IMPACT OF ENERGY PRICE ADJUSTMENTS ON BANGLADESH ECONOMY: A MACRO-ECONOMETRIC MODELING APPROACH

Monzur Hossain
Mohammad Mahbubur Rahman
Md. Atiqur Rahman

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Bangladesh Institute of Development Studies (BIDS)
E-17 Agargaon, Sher-e-Bangla Nagar
GPO Box No.3854, Dhaka-1207
Bangladesh

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Monzur Hossain
Senior Research Fellow, BIDS

Mohammad Mahbubur Rahman
Research Fellow, BIDS

Md. Atiqur Rahman
Research Associate, BIDS

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ACRONYMS

BBS	Bangladesh Bureau of Statistics
BIDS	Bangladesh Institute of Development Studies
BPC	Bangladesh Petroleum Corporation
BPDB	Bangladesh Power Development Board
GDP	Gross Domestic Product
IISD	International Institute for Sustainable Development
IOC	International Oil Company
REB	Rural Electrification Board

FOREWORD

This study sets out to examine the impact of energy prices on major macro variables, including growth, inflation, fiscal and external balances with the help of a macroeconomic simulation model. In this context, alternative policy scenarios and their implications are worked out. Specifically, five transmission channels are examined, such as the macroeconomic channel, fiscal channel, price channel, and trade and production channels.

Given that energy pricing policy in Bangladesh is ad hoc, involves huge subsidies and wastage, and faces a tremendous challenge in terms of policy reforms, the study provides a useful departure from the usual partial economic analysis in attempting a more comprehensive macro analysis to assess impact of pricing adjustments. This study therefore will go some way in bridging the policy-research gap in this key area of work.

I would like to thank the authors for conducting this study under our BIDS-REF banner.

May 2018

K. A. S. Murshid
Director General

ABSTRACT

The domestic price of energy products including electricity, oil and natural gas has long been administered in Bangladesh. The government provides subsidy to all these energy products in various forms. The government of Bangladesh incurs a large amount of expenditures in the form of subsidies every year for the energy sector. Against the backdrop of an overwhelming burden of subsidies, the Bangladesh government has intensified its reforms of energy prices in recent times in order to bring fiscal discipline. This study thus, aims to assess the impact of energy price adjustments under a macro-econometric modeling framework. Though this is a model of the macro-economy of Bangladesh, it has been extended to link up the macroeconomic consequences of the changes in the government energy expenditures. The effect of energy price changes on macroeconomic outcomes has been predicted with alternative scenarios of deregulations of domestic energy prices, particularly to the outcomes for growth, inflation, fiscal balances and external balances. The prediction has been done for the period 2015-16 to 2020-21 in line with Seventh Five Year Plan period (2015-2019) and Perspective Plan, 2021. Within sample (1985-2011) predictive accuracy (or validity) of the model is checked by the mean percentage error (MPE) and the root mean square percentage error (RMSPE). We run stochastic simulations to know the *out of sample* (2012-2021) performance of the model. Under these simulations, the bootstrap method is used to give random shocks into individual endogenous variables but for out of sample period. Random shocks are generated from individual residuals of variables for within sample period. 1000 stochastic simulations/replications are run through bootstrapping. 100 quintiles are computed to compare the magnitudes out of sample forecasts, because within the sample uncertainty captured by residuals, it makes variations out of sample forecasts. Overall, the out of sample performance of the model seems quite good. The model initially analyses macroeconomic data for the period 1980-2011. The sample validation and out of sample prediction imply that the model fit was good and it can be used for policy simulations through assumed shocks. Considering the current gap between subsidised and government's buying price of energy, reasonable alternative scenarios of price shocks were derived and subsequently applied. The simulated results are drawn for the period 2015-2021 making it consistent with the Seventh Five Year Plan and the Perspective Plan. The results suggest that any upward revision of energy prices will be slightly inflationary and as a result the real GDP growth rate will fall slightly during the predicted period. A note of caution in explaining the result is that it is based on the assumption that other variables will remain as usual. The GDP growth and inflationary situation might improve if changes in other macroeconomic indicators take place along with energy price adjustments.

CHAPTER 1

INTRODUCTION

The domestic price of energy products including electricity, oil and natural gas has long been administered in Bangladesh. The government provides subsidy to all these energy products in various forms. While natural gas is the main source of primary energy (85-90 per cent)[1], the government supplies it to the people at a subsidised price (after buying it at a higher price from gas companies). On the other hand, although the selling price of natural gas to the power (electricity) generation companies is not that much subsidised, the government provides huge subsidies for the power sector as it supplies electricity to the people and others at a rate lower than the market price. Power generation is also dependent on imported diesel or furnace oils, the price of which is also administered to be lower than the actual price. Therefore, the government of Bangladesh incurs a large amount of expenditure in the form of subsidies every year for the energy sector. Against the backdrop of an overwhelming burden of subsidies, the Bangladesh government has intensified reforms of energy[2]prices in recent times in order to bring fiscal discipline.

The retail gas price had increased by 15–20 per cent between 2000 and 2005. Tariff adjustment for the gas sector has not taken place since 2005.However, afterwards by July 2009 gas price had increased by about 10 per cent and price of feed gas (the gas supplied to CNG filling stations) had increased by 400 per cent. The significant increase in gas production between 2001 and 2008, with total output reaching 596 BCF in 2008, was due to mainly the rapid increase in gas production by international oil companies (IoCs). The increased gas production also resulted in increased tax payments from IoCs, amounting to over Tk. 29.5 billion ($433 million) in 2007 compared with Tk. 4.25 billion ($290 million) in 2000.

The Government of Bangladesh spends a major share of its budget expenditures by providing direct subsidies for fossil fuels and electricity, the costs of which have been escalating rapidly in recent years. In FY2012, the government reportedly spent BDT 81.4 billion (US$ 944 million) in direct expenditure on energy subsidies. However, the cost of

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[1]Bangladesh's energy sector is highly dependent on natural gas. About 57 per cent (i.e., inclusive of captive power generation) of the country's natural gas production is used in power generation. The consumers of electricity and electricity consumption have also increased during 1994– 2008. The total number of connections has increased from 2.2 million in 1994 (i.e., electrification rate of 10 per cent) to over 4.7 million by 2001 (electrification rate of over 17 per cent), and the majority of new consumer connections were provided by Rural Electrification Board (REB). By 2008, the total number of electricity consumers had reached was 10.6 million (i.e., electrification rate of over 37 per cent). Total electricity consumption grew by 181 per cent over the period, or 7.1 per cent per year. There has been a large increase in the number of electricity customers over the past 15 years, with the electrification rate increasing from 10 per cent to 37 per cent.

[2] The term "energy" is used to cover all commercial sources (e.g., electricity), petroleum products (e.g., octane,2 diesel, kerosene, furnace oil and other products) and natural gas that the government subsidises.

subsidies estimated by the GSI, in collaboration with the Bangladesh Institute of Development Studies (BIDS), is much higher, totaling BDT 148.9 billion (US $1.7 billion) in FY2012 while taking into account of off-budget subsidies, such as low-interest rate loans that the government provides to the Bangladesh Power Development Board (BRDB) and the Bangladesh Petroleum Corporation (BPC).

Considering the increasing burden of subsidies and fiscal imbalances, the government has made several rounds of revisions of energy prices in recent years. This has led to sharp reactions among various quarters on its possible consequences on the economy. While upward energy price revision is apparently inflationary from the consumers and producers perspective, allocative efficiency and diminishing fiscal burden could have an offsetting effect on the price level. Therefore, a partial analysis may not be appropriate to gauge the proper impact of energy prices on various economic indicators. From these concerns, this study aims to assess the impact of energy price adjustments under a macro-econometric modeling framework.

This study thus aims to analyse the impact of energy price changes on major macroeconomic variables, such as growth, inflation, fiscal balances and external balances in Bangladesh, with the help of a macroeconomic policy simulation model. The study also attempts to examine what would be the outcome for, say, growth or inflation if a particular set of policies are adopted under an assumed but realistic set of exogenous conditions. The model involves five major channels of transmission, such as the macroeconomic channel, price channel, fiscal channel, trade channel and production channel, have been explored. The effect of energy price changes on macroeconomic outcomes could be predicted with alternative scenarios of deregulations of domestic energy prices, particularly to the outcomes for growth, inflation, fiscal balances and external balances. The prediction has been done for the period 2015-16 to 2020-21 in line with Seventh Five Year Plan period (2015-2019) and Perspective Plan, 2021.

CHAPTER 2

ENERGY PRICE SHOCK, TRANSMISSION CHANNELS AND MACRO-ECONOMETRIC MODELS

Energy price shock has both expenditure and investment side responses. The literature on this topic mainly focuses on four complementary mechanisms by which consumption expenditures may be directly affected by energy price changes. First, higher energy prices are expected to reduce discretionary income, as consumers have less money to spend after paying their energy bills. Second, changing energy prices may create uncertainty about the future path of the price of energy, causing consumers to postpone irreversible purchases of consumer durables (see Bernanke 1983, Pindyck 1991). There has been no consensus on how energy price changes affect one's livelihood in the long run. While one stream of the argument is that the transfer of income to the refiner may be partially returned to consumers in the form of higher wages or higher stock returns on domestic energy companies. Even if the transfer is not returned, higher energy prices simply constitute an income transfer from one consumer to another that cancels in the aggregate. Another argument is that even when purchase decisions are reversible, consumption may fall in response to energy price shocks as consumers increase their pre-cautionary savings. This response may arise if consumers smooth their consumption because they perceive a greater likelihood of future unemployment and, hence, future income losses. By construction, this effect will embody general equilibrium effects on employment and real income.

In addition, the precautionary savings effect may also reflect a greater uncertainty about the prospects of remaining gainfully employed, in which case any unexpected change in energy prices would lower consumption. Consumption of durables that are complementary in use with energy will tend to decline even more, as households delay or forego purchases of energy-using durables. This operating cost effect is more limited in scope than the uncertainty effect, since it only affects specific consumer durables (see Hamilton 1988).

These direct effects have in common that they imply a reduction in aggregate demand in response to unanticipated energy price increases. In addition, there may be indirect effects related to the changing patterns of consumption expenditures. A large literature has stressed that shifts. Alternatively, one might expect durables consumption to fall in response to a positive energy price shock as consumers wait for more energy-efficient technologies to become available. This effect might be reflected in the reduction in the number of automobiles/energy apparatus sold and/or in substituting small energy-inefficient automobiles or lights/bulbs, etc. (see Bresnahan and Ramey 1993).

In the presence of frictions in capital and labour markets, these inter-sectoral and intra-sectoral reallocations will cause resources to be unemployed, thus causing further cutbacks in consumption and amplifying the effect of higher energy prices on the real economy. This indirect effect could be much larger than the direct effects listed earlier and is considered by many economists to be the primary channel through which energy price shocks affect the economy (see, e.g., Davis and Haltiwanger 2001 and Lee and Ni 2002 and the references therein).

As discussed earlier, energy price shocks may be transmitted not only through cutbacks or shifts in consumer expenditures, but also through similar adjustments in firms' investment expenditures (Hamilton 2008). There are two main channels by which energy price shocks may affect nonresidential investment. One is that an increase in the price of energy raises the marginal cost of production. This cost channel depends on the cost share of energy. The second channel is through reduced demand for the firm's output, as consumer expenditures fall in response to rising energy prices. For example, Herrera (2007) studies a linear-quadratic inventory model that links shifts in consumer demand in response to energy price shocks to real economic activity. There is also a direct link from reduced demand to cutbacks in nonresidential investment in equipment and structures (see Edelstein and Kilian 2007). The response of nonresidential fixed investment needs not be symmetric in energy price changes. For example, changes in energy prices are thought to create uncertainty about future energy prices, causing firms to postpone irreversible investment decisions. This uncertainty affect has implications for both supply-side and demand-side accounts of the transmission of energy-price shocks. Specifically, firms may respond to uncertainty about future production costs or to uncertainty about future sales and revenue. In either case, when energy prices rise, the uncertainty effect will reinforce the decline in firms' investment expenditures due to reduced consumer demand and higher energy costs.

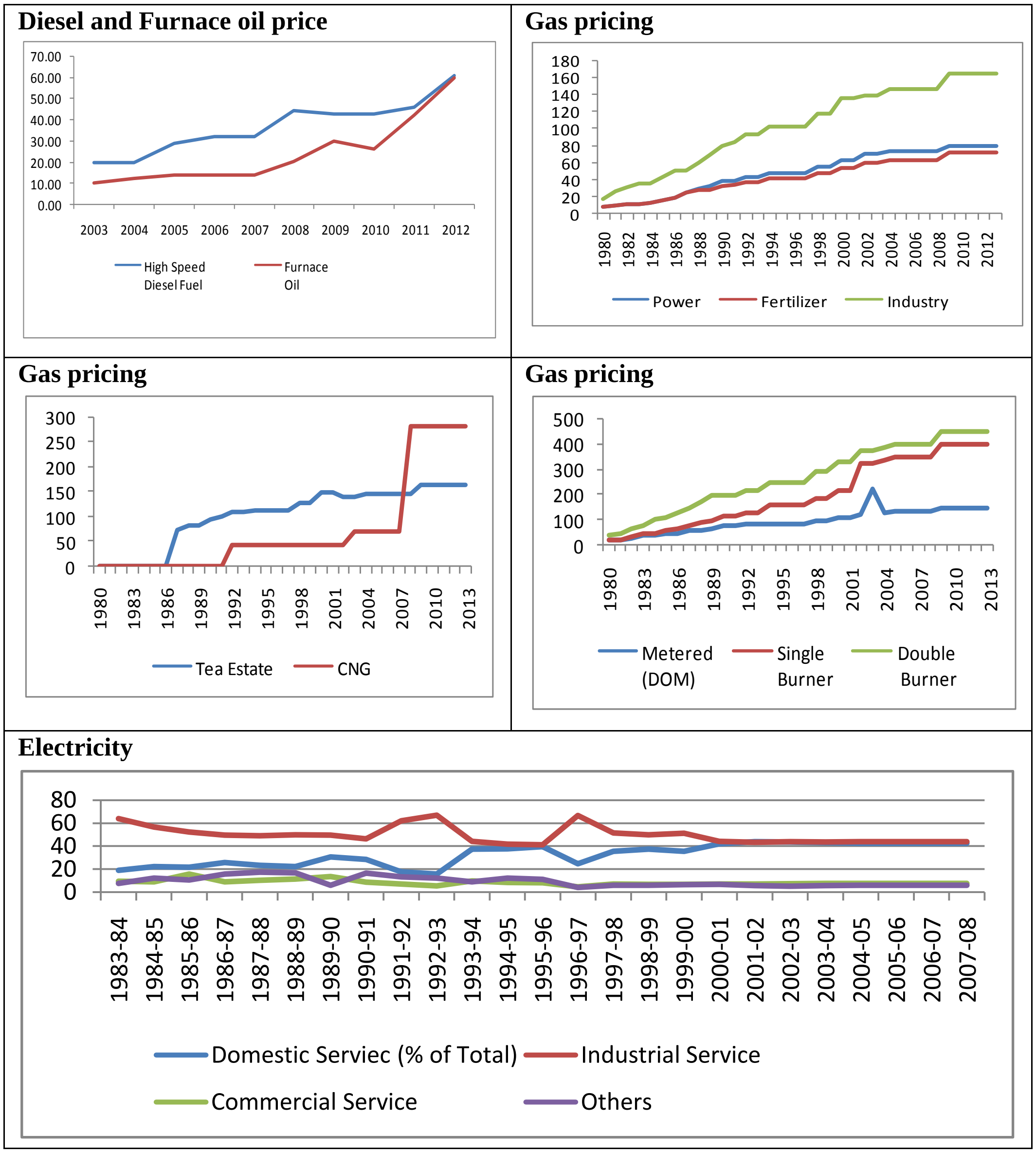
When energy prices fall, in contrast, the uncertainty effect counteracts the increase in investment expenditures driven by lower costs and increased consumer demand, dampening the increase in investment spending. Notwithstanding these theoretical arguments in support of asymmetries, there is no compelling empirical evidence of asymmetries in the responses of investment expenditures to energy price shocks, with the exception of some subcomponents of equipment investment.

The uncertainty and the reallocation effect necessarily generate asymmetric responses of macroeconomic aggregates to unanticipated energy price increases and decreases. The asymmetry arises because these effects amplify the response of macroeconomic aggregates to energy price increases but reduce the corresponding response to falling energy prices. Therefore, a macro-econometric modeling exercise involving all the important sectors of the economy could potentially capture the net effect of energy price changes to the economy.

2.1 Energy Price and Subsidy Scenario in Bangladesh

The Government of Bangladesh, like many countries around the world, has been providing subsidies for decades in a number of areas including agriculture, petroleum products, electricity, natural gas, health, education and food. Bangladesh started subsidising the retail prices of energy products following independence in 1971. Today, with soaring global fuel prices and rapidly rising demand for fuels, these subsidies take a heavy toll on government finances. Although subsidies create extra pressure on exchequers, they have wide-ranging impacts on the distribution of wealth within a country, economic growth and the environment. However, the government makes sporadically readjustments to energy prices (Figure 2.1) to bring it close to the market price level.

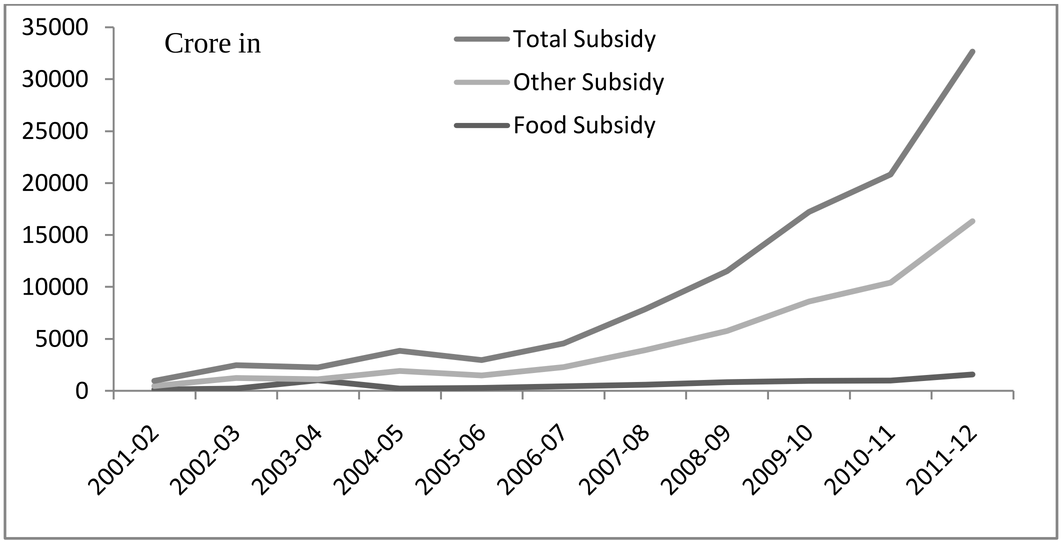
Figure 2.1: Energy Price Patterns (adjustments) in Bangladesh



Source: Bangladesh Energy Regulatory Commission; Petrobangla; Titas Gas and various issues of Newspapers.

In Bangladesh, while food subsidies dominated till the early 2000s, non-food subsidies including energy-subsidies started dominating the subsidy basket thereafter. Subsidies in non-food items have been increasing over time and reached about Tk. 15,000 crore in 2011-12. A joint study by BIDS, GSI and IISD in 2013 estimated that almost 90 per cent of total subsidies accounted for energy subsidies in recent times, mostly due to escalation of subsidies in quick rental power plants (Figure 2.2).

Figure 2.2: Pattern of Subsidies in Bangladesh



Source: *Statistical Year Book*, various issues, BBS; **BIDS (2013**).

2.2 Macro-econometric Models in Bangladesh

Several attempts have been made so far to construct Macroeconomic models for Bangladesh. Islam (1965) conducted one of the first studies of the macroeconomic model for the Pakistan economy, in which East Pakistan (the present Bangladesh) was treated as a region. The objectives of Islam's study were to formulate economic models of Pakistan, undertaking statistical estimation, as well as collecting, organising and processing both published and unpublished data systematically.

The empirical works on constructing macro-econometric models of Bangladesh economy have been intensified in the 1980s mainly due to aid the policymakers in rebuilding the economy after the shattered first decade of independence during the 1970s. Rashid (1981) developed a short-run macro-econometric model for Bangladesh economy with the primary objective of understanding the workings of the economy. Despite the absence of the rigorous formulation of the model (e.g., no policy simulation was carried out, therefore, no definite conclusions about the policy implications of the model was presented), the author made some tentative conclusions on the basis of the signs and magnitudes of the estimated coefficients which was actually the beginning of an attempt to quantify macro-econometric model of the Bangladesh Economy.

Parikh (1983) constructed a macroeconomic model of the Bangladesh economy using the Keynesian approach of price rigidity with quantity rationing. The model also explicitly delineated the structure of the economy and its interdependence between various sectors of the economy. One of the important features of the model was that it included the weather factor. However, Parikh's Model is confined to strict functional forms. One criticism of Parikh's model is that it did not test the equations and, therefore, no definite policy suggestions were offered. Chowdhury (1986) used vector auto regression (VAR) technique as an alternative approach to forecast the macroeconomic model in the context of Bangladesh's economy. However, the model was once again restricted into functional form and no estimation of the parameters was carried out.

Rahman and Shilpi (1996) developed a dynamic macroeconomic model for the Bangladesh economy with regard to five economic blocks such as expenditure, fiscal, money and finance, trade, and aggregate supply block. The objectives of the model were to estimate and validate followed by a dynamic policy simulation. Chowdhury, Dao and Wahid (1995) analysed the relationship between money, output, prices and exchange rate for Bangladesh using a VAR model with quarterly data over the 1974-1992 periods. They found, among other things, monetary policy is significant in explaining output, and monetary policy and inflation jointly determine the exchange rate.

More recently, Basher and Haque (2000) have developed a simulated macro-econometric model for Bangladesh economy. Their model consisted of five important sectors of Bangladesh Economy: demand, fiscal, money and finance, trade and supply side. It has also included remittance income as an endogenous factor in the model. The model was estimated using annual data from 1974 to 1997.

However, in Bangladesh insofar no such attempt has been made to develop a macro-econometric model to capture energy price shocks on the economy. Thus, we aim to develop a dynamic macro-econometric model for Bangladesh with a special focus on energy price adjustments. The model is being developed in order to assess an economy-wide impact of energy-price adjustments by linking possible effects in production, consumption as well as government expenditure, which might have a balancing effect on economic output.

CHAPTER 3

THE MODEL FRAMEWORK

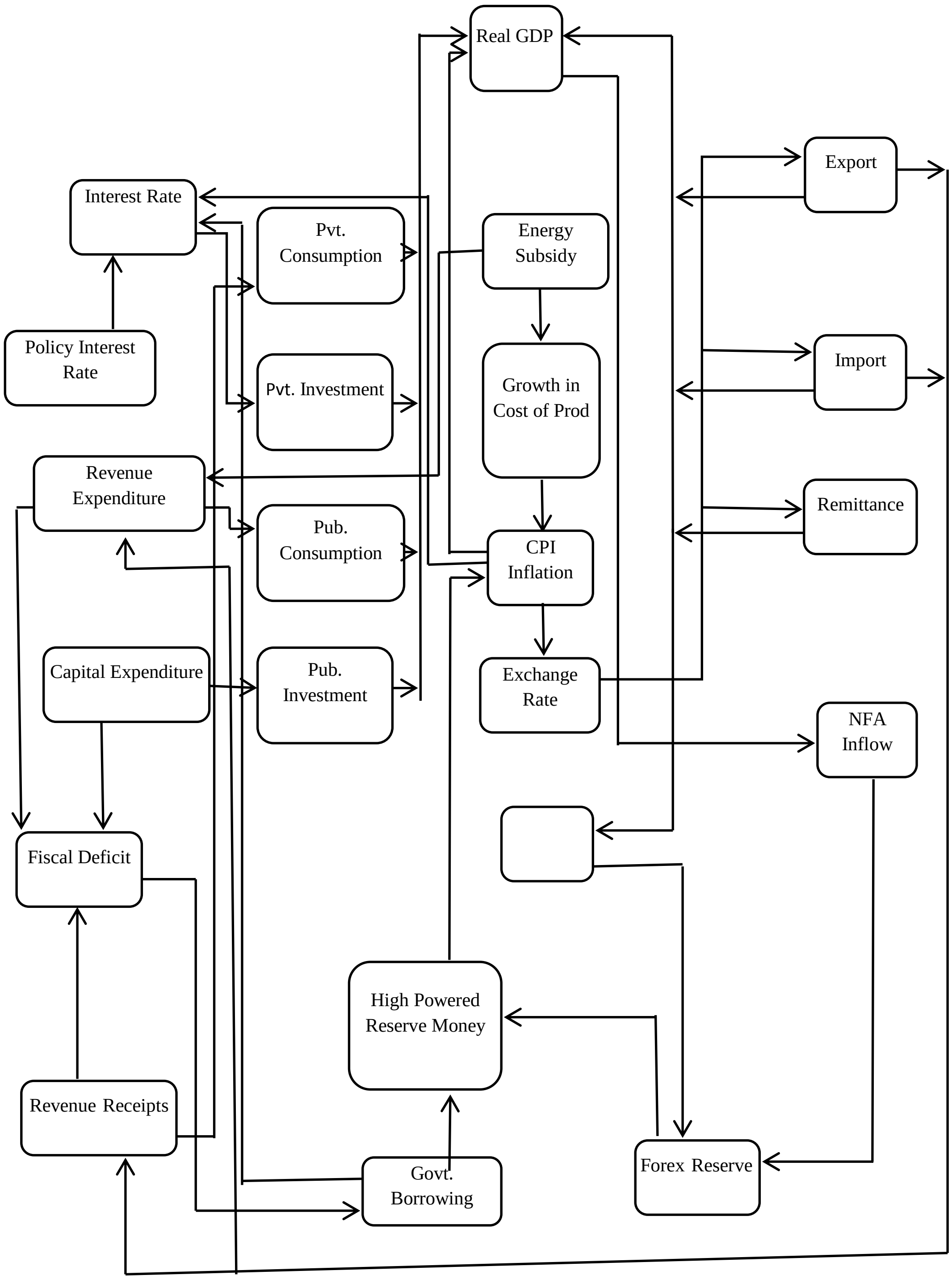
Macro-econometric model, developed in the Tinbergen-Goldberger-Klein (1955, 1967) tradition, is a simultaneous equations system model developed for policy simulation. The main outcomes of this model are conditional indicators of what would be the outcome for growth or inflation if a particular set of policies were adopted under an assumed, but realistic, set of exogenous conditions. In this exercise, an attempt has been made to capture the impact of energy price shocks on various macroeconomic indicators of Bangladesh. The model is a reduced form one with some equations and identities.

There are several blocks in the model *viz.* the macroeconomic, government, external, price, and monetary and production. The macroeconomic block is comprised of equations determining the nominal GDP, private consumption and private investment to GDP ratio. The government block is comprised of equations determining the combined current expenditure, the combined revenue receipts of the government along with the public investment and the fiscal deficit. The external block is comprised of equations determining the export, import, trade balance, net capital inflow, exchange rate and change in foreign exchange reserve. The monetary block contains equations determining the change in high-powered and narrow money, the public borrowing and the rate of interest

The scope of the model is limited to the study of macro-behaviour of the energy price changes and macro-relationships of this sector with the rest of the economy. It will not cover relative price impacts, energy efficiency, technological changes, alternative fuels and the linkages with financial markets.

Though this is a model of the macro-economy of Bangladesh, it has been extended to link up the macroeconomic consequences of the changes in the government energy expenditures. As most of the variables show a two-way causality, the model is of a simultaneous equation framework. This will give us a scope of policy appraisal of the Bangladesh economy. In accordance with a set of putative assumptions which place a greater consideration to real phenomena, the prime focus of the model is to shed light on the inflationary consequences in junction with the growth concern on the basis of some conditional factors. The shortcoming of the model is that it exerts no effort to underline the perceptions of the economic agents regarding the expectations of policy interventions which is dominant for the efficiency of this kind of interventions.

Figure 3.1: **Conceptual Framework of the Model**



3.1 Macroeconomic Block

The block of macroeconomy begins with the identity of national income where the national income in the economy in period t (Y_t) is presented in the expenditure method as follows.

$$Y_t \equiv C_t + G_t + I_t^p + I_t^g + NX_t + R_t$$

where C_t is the gross private consumption expenditure assumed to be a positive function of aggregate disposable income, G_t is the public consumption expenditure, I_t^p is the aggregate private investment expenditure, I_t^g is the public investment expenditure, NX_t is the balance of trade in all goods and services, and R_t is net inflow invisibles (such as remittances). So, the sum of balance of trade and net inflow invisibles, NX_t +R_t, gives the current account balance.

Inflation in period t (Π_t) is a behavioural equation, which is a function of the growth rate of narrow money $\Delta\mathrm{M}_{1t}$, the rate of change in the level of administered price of energy $\Delta\mathrm{P}_{Et}$, the rate of change in factor cost (wage, rent and interest costs) $\Delta\mathrm{F}_t$, and the import bill B_t .

$$\Pi_t = f\ (\ \Delta\mathrm{M}_{1t}, \Delta\mathrm{P}_{Et}, \Delta\mathrm{F}_t,\ B_t)$$

The process of capital accumulation in any period t depends on the real lending rate, r_t, the expected real output Y_t^e, and the import of capital machinery C_{mt}.

$$\mathrm{K}_t = f\ (\ \mathrm{r}_t, Y_t^e, \quad C_{mt})$$

Private Investment I_t is a behavioral equation, which is explained by the real lending rate r_t, the expected real output Y_t^e, and the public investment expenditure I_t^g.

$$\mathrm{I}_t = f\ (\ \mathrm{r}_t, Y_t^e, \quad I_t^g)$$

Following an adaptive expectation approach, the expected real output in period t (Y_t^e) is given by

$$Y_t^e \equiv Y_{t-1} + \Delta\,\bar{Y}_t$$

where Y_{t-1} is actual output in the immediate previous period and $\Delta\,\bar{Y}_t$ is the estimated first difference of output in period t. This is estimated from the equation below.

$$\Delta\,\bar{Y}_t = f\ (\Delta Y_{t-1},\ \Delta^2 Y_{t-1}).$$

where ΔY_{t-1} is the first difference of output in the previous period and $\Delta^2 Y_{t-1}$ is the second difference of output in the previous period. Here, the first derivative of the first difference of output in the previous period ΔY_{t-1} is positive and that of the second difference of output in the previous period $\Delta^2 Y_{t-1}$ is negative. That is $\Delta Y_{t-1}^{'} >$ 0and$\Delta^2 Y_{t-1}^{'} < 0$.

3.2 Government Block

The gross revenue expenditure of government (N_t) is the government revenue expenditure on the energy sector as subsidy (N_t^s) and the other revenue expenditure (N_t^o)

$$N_t = N_t^s + N_t^o$$

Total government expenditure is a function of revenue expenditure and the level of the total government expenditure in the immediate previous period

$$G_t = f\,(G_{t-1}, N_t)$$

Revenue expenditure on energy N_t^s is directly influenced by the domestic price of energy items, their prices in the international market and the domestic demand of energy. Theoretically, it should be the function of the degree of the pass-through of the cost of production or purchase of energy. If the pass-through of the purchasing or production cost on to domestic administered price is lower with higher quantity of energy sold domestically, the amount of subsidy would be higher. Thus, the energy subsidy in Bangladesh is fixed by the mechanism

$$N_t^s = f(P_t^{IE}, P_t^{DE}, Q_t^D)$$

where P_t^{IE} is the international price of energy items that Bangladesh imports.

Since the pattern of government expenditure as a subsidy among the different sectors is finally a policy variable decided by the government, the assumption that the changes in other subsidies follow a one to one relationship with the changes in energy subsidies is not totally justified. The level of government revenue T_t is the total figure of tax and non-tax revenue T_t^N, whereas tax revenue comprises energy import tax T_t^{EI}, energy sales tax T_t^{ES} and other tax T_t^O.

$$T_t \equiv T_t^{EI} + T_t^{ES} + T_t^O + T_t^N$$

$$\Delta T_t^{OT} \equiv \overline{\alpha}\frac{\Delta Y_t}{Y_{t-1}} T_{t-1}$$

$$\Delta T_t^{NT} \equiv \overline{\beta}\frac{\Delta Y_t}{Y_{t-1}} T_{t-1}$$

where the coefficients of other tax and non-tax changes $\overline{\alpha}$ and $\overline{\beta}$ are the policy choices of the government. Here, the presumption is that the government can set these through adjustments in tax rates and the administrative tax effort.

Energy sales revenue T_t^{ES} in period t, *levied at an ad-valorem rate*, is mainly influenced by the volume of domestic energy consumption and the domestic administered price of energy.

$$T_t^{ES} = f(\,Q_t^D, P_t^{DO})$$

Revenue from excise and customs duty on energy T_t^{EI}, levied as specific duty, is received by imposing the effective customs and excise duty to the quantity of energy import Q_t^{EM} and the international price of energy P_t^{IE}.

$$T_t^{EI} = f(\,Q_t^{EM}, P_t^{IE})$$

The quantity of energy import Q_t^{EM} in period t is a function of real output Y_t.

$$Q_t^{EM} = f(Y_t)$$

Public Investment in period t is assumed to be a function of government capital expenditure

$$I_t^g = f(S_t^g)$$

where S_t^g is the capital expenditure of the government in period t. Here, it is considered as a policy variable.

The fiscal deficit is given by D_t below. It is an identity which is a net of the government revenue income from the government revenue expenditure.

$$D_t \equiv N_t + S_t^g - T_t - V_t$$

where D_t is the aggregate market borrowing of the government in period t, $(N_t + S_t^g)$ is the government's total expenditure which is the sum of revenue and capital expenditure, and $(T_t + V_t)$is the government's total income which is the sum of tax revenue and non-debt capital receipts of the government (disinvestment, etc.).

3.3 External Block

The trade balance in period t (B_t^t) is given by the following identity.

$$B_t^t \equiv X_t - M_t - Q_t^{EM}$$

where X_t is the volume of exports of goods and services and M_t is the volume of imports other than energy and Q_t^{EM} is energy import in period t.

The volume of export in period t is given by the following function

$$X_t = f(Z_t, \quad U_t, \quad E_t)$$

where Z_t stands for the indicator of the special benefits by the government provided to the exporters for incentives, U_t is the average tariff rate determined by policy, and E_t is the exchange rate.

The volume of imports other than energy M_t in period t depends on the exchange rate E_t, and real domestic output presented Y_t as follows.

$$M_t = f(E_t, \quad Y_t)$$

The volume of energy imports Q_t^{EM} in period t is influenced by the exchange rate E_t, the real domestic income Y_t, and the price of energy in the international market P_t^{IE}.This is summarised by the following behavioural equation.

$$Q_t^{EM} = f(E_t, \quad Y_t, \quad P_t^{IE})$$

The net inflow of invisibles (remittances) R_t is considered as a function of migration of the skilled labours L_t^{SK}, and the unskilled labours L_t^{USK} in period t.

$$R_t = f(L_t^{SK}, L_t^{USK})$$

The balance of payments B_t^p in period t is an identity given by

$$B_t^p \equiv B_t^t + R_t + J_t + \Delta O_t$$

where B_t^t is the balance of trade, R_t is thenet Inflow of invisibles, J_t is the net capital inflow, and ΔO_t is the change in foreign exchange reserve in period t.

3.4 Monetary and Price Block

The change in narrow money supply ΔM_{1t} in period t is given by

$$\Delta M_{1t} = f(\Delta H_t)$$

where ΔH_t is the change in high-powered money supply in period t.

The growth of high-powered money supply in period t is considered a function of total government borrowing D_t , and the change in foreign exchange reserve ΔO_t. Thus we get

$$\frac{\Delta H_t}{H_{t-1}} = f(D_t, \quad \Delta O_t)$$

where $H_{t-1}$is the volume of high-powered money in the immediate previous period.

Total government borrowing in period t is an identity given byD_t

$$D_t \equiv D_t^d + D_t^f$$

where D_t^d is the government borrowing from the domestic sources, and D_t^f is the government borrowing from the foreign sources.

The economy-wide average nominal rate of interest r_t in period t is considered to be a function of the rate of inflation Π_t, the policy rate i_t, and the volume of government borrowing from the domestic market D_t^d, the potential crowding out element. So

$$r_t = f(\Pi_t, i_t, \quad D_t^d)$$

The general price level P_t in period t is a behavioural function given below

$$P_t = f(Y_t, \quad S_t^E, \Delta M_{1t})$$

where Y_t is the real domestic output, S_t^E is the total subsidy on the energy sector, and ΔM_{1t} is the change in narrow money supply in period t.

3.5 Variables of Interest

The key policy variables in solving this model include revenue and capital expenditure to GDP ratio, the rate of change in administered prices (apart from oil), the weighted average tariff rate for energy, public debt to GDP ratio, the ratio of government borrowing from market to that from the central bank and the change in foreign exchange reserve. The data come from various government sources including the BBS, Bangladesh Bank and Ministry of Finance.

The important exogenous variables include the growth of output in OECD countries as a group as well as in the USA, China, and the Middle East, the rainfall index, the capital-output ratio, and the cost of production (wage, rent and interest cost). A scenario is designed by setting the value of both the policy variables and the exogenous variables based on certain assumptions. The outcome variables of interest in each scenario include the growth rate, the inflation rate, the current account deficit to GDP ratio and the fiscal deficit-GDP ratio as well as some other key macroeconomic ratios, i.e., the trade deficit relative to GDP, the combined tax and non-tax revenue to GDP ratio and the revenue deficit to GDP ratio.

CHAPTER 4

MODEL OF SIMULATIONS

We run two types of simulations here. In the first case, we evaluate the predictive accuracy of the macro-econometric model, both within and out of sample. Second type of simulation is used to evaluate policy shocks in response to energy price changes, particularly on some key economic indicators. All simulation exercises are done using the software *Win solves*.

4.1 Validity Check of the Model

4.1.1 Within Sample Validity

Within sample (1985-20110) predictive accuracy (or validity) of the model is checked by the mean percentage error (MPE) and the root mean square percentage error (RMSPE). They are computed as follows:

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

where Y^s and Y^a are the simulated and actual values of an endogenous variable respectively and T is the number of simulated periods.We first run dynamic simulation that predicts endogenous variables using predicted values of other related endogenous variables, and exogenous variables . Then predicted and actual values of endogenous variables are used to compute MPEs and RMSPEs. Table 4.1 presents MPEs and RMSPEs for some key endogenous variables. We see that they are reasonably low in almost all variables, which indicates that within sample validity of the model is high. Two variables, net foreign asset and current account balance, have high estimates of MPE and RMSPE, indicating low level of predictive power. One possible explanation could be that the values of these two variables are often negative, which have mainly driven them to have high estimates of MPE and RMSPE. We also show predicted and actual series of variables (as in Table 4.1) in Figure 4.1. We view that most of the variables are predicted well, as predicted series are close to actual series.

4.1.2 Out of Sample Validity

We run stochastic simulations to know the out of sample (2012-2021) performance of the model. Under these simulations, the bootstrap method is used to give random shocks into individual endogenous variables but for the out of sample period. Random shocks are generated from individual residuals of variables for within sample period (to note, residuals are differences between actual series and predicted series generated from dynamic simulation for within sample). While1000 stochastic simulations/replications are run through bootstrapping, 100 quintiles are computed to compare the magnitudes of out of samples forecasts, because within sample uncertainty captured by residuals makes variations at out of sample forecasts. Figure 4.3 demonstrates out of sample forecasts of some of the key variables at 3rd, 50th and 97th quintiles. The 50th quintiles represent mean simulated values while 3rd and 97th quintiles represent the 95 per cent confidence intervals. In Figure 4.1 we see that variables with low confidence intervals or low magnitudes of variations are predicted well within sample. Two extreme examples are private consumption at constant price and current account balance. The former has the highest within sample prediction (as RMSPE, which is better than MPE, is the lowest in Table 4.1), which makes a low magnitude at out of sample predictions. The latter has the lowest within sample prediction but has a high level of magnitude at out of sample predictions. However, the out of sample performance of the model seems quite good, as shown in Figure 4.2.

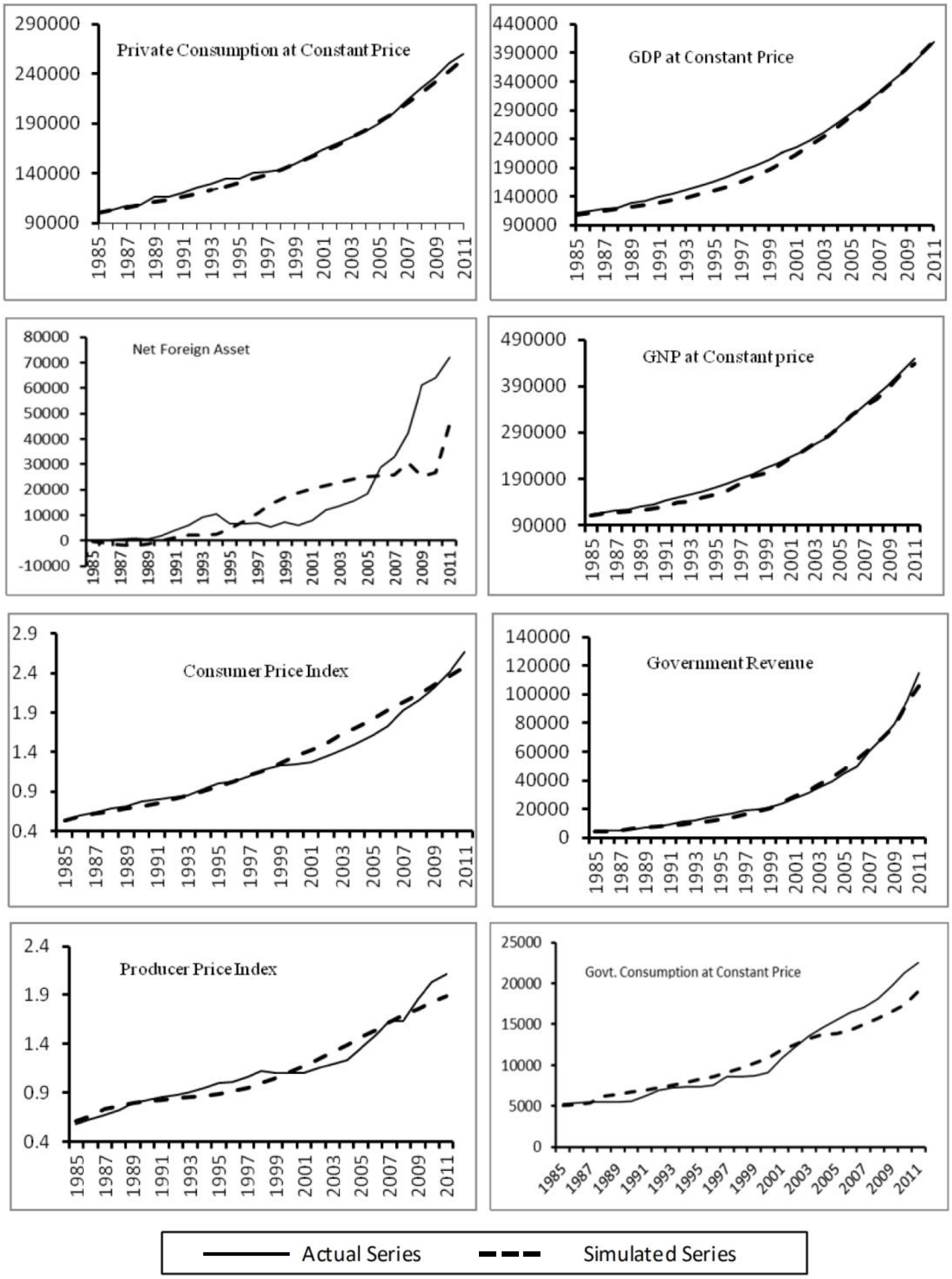
Table 4.1

Statistics of within Sample (1980-2011) Validity

Variable	MPE	RMSPE
Private Consumption at Constant Price	-0.01736	0.025248
GDP at Constant Price	-0.0483	0.059699
Net Foreign Asset	-0.47404	2.17057
GNP at Constant Price	-0.03754	0.049719
Consumer Price Index	0.021215	0.06977
Government Revenue	-0.03235	0.091989
Producer Price Index	-0.00707	0.072595
Govt. Consumption at Constant Price	0.018124	0.119925
Private Investment at Constant Price	-0.06609	0.145513
Value Addition in Agriculture Sector at Constant Price	-0.03341	0.04434
Value Addition in Industrial Sector at Constant Price	0.03994	0.08511
Value Addition in Service Sector at Constant Price	-0.03671	0.04446
Current Account Balance	-0.46456	2.433
Export at Constant Price	0.041566	0.11261
Import at Constant Price	-0.00841	0.10007
Narrow Money	0.031166	0.11344

Source: Authors' estimation.

Figure 4.1: Actual Series and Simulated Series **Derived from Dynamic Simulation** (1985-2011)



Contd. Figure 4.1

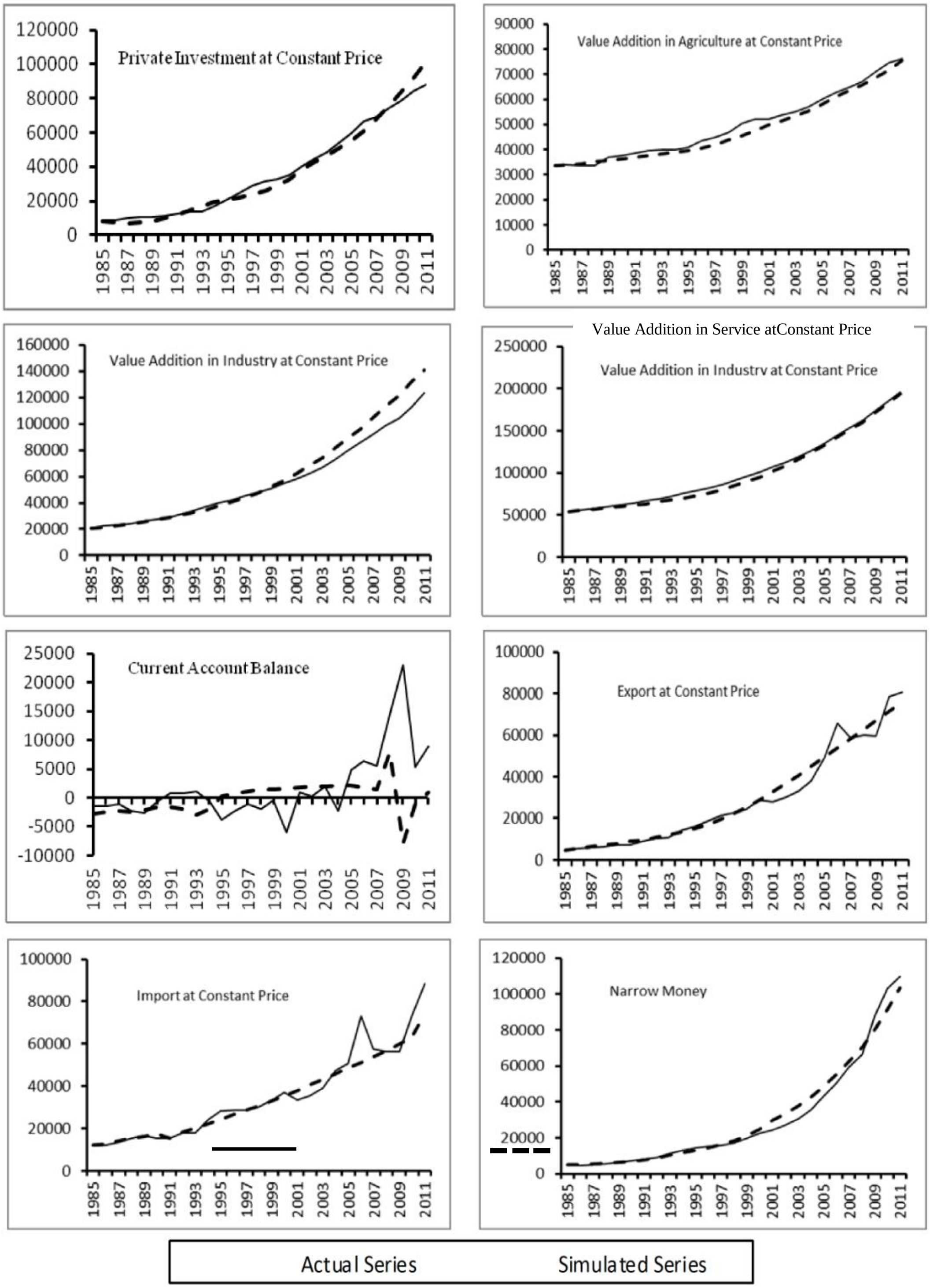

Private Investment at Constant Price
Value Addition in Agriculture at Constant Price
Value Addition in Industry at Constant Price
Value Addition in Service atConstant Price
Value Addition in Industry at Constant Price
Current Account Balance
Export at Constant Price
Import at Constant Price
Narrow Money
Actual Series
Simulated Series

Figure 4.2: Out of sample Predicted Values from Stochastic Simulations (2012-2021)

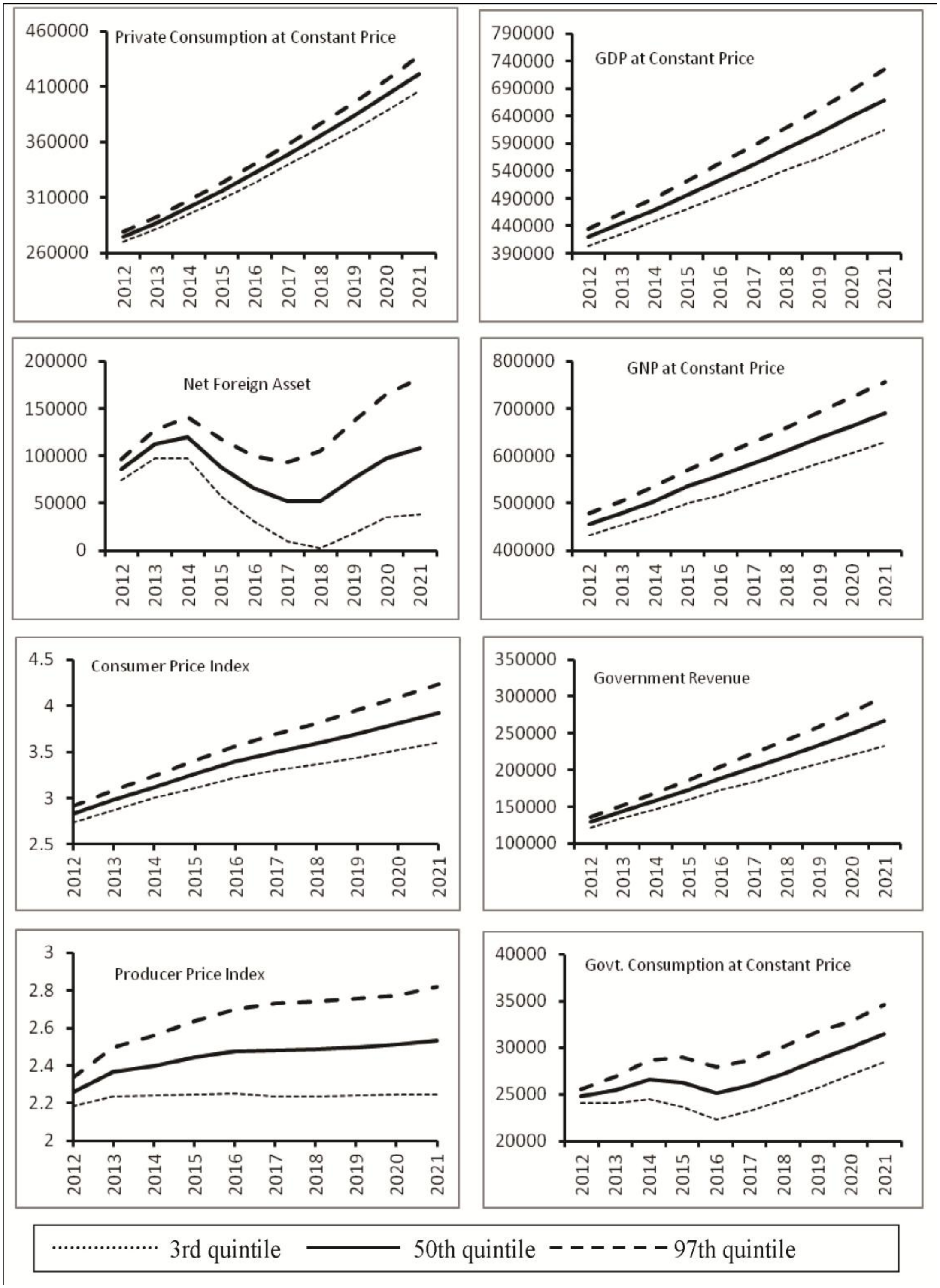
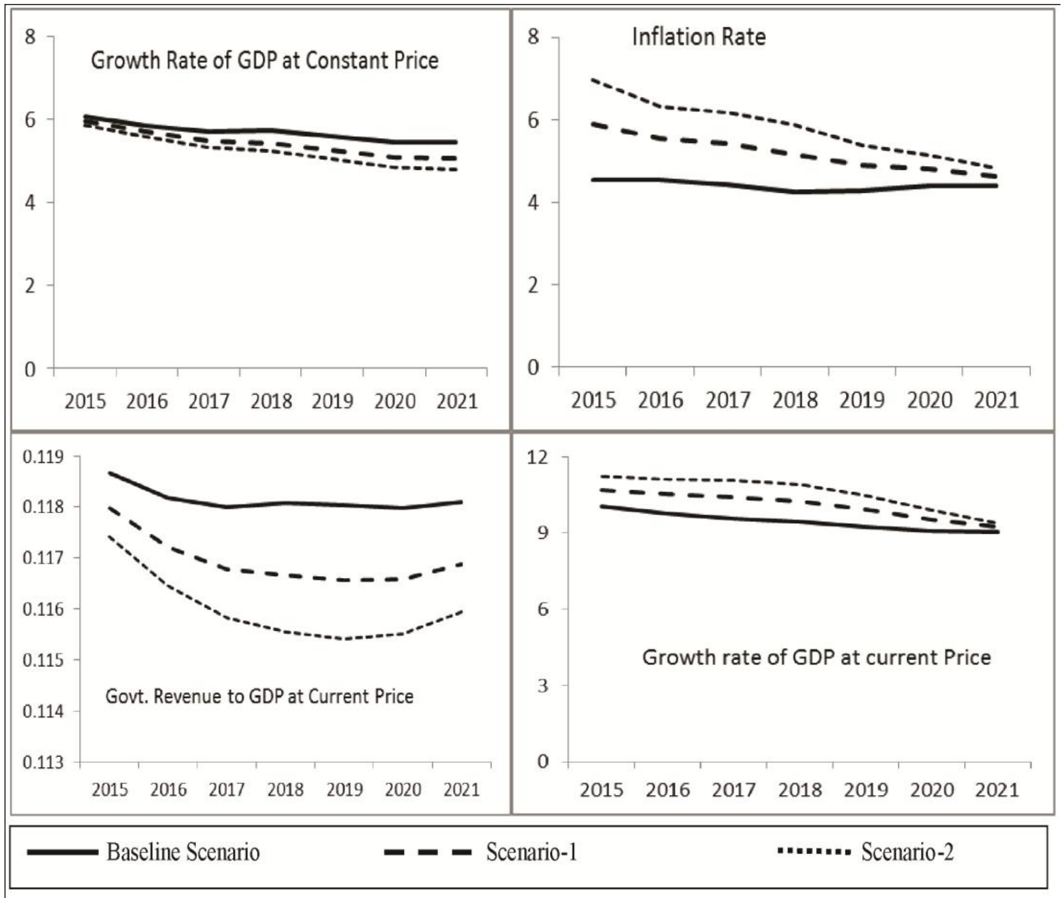


Figure 4.3: Out of Sample Predicted Values of Selected Indicators from Stochastic Simulations (2015-2021)



4.2 Results from Policy Shocks/Simulations

It has been estimated roughly that an increase of gas, fuel and electricity prices by around 40, 15 and 25 per cent respectively will help the government withdraw subsidy almost fully from the energy sector. We use these estimated/predicted energy prices' changes to give policy shocks into the model. We have simulated the model with two alterative scenarios, as shown in Table 4.2. When we assume that changes of energy prices will sustain forever or prices will not come back to normal levels after changes caused by subsidy withdrawal, then shocks following the assumption are called impulse shocks. Scenario-1 and Scenario-2 in Table 4.2 imply impulse shocks for extended period (2015-2021).

To know the effects of shocks on the economy, we first get base solutions or base predicted values of variables for out of sample period, after running a dynamic simulation for out of sample period without any changes of energy prices. Then we run two dynamic simulations for out of sample period applying two shocks and compare with that of baseline scenario. Figure 4.1 shows percentage changes of predicted values of some key variables under four shocks from base values. While Figure 4.1 compares the actual series with the predicted one, Figures 4.2 and 4.3 show out of sample predicted values under stochastic simulations.

Figure 4.4 and Table 4.3 report the simulated values of some selected indicators as a result of some energy shocks, as shown in Table 4.2. Due to energy price increase, it appears that inflation will increase and subsequently real GDP growth will fall slightly, but nominal GDP rises as consumer price index rises. Government budget/fiscal deficit will decrease slightly as a result of energy price increase as expected. However, note that all changes due to shocks are applicable if other variables remain normal. If other policy variables also change simultaneously, effects on the economy might be different.

Table 4.2

Energy Price Adjustments and Alternative Scenarios

	Shocks Applied to 2015-2021	
	Scenario-1	Scenario-2
Gas price	40%	80%
Fuel price	15%	30%
Electricity price	25%	50%

Note: The assumptions are based on current trends of price adjustments.

The results suggest that a combination of energy price increase (Scenario-1: 40% of gas price, 15 per cent of fuel price and 25 per cent of electricity price) will decrease GDP growth rate by about 0.4 per cent and increase inflation rate by 0.5 per cent over the period 2015-2019. Similarly, increase of energy price at a higher rate (Scenario-2: 80 per cent of gas price, 30 per cent of fuel price and 50 per cent of electricity price) will decrease GDP growth rate by about 0.44 per cent and increase inflation rate by 0.8 per cent over the same period. Thus, any upward revision of energy prices will be slightly inflationary and as a result the real GDP growth rate will fall slightly during the predicted period.

Figure 4.4: Effects of Energy Price Changes on Some Key Variables (% changes from base)

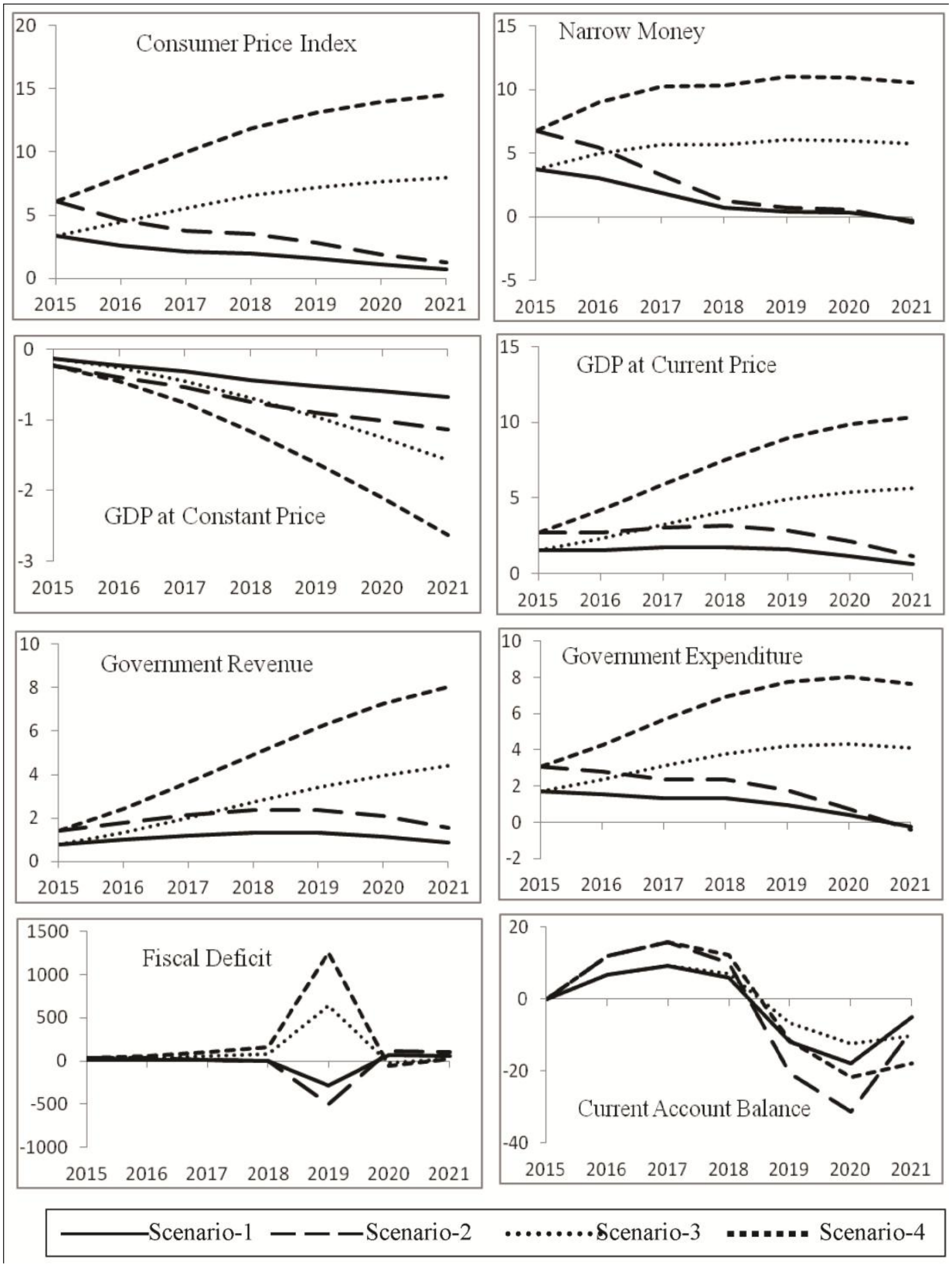


Table 4.3

Effects of Entergy Price Increases on Some key Variables

		Baseline	Scenario-1	Scenario-2
GDP Growth	2015	6.07	5.95	5.85
(Constant Price)	2015-2019	5.78	5.56	5.41
	2015-2021	5.69	5.42	5.24
Inflation rate	2015	4.55	5.89	6.96
	2015-2019	4.40	5.38	6.14
	2015-2021	4.40	5.19	5.81
Government revenue to GDP	2015	0.1187	0.1180	0.1174
	2015-2019	0.1182	0.1170	0.1161
	2015-2021	0.1181	0.1169	0.1160
GDP Growth	2015	10.02	10.68	11.22
(Current Price)	2015-2019	9.59	10.34	10.95
	2015-2021	9.44	10.07	10.57

Source: Authors' estimation.

CHAPTER 5

CONCLUDING REMARKS

This study attempts to analyse the economy-wide impact of energy price adjustments applying a Macro-econometric Model. The model initially analyses macroeconomic data for the period 1980-2011. In sample validation and out of sample predictions imply that the model fit was good and it can be used for policy simulations through assumed shocks. Considering the current gap between subsidised and government's buying price of energy, reasonable alternative scenarios of price shocks were derived and subsequently applied. The simulated results are drawn for the period 2015-2021, making it consistent with the Seventh Five Year Plan and the Perspective Plan. The results suggest that any upward revision of energy prices will be slightly inflationary and as a result the real GDP growth rate will fall slightly during the predicted period. A note of caution in explaining the result is that it is based on the assumption that other variables will remain as usual. The GDP growth and inflationary situation might improve if changes in other macroeconomic indicators take place along with energy price adjustments.

The results suggest that a combination of energy price increase (Scenario-1: 40per cent of gas price, 15 per cent of fuel price and 25 per cent of electricity price) will decrease GDP growth rate by about 0.4per cent and increase inflation rate by 0.5 per cent over the period 2015-2019. Similarly, increase of energy price at a higher rate (Scenario-2: 80 per cent of gas price, 30 per cent of fuel price and 50 per cent of electricity price) will decrease GDP growth rate by about 0.44 per cent and increase inflation rate by 0.8per cent over the same period. Thus, any upward revision of energy prices will be slightly inflationary and as a result the real GDP growth rate will fall slightly during the predicted period. Similarly, reduction of energy price including fuel price will likely to increase GDP growth rate at a similar rate. A note of caution in explaining the result is that it is based on the assumption that other variables will remain as usual. The GDP growth and inflationary situation might improve if changes in other macroeconomic indicators take place along with energy price adjustments.

REFERENCES

Bangladesh Bank (2006, 2007, 2008). *Monetary Policy Statement*, various issues.

_______ (2006, 2007, 2008). *Economic Trends*, various issues.

BBS (Bangladesh Bureau of Statistics). Various publications

Basher, Syed A., and Enamul A. K. Haque. 2000. "BANSIM - A Computer based Simulation Model for Bangladesh Economy, Environment and Development Services." Institute of Development, Environment and Strategic Studies, North South University.

Bernanke, Ben S. 1983. "Non-Monetary Effects of the Financial Crisis in the Propagation of the Great Depression." *The American Economic Review*, 73(3): 257-276.

Bresnahan, Timothy F. and Valerie A. Ramey. 1993. "Segment Shifts and Capacity Utilization in the U.S. Automobile Industry." *American Economic Review*, 83(2): 213–18.

Chowdhury, A. R. 1986. "Vector Auto Regression as Alternative Macro-modeling Technique." *The Bangladesh Development Studies*, 14(2):21-32.

Chowdhury, A. R., M. Q. Dao and A. N. M. Wahid. 1995. "Monetary Policy, Output and Inflation in Bangladesh: A Dynamic Analysis." *Applied Economics Letters*, 2(3):51-55.

Davis, Steven J. and John Haltiwanger. 2001. "Sectoral Job Creation and Destruction Responses to Oil Price Changes." *Journal of Monetary Economics*, Elsevier, 48(3): 465-512.

Edelstein, P. and L. Kilian. 2007. "The Response of Business Fixed Investment to Changes in Energy Prices: A Test of Some Hypotheses about the Transmission of Energy Price Shocks." *The B.E. Journal of Macroeconomics*, 7(1).

Hamilton, J. 1988. "A Neoclassical Model of Unemployment and the Business Cycle." *Journal of Political Economy*, 96(3):593–617.

Hamilton, James D. 2008. "Oil and the Macro Economy." In *The New Palgrave Dictionary of Economics*, Second edition, eds. Steven N. Durlauf and Lawrence E. Blume. Houndmills, U.K. and New York: Palgrave Macmillan.

Herrera, A. M. 2007. "Inventories, Oil Shocks and Macroeconomic Behavior." Department of Economics, Michigan State University.

IMF (International Monetary Fund).2005.*Bangladesh: Statistical Appendix*, IMF Country Report No. 05/243, Washington, D.C., accessed from http://www.imf.org on 20 August 2005.

______*International Financial Statistics*, various issues.

______*Directorate of Trade Statistics*, various issues.

Islam, Nurul. 1965. *A Short-Term Model for Pakistan Economy: An Econometric Analysis*. Dhaka: Oxford University Press.

Klein, L. R. and A. S. Goldberger. 1955. *An Econometric Model of the United States 1929-1952*. Amsterdam: North Holland Publishing.

Lee, Kiseok and Shawn Ni.2002. "On the Dynamic Effects of Oil Price Shocks: A Study using Industry Level Data." *Journal of Monetary Economics*, Elsevier, 49(4):823-852.

MoF. various years. *Bangladesh Economic Review* (2005, 2006, 2007, 2008). Finance Division, Ministry of Finance, Government of the People's Republic of Bangladesh.

Parikh, A. 1983. "Construction of Macroeconomic Model of the Bangladesh Economy." *The Bangladesh Development Studies*, 11:1–16

Pindyck, R. S. 1991. "Irreversibility, Uncertainty, and Investment." *Journal of Economic Literature*, 29:1110-1148.

Rahman, Sultan H. and F. J. Shilpi. 1996. *A Macro Econometric Model of the Bangladesh Economy: Model, Estimation, Validation and Policy Simulation.* Research Monograph No. 17. Bangladesh Institute of Development Studies, Dhaka.

Rashid, M. Ali. 1981. "A Macro Econometric Model of Bangladesh." *Bangladesh Development Studies*, IX (3).

Tinbergen J. 1967. *Economic Policy: Principles and Design*. Amsterdam: North Holland Publishing.

APPENDIX-I

Variables Definition of the Model and Units of Data

Variables	Name	Unit
PCONc	Private Consumption at Constant Price	Mil/TK
PCON	Private Consumption at Current Price	Mil/TK
NFIAc	Net Factor Income from Abroad at Constant Price	Mil/TK
NFIA	Net Factor Income from Abroad at Current Price	Mil/TK
GDPc	Gross Domestic Products at Constant Price	Mil/TK
GDP	Gross Domestic Products at Current Price	Mil/TK
GTAX	Govt. Tax Revenue	Mil/TK
NFA	Net Foreign Asset	Mil/TK
IRD	Interest Rate on Deposit	Mil/TK
IRL	Interest Rate on Lending	Mil/TK
GNPc	Gross National Products at Constant Price	Mil/TK
GNP	Gross National Products at Current Price	Mil/TK
DDEBT	Govt. Domestic Debt	Mil/TK
FDEBT	Govt. Foreign Debt	Mil/TK
DEBT	Total Govt. Debt	Mil/TK
DCCB	Domestic Credit of Central Bank	Mil/TK
DCDMB	Domestic Credit of Deposit Money Bank	Mil/TK
ER	Exchange Rate	Mil/TK
GREV	Total Govt. Revenue	Mil/TK
GREXP	Govt. Revenue Expenditure	Mil/TK
GEXP	Total Govt. Expenditure	Mil/TK
GDEF	Govt. Budget Deficit	Mil/TK
cGDEF	Cumulative Govt. Budget Deficit	Mil/TK
P_C	Consumer Price Index	
P_GDP	GDP Deflator	
P_INV	Investment Deflator	
P_M	Import Deflator	
P_X	Export Deflator	
P_P	Producer price Index	
GCONc	Govt. Consumption at Constant Price	Mil/TK
GCON	Govt. Consumption at Current Price	Mil/TK
GINVc	Govt. Investment at Constant Price	Mil/TK

(Contd. Appendix-I)

Variables	**Name**	**Unit**
GINV	Govt. Investment at Current Price	Mil/TK
PINVc	Private Investment at Constant Price	Mil/TK
PINV	Private Investment at Current Price	Mil/TK
INVc	Investment at Constant Price	Mil/TK
INV	Investment at Current Price	Mil/TK
CP	Credit to Private Sector	Mil/TK
VA1	Value Added in Agriculture at Current Price	Mil/TK
VA1c	Value Added in Agriculture at Constant Price	Mil/TK
VA2	Value Added in Manufacturing at Current Price	Mil/TK
VA2c	Value Added in Manufacturing at Constant Price	Mil/TK
VA3	Value Added in Service at Current Price	Mil/TK
VA3c	Value Added in Service at Constant Price	Mil/TK
BR	Bank Rate	
IRRIG	Irrigated area	
REM	Remittance at Current Price	Mil/TK
CAB	Current Account Balance	Mil/TK
X	Export at Current Price	Mil/TK
Xc	Export at Constant Price	Mil/TK
M	Import at Current Price	Mil/TK
Mc	Import at Constant Price	Mil/TK
RAIN	Rainfall	
FCPI	Foreign Consumer Price Index	
FGDPc	Foreign GDP at Constant Price	
M0	Currency in Circulation	
M1	Narrow Money	
M2	Broad money	
ADc	Aggregate Demand at Constant Price	Mil/TK
P_ad#OIL#lit	Administered oil Price per litre	
K	Capital Formation at Current Price	Mil/TK
Kc	Capital Formation at Constant Price	Mil/TK
GPW	Weighted Price of Gas	
FPW	Weighted Price of Fuel	
EPW	Weighted Price of Electricity	

APPENDIX-II

REGRESSION RESULTS UNDER DIFFERENT BLOCKS

I. Macroeconomic Block

A. Private Consumption Block

Private Consumption at Constant Prices

Δlog(PCONc) = 0.03892 - 0.3356*Δlog(PCONc(-1)) - 0.07153*ECM_PCONc
ECM_PCONc = log(PCONc(-1)) - 0.95*log(GNPc(-1) - GTAX(-1)/(GNP(-1)/GNPc(-1))) - 0.05*log((DDEBT(-1) + M0(-1) + NFA(-1))/P_C(-1)) + 0.001*(IRD(-2) - 100*dlog(P_C(-2)))

Diagnostic Tests:

Sigma	0.0155215
R^2	0.353919
AR 1-2 test:	F(2,23) = 0.34059 [0.7149]
ARCH 1-1 test:	F(1,23) =0.0066794 [0.9356]
Normality test:	Chi^2(2) = 6.6762 [0.0355]*
hetero test:	F(4,20) = 0.43762 [0.7799]
hetero-X test:	F(5,19) = 0.40672 [0.8381]
RESET test:	F(1,24) = 0.67548 [0.4192]

B. Private Investment Block

Private Investment at Constant Prices

Δlog(PINVc) = - 1.678 + 0.4878*Δlog(PINVc(-1)) + 0.363*(log((DCCB(-2) + DCDMB(-2))/P_INV(-2)) -

log((DCCB(-3) + DCDMB(-3))/P_INV(-3))) - 0.3807*ECM_PINVc

ECM_PINVc = log(PINVc(-1)) - log(GNPc(-1)) + 0.001*(IRL(-2)-100*dlog(P_INV(-2)))- 0.85*log(time(1981))

Diagnostic Tests:

Sigma	0.0447481
R^2	0.463892
AR 1-2 test:	F(2,17) = 0.12531 [0.8830]
ARCH 1-1 test:	F(1,17) = 0.19853 [0.6615]
Normality test:	Chi^2(2) = 1.4364 [0.4876]
Hetero test:	F(6,12) = 1.3098 [0.3244]
Hetero-X test:	not enough observations
RESET test:	F(1,18) = 0.66885 [0.4241]

Private Investment at Current Prices

Δlog(PINV) = log(PINVc)+log(PINV(-1)/PINVc(-1)) - 0.2808*(log(PINV(-1)/PINVc(-1))

-log(PINV(-2)/PINVc(-2))) + 0.2077*dlog(P_M) + 0.6601*log(VA2(-3)/VA2c(-3))-

log(VA2(-4)/VA2c(-4))) - 0.1749*ifeq(1999) - 0.1899*ECM_PINVc

ECM_PINV =log(PINV(-1)/PINVc(-1)) - 0.5*log(P_M(-1)) - 0.5*log(VA2(-3)/VA2c(-3))

Diagnostic Tests:

Sigma	0.0334281
log-likelihood	58.1777
AR 1-2 test:	F(2,21) = 2.2873 [0.1263]
ARCH 1-1 test:	F(1,21) = 0.38265 [0.5428]
Normality test:	Chi^2(2) = 1.3126 [0.5188]
Hetero test:	F(9,13) = 1.0978 [0.4259]
Hetero-X test:	not enough observations
RESET test:	F(1,22) = 2.0178 [0.1695]

C. Production Block

Value Added in Agriculture Sector in Constant Prices

Δlog(VA1c)= 0.6802*Δlog(VA3c) - 0.3325*Δlog(IRRIG) + 0.2721*Δlog(IRRIG(-1))

- 0.574*ECM_VA1c

ECM_VA1c =log(VA1c(-1)) - 2.21093 + 0.142550*log(VA2c(-1)) - 0.842551*log(VA3c(-1))

- 0.0572921*log(RAIN(-1))

Diagnostic Tests:

Sigma	0.0166401
log-likelihood	77.1142
AR 1-2 test:	F(2,22) = 0.77360 [0.4735]
ARCH 1-1 test:	F(1,22) = 0.14526 [0.7068]
Normality test:	Chi^2(2) = 3.4625 [0.1771]
Hetero test:	F(8,15) = 0.13374 [0.9963]
Hetero-X test:	F(14,9) = 0.16939 [0.9983]
RESET test:	F(1,23) = 0.47500 [0.4976]

Value Added in Agriculture Sector in Current Prices

log(VA1) = log(VA1c) + log(VA1(-1)/VA1c(-1)) + 0.01868 + 0.7142*dlog(P_P) - 0.121*ifeq(1992))

- 0.4091*ECM_VA1

ECM_VA1 =log(VA1(-1)/VA1c(-1)) - 0.90*log(P_P(-1))

Diagnostic Tests:

Sigma	0.0265619	
R^2	0.816459	
AR 1-2 test:	F(2,24)	= 3.7882 [0.0372]*
ARCH 1-1 test:	F(1,24)	= 0.34507 [0.5624]
Normality test:	Chi^2(2)	= 1.2792 [0.5275]
Hetero test:	F(5,20)	= 2.4039 [0.0732]
Hetero-X test:	F(6,19)	= 2.0532 [0.1080]
RESET test:	F(1,25)	= 0.12616 [0.7254]

Value Added in Manufacturing Sector in Constant Prices

Δlog(VA2c) = 0.1754 + 1.176*Δlog(VA3c) + 0.1336*(log(Kc(-1)*(VA2(-1)/GDP(-1)))-log(Kc(-2)*

(VA2(-2)/GDP(-2)))) + 0.05199*Δlog(Xc) + 0.04261*Δlog(Xc(-3)) - 0.07246*ECM_VA2c

ECM_VA2c =log(VA2c(-1)) - 0.40*log(Kc(-1)*(VA2(-1)/GDP(-1))) - 0.30*log(VA3c(-1))

- 0.05*log(time(1981))

Diagnostic Tests:

Sigma	0.0113262	
R^2	0.797123	
AR 1-2 test:	F(2,20)	= 0.062210 [0.9399]
ARCH 1-1 test:	F(1,20)	= 0.37028 [0.5497]
Normality test:	Chi^2(2)	= 1.3067 [0.5203]
Hetero test:	F(10,11)	= 0.44105 [0.8960]
Hetero-X test:	not enough observations	
RESET test:	F(1,21)	= 2.7510 [0.1121]

Value Added in Manufacturing Sector in Current Prices

Δlog(VA2)= Δlog(VA2c) + 0.4812*Δlog(P_P) + 0.2821*Δlog(P_M) - 0.6683*ECM_VA2

ECM_VA2 = log(VA2(-1)/VA2c(-1)) - 0.60*log(P_P(-1)) - 0.20*log(P_M(-1)) - 0.26*log((VA3(-1)/

VA3c(-1))/(VA1(-1)/VA1c(-1)))

Diagnostic Tests:

Sigma	0.0222731	
log-likelihood	75.5262	
ARCH 1-1 test	F(1,26)	= 0.59667 [0.4468]
Normality test:	Chi^2(2)	= 2.2523 [0.3243]
Hetero test:	F(6,21)	= 0.29711 [0.9314]
Hetero-X test:	F(9,18)	= 0.60531 [0.7768]
RESET test:	F(1,27)	= 1.4544 [0.2383]

Value Added in Service Sector in Constant Prices

Δlog(VA3c) = - 0.2502 + 0.3651*Δlog(ADc) + 0.2943*Δlog(ADc(-2)) - 0.3582*ECM_VA3c
ECM_VA3c = log(VA3c(-1)) - log(ADc(-1))

Diagnostic Tests:

Sigma	0.0176603	
R^2	0.262108	
AR 1-2 test:	F(2,23)	= 0.65276 [0.5300]
ARCH 1-1 test:	F(1,23)	= 2.5233 [0.1258]
Normality test:	Chi^2(2)	= 8.7262 [0.0127]*
Hetero test:	F(6,18)	= 0.97352 [0.4708]
Hetero-X test:	F(9,15)	= 1.5891 [0.2055]
RESET test:	F(1,24)	= 14.622 [0.0008]**

Value Added in Service Sector in Current Prices

log(VA3) = log(VA3c) + log(VA3(-1)/VA3c(-1)) + 0.02006+ 0.0587*(log(VA3(-3)/VA3c(-3))-
log(VA3(-4)/VA3c(-4))) –0.06095*(log(GCON(-1)/GCONc(-1))-log(GCON(-2)/GCONc(-2)))
+ 0.5333*dlog(P_C) - 0.3753*ECM_VA2

ECM_VA2 =log(VA3(-1)/VA3c(-1)) - log(P_C(-1)) + 0.107812*log(P_M(-1))
- 0.000175127*log(time(1981))

Diagnostic Tests:

Sigma	0.025641	
R^2	0.47869	
AR 1-2 test:	F(2,21)	= 0.53202 [0.5951]
ARCH 1-1 test:	F(1,21)	= 1.0179 [0.3245]
Normality test:	Chi^2(2)	= 8.5870 [0.0137]*
Hetero test:	F(8,14)	= 0.53672 [0.8104]
Hetero-X test	not enough observations	
RESET test:	F(1,22)	= 0.022487 [0.8822]

GNP in Constant Prices

log(GNPc)= log(GNP) - log(GNP(-1)/GNPc(-1)) - 0.01598 - 0.3451*(log(VA1/VA1c) - log(VA1(-1)/

VA1c(-1))) - 0.266*(log(VA2/VA2c) - log(VA2(-1)/VA2c(-1))) - 0.1756*(log(VA3/VA3c)

- log(VA3(-1)/VA3c(-1))) + 0.8726*ECM_GNPc

ECM_GNPc = log(GNP(-1)/GNPc(-1)) - 0.277787*log(VA1(-1)/VA1c(-1)) - 0.397247*log(VA2(-1)/VA2c(-1)) - 0.374275*log(VA3(-1)/VA3c(-1))

Diagnostic Tests:

Sigma	0.01162	
R^2	0.85793	
AR 1-2 test:	F(2,24)	= 3.3388 [0.0526]
ARCH 1-1 test:	F(1,24)	= 0.15256 [0.6995]
Normality test:	Chi^2(2)	= 21.323 [0.0000]**
Hetero test:	F(8,17)	= 3.8100 [0.0098]**
Hetero-X test:	F(14,11)	= 7.0421 [0.0013]**
RESET test:	F(1,25)	= 1.6042 [0.2170]

Net Factor Income from Abroad

Δlog(NFIA) = 0.25469 -0.47142*Δlog(NFIA(-2))- 0.03110*ECM_NFIA

ECM_NFIA =log(NFIA(-1)) +1.45*log(ER(-1)*(FCPI(-1)/P_P(-1))) - 4.95*log(time(1981))

Diagnostic Tests:

Sigma	0.098694	
R^2	0.491495	
AR 1-2 test	F(2,23)	= 0.27155 [0.7646]
ARCH 1-1 test	F(1,23)	= 0.35577 [0.5567]
Normality test:	Chi^2(2)	= 1.9064 [0.3855]
Hetero test:	F(4,20)	= 0.26558 [0.8966]
Hetero-X test:	F(5,19)	= 0.71541 [0.6196]
RESET test:	F(1,24)	= 1.5517 [0.2249]

II. Government Block

Government Revenue at Current Prices

Δlog(GREV) = 0.1493 + 0.5011*Δlog(GTAX) - 0.3717*ECM_GREV

ECM_GREV= log (GREV (-1))-log (GTAX (-1))

Diagnostic Tests:

Sigma	0.0210324	
R^2	0.709137	
AR 1-2 test:	F(2,26)	= 0.80690 [0.4571]
ARCH 1-1 test:	F(1,26)	= 1.0230 [0.3211]
Normality test:	Chi^2(2)	= 1.2843 [0.5262]
Hetero test:	F(4,23)	= 0.13251 [0.9688]
Hetero-X test:	F(5,22)	= 0.18297 [0.9661]
RESET test:	F(1,27)	= 0.15531 [0.6966]

Government Tax Revenue in Current Prices

Δlog(GTAX) = - 0.6725 + 0.9238*Δlog(GNP) + 0.11*ifeq(2000) + 0.1289*ifeq(2010) - 0.2135*ECM_GTAX

ECM_GTAX = log(GTAX(-1))-log(GNP(-1))-0.20*log(time(1981))

Diagnostic Tests:

Sigma	0.044885	
R^2	0.477251	
AR 1-2 test:	F(2,23)	= 0.67129 [0.5208]
ARCH 1-1 test:	F(1,23)	= 0.47496 [0.4976]
Normality test:	Chi^2(2)	= 0.41815 [0.8113]
hetero test:	F(6,18)	= 3.2838 [0.0232]*
Hetero-X test: not enough observations		
RESET test:	F(1,24)	= 0.12942 [0.7222]

Government Consumption in Constant Prices via Deflator Equation

log(GCONc) = log(GCON)-log(GCON(-1)/GCONc(-1)) - 0.5141*(log(GCON(-1)/GCONc(-1))-log(GCON(-

2)/GCONc(-2))) - 0.3882*(log(VA3/VA3c)-log(VA3(-1)/VA3c(-1))) + 0.3163*ECM_GCONc

ECM_GCONc = log(GCON(-1)/GCONc(-1))-log(VA3(-1)/VA3c(-1))

Diagnostic Tests:

Sigma	0.0201784		
log-likelihood	73.6253		
AR 1-2 test:	F(2,24)	=	4.8118 [0.0175]*
ARCH 1-1 test:	F(1,24)	=	8.3306 [0.0081]**
Normality test:	Chi^2(2)	=	6.4245 [0.0403]*
Hetero test:	F(6,19)	=	1.2507 [0.3255]
Hetero-X test:	F(9,16)	=	1.8906 [0.1277]
RESET test:	F(1,25)	=	3.7072 [0.0656]

Government Consumption in Current Prices

Δlog(GCON) = 0.607*Δlog(GREV(-1)) + 0.4478*(log(GEXP2(-3)/GREV(-3))-log(GEXP2(-4)/GREV(-4)))

- 0.06818* ECM_GCON

ECM_GCON **=**log(GCON(-1)) - log(GREV(-1)) + 0.007*log(time(1981))

Diagnostic Tests:

Sigma	0.0321337		
log-likelihood	58.1162		
AR 1-2 test:	F(2,23)	=	0.16220 [0.8512]
ARCH 1-1 test:	F(1,23)	=	3.7558 [0.0650]
Normality test:	Chi^2(2)	=	6.1587 [0.0460]*
Hetero test:	F(6,18)	=	2.2078 [0.0901]
Hetero-X test:	F(9,15)	=	1.8334 [0.1438]
RESET test:	F(1,24)	=	0.00063080 [0.9802]

Government Revenue Expenditure in Current Prices

Δlog(GREXP) = - 0.3806+ 3.488*Δlog(GREV) + 2.391*Δlog(GREV(-1)) - 1.05*ECM_GREXP

ECM_GREXP =log(GREXP(-1))-0.90*log(GREV(-1))-0.20*log(time(1981))

Diagnostic Tests:

Sigma	0.119731		
R^2	0.712494		
AR 1-2 test:	F(2,10)	=	1.8132 [0.2129]
ARCH 1-1 test:	F(1,10)	=	0.090820 [0.7693]
Normality test:	Chi^2(2)	=	1.5656 [0.4571]
hetero test:	F(6,5)	=	4.9169 [0.0507]
Hetero-X test: not enough observations			
RESET test:	F(1,11)	=	0.18669 [0.6740]

Government Development Expenditure/Public Investment in Current Prices

Δlog(GINV) = - 0.09583 + 0.4212*Δlog(GINV(-1)) + 0.7257*Δlog(DEBT) - 0.8892*ECM_GINV

ECM_GINV = log(GINV(-1))-0.85*log(DEBT(-1))

Diagnostic Tests:

Sigma	0.104452		
R^2	0.379036		
AR 1-2 test:	F(2,24)	=	0.10207 [0.9034]
ARCH 1-1 test:	F(1,24)	=	1.0435 [0.3172]
Normality test:	Chi^2(2)	=	5.2643 [0.0719]
Hetero test:	F(6,19)	=	0.81166 [0.5738]
Hetero-X test:	F(9,16)	=	1.0888 [0.4217]
RESET test:	F(1,25)	=	0.83655 [0.3691]

Domestic Debt in Current Prices

Δlog(DDEBT) = -0.30577*Δlog(DDEBT(-2)) -0.02328*ECM_DDEBT

ECM_DDEBT =log(DDEBT(-1))-0.86*log(FDEBT(-1))-3.50*log(IRL(-1))

Diagnostic Tests:

Sigma	0.461213		
log-likelihood	-17.0237		
AR 1-2 test:	F(2,24)	=	0.27567 [0.7614]
ARCH 1-1 test:	F(1,24)	=	0.40827 [0.5289]
Normality test:	Chi^2(2)	=	7.8212 [0.0200]*
Hetero test:	F(4,21)	=	1.5550 [0.2230]
Hetero-X test:	F(5,20)	=	1.1913 [0.3486]
RESET test:	F(1,25)	=	0.072401 [0.7901]

Foreign Debt in Current Prices

∆log(FDEBT) = 0.2611*(log(-cGDEF(-1))-log(-cGDEF(-2))) + 1.094*(NFA/(DCCB+DCDMB)-NFA(-1)/
(DCCB(-1)+DCDMB(-1))) + 0.6283*(NFA(-2)/(DCCB(-2)+DCDMB(-2))-NFA(-3)/
(DCCB(-3) +DCDMB(-3))) + 0.9381*∆log(ER) - 0.4557*ECM_FDEBT

ECM_FDEBT = log(FDEBT(-1))- 4.13062-0.358651*log(-cGDEF(-1))- 0.748811*log(ER(-1)) -
0.998947*(NFA(-2)/(DCCB(-2)+DCDMB(-2)))

Diagnostic Tests:

Sigma	0.04332	
log-likelihood	50.9196	
AR 1-2 test:	F(2,21)	= 1.1516 [0.3353]
ARCH 1-1 test:	F(1,21)	= 0.014222 [0.9062]
Normality test:	Chi^2(2)	= 0.82357 [0.6625]
hetero test:	F(10,12)	= 0.31343 [0.9623]
Hetero-X test: not enough observations		
RESET test:	F(1,22)	= 0.0032061 [0.9554]

III. TRADE BLOCK

Exports in Constant Prices

∆log(Xc) = 0.218 - 0.738*(log(ER(-3)*(FCPI(-3)/P_P(-3)))-log(ER(-4)*(FCPI(-4)/P_P(-4))))
1.53*∆log(FGDPc(-2)) - 0.21*ECM_Xc

ECM_Xc = log(Xc(-1)) - 1.18773*log(ER(-1)*(FCPI(-1)/P_P(-1))) - 0.314626*log(FGDPc(-1))-
0.427229*log(time(1981))

Diagnostic Tests:

Sigma	0.0875171		
R^2	0.444844		
AR 1-2 test:	F(2,21)	=	0.42347 [0.6602]
ARCH 1-1 test:	F(1,21)	=	0.088985 [0.7684]
Normality test:	Chi^2(2)	=	5.4857 [0.0644]
Hetero test:	F(6,16)	=	0.61355 [0.7165]
Hetero-X test:	F(9,13)	=	0.60779 [0.7705]
RESET test:	F(1,22)	=	0.016296 [0.8996]

Imports in Constant Prices

Δlog(Mc) = 0.07807 + 0.3333*Δlog(Mc(-2)) + 0.8252*dlog(Xc) + 0.3675*Δlog(Xc(-1)) -

0.3387*dlog(Xc(-2)) - 0.339*(log(ER*(FCPI/P_P))-log(ER(-1)*(FCPI(-1)/P_P(-1))))+

0.6117*(log(ER(-3)*(FCPI(-3)/P_P(-3)))-log(ER(-4)*(FCPI(-4)/P_P(-4)))) - 0.7889*ECM_Mc

ECM_Mc =log(Mc(-1))- 0.50*log(PCONc(-1)+GCONc(-1)+PINVc(-1)) - 0.50*log(Xc(-1))

+ 0.24*log(ER(-1)*(FCPI(-1)/P_P(-1)))

Diagnostic Tests:

Sigma	0.0590461		
R^2	0.837801		
AR 1-2 test:	F(2,18)	=	0.56582 [0.5777]
ARCH 1-1 test:	F(1,18)	=	0.61494 [0.4431]
Normality test:	Chi^2(2)	=	1.9212 [0.3827]
Hetero test:	F(14,5)	=	0.58687 [0.8016]
Hetero-X test: not enough observations			
RESET test:	F(1,19)	=	0.29780 [0.5916]

Current Account Balances in Current Prices

Δ(CAB) = - 1432 - 0.3742*Δ(CAB(-1)) - 0.8206*(X(-2)-M(-2)-X(-3)+M(-3)) - 0.9523*(X(-3)-M(-3)-

X(-4)+M(-4)) - 0.3758*ECM_CAB

ECM_CAB = CAB(-1)+ 1656+ 0.17*(X(-1)-M(-1))

Diagnostic Tests:

Sigma	2256.73		
R^2	0.821872		
AR 1-2 test:	F(2,21)	=	0.034961 [0.9657]
ARCH 1-1 test:	F(1,21)	=	0.00063578 [0.9801]
Normality test:	Chi^2(2)	=	2.3322 [0.3116]
Hetero test:	F(8,14)	=	0.43740 [0.8792]
Hetero-X test: not enough observations			
RESET test:	F(1,22)	=	0.11957 [0.7328]

IV. MONEY BLOCK

Money in Circulation

$\Delta\log(M0) = -0.4268*\Delta\log(M0(-2)) + 0.7671*\Delta\log(M1) + 0.2727*\Delta\log(M1(-2)) - 0.1009*ECM\_M0$

$ECM\_M0 = (\log(M0(-1)) - \log(M1(-1))$

Diagnostic Tests:

Sigma	0.0361518		
log-likelihood	55.3886		
AR 1-2 test:	F(2,22)	=	0.40415 [0.6724]
ARCH 1-1 test:	F(1,22)	=	0.17126 [0.6830]
Normality test:	Chi^2(2)	=	4.9178 [0.0855]
Hetero test:	F(8,15)	=	1.1826 [0.3705]
Hetero-X test:	F(14,9)	=	1.3256 [0.3421]
RESET test:	F(1,23)	=	5.6891 [0.0257]*

Narrow Money

$\Delta\log(M1) = \Delta\log(P\_C) - 0.7956 - 0.2771*(\Delta\log(M1(-3)) - \Delta\log(P\_C(-3))) + 1.365*\Delta\log(ADc(-2))$
$- 0.2475*ECM\_M1$

$ECM\_M1 = \log(M1(-1)/P\_C(-1)) - \log(ADc(-1)) + 0.008*(IRL(-1) - 100*\Delta\log(P\_C(-1)))$
$- 0.30*\log(time(1981))$

Diagnostic Tests:

Sigma	0.0662882		
R^2	0.404229		
AR 1-2 test:	F(2,22)	=	1.0763 [0.3581]
ARCH 1-1 test:	F(1,22)	=	0.53500 [0.4722]
Normality test:	Chi^2(2)	=	2.9824 [0.2251]
Hetero test:	F(6,17)	=	0.68394 [0.6651]
Hetero-X test:	F(9,14)	=	2.9895 [0.0326]*
RESET test:	F(1,23)	=	11.561 [0.0025]**

Broad Money

Δlog(M2) = + 0.2416*Δlog(M2(-1)) + 0.574*(log(DCCB+DCDMB+NFA)-log(DCCB(-1)+DCDMB(-1)+NFA(-1))) - 0.1783*ECM_M2

ECM_M2 =log(M2(-1))-log(DCCB(-1)+DCDMB(-1)+NFA(-1))

Diagnostic Tests:

Sigma	0.0361319	
log-likelihood	58.6296	
AR 1-2 test:	F(2,25)	= 9.9780 [0.0007]**
ARCH 1-1 test:	F(1,25)	= 24.204 [0.0000]**
Normality test:	Chi^2(2)	= 8.5917 [0.0136]*
Hetero test:	F(6,20)	= 3.7812 [0.0111]*
Hetero-X test:	F(9,17)	= 2.5962 [0.0432]*
RESET test:	F(1,26)	= 0.62176 [0.4375]

Net Foreign Asset

Δ(NFA)= Δ(NFA(-1)) + 1061 + 0.7546*Δ(CAB) - 0.4242*Δ(CAB(-2)) - 0.6238*ECM_NFA

ECM_NFA =Δ(NFA(-1)) - CAB(-1)

Diagnostic Tests:

Sigma	1548.26	
R^2	0.897147	
AR 1-2 test:	F(2,22)	= 0.43728 [0.6513]
ARCH 1-1 test:	F(1,22)	= 3.3356 [0.0814]
Normality test:	Chi^2(2)	= 0.38018 [0.8269]
Hetero test:	F(6,17)	= 3.9846 [0.0113]*
Hetero-X test:	F(9,14)	= 4.2894 [0.0076]**
RESET test:	F(1,23)	= 25.473 [0.0000]**

Domestic Credit of Central Bank

Δlog(DCCB)= 0.1453 +0.9768*(log(Δ(DDEBT)+50000)-log(Δ(DDEBT(-1))+50000)) - 0.1238*ECM_DCCB

ECM_DCCB = log(DCCB(-1)) +22 - 2.52*log(Δ(DEBT(-1))+50000) - 1.22*log(time(1981))

Diagnostic Tests:

Sigma	0.204798		
R^2	0.236123		
AR 1-2 test:	F(2,25)	=	0.065650 [0.9366]
ARCH 1-1 test:	F(1,25)	=	0.11489 [0.7375]
Normality test:	Chi^2(2)	=	2.8479 [0.2408]
Hetero test:	F(4,22)	=	2.3240 [0.0884]
Hetero-X test:	F(5,21)	=	1.7748 [0.1618]
RESET test:	F(1,26)	=	3.0232 [0.0939]

Domestic Credit of Deposit Money Banks

Δlog(DCDMB) =1.209*Δlog(INV) - 0.2178*ECM_DCDMB

ECM_DCDMB = log(DCDMB(-1)) +2.10 -1.23*log(INV(-1))+0.001*(IRL(-1)-100*Δlog(P_C(-1)))

Diagnostic Tests:

Sigma	0.0353202		
log-likelihood	52.9967		
AR 1-2 test:	F(2,23)	=	0.23524 [0.7923]
ARCH 1-1 test:	F(1,23)	=	0.047610 [0.8292]
Normality test:	Chi^2(2)	=	6.2479 [0.0440]*
Hetero test:	F(4,20)	=	1.9279 [0.1450]
Hetero-X test:	F(5,19)	=	1.7251 [0.1773]
RESET test:	F(1,24)	=	2.2865 [0.1436]

Deposit Rate

Δ(IRD) = + 0.5785*Δ(BR) + 0.09656*Δ(ER) - 0.09438*Δ(ER(-3)) - 0.5344*ECM_IRD

ECM_IRD = IRD(-1) + 2.52 - 0.82*BR(-1) - 0.08*ER(-1)

Diagnostic Tests:

Sigma	0.380562		
AR 1-2 test:	F(2,20)	=	0.037920 [0.9629]
ARCH 1-1 test:	F(1,20)	=	1.0457 [0.3187]
Normality test:	Chi^2(2)	=	1.9972 [0.3684]
Hetero test:	F(8,13)	=	0.43143 [0.8818]
Hetero-X test:	F(14,7)	=	0.18466 [0.9964]
RESET test:	F(1,21)	=	0.13951 [0.7125]

Lending Rate

Δ(IRL) = 0.7863*Δ(IRD) - 0.2139*ECM_IRL

ECM_IRL = IRL(-1) - 11 - 0.70*IRD(-1) + 0.28*log(DDEBT(-1))

Diagnostic Tests:

Sigma	0.427457		
AR 1-2 test:	F(2,23)	=	0.92255 [0.4117]
ARCH 1-1 test:	F(1,23)	=	0.019697 [0.8896]
Normality test:	Chi^2(2)	=	7.9926 [0.0184]*
Hetero test:	F(4,20)	=	2.0860 [0.1207]
Hetero-X test:	F(5,19)	=	1.7556 [0.1704]
RESET test:	F(1,24)	=	1.2794 [0.2692]

V. PRICE BLOCK

GDP Deflator

Δlog(P_GDP) = 0.4667*Δlog(P_GDP(-1)) + 0.1885*Δlog(P_GDP(-3)) + 0.6552*(log((PCON+
GCON+INV)/(PCONc+GCONc+INVc))-log((PCON(-1)+GCON(-1)+INV(-1))/(PCONc(-1)
+GCONc(-1)+INVc(-1)))) - 0.3345*(log((PCON(-1)+GCON(-1)+INV(-1))/(PCONc(-1)+
GCONc(-1)+INVc(-1)))-log((PCON(-2)+GCON(-2)+INV(-2))/(PCONc(-2)+GCONc(-2)+
INVc(-2)))) - 0.3353*ECM_P_GDP

ECM_P_GDP = log(P_GDP(-1))-0.91*log((PCON(-1)+GCON(-1)+INV(-1))/(PCONc(-1)+GCONc(-1)
+INVc(-1)))

Diagnostic Tests:

Sigma	0.00875871		
log-likelihood	92.3715		
AR 1-2 test:	F(2,20)	=	0.045236 [0.9559]
ARCH 1-1 test:	F(1,20)	=	1.0296 [0.3224]
Normality test:	Chi^2(2)	=	0.83493 [0.6587]
Hetero test:	F(10,11)	=	1.0692 [0.4539]
Hetero-X test:	not enough observations		
RESET test:	F(1,21)	=	1.1421 [0.2973]

Consumer Price Index

$$\Delta\log(P\_C) = 0.03688 + 0.3802*\Delta\log(P\_P) + 0.1699*\Delta\log(P\_M) + 0.1917*\Delta\log(P\_M(-1)) - 0.3982*ECM\_P\_C$$

$$ECM\_P\_C = \log(P\_C(-1)) - 0.33*\log(P\_P(-1)) - 0.18*\log(P\_M(-1)) - 0.26*\log(M2(-1)/GDPc(-1)) - 0.03*\log(GPW2(-1)) - 0.04*\log(FPW2(-1)) - 0.06*\log(EPW2(-1))$$

Diagnostic Tests:

Sigma	0.0177119		
R^2	0.658657		
AR 1-2 test:	F(2,20)	=	0.22329 [0.8019]
ARCH 1-1 test:	F(1,20)	=	0.37002 [0.5498]
Normality test:	Chi^2(2)	=	2.0840 [0.3528]
Hetero test:	F(8,13)	=	0.75906 [0.6432]
Hetero-X test	not enough observations		
RESET test:	F(1,21)	=	2.6695 [0.1172]

Producer Price Index

Δlog(P_P) = 0.364239*Δlog(P_P(-1)) + 0.321486*Δlog(P_P(-3)) +0.229704*Δlog(P_M(-2)) -0.214906*ECM_P_P

ECM_P_P =log(P_P(-1)) + 1.20 - 0.46*log(P_M(-1)) - 0.25*log(GPW2(-1))

Diagnostic Tests:

Sigma	0.0354513		
log-likelihood	55.9365		
AR 1-2 test:	F(2,22)	=	1.3451 [0.2811]
ARCH 1-1 test:	F(1,22)	=	0.37581 [0.5461]
Normality test:	Chi^2(2)	=	5.2604 [0.0721]
Hetero test:	F(8,15)	=	0.65827 [0.7194]
Hetero-X test:	F(14,9)	=	0.77607 [0.6765]
RESET test:	F(1,23)	=	0.18601 [0.6703]

Investment Deflator

Δlog(P_INV) = 0.4952*(log(VA3(-2)/VA3c(-2)) - log(VA3(-3)/VA3c(-3))) -0.1624*ifeq(1999) -0.4997*ECM_P_INV

ECM_P_INV = log(P_INV(-1)) - 0.60*log(VA2(-1)/VA2c(-1)) - 0.35*log(VA3(-1)/VA3c(-1)) - 0.001*IRL(-2)

Diagnostic Tests:

Sigma	0.0282803		
log-likelihood	63.8363		
AR 1-2 test:	F(2,24)	=	0.32778 [0.7237]
ARCH 1-1 test:	F(1,24)	=	0.068873 [0.7952]
Normality test:	Chi^2(2)	=	0.45551 [0.7963]
Hetero test:	F(5,20)	=	0.68335 [0.6414]
Hetero-X test:	F(6,19)	=	0.54284 [0.7693]
RESET test:	F(1,25)	=	2.3988 [0.1340]

Export Deflator

Δlog(P_X) = - 0.219*Δlog(P_X(-1)) + 0.4864*(log(VA2(-3)/VA2c(-3)) - log(VA2(-4)/VA2c(-4)))

+ 0.4109*Δlog(P_M) - 0.2565*ECM_P_X

ECM_P_X = log(P_X(-1)) - 0.5*log(P_M(-1)) - 0.5*log(VA2(-1)/VA2c(-1))

Diagnostic Tests:

Sigma	0.0246245		
log-likelihood	66.1403		
AR 1-2 test:	F(2,22)	=	0.40800 [0.6699]
ARCH 1-1 test:	F(1,22)	=	0.025071 [0.8756]
Normality test:	Chi^2(2)	=	7.7422 [0.0208]*
Hetero test:	F(8,15)	=	1.0970 [0.4166]
Hetero-X test:	F(14,9)	=	3.7995 [0.0250]*
RESET test:	F(1,23)	=	1.9806 [0.1727]

Import Deflator

Δlog(P_M) = 0.0191048 +0.767812*Δlog(P_X)- 0.136711*ECM_P_M

ECM_P_M =log(P_M(-1))+4.34921+ 0.261571*log(time(1981)) - 0.673132*log(FCPI(-1))

- 1.37486*log(ER(-1))

Diagnostic Tests:

Sigma	0.0311255		
R^2	0.598272		
AR 1-2 test:	F(2,26)	=	0.051444 [0.9500]
ARCH 1-1 test:	F(1,26)	=	0.30609 [0.5848]
Normality test:	Chi^2(2)	=	6.3204 [0.0424]*
Hetero test:	F(4,23)	=	2.9677 [0.0410]*
Hetero-X test:	F(5,22)	=	5.8836 [0.0013]**
RESET test:	F(1,27)	=	0.86269 [0.3612]

The Authors

Dr. Monzur Hossain is working as a Senior Research Fellow at BIDS. He obtained his Ph.D. in International Economics from the National Graduate Institute for Policy Studies (GRIPS), Tokyo in 2007 and Master's in Public Policy (Economics) from the same institute in 2003. He joined BIDS as a Research Fellow in 2008. His primary areas of interest include macroeconomics, international trade and finance (aid, exchange rate, etc.), local government finance, industrial development (ICT, RMG, SME, etc.) and banking and financial sector.

Dr. Mohammad Mahbubur Rahman (on leave) is a Research Fellow at BIDS. He obtained his M.A. in Economics from the University of Dhaka in 2005 and earned M.Sc. in Economics and Econometrics and Ph.D. in Economics from the University of Manchester, UK in 2009 and 2014 respectively. His research interests include environmental economics, program evaluation, intra-household behaviour, political economy, labour economics, development economics, macroeconometric modelling, domestic violence, corruption, migration, poverty and inequality, and returns to education. However, his current research involves applications of regression discontinuity design.

Md. Atiqur Rahman (On study leave) joined BIDS as a Research Associate in February 2014. He has completed his BSS (Hons.) and MSS in Economics from the University of Dhaka in 2012 and 2013 respectively. Prior to joining BIDS, he has worked as an Assistant Director at Research Department in the Bangladesh Bank. Rahman's areas of research interests include macroeconomic issues, theoretical economics, mathematical economics, international trade and finance, theoretical and applied econometrics, development economics and public policies.