CHAPTER III

CONCEPTUALIZATION OF THE RESEARCH

3.1 Conceptual Framework

Macroeconomic forecasting is a very difficult task due to the lack of an accurate, convincing model of the economy. The most accurate models for economic forecasting, "time series" models, assume little about the structure of the economy (Moody J., Genevieve B., Müller K.R., 2006). However, constructing reliable time series models is challenging due to short data series, high noise levels, non-stationarities, and nonlinear effects. This thesis describes these challenges and reconstructs the most up-to-date model that can give the results under different policy scenarios.

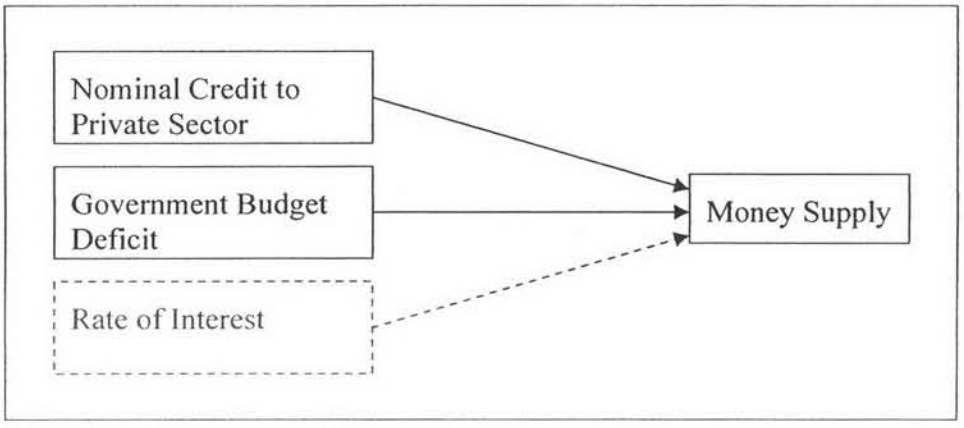
Mainly the central bank of Bangladesh (Bangladesh Bank) is responsible to prepare and publish macroeconomic forecasts for Bangladesh economy on a regular basis. The purpose of these forecasts is to support economic agents' decision-making by providing a coherent picture of the present state of the economy and the outlook for the future. The forecast presented is the scenario identified as most likely. Apart from the central bank of Bangladesh, the systematic analysis of alternative scenarios has either not attracted much attention or been based purely on qualitative assessments.

The preparation of alternative calculations requires a systematic description of economic agents' behavior across the economy as a whole. Such a description is referred to as a macroeconomic model. A few economists have put their efforts into developing macroeconomic models specifically for use in the drafting of alternative scenarios. Macroeconomic models have also proven useful when assessing how changes in economic policy or in the external environment propagate through Bangladesh economy.

In recent years, one of the most comprehensive models has been formulated by Hossain (1995) that included 29 behavioral equations and 15 identities. However, this model cannot be estimated empirically as it does not achieve a convergence rule to run the simulation. In other words, lexically a model is said to constitute a system of simultaneous equations if all of the relationships involved are needed for determining the value of at least one of the endogenous variables included in the model. This situation implies that at least one of the relationships includes more than one endogenous variable. Due to this estimation problem, Hossain and Razzaque (2003a) have revised the model that can run policy simulation scenarios. However, this model has only 18 behavioral equations and 13 identities, which are not enough to explain the diversified economy of Bangladesh. Therefore, the thesis has considered the initial Hossain (1995) model and attempted to reconstruct for accomplishing empirical forecasting with alternative shocks based on monetary, fiscal, and exchange rate policies.

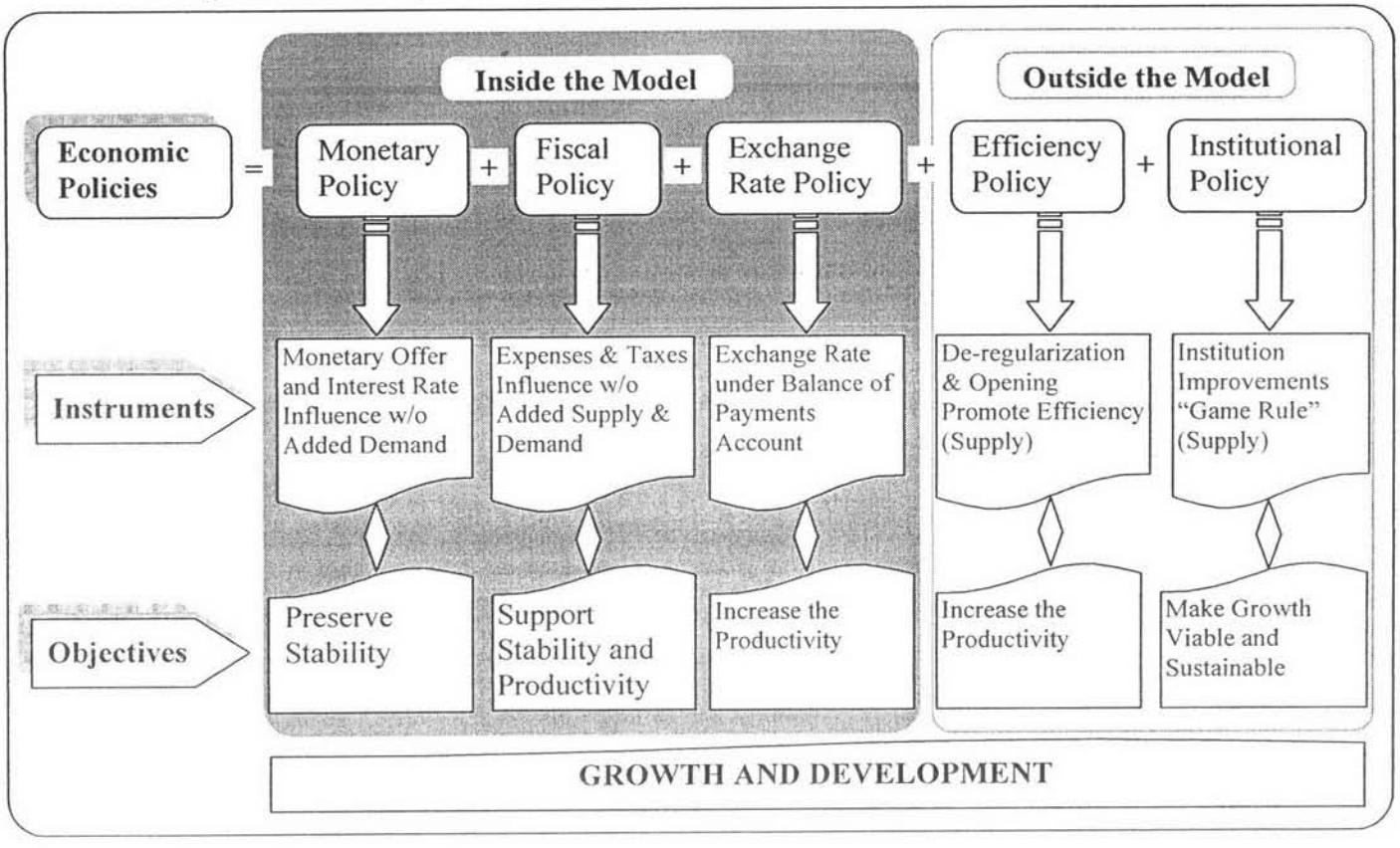
It is argued that interest rate is regulated by the government. There is also rigidity in the interest rate because of the oligopolistic structure of the banking system. The equilibrating mechanism in the monetary sector does not work through the demand for and supply of money determining the rate of interest. Rather, the change in money supply affects the price level (Hossain, 1995). However, rate of interest is the primal variable for applying monetary policy implications on the economy. Furthermore, recently the banking sector of Bangladesh is facing a competitive environment as the central bank of Bangladesh has approved many domestic as well as international banks to run the operational activities in the economy. Hence, money supply is now fundamentally dependent on the rate of interest (Diagram 3.1). The model used in this thesis, that is why, has included rate of interest under monetary block.

Diagram 3.1: Money Supply and Rate of Interest



The thesis has identified total government expenditure as a fiscal policy variable. For the sake of giving a fiscal shock in the model, total government expenditure is exogenously determined. Likewise, exchange rate has included as exogenous variable to get policy scenarios through balance of payments block. The thesis, therefore, has covered monetary, fiscal and exchange rate policies that are framed in Diagram 3.2.

Diagram 3.2: Components of Economic Policies



An overwhelming volume of literatures has been done already to analyze the effects of monetary and fiscal policies. Nevertheless, nobody knows which policy is effective for which countries at what context. Conventional wisdom about monetary and fiscal policies agreed that both can be useful to achieve high growth, low inflation, and low unemployment rate. Of the two, it is well accepted that monetary policy is the more important policy for short-run stabilization. It is more flexible and less influenced by politics than fiscal policy. However, there is no stylized facts for the policymakers to utilize such policies with certainty. This is one of the most important reasons to build a macroeconometric model, which can anticipate the effects of potential policy shocks in the economy. Overall, both policies have some advantages and disadvantages by default that are pointed out in Table 3.1.

Table 3.1: Conventional Wisdom about Monetary and Fiscal Policy

	Option	Advantages	Disadvantages
Monetary policy	Expansionary	1. Interest rates may fall 2. Economy may grow. 3. Decreases unemployment	1. Inflation may worsen. 2. Capital outflow 3. Trade deficit may increase.
	Contractionary	1. Helps fight inflation. 2. Trade deficit may decrease 3. Capital inflow	1. Risks recession 2. Increases unemployment 3. Slows growth 4. May help cause short-run problems 5. Interest rates may rise
Fiscal Policy	Expansionary	1. May increase output growth 2. May help solve short-run political problems 3. Decreases unemployment	1. Budget deficit worsens. 2. Hurts country's ability to borrow in the future 3. Trade deficit may increase 4. Upward pressure on interest rate
	Contractionary	1. May help fight inflation 2. May allow a better monetary-fiscal mix 3. Trade deficit may decrease 4. Interest rates may fall	1. Risks recession 2. Increases unemployment 3. Slows output growth in short run 4. May help cause short-run political problems

Nonetheless, macro policymakers have another option to adopt both policies at a time, i.e. a policy mix strategy. A policy mix can be of four combinations that are picturized in Diagram 3. As for instance, when expansionary monetary and fiscal policies are adopted together, consumption (c) has to be increased that will induce income level (Y). On the contrary, a combination of both contractionary monetary and fiscal policies diminishes consumption along with aggregate income.

Diagram 3.3: Macroeconomic Policy Mix

The Effects of the Macroeconomic Policy Mix			
		FISCAL POLICY	
		Expansionary (↑ G or ↓T)	Contractionary (↓ G or ↑T)
MONETARY POLICY	Expansionary (↑ M)	$Y\uparrow, r?, I?, C\uparrow$	$Y?, r\downarrow, I\uparrow, C?$
	Contractionary (↓ M)	$Y?, r\uparrow, I\downarrow, C?$	$Y\downarrow, r?, I?, C\downarrow$

Notes:

↑ = Variable increases;

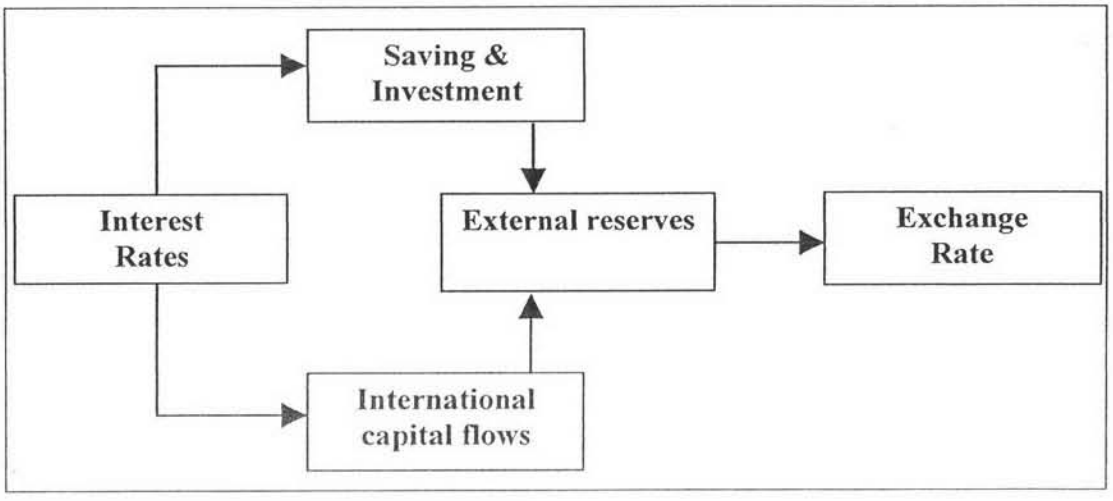
↓ = Variable decreases;

? = Forces push the variable in different directions. Without additional information, we cannot specify which way the variable moves;

It is, however, to be mentioned that in this model monetary and fiscal policy are not the only policies that affect aggregate demand. Logically any policy that affects autonomous spending without having offsetting effects on other expenditures can achieve the same results. In this regard, exchange rate policy has included in the model that means a policy of deliberately affecting a country's exchange rate in order to affect its international trade balance. In general, a low value of a country's currency relative to other currencies encourages exports and discourages imports, and vice versa.

It is arguable that monetary and exchange rate policy can be interlinked. Changes in interest rates affects on savings as well as investments, which can change international trade flows of the economy. As balance of payments changes, volume of international currencies eventually changes that determines a new exchange rate. The reverse can also be trustworthy in this regard. This concept can be interpreted in Diagram 3.4.

Diagram 3.4: Linkage between Monetary and Exchange Rate Policy



From the above discussion regarding the conceptual framework, it has to be realized that the calibration of a macroeconometric model can be very effective to formulate the best alternative policy package to address present crisis and future challenges of the economy. The idea is to develop a model that would take advantage of incorporating recent macroeconomic scenarios and the experiences the Bangladesh economy had gained. In the reconstructed model, the behavior of economic agents is based on dynamic changes, and the model is substantially consistent to the identities. In Chapter V, detailed causal linkages among the variables of the model have been sketched in a schematic diagram. The diagram has provided more clarifications of how precisely the model describes the various aspects of the Bangladesh economy before using it in evaluating economic policy options.

3.2 Research Methodology: A Scientific Approach

An important dimension of macroeconomic modeling exercise is the explicit consideration of the time series properties of the data and use of estimation techniques suitable for dealing with the non-stationary data. Previous studies on Bangladesh and for many other countries have failed to recognize the problem (Hossain and Razzaque 2003a). For this reason, Lipsey and Chrystal (1999) have adopted a procedure to build

up a scientific theory. They said that there are five distinctive stages in theorizing an empirical evidence including variable specification, assumption notification, hypothesis formulation, prediction postulation and finally hypothesis testing. The thesis has used this procedural scientific approach to restructure the model.

At first, to build up a model, it is indispensable to identify variables. In case of structural macroeconometric model, one has to specify some building blocks that can explain the aggregate economy simultaneously. The thesis has used 6 building blocks including production, expenditure, balance of payments, government, monetary and price blocks. For maintaining a smooth relationship among the blocks, some crucial assumptions have been imposed on the model. After considering ceteris-paribus, a hypothesis has been formulated to measure the performance of the model based on empirical dataset.

In the stage of prediction, it is needed to mention that a scientific prediction is not the same thing as a prophecy. The scientific prediction is a conditional statement that takes the form: *If something is done, then such and such things will follow* (Lipsey and Chrystal 1999). In theorizing macroeconomic model, the thesis has used prevalent economic theories and philosophies under Keynesian framework (the reason of selecting Keynesian model has been discussed in Chapter I). The rationale behind each behavioral equation has been given in a causal linkage diagram at the later phase of the thesis. In this regard, it is to be mentioned that the results of these experiments are more or less expected to be the same as a Keynesian model.

After that, a theory is tested by confronting its predictions with evidence. It is to be recalled that this macroeconometric model contains 44 equations, of which 28 are behavioral, 16 are identities. Each equation in the multi-equation model is estimated using some form of ordinary least squares method. At first, for hypothesis testing, the model has been explained underlying the specification on an equation-by-equation basis.

Once the coefficients in each behavioral equation are estimated, a simulation can be conducted to solve for each endogenous variable. Given certain initial values, interactions among variables across blocks are repeated until the system finds the equilibrium for the economy. That is, the model is supposed to be simulated as a complete system. Two historical simulations including *ex ante* and *ex post* forecasts were performed in order to evaluate the model's ability to replicate the actual data. Besides, a counter historical simulation have been done within the period by making a policy shock to see the magnitude and direction of the economy. In this context, all simulations are *dynamic*, in the sense that simulated (rather than actual) values for the endogenous variables in a given period are used as inputs when the model is solved in future periods.

It is well accepted that well-specified individual behavioral equations are a prerequisite for a good macroeconometric model. From a statistical perspective, individual equation estimation should exhibit high goodness of fit, and the coefficient estimates should be statistically significant. However, good statistical properties in individual equations do not necessarily imply a good performance of the model as a whole. Rather, good forecasting performance of the model depends on how well the relations between behavioral equations are linked and if the coefficient estimates are economically reasonable. Tests need to be carried out to determine whether the predicted values from the system trace the actual history of the variables reasonably well to evaluate the forecasting performance of the model.

Finally, the primary purpose of developing the model is to provide guidelines for macroeconomic planning and management by forecasting the future path of the economy. However, forecasting performance usually declines with the length of the forecasting horizon. In the case of Bangladesh, considering the rapidly changing economic structure, it is more likely to be so. Considering this, the forecasting horizon is set at 10 years.

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It follows that a set of assumptions are needed on the future values of exogenous variables including government policy variables. In particular, since policy variables have great influence on the course of the economy, it is important to set the future values of policy variables in a consistent way. As mentioned earlier, the model has three policy variables: (i) real total government expenditures, (ii) interest rate, and (iii) exchange rate. Therefore, the following four simulation experiments should be performed:

A. ***Baseline forecast:*** In this first experiment, an out to the end forecast of 2010 should be generated under the assumption that all the exogenous variables grow at their historical rates of growth.

B. ***Expansion of real total government expenditures:*** In this experiment, government spending on both consumption and investment is set to grow at a certain rate. All other variables follow the same paths as in the base forecast. The objective is to examine how an increase in total government spending will affect on endogenous variables especially real GDP.

C. ***Interest rate experiment:*** Suppose lower interest rates leads to a more rapid rate of growth of GNP and investment. In Bangladesh, interest rate is totally controlled by the central bank of Bangladesh for manipulating money supply of the economy. Hence, this research has tried to visualize the impact of a change in interest rate on economic growth.

D. ***Exchange rate experiment:*** Recently the government of Bangladesh has initiated a managed floating exchange rate policy. However, empirically it has been observed that exchange rate is wholly manipulated by the Bangladesh Bank[13]. Therefore, in this research, exchange rate has been considered as an exogenous variable. That is, exchange rate is not determined by the competitive market mechanism. Hence, this

[13] Bangladesh Bank is the central bank of Bangladesh.

research has made a shock on exchange rate to see the impact on other macroeconomic indicators including real GDP.

After giving the above policy shocks on the model, the thesis has attempted to compare among each policies and tried to find out which policy is more effective to the economy. Finally yet importantly, by considering different combinations of the policy variables, some policy mix simulations have also be conducted to visualize the effect and point out whether policy mix is a good option for the macroeconomic development of Bangladesh.

3.3 Research Methods: Selection of Structural Macroeconometric Model

The main rationale for the considerations of this part is the question how econometrics can help to a better understanding of main macroeconomic problems at the large-scale. Generally, two criteria are widely used for macroeconomic policy simulations under simultaneous equation model (SEM) that needs to be discussed and compared for selecting the most appropriate technique to run the model.

Firstly, a macroeconomic system can be simulated under structural model. In the beginning the structural macroeconometric models according to the Cowles Commission approach (SMCC), with no restriction on the number of variables to be explained, were a real success. In the late seventies, however, a strong decline of the popularity of this approach was recognized, mainly because of following critical points:

- a strong commercialization of macroeconometric models,
- the large size and complexity of these models,
- rather poor prediction performance,
- the so-called Lucas-criticism (policy-dependent parameters),

- the necessity of a large number of a-priority-restrictions for the identification of these models (the reason for the development of vector autoregressive models).

All these points have a strong degree of validity. However, if one goes more deeply into it, one realizes that they have more to do with the way econometricians deal with such models rather than pointing to basic conceptual defects of this approach.

Secondly, vector-autoregressive models (VAR) are vector-generalizations of autoregressive models and can be regarded as an unrestricted reduced form of a structural model, where the specification is purely determined on the information contained in the available data. Contrary to SMCC, one does not need any additional non-testable a-priori-restrictions ('a-theoretical approach') - at least not in the basic version. Nevertheless, it has given some unavoidable drawbacks in comparison to SMCC model including the following issues.

- The complete lack of a-priori-information leads to losses in efficiency;
- Vector-autoregressive models are in principle of very small size in order to allow for intensive testing and estimation - more than eight equations are very rare. Thus phenomena of large size and complexity cannot be modelled adequately;
- VAR-models have - at least in the basic version - problems with policy simulations: As the residuals of the equations of vector-autoregressive models are normally correlated, the execution of impulse-response-analysis is problematic;

However, the above criticisms to VAR technique are not exhaustive and decisive. The criteria for the comparison between VAR and SMCC models can be divided into two groups that are discussed respectively.

Criterion I: Adequate reflection of the reality of the phenomenon with respect to the introduction of all 'important' endogenous variables, incorporation of all available valid a-priori-information, and adequate use of the data information for the specification process

Criterion II: High qualification for policy simulation analysis

The fundamental advantages of criterion I can be indicated with respect to the number of variables. SMCC characterizes with less restrictions to put longer timeline in contrast to VAR. From the viewpoint of incorporating a valid priori-information, SMCC can handle the case of a-priori-information. Generally, a-priori-restrictions are given in terms of the structural form of a model. It needs to be mentioned that with respect to the incorporation of data information directly in the specification process, there is an obvious strong advantage on the side of VAR.

On the contrary, Criterion II has to be the possibility of an unambiguous analysis of the effects of exogenous shocks in ceteris paribus-experiments. In case of VAR, one can run into problems because of cross-equation-correlations of residuals. Therefore, the residuals in VAR-models are very often orthogonalized, via a Choleski-decomposition. This produces the desired diagonal variance-covariance-matrix of the residuals, but also a recursive structure of the system. To solve this problem, structural vector-autoregressive models (SVAR) have been developed which are based on a-priori-information. However, these models are obviously very close to SMCC, i.e. the basic VAR-advantage (no need of a-priori-information) is not there anymore.

In SMCC, cross-equation-correlation of the residuals will cause the same problems. In case of an analysis of effects of changes of exogenous variables one will observe very similar difficulties with SMCC. Policy analysis makes only sense if the 'exogenous' variables are not correlated with the residuals. Very often one cannot assume such non-correlation, but unfortunately the model will not be able to detect this defect in the specification process.

As far as the incorporation of valid a-priori-information and of larger numbers of variables is concerned, there is an obvious advantage on the side of SMCC. In contrast, VAR makes much better use of the available data in the specification process. Thus, a step-wise procedure in the specification process seems to be adequate: One should start from a SMCC and should - in the process of the detailed specification - make intensively use of the VAR approach. As far as the question of policy simulation is concerned, both approaches suffer from cross-equation-correlation of residuals. Precisely, according to well-founded econometric tradition, interrelations of residuals are very often an indication of specification defects. A new specification of the model could result in an elimination of these correlations. So one should basically look for 'super-structural' macroeconometric models, i.e. models without cross-equation-correlation of the residuals. Based on this technique, the model used in this thesis has attempted to utilize SMCC approach by avoiding cross-equation-correlation of the residuals in the system.

To run the macroeconometric model under simultaneous equation system, there are many softwares including G[14], STELLA, Fair Model, Fair-Parke (FP) program[15], MCA model, MCB model, MCC model, AD Model Builder etc. However, all of the softwares are very complicated as well as sophisticated in terms of operations and applications. For avoiding complexities, the thesis has used simple user-friendly software titled "Econometric Views"[16] (Eviews). Though this software is not designed for model builders, a long but simple procedure can run a macroeconometric model under Eviews system for having the results of forecasting and policy shocks. To make the model start, at first all 28 behavioral equations have been estimated individually by selecting Two Stage Least Squares (TSLS) method with the inclusion of all exogenous and lag variables of the model as instrument lists.

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[14] *G* is an econometric regression and model-building program for the IBM PC and compatible computers. It is designed for estimation of regression equations with annual, quarterly, or monthly data. *G* takes its name from Carl Friedrich Gauss, the originator of the method of least squares.

[15] The Fair-Parke (FP) program is a DOS-based, command-line program. It allows one to estimate and analyze dynamic, nonlinear, simultaneous equations models.

[16] Eviews is a software developed by the Quantitative Micro Software (QMS) Corporation that provides estimation, forecasting, statistical analysis, graphics, simulation, data management, all in a powerful, graphical object-oriented interface.

After that, 16 identities have been amalgamated into the system mentioning that the total number of endogenous variables has to be equal to the total number of equations and identities. Otherwise, the model could not achieve the convergence to run under Eviews system.

After that, by choosing deterministic type simulation with static solution, the model has been run within the range. Then both sample and range have been extended to 2010 to use ARIMA/ ARMA (as appropriate) model for forecasting exogenous variables. In this regard, to specify the model, it is needed to check whether exogenous data are stationary or non-stationary. If the time series dataset is stationary, ARMA Model is appropriate to work with. Conversely, if it is non-stationary, ARIMA Model is more effective as an estimation tool. To check stationarity, unit root test has been performed considering Augmented-Dickey Fuller (ADF) test under Akaike Info Criterion. After that, Correlogram has been sketched to get the autocorrelation function. If the autocorrelation function dies off smoothly at a geometric rate, and the partial autocorrelations were zero after one lag, then a first-order autoregressive model [AR(1)] is appropriate. Alternatively, if the autocorrelations were zero after one lag and the partial autocorrelations declined geometrically, a first-order moving average process [MA (1)] would seem appropriate. If the autocorrelations appear to have a seasonal pattern, this would suggest the presence of a seasonal ARMA structure (Source: Eviews Manual). Following the process, all exogenous equations have been estimated under ARIMA/ ARMA model to do the out-of-samples forecasting. After incorporating the forecasting for each exogenous variables, the model has been run once again with the consideration of deterministic type simulation under dynamic solution approach. The process has compared between the baseline and the forecasted estimation after having a policy shock on the model.

3.4 Data and Measurement

Before explaining the structure of the model, brief explanations of data sources in this model is presented below.

3.4.1 Sources of data and time period specification

The currency unit of all variables in the model is the Bangladeshi Taka, including the variables in the Balance of Payment (BOP) account. The variables denominated in US dollars are converted to Bangladeshi Taka by multiplying the end of the period exchange rate. The currency denomination is not a major issue in estimation and simulation. Nevertheless, denomination by domestic currency is preferred since it is more efficient when the values of the variables from different sources are compared. For instance, the exports of goods and non-factor services in the national income account can be easily compared with the merchandise exports in the BOP account once all the variables are denominated in domestic currency.

The model used in the thesis has several distinguishing features leading to important contributions to the applied macroeconomics literature on Bangladesh. Very recently, the Bangladesh Bureau of Statistics (BBS) has published new national income estimates for the country by incorporating extensive methodological and data improvements. This has resulted in an increase in national income by 26 – 43 per cent (in nominal terms) for every year between 1981 and 2000[17]. That is why, in this research, as for the sample period, annual data has been considered from fiscal year 1981 to 2000. There are concerns regarding the reliability of national income account data before 1990 due to potential data inconsistency, as Bangladesh has reinstalled democracy just after 1990. However, the advantage of a relatively large number of observations in a time series for obtaining more robust and reliable estimates outweighed the risk.

[17] The revised national income estimates by the BBS are available only since 1980.

3.4.2 Data adjustments and transformations

The data series are obtained from various Monthly Economic Trends published by Statistics Department of Bangladesh Bank, Various Yearly Statistical Bulletins published by the Bureau of Statistics, Bangladesh; Bangladesh Economic Review, published by the Ministry of Finance, Bangladesh; Quarterly Balance of Payments published by the Bangladesh Bank; and International Financial Statistics data on the website provided by International Monetary Fund.

It is to be mentioned that the fiscal year of the Republic Government of Bangladesh ends on 30 June. Hence, a convention is used such that Data on fiscal year 1980/81 is considered as the calendar year 1981 and so on. The unique dating convention makes it necessary to adjust foreign variables in the model to maintain data coherence.

PART III RECONSTRUCTION OF MACROECONOMETRIC MODEL