A Small Macroeconometric Model of the Bangladesh Economy

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Abstract

This paper describes a macroeconometric model of the Bangladesh economy using annual time series data from FY-1980 to FY-2006. The model is constructed with seven macroeconomic blocks, consumption, investment, production, government, trade, money, and price, capturing transmission among blocks. Structural equations under each block are estimated using short-run error correction model, where long-run equations into error correction terms represent economic theory. Hendry's general to a specific procedure is followed to get final short-run error correction equations. Validity of the model is checked both within the sample and out of sample cases. Results from validity study mark that the model is reasonably useful for forecasting and policy analysis.

JEL Classification: C51, E17

Key words: Macroeconometric model; Forecasts; Simulations

1 Introduction

Over the last two decades, the Bangladesh economy that is growing moderately, has drawn a lot of attention to researchers for macroeconomic policy analyses. Therefore, a tradition of macromodeling has been developed where most of them are Computable General Equilibrium (CGE) models (see e.g., Mujeri and Khondker

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(1998), Rahman (2001), Raihan (2010)). Though CGE models have their own appeal for analyzing distributional aspects, they have their limitations in structural modeling and thereby macroeconomic policy analyses (see e.g. Hall (1995)). The early static type of CGE models can provide only a snapshot of the macro economy. Even recent development of the dynamic CGE models cannot capture the dynamics of the adjustment process which is the core of formal macroeconometric modeling.

For the Bangladesh economy, a number of macroeconometric models listing Rashid (1981), Hossain (1995), Rahman and Shilpi (1996), Hossain and Razzaque (2003), Quin, Razzaque and Rahman (2006), Haque (2007) was also constructed. However, most of these models can be criticized in the ground of both the application of time series econometrics in estimating behavioural equations and the construction of such equations in the models. For example, the early macroeconometric models (e.g., Rashid (1981), Hossain (1995), Rahman and Shilpi (1996)) assumed variables to be stationary, did not test the stability of the parameters, used many time dummies in equations, and even did not follow economic theory to judge the range of long-run parameters. These models considered GDP from the demand side, while it is calculated from the supply side in Bangladesh.

However, the Hossain and Razzaque (2003) model considered the time series properties of data by using the Engle-Granger two step cointegration method, but simulations were run using only static long-run equations. The only quarterly macroeconometric model (Quin, Razzaque and Rahman (2006)) used short-run dy-

namics in shock analyses. However, the model relied on interpolation of annual data to quarterly with manipulations in the absence of quarterly data, more importantly in GDP estimation. Manipulations raised the question about policy simulations in the model.

This paper presents a macroeconometric model where the above limitations have been as much as surmounted. The model uses annual time series data of the Bangladesh economy from FY-1980 to FY-2006 contains 56 endogenous and 14 exogenous variables; 37 behavioural equations and 19 identities under seven blocks, consumption, investment, production, government, trade, money, and price. All the behavioural equations are estimated giving consideration to the time series properties of variables, applying Error Correction Model (ECM) to incorporate theoretically plausible long-run specifications into short-run dynamics. The model combines the demand and the supply sides of the real sector with an application of Keynesian theory where the supply side estimate of GDP is directly linked to the aggregate demand. The use of time dummy variables is minimal. In addition, stability of parameters is tested to ensure convergence of the model. Out of sample validity of the model is tested along with within sample validity.

The rest of the paper is organized as follows. Section 2 describes an overview of the Bangladesh economy. Data are explained in Section 3. Section 4 elaborates the model disaggregating into seven blocks. Estimation methodology of behavioural equations is described in Section 5. Section 6 reports validity of the model within

and out of sample, and Section 6 is the conclusion.

2 Overview of the Bangladesh Economy

Macroeconomic indicators had started to improve significantly from 1990s, when the Bangladesh government reformed the Bangladesh economy undertaking the structural adjustment policy. Over the last two decades, GDP growth rate increased from around 4 to 6 percent, and it crossed the target of 6 percent in recent times. The transition economy shifts its share in the primary sector (agriculture) to the secondary sector (manufacturing), where the latter outperformed the former from the start of the millennium. In recent times, the tertiary sector (services) contributes almost half of the GDP, while the secondary sector is 30 percent, and the remaining 20 percent comes from the primary sector. From the demand side, aggregate demand growth rate varies between 5 and 7 percent, with a private consumption growth of around 4 to 5 percent and 8 to 9 percent investment growth. The external sector of the country is relatively balanced with a steady export and remittance growth and growth of imports to support the developing stage of the economy. In the process of development, government tax revenue as well as government expenditure increased sharply. These along with emerging financial sector decreased dependency on foreign borrowing but increased domestic borrowing of the government. In this development process, inflation increased too. Therefore, current economic

growth demands a constructive macroeconometric model, to represent the linkages of macroeconomic sectors and then impact of policy shocks.

3 Data

In the model, we use annual data from FY-1980 to FY-2006 to estimate equations to incorporate the new series of GDP available from FY-1980. It has been restricted to the use of time series variables in annual frequency subject to unavailability of some important series e.g. GDP in higher frequencies.

Data are collected from various publications of Bangladesh Bureau of Statistics, Bangladesh Bank, Ministry of Finance of Bangladesh, International Monetary Fund and Petro-Bangla. Variables used in the model are presented in Appendix A with their sources.

4 Model Structure

We have constructed the model with seven blocks, consumption, investment, production, trade, government, money, and price that contain 70 variables (56 endogenous and 14 exogenous variables). The variables are linked to one another through 37 behavioural equations and 19 identities, considering Bangladesh as a market economy. All behavioural equations are modeled based on economic theories (see e.g., Klein

et. al. (1999) for model building). The model can be considered as supply determined and does not impose the economy to be in equilibrium. General structure of the model is briefly explained here.

4.1 Consumption block

The only behavioural equation in this block, private consumption in constant prices, is modeled with real disposable income, real wealth and real interest rate, where real disposable income is real GDP less real tax, real wealth is a total of domestic Debt, money circulation and net foreign asset, deflated by consumer price index, and real interest rate is the deposit interest rate adjusted for inflation. Private consumption in current prices, an identity, is equal to private consumption in constant prices times the consumer price index. They can be expressed as follows,

Private consumption in constant prices
$C_c = c(Y_{nc} - T/(Y_n/Y_{nc}), (D_d + M_0 + N_f)/P_{cd}, i_d - 100 * \Delta log(P_{cd}), \epsilon_c)$
Private consumption in current prices
$C = C_c * P_{cd}$

4.2 Investment block

In this block, only private investment both in constant prices and current prices have been treated as behavioural equations. Private investment in constant prices

is explained by real GNP, real lending rate (nominal rate adjusted with the inflation rate), bank credit to the private sector deflated by investment deflator and a change in the Debt-GDP ratio (to capture the crowding-out effect), and private investment in current prices that is modeled via deflator equation is a function of import deflator and output deflator in the secondary sector. Total investment (both real and nominal), capital stock (both real and nominal) and bank credit to the private sector are identities here. The reason why total investment is an identity is that it can establish the direct link with government block to transmit any fiscal shocks to it and thereby to GDP that is connected with total investment. Similarly, the identity, bank credit to private sector, plays a crucial role to transmit any monetary shocks to GDP via this block. In equation forms they can be written in the following way,

Private investment in constant prices
$I_{pc} = i_1(Y_{nc}, i_l - 100 * \Delta log(P_{cd}), C_p/P_i, D/Y_s, \epsilon_{i_1})$
Private investment in current prices via deflator
$I_p/I_{pc} = i_2(P_m, X_2/X_{2c}, \epsilon_{i_2})$
$\Rightarrow I_p = I_{pc} * i_2(P_m, X_2/X_{2c}, \epsilon_{i_2})$
Total investment in current prices
$I = I_p + I_g$
Total investment in constant prices
$I_c = I/P_i$
Capital stock in current prices
$K = (K(-1) - K_e(-1)) * (1 - d/100) + I + K_e$
Capital stock in constant prices
$K_c = K/P_i$
Bank credit to private sector

$C_p = D_{bb} + D_{db} - D_b$

4.3 Government block

The government block is designed with seven behavioural equations and four identities listed below in equation forms, to accommodate it connecting well with other blocks. For example, government consumption in constant prices modeled as a deflator equation is explained by the tertiary sector deflator because in Bangladesh the biggest share of government consumption expenditure goes to the tertiary sector. On the other hand, government consumption in current prices is modeled with government total revenue and the ratio of government investment to government total expenditure which are available only in current prices. The rationale of using the ratio in this equation is that there is a trade off between two types of government expenditures (investment and consumption). However, government investment is mostly financed by government borrowing (both domestic and foreign). Therefore, change in total Debt is treated as an explanatory variable to model government investment in current prices.

Government total revenue
$R = g_1(T, \epsilon_{g_1})$
Government tax revenue
$T = g_2(Y_n, G_e/R, \epsilon_{g_2})$
Government consumption in constant prices via deflator

$G/G_c = g_3(X_3/X_{3c}, \epsilon_{g_3})$
$\Rightarrow G_c = G/g_3(X_3/X_{3c}, \epsilon_{g_3})$
Government consumption in current prices
$G = g_4(R, I_g/G_e, \epsilon_{g_4})$
Government investment in current prices
$I_g = g_5(\Delta D, \epsilon_{g_5})$
Government total expenditure
$G_e = g_6(G, I_g, \epsilon_{g_6})$
Change in foreign debt
$\Delta D_f = g_7(N_f/(D_{db} + D_{bb}), D_g, \epsilon_{g_7})$
Government budget deficit
$D_g = R - G_e$
Total debt
$D = D_d + D_f$
Domestic borrowing of government
$D_b = D_{bb} * r_1 + D_{db} * r_2$
Change in domestic debt
$\Delta D_d = D_b - P$

4.4 Trade block

Trade block is designed to pass on external shocks into the economy. Therefore, exports in current prices is estimated as a function of real exchange rate and foreign GDP where real exchange rate is calculated adjusting nominal exchange rate with the world prices relative to domestic prices, and foreign GDP and world prices are trade weighted indices of 20 trading partners of Bangladesh accounting for 70 percent of its total trade. Imports in current prices includes exports in current prices,

real exchange rate, aggregate demand in current prices as a sum of private and government consumption and total investment as explanatory variables. Current account balance in current prices is explained by the sum of remittances and trade balance. By deflating exports and imports in current prices, exports and imports in constant prices have been set to identities. They are expressed as follows,

Exports in current prices
$E = t_1(e * (P_{cw}/P_p), Y_f, \epsilon_{t_1})$
Imports in current prices
$M = t_2(E, e * (P_{cw}/P_p), (C + I + G), \epsilon_{t_2})$
Current account balance in current prices
$B = t_3(F + E - M, \epsilon_{t_3})$
Exports in constant prices
$E_c = E/P_e$
Imports in constant prices
$M_c = M/P_m$

4.5 Production block

This block that contains eight behavioural equations and five identities is specially designed to estimate GDP from supply side. Therefore, GDP in constant prices, an identity, is estimated as a sum of three sectoral outputs in constant prices, where real output in primary sector is modeled with a sum of real output in secondary and tertiary sectors, annual irrigated land area and average of annual rainfall, real output in secondary sector is explained as a function of capital stock in this sector,

real output in tertiary sector and real exports, and real output in tertiary sector is modeled as a function of real aggregate demand. On the other hand, nominal outputs in all three sectors are modeled as deflator equations with other deflators and prices so that any price shocks can be generated into GDP through this block. Other identities and behavioural equations also enrich the block with making well connectivity with other blocks. All behavioural equations and identities are written as follows,

Value added in primary sector in constant prices
$X_{1c} = o_1(X_{2c} + X_{3c}, W_1, W_2, \epsilon_{o_1})$
Value added in primary sector in current prices via deflator
$X_1/X_{1c} = o_2(P_p, P_a, \epsilon_{o_2})$
$\Rightarrow X_1 = X_{1c} * o_2(P_p, P_a, \epsilon_{o_2})$
Value added in secondary sector in constant prices
$X_{2c} = o_3(K_c * (X_2/Y_s), X_{3c}, E_c, \epsilon_{o_3})$
Value added in secondary sector in current prices via deflator
$X_2/X_{2c} = o_4(P_p, P_m, (X_3/X_{3c})/(X_1/X_{1c}), \epsilon_{o_4})$
$\Rightarrow X_2 = X_{2c} * o_4(P_p, P_m, (X_3/X_{3c})/(X_1/X_{1c}), \epsilon_{o_4})$
Value added in tertiary sector in constant prices
$X_{3c} = o_5(Y_d, \epsilon_{o_5})$
Value added in tertiary sector in current prices via deflator
$X_3/X_{3c} = o_6(G/G_c, P_{cd}, P_m, \epsilon_{o_6})$
$\Rightarrow X_3 = X_{3c} * o_6(G/G_c, P_{cd}, P_m, \epsilon_{o_6})$
Gross national product in constant prices via deflator
$Y_n/Y_{nc} = o_7(X_1/X_{1c}, X_2/X_{2c}, X_3/X_{3c}, \epsilon_{o_7})$
$\Rightarrow Y_{nc} = Y_n/o_7(X_1/X_{1c}, X_2/X_{2c}, X_3/X_{3c}, \epsilon_{o_7})$
Net factor income from abroad in current prices
$N_{fa} = o_8(F, \epsilon_{o_8})$

GDP in constant prices

$Y_{sc} = X_{1c} + X_{2c} + X_{3c}$

GDP in current prices

$Y_s = Y_{sc} * P_y$

Gross national product in current prices

$Y_n = Y_s + N_{fa}$

Net factor income from abroad in constant prices

$N_{fac} = Y_{nc} - Y_{sc}$

Aggregate demand in constant prices

$Y_d = C_c + G_c + I_c + E_c - M_c$

4.6 Price block

Price block that consists of eight behavioural equations and two identities has an ability to transmit international oil price shock and Indian price shock where none of the existing Bangladesh macroeconometric models considered this. Oil price needs to be incorporated into the Bangladesh model as it is a crucial economic as well as political factor in Bangladesh. On the other hand, neighbour country India is the biggest exporter of Bangladesh, and therefore it plays a key role to influence prices in Bangladesh. This block can also capture aggregate demand shock, shock in prices of most of the trade partners of Bangladesh and narrow money shock. Here, it should be noted that one barrel oil is equivalent of 120 litres of oil and administered oil price means domestic oil price adjusted with subsidies for some of its components like diesel. Behavioural equations and identities in this block are presented in the

following form,

GDP deflator
$P_y = p_1((C + G + I)/(C_c + G_c + I_c), P_e/P_m, \epsilon_{p_1})$
Consumer price index
$P_{cd} = p_2(P_y, P_p, P_m, M_1/Y_s, \epsilon_{p_2})$
Producer price index
$P_p = p_3(P_m, X_1/X_{1c}, X_2/X_{2c}, X_3/X_{3c}, \epsilon_{p_3})$
Investment deflator
$P_i = p_4(X_2/X_{2c}, X_3/X_{3c}, i_l - 100 * \Delta log(P_{cd}), \epsilon_{p_4})$
Export deflator
$P_e = p_5(X_2/X_{2c}, P_m, \epsilon_{p_5})$
Import deflator
$P_m = p_6(P_e, P_{cw} * (e/40.84), \epsilon_{p_6})$
World consumer price index
$P_{cw} = p_7(P_{ci}, P_{ob}/20.46, \epsilon_{p_7})$
Administered price of per litre oil in taka
$P_a = p_8(P_{ol}, \epsilon_{p_8})$
Per barrel oil price in taka
$P_{ob} = P_o * e$
Per litre oil price in taka
$P_{ol} = P_{ob}/120$

4.7 Money block

Major monetary policies of the central bank of Bangladesh can be transmitted into the economy through this block that contains eight behavioural equations. Here, money stocks (money circulation, narrow money and broad money) are treated as

endogenous variables to bring them in forecasting and to see the effects of other economic factors on them. Domestic credits of the central bank and deposit money banks are often used to control prices and investment in Bangladesh, and therefore it is very important to keep them into the model. All behavioural equations are as follows,

Currency in circulation
$M_0 = m_1(M_1, \epsilon_{m_1})$
Narrow money
$M_1/P_{cd} = m_2(Y_d, (D_{db} + D_{bb})/Y_s, i_l - 100 * \Delta log(P_{cd}), \epsilon_{m_2})$
$\Rightarrow M_1 = P_{cd} * m_2(Y_d, (D_{db} + D_{bb})/Y_s, i_l - 100 * \Delta log(P_{cd}), \epsilon_{m_2})$
Broad money
$M_2 = m_3(N_f + D_{bb} + D_{db}, \epsilon_{m_3})$
Net foreign assets
$N_f = m_4(B, \epsilon_{m_4})$
Domestic credit of deposit money banks
$D_{db} = m_5(I, i_l - 100 * \Delta log(P_{cd}), \epsilon_{m_5})$
Domestic credit of the central bank
$D_{bb} = m_6(D_g, r, \epsilon_{m_6})$
Deposit interest rate
$i_d = m_7(r, e, \epsilon_{m_7})$
Lending interest rate
$i_l = m_8(i_d, M_2/P_{cd}, \epsilon_{m_8})$

5 Methodology

Behavioural equations are run applying Error Correction Model (ECM) following Engle-granger (1987). Here, we assume that all series are non-stationary, and therefore no unit root test is done. Long-run static equations have been run based on long-run economic theories. If economic theories did not hold in some cases, then theoretically plausible parameters have been imposed into ECM. Hendry's 'general to a specific' procedure (Hendry, (1995)) is applied to reach final short-run equations. The use of time dummies is extremely low, as these reduce stability of parameter. In addition, parameter stability is tested jointly as well as individually for each parameter in the final short-run equations. Autocorrelation test, specification test, heteroscedasticity test are also done to select the best specific model. All behavioural equations are run in PcGive and PcGets.

6 Validity of the model

Validity of the model is checked through both within-sample and out-of-sample forecasts. Within-sample validation is done via the mean percentage errors (MPE) and the root mean square percentage errors (RMSPE). Out-of-sample forecast is validated by stochastic simulations. For validity checks, all required simulations (static and dynamic simulations within-sample, and stochastic simulations out-of-sample) are run in Winsolve (see Pierse (2001)).

6.1 Within-sample validation

Time series data of 27 years from FY-1980 to FY-2006 is used to generate both static and dynamic solutions. The results are then compared to the actual data to calculate MPE and RMSPE. Table 1 reports the calculations of them for some selected variables. As is shown in the table, the errors are considerably small and the model predicts historical data reasonably well. The actual values are plotted against the static and dynamic simulation results for 6 key variables in Figure 1. The figure also shows that predicted series (both static and dynamic) are very close to actual series which again indicate good forecasting power of the model. Previous models did not have such power, rather there were huge gaps between actual and predicted series.

6.2 Out-of-sample validation

The model is checked for out of sample validation using stochastic simulation exercises. Stochastic simulation, applying the bootstrap method, exerts random shocks from individual equation residuals into each estimated equation for a specified period, and thereby introduces uncertainty into model forecasts. The magnitude of uncertainty is shown using quantiles. Figure 2 represents the 96 percent confidence band for uncertainty in out-of-sample simulations for 6 selected variables with the 2 percent and 98 percent quantiles generated from 100 simulations. In addition to

Table 1

Statistics for Validity Check of the Model: FY-1986 to FY-2006[a]

Variable	Static		Dynamic	
	MPE	RMSPE	MPE	RMSPE
X_{1c}	-0.0140	0.0203	-0.0272	0.0429
X_{2c}	-0.0010	0.0063	0.1331	0.1593
X_{3c}	-0.0133	0.0141	-0.1064	0.1200
C_c	0.0035	0.0155	0.0217	0.0510
I_c	0.0005	0.0310	0.0277	0.0786
G_C	-0.0220	0.0431	-0.0950	0.1154
E	-0.0312	0.0685	-0.0802	0.1343
M	-0.0222	0.0641	-0.0842	0.1137
R	-0.0159	0.0358	-0.1247	0.1506
D_{db}	-0.0181	0.0531	0.0041	0.0863
M_1	-0.0159	0.0382	-0.0073	0.0796
M_2	-0.0099	0.0475	0.1057	0.1129
N_f^b	0.3837	1.5590	1.6168	3.1421
P_y	-0.0081	0.0130	-0.0538	0.0664
P_{cd}	-0.0166	0.0250	-0.0674	0.0743
Y_{sc}s	-0.0453	0.0463	-0.0616	0.0658
D_d	0.0000	0.0116	0.1886	0.2413
D_f	0.0109	0.0727	0.2153	0.2347
r_l	-0.0013	0.0228	-0.0087	0.0281
D_{bb}	0.0372	0.1569	0.5089	0.6935

[a]The MPE and RMSPE are computed as follow :

MPE $= \frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)$, RMSPE $= \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y_t^s - Y_t^a}{Y_t^a}\right)^2}$

where Y_t^s and Y_t^a are the simulated and actual values of an endogenous variable respectively in period t and T is the number of simulated periods.

[b]As there are negative values in actual data, the calculated MPE and RMSPE come out to be high in magnitude.

this, the 50 percent quantile is shown to represent the mean simulated value. As shown in figure 2, out-of-sample performance of the model appears to be reasonably good.

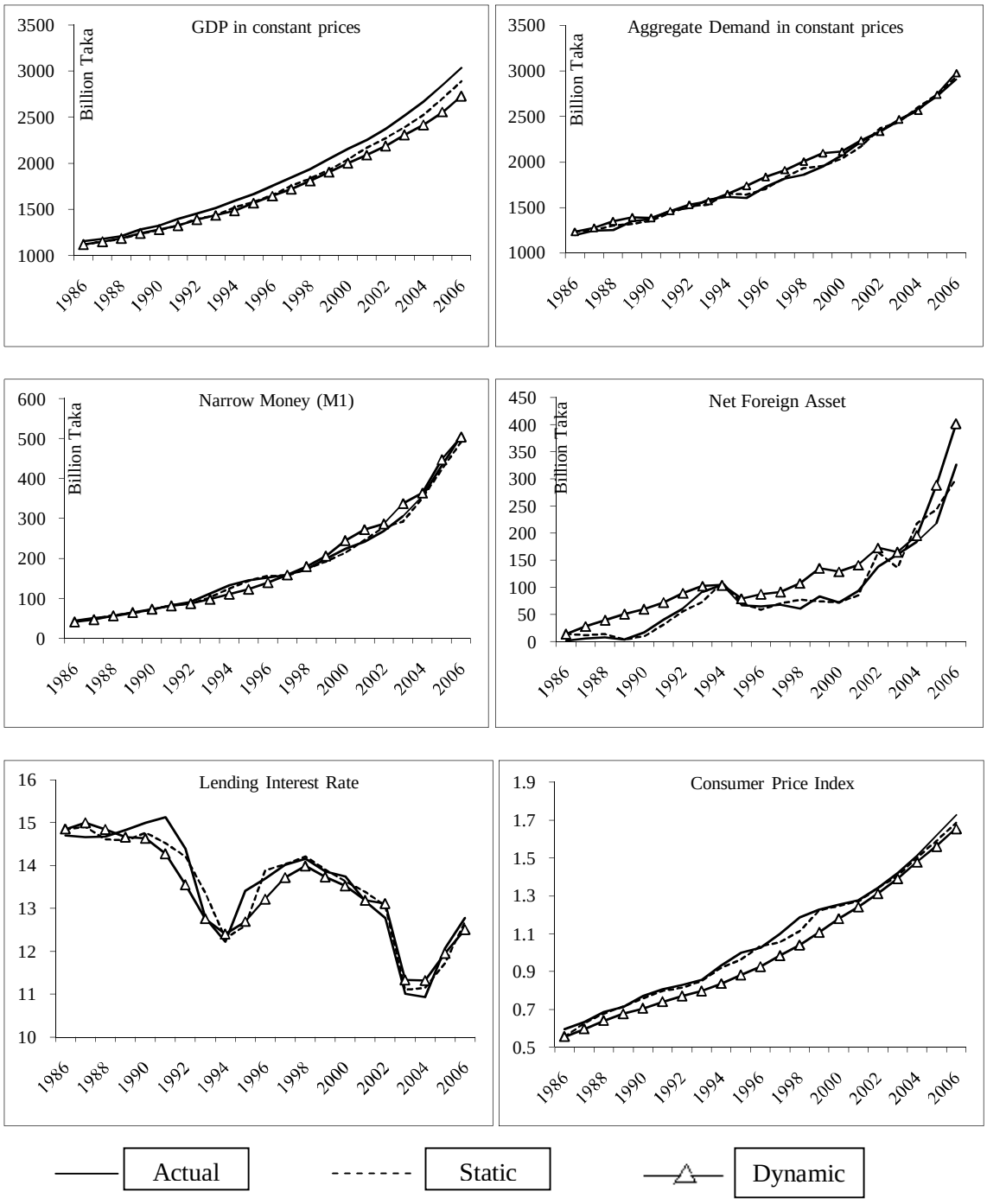

Figure 1: Static and Dynamic forecasting: a few key variables

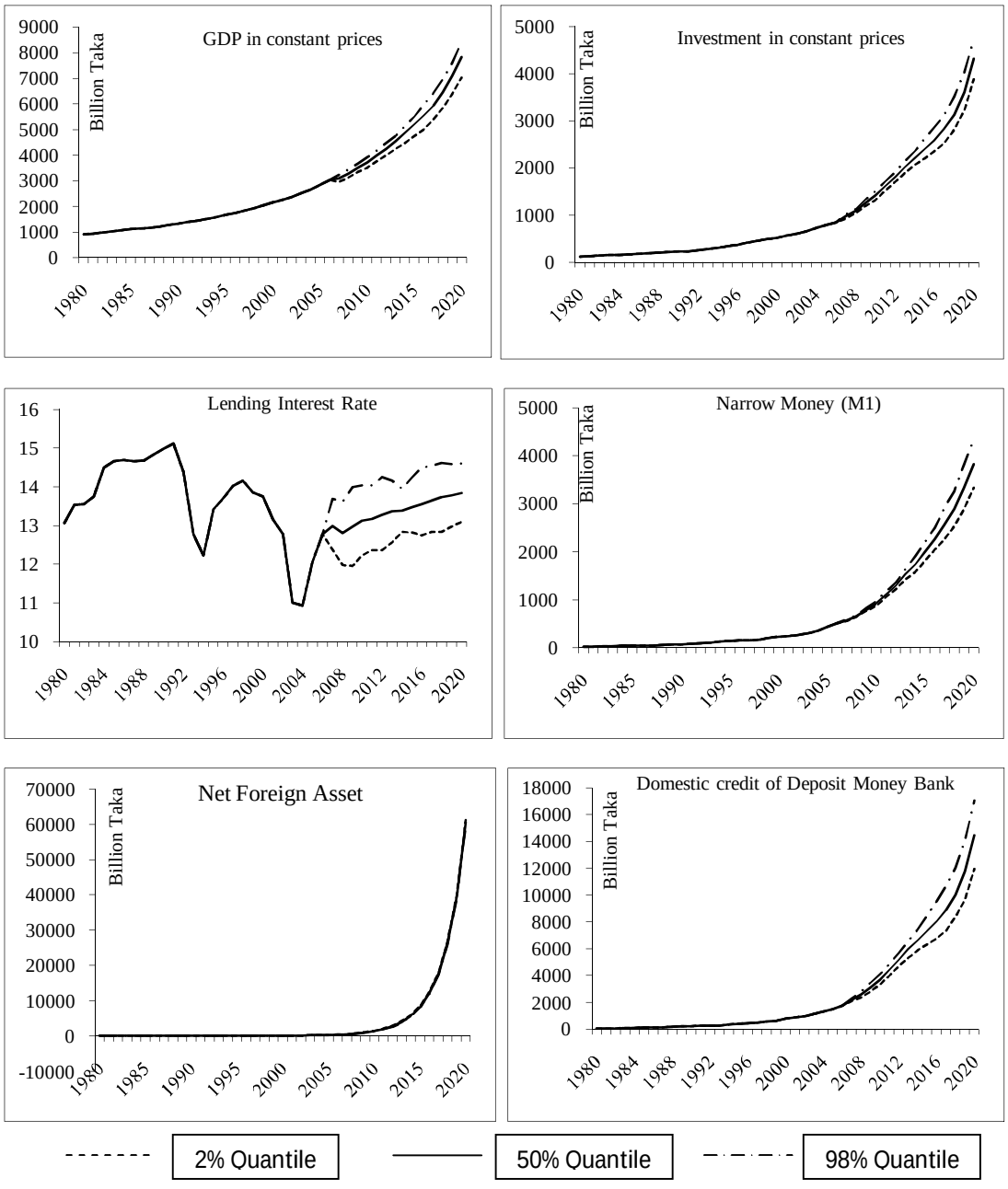

Figure 2: Stochastic forecasting: a few key variables

7 Conclusion

In spite of small sample period, the model presented here is a robust macroeconometric model of the Bangladesh economy. Compared to the previous models, the use of time series econometrics in the model is in advanced level. In addition, intensive attention is given to hold economic theory while running long-run equations. The use of time dummies is kept minimal to make the model stable. Thus, both within-sample and out-of-sample simulation show that the model has high ability of forecasting and policy simulations, indicating the usefulness of the model.

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Appendix A : Variables and Sources of Data

Endogenous Variables

Variable Name	**Definition**	**Source**	**Units**
B	Current account balance	Economic Trends, Bangladesh Bank	Million Taka
C_c	Private consumption in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
C	Private consumption in current prices	Bangladesh Bureau of Statistics	Million Taka
C_p	Credit to private sector	Bangladesh Bureau of Statistics	Million Taka
D_b	Domestic borrowing of government	Bangladesh Bureau of Statistics	Million Taka
D_{bb}	Domestic credit of central bank	Economic Trends, Bangladesh Bank	Million Taka
D_{db}	Domestic credit of deposit money bank	Economic Trends, Bangladesh Bank	Million Taka
D_d	Domestic Debt	Ministry of Finance, Government of Bangladesh	Million Taka
D_f	Foreign Debt	Ministry of Finance, Government of Bangladesh	Million Taka
D	Total Debt	Ministry of Finance, Government of Bangladesh	Million Taka
D_g	Government budget deficit	Bangladesh Bureau of Statistics	Million Taka
E_c	Exports in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
E	Exports in current prices	Bangladesh Bureau of Statistics	Million Taka
G_c	Government consumption in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka

Variable Name	**Definition**	**Source**	**Units**
G	Government consumption in current prices	Bangladesh Bureau of Statistics	Million Taka
G_e	Government expenditure in current prices	Bangladesh Bureau of Statistics	Million Taka
I_g	Government investment in current prices	Bangladesh Bureau of Statistics	Million Taka
I_{pc}	Private investment in constant prices	Bangladesh Bureau of Statistics	Million Taka
I_p	Private investment in current prices	Bangladesh Bureau of Statistics	Million Taka
I_c	Total investment in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
I	Total investment in current prices	Bangladesh Bureau of Statistics	Million Taka
i_d	Deposit interest rate	Economic Trends, Bangladesh Bank	
i_l	Landing interest rate	Economic Trends, Bangladesh Bank	
K_c	Capital in constant prices	MIMAP	Million 1995 Taka
K	Capital in current prices	MIMAP	Million Taka
M_c	Imports in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
M	Imports in current prices	Bangladesh Bureau of Statistics	Million Taka
M_0	Money circulation	Economic Trends, Bangladesh Bank	Million Taka
M_1	Narrow money	Economic Trends, Bangladesh Bank	Million Taka
M_2	Broad money	Economic Trends, Bangladesh Bank	Million Taka
N_f	Net foreign asset	Economic Trends, Bangladesh Bank	Million Taka
N_{fac}	Net factor income from abroad in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka

Variable Name	Definition	Source	Units
N_{fa}	Net factor income from abroad in current prices	Bangladesh Bureau of Statistics	Million Taka
P_{cd}	Consumer price index	Economic Trends, Bangladesh Bank	1995=1
P_{cw}	World consumer price index (trade-weighted CPI for 20 major trading partners of Bangladesh)	International Financial Statistics, Directorate of Trade Statistics	1995=1
P_y	GDP deflator	Bangladesh Bureau of Statistics	1995=1
P_i	Investment deflator	Bangladesh Bureau of Statistics	1995=1
P_m	Import deflator	Bangladesh Bureau of Statistics	1995=1
P_{ob}	Oil price per barrel		Taka
P_{ol}	Oil price per litre		Taka
P_p	Producer price index	Economic Trends, Bangladesh Bank	1995=1
P_e	Export deflator	Bangladesh Bureau of Statistics	1995=1
P_a	Administered price of per litre oil	Petro Bangla	Taka
R	Government total revenue	Bangladesh Bureau of Statistics	Million Taka
T	Tax revenue	Economic Trends, Bangladesh Bank	Million Taka
X_{1c}	Value added in primary sector in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
X_1	Value added in primary sector in current prices	Bangladesh Bureau of Statistics	Million Taka
X_{2c}	Value added in secondary sector in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
X_2	Value added in secondary sector in current prices	Bangladesh Bureau of Statistics	Million Taka

Variable Name	Definition	Source	Units
X_{3c}	Value added in tertiary sector in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
X_3	Value added in tertiary sector in current prices	Bangladesh Bureau of Statistics	Million Taka
Y_{sc}	GDP in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
Y_s	GDP in current prices	Bangladesh Bureau of Statistics	Million Taka
Y_{nc}	GNP in constant prices	Bangladesh Bureau of Statistics	Million 1995 Taka
Y_n	GNP in current prices	Bangladesh Bureau of Statistics	Million Taka
Y_d	Aggregate demand in constant prices	Bangladesh Bureau of Statistics	Million Taka

Exogenous Variables

Variable Name	Definition	Source	Units
d	Annual depreciation rate of capital		
e	Exchange rate	Economic Trends, Bangladesh Bank	Million Taka
F	Remittance at Current Prices	Economic Trends, Bangladesh Bank	Million Taka
K_e	Capital error		Million Taka
P	Repayment of domestic Debt	Economic Trends, Bangladesh Bank and Ministry of Finance, Government of Bangladesh	Million Taka
P_{ci}	Consumer price index of India	International Financial Statistics	1995=1
P_o	Oil price per barrel	Petro Bangla	Dollar

Variable Name	**Definition**	**Source**	**Units**
r	Bank rate	Economic Trends, Bangladesh Bank	Million Taka
r_1	Rate of central bank credits as government borrowing		
r_2	Rate of deposit money bank credits as government borrowing		
W_1	Irrigated area	Bangladesh Bureau of Statistics	Acres
W_2	Rain falll	Bangladesh Bureau of Statistics	Millimeter
Y_f	Foreign GDP (trade-weighted GDP index for 20 major trading partners of Bangladesh)	International Financial Statistics, Directorate of Trade Statistics	1995=1
ϵ_k	Error term in equation k		