manufacturing Industries increased to 470.58 in December 2020 from 393.26 of June 2020 after continuous fall since January 2020. As economies across the world have started to open up, Bangladesh's total exports also grew in the first quarter of FY21. This is mainly due to increased apparel exports. Most of the global brand customers of Bangladesh are returning and reinstating their orders. Bangladeshi apparel exports also do not adversely affect in April 2021 due to the recent second wave of the pandemic. According to the Export Promotion Bureau (EPB), RMG exports in July–April 2020-21 has achieved 95.37 percent of the strategic target and the export amount is higher compared to that of the same period of the last fiscal year. Overall export of Bangladesh also increased by 8.74 percent in July-April 2020-21 compared to the same period of the previous fiscal year.

Construction sub-sector is also gaining its lost momentum with resuming government mega projects like construction of Padma Bridge, Metrorail Project, Rooppur Nuclear Power Plant etc. Real Estate, renting, and business sub-sector has showed rebounding sign. Government initiative is adding impetus to the recovery of this sector. The government has allowed the use of untaxed income to purchase land or apartments while the reduction in registration fees is helping to increase the demand for land and apartments.

Rest of the sub-sectors of the economy represents other fifty percent of GDP. Now, the current situation is showing challenging recovery path of those sub-sectors which may result in the underperformance of the sub-sectors compared to the expected growth of GDP set for FY21. For instance, education sub-sector is facing severe uncertainty over its reopening through online classes are introduced to reduce the loss, but the sector is unlikely to support adequately to achieve the government's GDP target. Transport, storage & communication sub-sector is also doing well with the economic activities across the country until the second wave of COVID-19 pandemic. However, this sub-sector is likely to suffer due to the recent country-wide lockdown starting from April 2021. Hotels and restaurants, and wholesale and retail trade sector are also affected adversely due to the recent lockdown.

Agriculture may also suffer from the demand shock caused by the 2<sup>nd</sup> wave of Covid-19 pandemic and the supply shock caused by the various natural calamities from the upcoming monsoon which makes it difficult for the sector to outperform its last few years' contribution to GDP growth.

However, record high amount of remittance inflow may play important role in improving dampened consumer demand caused by the pandemic. Considering significant

share of remittance (5.51 percent) in GDP, its role in expediting the economic recovery is important. Remittance inflow in July-April FY21 was USD 20665.87 million which is 39.00 percent higher compared to the remittance inflow in the same period of the previous fiscal year.

#### **Section 4: Model-based GDP Forecast of Bangladesh**

Bangladesh Bank also pursues a macroeconomic model to forecast GDP growth rate along with a sector-wise framework. This macroeconomic model includes output gap and growth of potential GDP. The model can be summarized as follows:

GDP growth at constant price = f (output gap, growth of potential GDP)

Output gap = f (CLIW, RRL)

Here, CLIW and RRL are the weighted composite leading indicator and real lending rate respectively. CLIW represents world output by taking weighted average of composite leading indicators of the major trading partners of Bangladesh (CHINA, Euro Area, India, USA, and UK) when RRL is found by adjusting the lending rate for inflation. Both CLIW and RRL are in monthly frequency for the period 1994M01 to 2020M12.

Since neither output gap nor potential GDP are readily available, both indicators following a structured methodology are calculated. Besides, potential output and output gap calculation, the macroeconomic model-based GDP growth forecast process incorporates other steps like forecasting potential output growth, conversion of annual output growth into monthly frequency, forecasting output gap, and finally, the GDP growth rate forecast. After estimating the growth forecast, we do scenario analysis to examine the impact on the GDP growth rate due to changes in the control variables. The steps are briefly described below to forecast GDP growth rate of Bangladesh for FY22.

##### **4.1. Methodology**

Starting from a Cobb-Douglas production function, it can be shown that a long run increase in the country's output requires expansion of its productive capacity through investment expenditures. Using ARDL dynamic equation, the potential output path of the Bangladesh economy is calculated. The annual time series of output and investment for the period 1982 to 2020 are collected from World Development Indicators (WDI) to do necessary estimation for calculating the potential output. After calculating potential output, the output gap is estimated.

The growth rate of potential output from the potential output series is generated as part of output gap estimation in the previous step. Then, the forecast potential growth rate for the year 2021 is forecasted.

The trend cycle component of the quantum index of industrial production or alternatively proxy output of the economy is used to convert annual output gap into monthly frequency following Chow-Lin method.

At this point, CLIW, RRL, and output gap series of monthly frequency are converted into quarterly frequency using average method in Eviews, which is later used to forecast output gap for four quarters ahead a dynamic solution.

A model comprising of potential GDP growth rate and output gap is constructed, and solved the model following dynamic solution to get one year ahead forecast of GDP growth rate at base price as the baseline forecast.

#### 4.2. An Example of forecasting GDP for the current Fiscal Year

The forecast based on an output-gap model finds 6.17 percent GDP growth under the baseline and 6.63 percent under alternative scenario for FY22. Model based forecast starts with forecasting potential GDP of Bangladesh for the period of FY82 to FY21 from which a series of output-gap for the same period are derived. Then using composite leading indicators, CLIW, real lending rate, RRL, and binary variables addressing COVID-19 pandemic with the stated series of output-gap, the output-gap of Bangladesh for FY22 is forecasted. This forecasted output-gap and estimated potential GDP growth allows to get the forecast of GDP growth of FY22 at constant price for Bangladesh. Here, output-gap is a function of CLIW and RRL while GDP growth at constant price is a function of output-gap and growth of potential GDP. The GDP forecast using model-based approach is summarized in the table no 4.2.

<b>Table 4.2: Model-based GDP growth forecast of Bangladesh for FY22</b>	
<b>Baseline</b>	<b>Alternative Scenario</b>
6.17	6.63

Source: Authors' calculation.

*Assumptions: Model-based GDP forecast assumptions*

*Baseline:* No change in Composite Leading Indicators of the World (CLIW\*) from April 2021& onwards (May 2021– 100.45 vs. May 2020-90.58) and unchanged RRL (Real Lending Rate) from February 2021& onwards (2.08%).

*Alternative Scenario:* 1.0 percent growth in first quarter of FY22 on the preceding quarter, 1.0 percent growth in the second quarter of FY22 on the preceding quarter, 1.2 percent growth in the third quarter of FY22 on the preceding quarter, 1.2 percent growth in the fourth quarter of FY22 on the preceding quarter to address the world economic outlook of 4.44 percent as per April 2021 IMF assessment, and decreasing RRL to 1.0% from May 2021& onwards.

\*CLIW is the weighted (trade) average of CLI values of CHINA, Euro Area, India, USA, and UK. CLIW data is available till May 2021 and Lending Rate data is available till April 2021 during the analysis.

## **Section 5: Nowcasting of GDP Growth**

Nowcasting is the estimate of the current state of the economy based on the very recent state of some selected economic indicators with high frequency data. The term is a contraction of ‘Now’ and ‘forecasting’.

Nowcasting is mostly used in case quarterly data are available but with considerable delay, to obtain an estimate of GDP (growth) in the current quarter.

The basic principle of nowcasting is the exploitation of the information which is published early and possibly at higher frequencies than the target variable of interest (for example GDP) in order to obtain an early estimate before the official figure becomes available

To produce a monthly “nowcast” of GDP growth, incorporating several high frequency macroeconomic indicators are incorporated as those become available. The high frequency macroeconomic variables used in the model are CLIW, growth of industrial production index, real broad money growth, and lending rate.

### **5.1. Methodology**

Monthly indicators are collected which are timely available over a sufficient period of time in the past. Annualizing these indicators and explore their past correlation with annual GDP growth and select the best indicators based on the correlation result. Using these best indicators in the E-views based Chow-Lin method to obtain a Monthly Economic Indicator (MEI) that is correlated with GDP.

### **5.2. Example of Nowcasting GDP for the Current Fiscal Year (FY2020 and FY2021)**

The table no 5.1 in the next page shows the Monthly Economic Indicator (MEI) or GDP growth of Bangladesh for FY20 and FY21. The graph shows that real GDP of Bangladesh dropped significantly in April 2020 to 1.27 percentages due to the domestic economic shutdown triggered by COVID-19 pandemic following the detection of first domestic infection in March 2020. Shaded area of the graph indicates the period since the confirmation of first COVID-19 patient in Bangladesh. The graph also shows that Bangladesh economy was suffering from the pandemic-led economic catastrophe since December 2019 because of sluggish global economic activities after emergence of the virus in China. However, Bangladesh economy experienced sharp rebound with increasing GDP growth from June 2020 which indicates possible V-shaped recovery of the economy. Accordingly, nowcast of real GDP of Bangladesh in March 2021 stands at 6.36 percentages when the annualized nowcast of real GDP of Bangladesh in the same month is 6.99 which is the arithmetic mean of MEI of the first nine months of FY2021.

However, the second wave of COVID-19 is posing risk to Bangladesh economy through country-wide limited shutdown since 14 April 2021. Since the prudent government initiatives have not only contained the spread of the virus but also kept the economy active, the forecasted MEI for June 2021 seems to decrease to 6.30 percentage compared to the previous months, and the annualized MEI at the end of FY21 is likely to remain at 6.31 percentage.

**Table 5.1: Forecasting GDP through Nowcasting MEI (%) of FY20 and FY21**

Month	MEI	Annualized MEI	Quarterly MEI
Jul-20	7.43	7.43	7.09
Aug-20	6.73	7.08	
Sep-20	7.12	7.09	
Oct-20	6.61	6.97	7.15
Nov-20	7.71	7.12	
Dec-20	7.12	7.12	
Jan-21	7.16	7.12	6.74
Feb-21	6.69	7.07	
Mar-21	6.36	6.99	
Apr-21*	3.18	6.61	4.28
May-21*	3.35	6.31	
Jun-21*	6.30	6.31	

*Source: Authors' calculation.*

## Section 6: Forecasting inflation through Time-series Approach

### 6.1. Methodology

Bangladesh Bank forecasts inflation using time series data collected from the Bangladesh Bureau of Statistics (BBS). Inflation forecasting is mainly done through two important forecasting models:

#### ARMA model

The Model has three main sub parts:

- Univariate ARMA model.
- Univariate ARMA process with Monthly Dummies to capture the seasonality of targeted variable.
- Univariate ARMA process with exogenous variables to capture the influence of other factors like food price, oil price, remittance inflows etc.

#### VAR model

The Model has also two main sub parts:

- An unrestricted VAR with inflation and Broad Money (M2).
- An unrestricted VAR with inflation and Broad Money (M2) with exogenous variables.
- Usage of Uncertainty Fan-chart

## 6.2. Example of forecasting inflation through ARIMA and VAR approach

The time-series inflation projection suggests that Bangladesh is likely to remain in a stable inflation trajectory with a slight diminishing trend in the upcoming months. Various models have been employed to forecast the twelve-month general inflation for FY22. The outputs of the analytical exercise (given in table 6.2) on inflation projection of Bangladesh indicate that the twelve-month general inflation in June 2022 is likely to remain between 5.41 to 5.56 against the targeted ceiling of 5.30 percent for the ongoing fiscal year, declared earlier by the Government of Bangladesh.

**Table 6.2: Inflation prediction using ARIMA and VAR approach for FY 2022**

Month	Inflation Projection using Various Models (July, 2021 to June, 2022) Sample: July, 2000 to June, 2021 (Total: 252 sample periods)				
	Univariate ARMA*	Univariate ARMA with Monthly Dummies**	Univariate ARMA with Exogenous Variables***	Using VAR with M2 <sup>#</sup>	Using VAR with M2 and Exogenous Variables <sup>##</sup>
July, 2021	5.53	5.54	5.53	5.54	5.55
August, 2021	5.49	5.50	5.50	5.52	5.55
September, 2021	5.47	5.49	5.49	5.51	5.56
October, 2021	5.46	5.49	5.49	5.50	5.59
November, 2021	5.45	5.49	5.48	5.50	5.62
December, 2021	5.43	5.48	5.46	5.50	5.66
January, 2022	5.42	5.48	5.46	5.50	5.70
February, 2022	5.42	5.49	5.46	5.51	5.74
March, 2022	5.42	5.50	5.46	5.52	5.79
April, 2022	5.41	5.50	5.46	5.53	5.83
May, 2022	5.41	5.51	5.46	5.54	5.87
<b>June, 2022</b>	<b>5.41</b>	<b>5.50</b>	<b>5.47</b>	<b>5.56</b>	<b>5.91</b>

Source: Authors' calculation.

\* ARMA(4,3) model under dynamic simulation

\*\* ARMA(4,4) model under dynamic simulation with monthly dummies

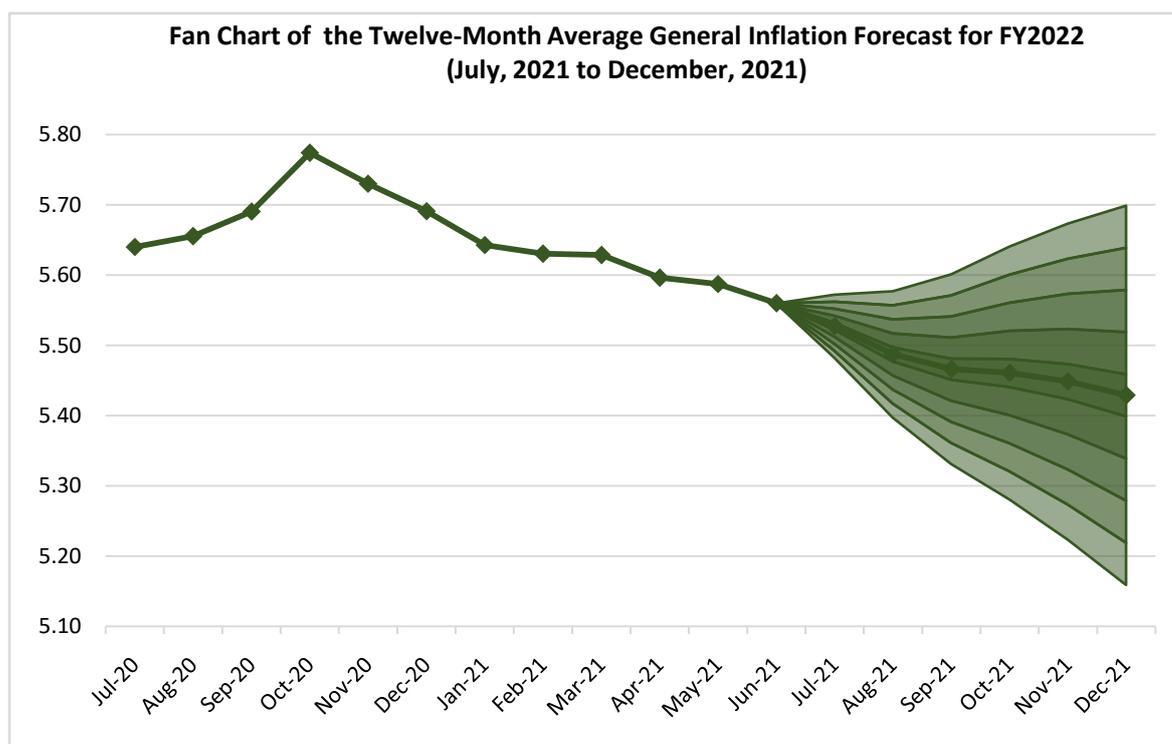
\*\*\* ARMA(4,3) model under dynamic simulation with exogenous variables (world food price, oil prices and remittance inflow)

# Forecast from an unrestricted VAR with inflation and Broad Money (M2)

## Forecast from an unrestricted VAR with inflation and Broad Money (M2) and some exogenous variables (world food price, oil prices and remittance inflow).

Another uncertainty 'Fan Chart' has been drawn using the 6-months ahead (till December 2021) forecasted values obtained from the univariate ARMA model among all the models used in the exercise of time-series inflation projection. The satisfactory accumulation of foreign exchange reserve and uninterrupted production of agricultural commodities seems to provide a safeguard for the economy in the post-pandemic inflation scenario. However, agricultural output loss from any sudden natural calamities could impose pressure on food prices.

**Graph 6.2: Inflation forecast for FY 2022 using Fan Chart**



*Source: Authors' calculation and Bangladesh Bureau of Statistics.*

## **Section 7: An Alternative ARDL Based Approach of Forecasting Inflation**

To calculate twelve month average inflation through model-based approach, variables such as, consumer price index (CPI), moving average and lags of CPI for twelve months, moving average of inflation for twelve months, broad money M2, monthly and seasonal dummies, log of M2 and CPI, and real lending rate (RRL) have been used. Various econometric tools like Vector Autoregression (VAR), Vector Error Correction Mechanism (VECM), and Autoregressive Distributed Lag Co-integration (ARDL) have been employed for econometric analysis and finally ARIMA approach has been adopted for forecasting twelve month average inflation.

### **7.1. Methodology**

The steps are briefly described below to forecast inflation of Bangladesh through model-based approach:

#### **Data collection, Calculation of M2, and Generate seasonal dummy**

The monthly data of CPI and inflation have collected from FY 1993 to FY 2021. Then moving average of CPI for twelve months using the lag value of CPI for twelve months is generated and also moving average of inflation for twelve months with the help of those equation is calculated. After that, M2 is calculated by the seasonally adjusted data of M2 and seasonal dummy for twelve months is generated.

## **Estimation of VARINFLATION**

VARINFLATION through Vector Error correction Mechanism (VECM) is estimated which states long run co-integrating relationship as well as removes short run disequilibrium among the variables. In this estimation, there is an intercept in VECM but no intercept in VAR. The coefficients of VECM are estimated which were very stable over the last 10 years. For forecasting purposes, the long run equilibrium vector is imported into an ARDL equation.

## **Calculation of VARARDL**

In order to test the null of no levels relationship in the ARDL, we the procedures is followed proposed in Pesaran, H., Y. Shin, and R. Smith, 2001, “Bounds Testing Approaches to the Analysis of Level Relationships”. Then ARDL equation (t-values between brackets) is estimated where the current value of CPI is calculated based on the current food price, lag value of CPI, seasonally adjusted M2, and RRL for one year( 6 months dynamics and 11 months seasonal dummies). In this equation, CPI is log of CPI index, m2\_sa is log of M2 seasonally adjusted, RRL is real lending rate, and FP is log of international food price index. The data of all those variables are taken from World Bank’s Pink Sheet. After that we used Automatic ARIMA forecasting using M2, selected model, and generated the equation of moving average of seasonally adjusted M2 for twelve months based on the lag value of seasonally adjusted M2 for twelve months have been used. Then seasonally adjusted growth rate of M2 for twelve months is calculated following seasonally adjusted M2 dividing lag value of seasonally adjusted M2 for twelve months multiplying 100. Finally moving average of seasonally adjusted growth rate of M2 for twelve months is calculated by moving average of seasonally adjusted M2 for twelve months dividing lag value of moving average of seasonally adjusted M2 for twelve months multiplying 100.

## **Creation of MODELVARARDL and Forecasting inflation**

VARARDL equation from Automatic ARIMA forecasting approach is generated which is an equation of M2 (EQM2). In VARARDL equation, First of all, seasonally adjusted growth rate of M2 for twelve months is calculated using seasonally adjusted M2 and lag value of seasonally adjusted M2 for twelve months. After that moving average of CPI for twelve months is calculated based on the lag value of CPI for twelve months. From this equation, moving average of inflation for twelve months has been found. Moving average of seasonally adjusted M2 for twelve months is generated based on the lag value of seasonally adjusted M2 for twelve months. Finally moving average of seasonally adjusted growth rate of M2 for twelve months is calculated from the previous equation. From this equation, dynamic 2020M3 to 2021M12 is solved and forecast twelve month average inflation is generated.

## 7.2. Example of Forecasting Inflation in Bangladesh through Model-based approach

Finally, inflation is forecasted from July 2021 to June 2022 for FY22 using the model with dynamic solution which gives the average inflation outputs (given in table 7.2). It is seen from the output of model-based inflation that inflation is likely to remain between 5.51 to 5.82 for FY22.

**Table 7.2: Model-based Inflation Forecast for FY22**

Month	Inflation Twelve Month Average	Month	Inflation Twelve Month Average
Jul-21	5.55	Jan-22	5.60
Aug-21	5.51	Feb-22	5.64
Sep-21	5.51	Mar-22	5.71
Oct-21	5.51	Apr-22	5.82
Nov-21	5.53	May-22	5.82
Dec-21	5.54	Jun-22	5.82

*Source: Authors' calculation.*

## Section 8: Future Planned Activities

In addition to the regular modeling and forecasting initiatives, EMFU of Bangladesh Bank also plans to carry out the following activities:

In order to enhance the accuracy of the forecasted values, the EMFU is continuing its effort to adopt some advanced macroeconomic frameworks such as DSGE, structural forecasting models like SVAR, Open Economy Quarterly Projection Model, and FPAS model.

The officials working in EMFU will contribute to modernize the monetary policy framework of BB facilitating the shift towards a model-based decision-making process.

The EMFU will be equipped with all necessary apparatus and softwares for the holistic forecasting of macroeconomic variables for Bangladesh.

Extending affiliation with various external organizations and SAARC central Banks to enhance analytical capacity of BB officials.

## Section 9: Conclusion

Forecasting GDP and Inflation are always a continuous process. It changed based on the new information. As we can see that forecast numbers are different from different methodology. Finally, judgmental approach is used for the final forecast. The Economic Modeling and Forecasting Unit (EMFU) under the Research Department of Bangladesh Bank is regularly providing its output such as forecasted growth rate of GDP and inflation for the Monetary Policy Statement and other policy making purposes that portrays a positive outlook on country's price stability, employment, income, savings, investment, and overall growth rate of GDP.

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## Annexure

**Table 1: Sector-wise GDP Forecast of Bangladesh for FY 2021-22**

Major sectors and sub-sectors		FY21 (Actual)	FY22 Forecast	
			FY22 (Projected)	FY22 (Projected)
		Growth	Growth	Growth
<b>Agriculture</b>	Agriculture and forestry	2.65	2.60	2.97
	Fishing	5.74	5.78	5.81
	<b>Agriculture Total</b>	<b>3.45</b>	<b>3.44</b>	<b>3.75</b>
<b>Industry</b>	Mining and quarrying	0.29	5.30	7.25
	Manufacturing	5.77	8.65	9.31
	Electricity, gas, water	4.74	6.82	7.07
	Construction	8.68	8.79	8.62
	<b>Industry Total</b>	<b>6.12</b>	<b>8.44</b>	<b>8.96</b>
<b>Services</b>	Wholesale and retail trade	6.54	5.44	6.28
	Hotels and Restaurants	6.85	5.82	5.82
	Transport, Storage & Communication	6.07	5.49	6.71
	Financial Intermediations	4.31	6.24	8.89
	Real estate, Renting and Business Activities	4.90	3.93	3.93
	Public administration	6.16	7.55	7.58
	Education	5.56	5.14	6.11
	Health and Social Works	9.94	8.18	7.12
	Community, Social and Personal services	3.05	3.54	3.51
	Tax less subsidy	4.93	3.20	3.20
<b>Services Total</b>	<b>5.57</b>	<b>5.13</b>	<b>5.80</b>	
<b>GDP at Constant Price (base 2005-06=1000)</b>		<b>5.47</b>	<b>6.10</b>	<b>6.68</b>

Source: Authors' calculation and Bangladesh Bureau of Statistics.