THE JOURNAL OF ECONOMIC SCIENCES: THEORY AND PRACTICE, V.70, # 2, 2013, pp. 32-66

AN INTEGRATED MACRO-FISCAL FORECASTING MODEL AND ITS APPLICATION FOR THE BANGLADESH ECONOMY

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(Paper to be presented at the International Conference on Economic Modeling – EcoMod2013 – in Prague, Czech Republic, July 1-3, 2013)

Received 30 August 2013; accepted 11 December 2013; published online 25 December 2013

Abbreviations

BB	Bangladesh Bank
BBS	Bangladesh Bureau of Statistics
BMFFM	Bangladesh Macro-Fiscal Forecasting Model
CES	Constant Elasticity of Substitution
CPI	Consumer Price Index
EPB	Export Promotion Bureau
FD	Finance Division
FDI	Foreign Direct Investment
FTS	Foreign Trade Statistics
GDP	Gross Domestic Product
GDPD	Gross Domestic Product Deflator
iBAS	Integrated Budget Accounting System
MEW	Macroeconomic Wing
MOF	Ministry of Finance
MTBF	Medium Term Budget Framework
MTMF	Medium Term Macroeconomic Framework
NBR	National Board of Revenue
PFM	Public Finance Management
PIP	Public Investment Programme
TFP	Total Factors Productivity

1. Abstract and Background:

The main objective of this modelling efforts is to formulate and articulate, a macroeconomic and fiscal model for forecasting and decision purposes for Bangladesh. Given the actual modeling needs, the limitation and coverage of the available statistical data and limited modelling related capacity within the ministry of finance (MOF), an attempt has been made here to structure, formulate and numerically articulate a macro-fiscal forecasting model that is characterized as; realistic, simple, though comprehensive but easy to understand and comprehend, integrated for all

the segments of the national economy (real economy, fiscal, financial and external sector) included in the model and brought together, in an economically viable causal-chain sequential relationship, with impact oriented and feed-back solutions processes. The constructed model however, has been structured in such a way so that it can be absorbed by the prevailed technical capabilities and capacities of the existing MOF/macroeconomic wing (MEW) staff, can be calibrated, empirically articulated, and implemented as well as run with different economic and development scenario alternatives, for future projections, and hence, it can be used as an effective tool for forecasting and decision as well as policy making process.

Accordingly, the integrated macro-fiscal forecasting model has been constructed and established based on the following principles and assumptions:

- The macro-fiscal forecasting model constructed and implemented during this assignment, for Bangladesh economy, is a comprehensive integrated economic and fiscal model, in which all the segments of the national economy of Bangladesh, i.e. real economy, fiscal sector, financial (monetary) sector, external sector and social sector, have been structured and modeled, in such a way that economic decomposable relationships and interactions of the various segments with each other have been captured and worked out, and hence, identifying and measuring the behavioral impacts on each other development and progress, in expansion and/or contraction. Thus, such an interactions and feed-backs between different segments of the economy, have been considered as the main backbone of this applied model.

- Methodologically, the model is a forecasting, strategic simulation and decision/policy making model, based on specifying and structuring a variety of simultaneous equations and systems relationships. Moreover, and in order to empirically solve these structured system of equations and economic functional relationships, the adopted modelling techniques is based on and applied a hybrid approach of econometric methods, algebraic settings, and mathematical techniques and algorithms. These all based on the general equilibrium concepts and principles.

- Essentially, the model is a macro-fiscal forecasting and simulation model, but actually, in its schematic framework has been developed and gone further than this. Therefore, it has economically adopted and specifically built-in an "equilibrium mechanism" on different aspects and dimensions, in a dynamic and non-linear setting.

- The model, in order to be complete and more beneficial to the development of Bangladesh economy and its future outlook, has been deliberated to cover further economic

dimensions other than the aggregated macro-fiscal and the five segments of the national economy. These additional dimensions are the sectoral/sub-sectoral and commodities dimension. Whereas, all these sectoral and commodity dimensions have been included and considered, as an integral part of the main modules of the model. This has, nonetheless, covered all economic/fiscal, outputs, products, inputs, imports and resources requirements functional relationships.

- The model has been solved simultaneously, i.e. that all the system of equations are integrated and solved simultaneously, with all impacts, feedbacks and interactions are calibrated/simulated, in one go. Despite these vital economic and mathematical facts, the model also be solved in an individual manner, with various segments of the model handled and ran separately. Given the built-in flexibility, the solution outcomes of a given segment would be plugged and fed-in an alternative segment's model setting "exogenously", when deemed necessary. Thus, this of course depends on the immediate needs for policy decision, data availability, computer programming capabilities, and functional/analytical objectives and purposes.

- One of the most important features of the model is that, in its formulation and when it has empirically implemented and solved, it has achieved and preserved the aimed at equilibrium in, amongst others, the overall economy supply and demand, consumption and production, investment and saving, revenues and expenditure, to mention but a few.

- The model is characterized with the built-in mechanism and fact that all its parts and segments are interconnected, and follow sound logical economic sequences. This is, in addition to the fact that the optimum feed-back mechanism that has been analytically and mathematically established, between different segments and variables of the constructed macro-fiscal forecasting model, are identified and quantified within and by the model's solution procedures. The macro-fiscal forecasting model formulation, settings and solution have ensured inclusion, in a realistic manner, all economically viable relationships, activities and aspects that practically existing and normally dominating the growth path of developing economies such as Bangladesh economy. Having said that, the related and applicable activities, in the context of Bangladesh, have been determined during the implementation stages, subject to the availability and the conditions of the relevant information.

- Furthermore, it is imperative to state that the macro-fiscal forecasting model structured, developed and articulated for the Bangladesh economy, is based on the following characteristics: i) be an effective forecasting tool, ii) creating and develop a baseline ('As Is') forecast (solution) for the Bangladesh economy, iii) produce alternative scenarios (based on policy, risk and

sensitivity analysis) for the economy, v) demining priority and leading growth sectors for the optimal allocation of investment and other government expenditures, based on factors including economic growth, job creation, and social benefits and outcomes, and vi) provide an analytical framework for monitoring of the impact of the annual budget, medium-term budget framework and any adopted development and public investment programme.

- The model and its different segments, sectors/sub-models, and equation systems, have been numerically articulated and solved, for the Bangladesh economy, using a hybrid of different types and sources of statistical data. In order to articulate various incorporated relationships and functions within the model's framework. Accordingly, the macro-fiscal model is designed to use and utilize all available and valid data, in the format of; time series, cross-section, inter-industrial/inter-sectoral input-output data, simulated data, borrowed data and/or experts assumptions, views and judgment, as well as handling different policy scenarios alternatives.

- Most importantly, the macro-fiscal model, in its entirety and for all of its segments/sectors, have been used as a viable analytical and knowledge topic for a thorough practical training programmes. Such a programmes have been successfully delivered to selective MOF/FD/MEW staff. Whereby, such modelling techniques, procedures and solution results, together with how to interpret the outcomes and how be used in by the related divisions for preparation of MTMF and MTBF, have been achieved. This is besides, that MEW staff have been trained and guided on the required statistical data to apply and articulate the model's modules and contents. Hence, data needed to run the model, and on different variables and dimensions, have properly gathered, cleaned, tabulated and normalized in values, prices, quantities, indexations, etc. Thereafter, all the stated and demonstrated model's mathematical/econometric and economic equations and functional relationships, have been calibrated and numerically articulated, with the full participation of the MOF/MEW staff. Thus, in doing so the staff would be able, from now onward, to assist in the process of carrying out the sought after forecasting and projections of various parts and segments of the model and the economy, as identified therein. These empirical solutions would eventually serve in an effectively manner, and facilitate the MOF work, amongst others, on preparation of medium term macroeconomic framework (MTMF), medium term budget framework (MTBF), public finance management (PFM), investment programmes (PIP), and on all other related macro and sectoral issues and strategies/policies affecting socio-economic development, macroeconomic stability and fiscal sustainability of Bangladesh economy, at large, and for the future years to come.

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- Finally, this modelling technical report has been concluded by specifying the actual statistical data used in solving the integrated model's equations, the estimated parameters and coefficients, and the forecasting results on different variables and dimensions until 2017. This model, however, has been solved in two versions, namely: **version one;** is solving segmental four modules modelling and forecasting, covering the four segments of the economy, while **version two;** is solving an integrated policy model that pooling together all segments in one integrated framework, that can handle various policy scenario alternatives. This will assist and expedite developing and enhancing the obtaining and updating the statistical data for the modelling uses. Moreover, and by so doing, national indigenous capacity, in macroeconomic and fiscal management models structuring, formulating, forecasting and uses, within the Ministry of Finance and in Bangladesh at large, would be enhanced and furthered.

2. Introduction:

Comprehensive economic models in general, and macro-fiscal integrated models in particular, are needed to ensure consistency and optimality in constructing government annual integrated budgets and economic development programmes. Mathematical models can provide decision-makers and planners with alternative optimal policies and scenarios, based on slightly different objectives and/or assumptions. Hence, an informal choice may be made among these scenario alternatives. Thus, this allows policy making to be evidence-based with objectivity and scientific in orientation. In addition to revealing the implications of policy decisions by the relevant authority, the macroeconomic-fiscal models make direct and indirect impacts of various policies obvious to decision-makers. Besides, the future structure and growth path for the economy can be simulated using these mathematical/economic models. This is basically what macro-fiscal forecasting models do and that is why so much consideration and attention has been given, in recent years, to the use of applied models in macroeconomic development and planning, national and sectoral economic analysis and public finance management fields.

Without an analytical framework, attempts to solve problems in one area or segment of the economy often aggravate those in other areas and segments. Arising from the situation analysis which was made possible by macroeconomic-fiscal models, for instance governments in some countries, have been able to take remedial actions on the most feasible ways of redressing the negative impacts of policy, which arise from the implementation of medium-term plans, investment programmes, medium-term budget frameworks and/or annual budgets. Ordinarily, annual budgets, medium term plans and strategies as well as long term development visions, evolve their policy

options from simulations, and result-oriented macroeconomic-fiscal models. It is when short, medium and long term development programmes are articulated from the results of macroeconomic-fiscal models' simulation, that governments are considered to be planning or budgeting with facts; otherwise such governments are referred to as planning without quantified facts.

Having said that, the followings is the articulated macro-fiscal forecasting model for the Bangladesh economy. The Model's systems of equation, their mathematical sequences and their economic-fiscal and development rationales, are based on the author's written and submitted modelling work early 2012, which contained the proposed structure of the appropriate macro-fiscal forecasting model, for the economy [**See** Al-Ali, Hashim "The Structure and Features of the Proposed Macro-Fiscal Forecasting Model for the Bangladesh Economy", Technical Report Number -3-, Macroeconomic Wing (MEW), Ministry of Planning (MOF), January, 2012, Dhaka.].

3. The Integrated Macro-Fiscal Model's Formulation, Schematic Structural Framework and Causal-Chain

The two charts below depicting the integrated macro-fiscal modelling theme and its various variables and markets interrelationships and causal-chain.

Chart -1-

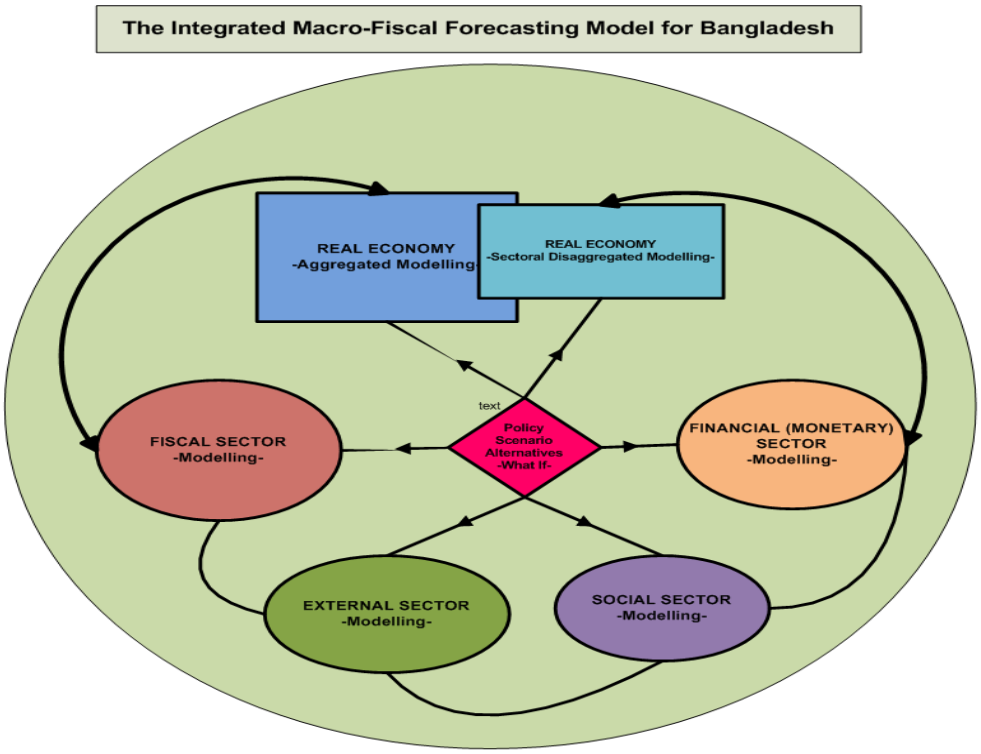
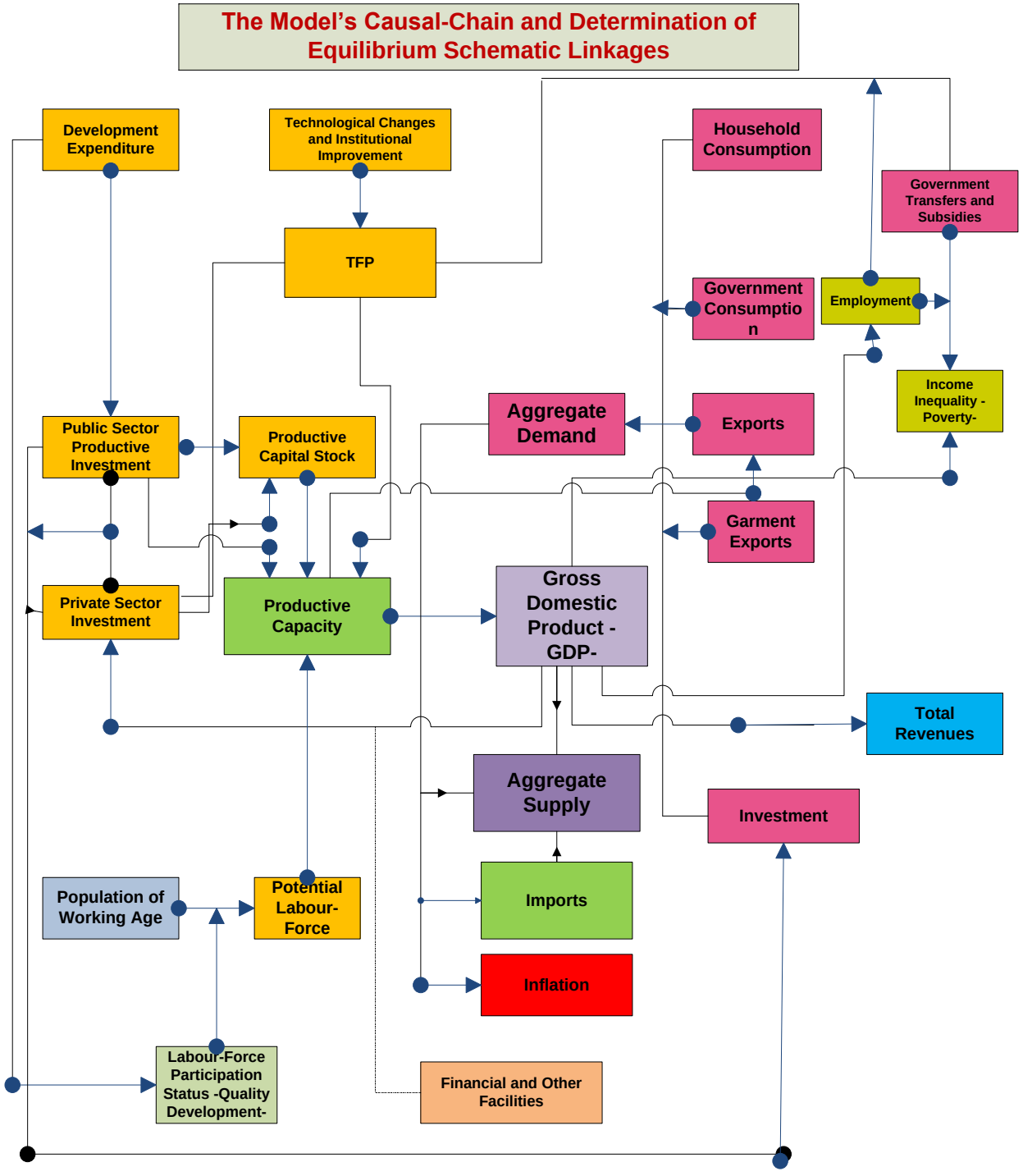


Chart -2-



3.1 The Macro-Fiscal Forecasting Model's Variables

The followings are the macro-fiscal forecasting model's variables, listed by each segment of the main four segments of the model, with some necessary interactions;

Table -1- : Macro-Fiscal Model's Variables

No.	variable (symbol)	variable interpretation
1	X_t	is the gross domestic products (GDP) in year t
2	CP_t	is the productive capacity in the economy
3	K_{t-1}	is the aggregated capital at year t-1
4	K_t	is the capital stock at year t
5	I_t	is the investment (GFCF) at year t
6	X_0	is the gross domestic products (GDP) at base year
7	X^i_t	is the product of sector (i) in year t where i is run from 1 to n
8	X^i_0	is the ith sector initial product
9	X^i_{t-1}	is the sectoral product at year t-1
10	X^{ag}_t	agriculture sector gross domestic product in year t
11	X^{in}_t	manufacturing industry seector gross domestic product in year t
12	X^{sv}_t	services sector gross domestic product in year t
13	I^g_{t-1}	is the government sector investment in ith sector at the period t-1
14	I^p_{t-1}	is the private sector investment in ith sector at the period t-1
15	L_t	is the total labour requirements (employment) in the economy, at year t
16	L^s_t	is the labour force size (labour supply) in the economy, at year t
17	L^s_0	is labour force at the base year
18	$GPOWA_t$	is the total (gross) working age population at year t
19	$NPOWA_t$	is the net working age population at year t
20	PRR_t	is the labour participation rate at year t
21	ROU_t	is the unemployment rate in the economy at year t
22	p^t_ℓ	is labour productivity (products per worker) at year t
23	p^0_ℓ	is labour productivity at base year (0)
24	C_t	is the private consumption in year t
25	c_t	is private per-capita consumption in year t
26	G_t, GE_t	are the government recurrent and total Expenditures, respectively in year t
27	CS_t	is the changes in Stock at year t
28	E_t	is the total exports in year t
29	M_t	is the total imports into the economy in year t
30	DIN_t	is the disposable income at year t
31	din_t	is per-capita disposable income in year t
32	$GNDI_t$	is the gross national disposible income at year t
33	POP_t	is the population size in year t
34	WSA_t	is wages, salaries and other allowances,
35	GS_t	is goods and services bought and used by the government
36	GCO_t	Other government expenditures at year t
37	$FOCS_t$	is the food, commodity and other subsidies at year t
38	EFS_t	is the energy and fuel subsidy at year t
39	PDS_t	Public debts interest service at year t
40	DD_{t-1}	Domestic debts at year t-1
41	ED_{t-1}	External debts at year t-1
42	PD_t	Public debts at year t
43	PD_{t-1}	Public debts at year t-1

Macro-Fiscal Model's Variables (continued)		
44	ΔPD_t	Changes in Public debts in year t
45	I_t^n	is the total national investment in year t
46	I_t^g	is the government investment in year t
47	I_t^p	is the private sector investment in year t
48	ADP_t	annual Development Plan Expenditure in year t
49	$NADP_t$	non-ADP Capital Investment in year t
50	WSA_{t-1}	is the wage, salary and other allowance level in year t-1 (previous budget year)
51	GS_{t-1}	is the government expenditure on the same item over the past year
52	$COP_{US\$t}$	is the crude oil international price per barrel in US Dollar in year t
53	EXR_t	is the prevailed exchange rate of the Dollar versus the Bangladesh Taka at year t
54	DOP_t	is the domestic price of crude oil in Taka for a barrel equivalent in year t
55	$DFCON_t$	is the domestic consumption of fuel in barrel equivalent at year t
56	$FOCS_{t-1}$	is the food and other commodities and services subsidies at previous year (t-1)
57	R_t	is government revenue at year t
58	TR_t	tax revenue at year t
59	NTR_t	non-tax revenue at year t
60	DTR_t	revenue from direct tax at year t
61	ITR_t	revenue from indirect tax at year t
62	CUS_t	revenue from custom duties at year t
63	VAT_t	value-added tax revenue at t
64	F_t	total final demand in the economy (C+G+I) at year t
65	BB_t	budget balance (surplus/deficit) at year t
66	ΔPD_t	change in public debt at year t
67	GDP_t	is the gross domestic product at year t (X_t)
68	GDP_{t-1}	is gross domestic products at year t-1 (X_{t-1})
69	S_t^n	is the national saving at year t
70	NR_t^e	is the net remittances of Bangladeshi workers abroad in year t
71	RNI_t	is the net investment returns abroad in year t
72	ONT_t	is the other net transfers inflow in year t
73	ΔNRV_t	is the change in national reserve brought about by balance of payments surplus in the economy in year t
75	EG_t	is the Bangladesh Garments export in year t
76	WGT_t	is the world total Garments trade in year t
77	EG_{t-1}	is the total garments export at previous year
78	EO_t	is other exports at year t
79	W_t	is the world economic growth at year t
80	ES_t	is the export services in year t
81	M_{ct}^n	is the total economy commodity imports at year t
82	M_{st}	is the total services imports at year t
83	M_t^i	is the import of ith commodity or commodity group in year t
84	M^{kg}_t	imports of capital goods in year t
85	M^{ig}_t	imported intermediate goods in year t
86	M^{cg}_t	imported consumption good in year t

Macro-Fiscal Model's Variables (concluded)

No.	variable (symbol)	variable interpretation
87	P_{mi}	is the import price index for commodity (i) in year t
88	P_d^t	is the consumer price index at year t
89	M^i_{t-1}	is the ith commodity's imports into the economy in year t-1
90	GS_{t-1}	is the government expenditure on Goods and Services in t-1
91	y_t	is per-capita real income
92	RMD_t	is real money demand in year t
93	GNI_t	is real gross national income (GNP)
94	$RINR_t$	is the short term real interest rate in year t
95	SM_{t-1}	is actual stock of money at previous year
96	M_2^t	is broad money supply at year t
97	NX_t	nominal gross domestic product (X)
98	VM_t	is the velocity of the money in year t (= NX_t/M_2)
99	P_m^t	is the total imports price index
100	BOT_t	is the balance of trade in year t
101	M_t^n	is the total imports of the economy, i.e. [$M_t^n = M_{ct} + M_{st}$]
102	CAB_t	is the current account balance at year t
103	ONT_t	is estimated other net transfers in year t
104	FIR_t and FIR_{t-1}	are the foreign investment revenues paid by Bangladesh in current year and last year respectively
105	$NCAPA_{t-1}$	is the net capital account of the economy's BoPs
106	RNI_t	is revenue from Bangladesh investment abroad in year t
107	NRV_{t-1}	is the national reserve (foreign currencies) at year t-1
108	$CAPAB_t$	is the BoPs capital account in year t
109	$BoPs_t$	is the country balance of payments in year t

3.2 The Model's Coefficients

Below are the main coefficients of the model that required to be estimated:

Table -2- : Macro-Fiscal Model's Coefficients

No.	Coefficient Symbol	Coefficient's Name
1	$\alpha\varkappa$	Productivity of Capital
2	$1-\alpha\varkappa$	Productivity of Labour
3	A_t	Total Factor Productivity
4	α_{lb}	Constant Term of Sectoral Labour Function Estimates
5	l	Sectoral Labour-Output Ratio
6	α_1	Constant term of the Consumption Function Estimates
7	β_1	Income Elasticity of Consumption
8	β_2	Lagged Consumption Elasticity
9	α_g	Public Investment Constant Term
10	μ_1	Public Investment Coefficient Related to Government Revenue
11	μ_2	Public Investment Coefficient Related to Annual Development Programme
12	α_E	Constant Term for Other Exports

The Model's Main Coefficients and the Constant Terms

No.	Coefficient Symbol	Coefficient's Name
13	γ_1	Other Exports Coefficient of World Economic Growth
14	γ_2	Other Exports Coefficient of Real Exchange rate
15	γ_3	Other Exports Coefficient of Terms of Trade
16	α_m	Constant Term -commodity imports by by commodity Type
17	ν_{n1}	Total Commodity Imports Coefficient/Output
18	ν_{n2}	Total Commodity Imports Coefficient/Imports relative Prices
19	ν_{n3}	Total Commodity Imports Coefficient/Lagged Commodity Imports
20	ν_1^i	Commodity i Imports Coefficient/Output
21	ν_2^i	Commodity i Imports Coefficient/Imports relative Prices
22	ν_3^i	Commodity i Imports Coefficient/Lagged Commodity Imports
23	α_{dt}	Direct Tax Estimate Constant Term
24	σ	Direct Tax Coefficient of Per-Capita Income
25	α_{cust}	Constant Term for Customs Revenue Estimate
26	τ	Coefficient of Custom Revenue-Commodity imports
27	α_{vat}	Constant Term of VAT Revenue Estimates
28	π_{vat}	Coefficient of VAT Revenue/Per-Capita Consumption
29	α_{ri}	Constant Term of Revenue from Investment Abroad
30	η	Investment Abroad Coefficient
31	α_{md}	Money Demand Constant Term Estimates
32	θ_1	Money Demand Coefficient/ National Income
33	θ_2	Coefficient of Money Demand Related to Real Interest Rate
34	θ_3	Money Demand Coefficient Estimates in Relation To Lagged Stock of Money
35	α_{gov}	Constant Term of Government Spending/Inflation Estimates
36	s	Coefficient of Impact of Government Expenditure on Inflation
37	α_{vm}	Constant term of Velocity of Money/Inflation
38	z	Inflation Coefficient of Velocity of Money
39	α_{mp}	Constant Term Import Prices on Inflation
40	q	Inflation Coefficient of Import Prices
41	α_{mk}	Constant term of imported capital goods price on inflation
42	q_1	Inflation impact of imported capital goods prices
43	α_{mr}	Constant term of imported Intermediate goods price on inflation
44	q_2	Inflation impact of imported intermediate goods prices
45	α_{mc}	Constant term of imported consumption goods price on inflation
46	q_3	Inflation impact of imported consumption goods prices

3.3 The Model's Policy Variables and Exogenous Parameters

The following is a set of policy variables and exogenous parameters, which would be used as instruments by decision makers, to introduce different economic and fiscal policy alternatives.

Hence, assessing and measuring their impacts, using the build-in alternative scenarios implication of the macro-fiscal model.

Table -3- : The Main Policy Variables and Exogenous Parameters

No.	Detail	Parameter
1	Incremental Capital-Output Ratio	**ICOR (k)**
2	Rate of Depreciation	**d**
3	Labour-Output Ratio	ι
4	Sectoral Share in GDP (Agriculture Sectoral Structure)	φ_1
5	Sectoral Share in GDP (Industrial Sectoral Structure)	φ_2
6	Sectoral Share in GDP (Services Sectoral Structure)	φ_3
7	Productivity Growth Rate	**p**
8	Capacity Utilization Rate	**Ω**
9	Growth rate of Labour Supply	**lsg**
10	Growth Rate of Wages, Salaries & Allowances	r_{wsa}
11	Growth Rate Of Expenditure on Goods & Services	**λ**
12	Growth Rate of Annual Devl. Prog. Investment	r_{adp}
13	Growth Rate of Non-Annual Devel. Prog. Invest.	r_{nadp}
14	Proportion of Energy and Fuel Subsidies to G_t	$_{pes}$
15	Growth Rate of Food and Other Subsidies	δ_{os}
16	Proportion of Other Govt. Expen. To G_t	pro_{gco}
17	Natural growth of population	r_{pop}
18	Share of domestic debt in total debt	p_{dd}
19	Share of external debt in total debt	p_{ed}
20	Average interest rate on domestic public borrowing	π_1
21	Average interest rate on external public borrowing	π_2
22	Change in Stock Propor. To Total Supply	**ρc**
23	Propor. Of BGD Garment Export to the World Garment Trade	σ_{gt}
24	Growth Rate of Garment Export	r_{eg}
25	Proportion of Import of Services to total commodity Imports	λ_{sp}
26	Rate of Value-Added Tax	**RVAT**
27	Proportion of export services to total commodity exports	λ_{es}
28	Proportion of Non-Tax Revenue to GDP (X)	ω_{ntr}
29	Growth Rate of Remittances	r^e
30	Growth Rate of Other Net Transfers	r^{on}
31	Proportion of Net Foreign Invest. Returns	δ^{fi}
32	The New Planned Rate for Value-Added Tax	**NRVAT**
33	Value -Added Tax Proportion to Total Final Demand at yeat t	$VATFC_t$

3.4 The Macro-Fiscal Forecasting Model Complete System of Equations:

The followings are the main equations system of the model that have been solved in an integral manner and simultaneously, with the main segments of the economy have been dealt with separately and in an integral and joint manner, when the model has empirically articulated and implemented, both; for forecasting and decision making:

The Macro-Fiscal Forecasting Model's Equations	
The Main Equations	**No.**
$X_t = \Omega_t \ CP_{t-1} = X_{t-1} + \Omega_t (PC_t - PC_{t-1}) + (\Omega_t - \Omega_{t-1}) CP_{t-1}$	**1**
$\Omega_t = X_t / CP_t$	**2**
$CP_t = K_{t-1} / k$	**3**
$K_t = (1- ď) K_{t-1} + I^n_t$ and $K_{t-1} = (1- ď) K_{t-2} + I^n_{t-1}$	**4**
$r = [X_t / X_0]^{1/n} - 1$	**5**
$X_t = \Sigma X^i_t$ (i= 1,…..n , and n =3) {Agr., Ind., & Ser.}	**6**
$X^i_t = \varphi_i X_t$	**7**
$X^{ag}_t = \varphi_1 X_t$	**8**
$X^{in}_t = \varphi_2 X_t$	**9**
$X^{sv}_t = \varphi_3 X_t$	**10**
$r^i = (X^i_t / X^i_0)^{1/n} -1$	**11**
$r = \Sigma \{ r^i * X^i_t / \Sigma X^i_t \}$	**12**
$X_t = A_t [K_t^{\alpha_K} L_t^{1-\alpha_K}]$	**13**
$L_t = \alpha_{lb} + l X_t$	**14**
$L^s_t = (1 + lsg) L^s_{t-1}$	**15**
$ROU_t = (L^s_t - L_t)/ L^s_t$	**17**
$g_e = \{ L^s_t / L^s_0 \}^{1/n} -1$	**18**
$P^t_ℓ = X_t / L_t$ and $P^0_ℓ = X_0 / L_0$	**19**
$\rho_ℓ = \{ P^t_ℓ / P^0_ℓ \}^{1/n} -1$	**20**
$X_t = C_t + G_t + I_t + CS_t + E_t – M_t = GDP$	**21**
$c_t = \alpha_1 + \beta_1 din + \beta_2 c_{t-1}$	**22**
$c_t = C_t / POP_t$ and $POP_t = (1 + r_{pop}) POP_{t-1}$	**23**
$din_t = DIN_t / POP_t$	**24**
$DIN_t = GNDI_t - DTR_t$	**25**
$GNDI_t = X_t + NR_t + RNI_t + ONT_t$	**26**
$GNI_t = X_t + NR^e_t$	**27**
$G_t = WSA_t + GS_t + FOCS_t + EFS_t + GCO_t + PDS_{t\ r}$	**28**
$GE_t = G_t + ADP_t + NADP_t$	**29**
$WSA_t = (1 + r_{wsa}) WSA_{t-1}$	**30**
$GS_{t\ =\ c} GS^{\lambda}_{t-1\ ,\ or}$ $GS_{\ =} (1 + \lambda) GS_{t-1}$	**31**
$ADP_t = (1 + r_{adp}) ADP_{t-1}$	**32**
$NADP_t = (1+ r_{nadp}) NADP_{t-1}$	**33**
$EFS_t = pes (G_{t-1})$	**34**
$FOCS_t = (1 + \delta_{os}) FOCS_{t-1}$	**35**
$GCO_t = pro_{gco} (G_{t-1})$	**36**
$PDS_t = \pi_1 DD_{t-1} + \pi_2 ED_{t-1}$	**37**
$I^n_t = I^g_t + I^p_t$	**38**

Model's Equations (Cont.)	**No.**
$I_t^g = \alpha_g + \mu (I^g_{t-1} ((ADP_t + NADP_t) / (ADP_{t-1} + NADP_{t-1})) + \varepsilon_t$	**39**
$I_t^p = I_t^n - I_t^g$	**40**
$I_t^n = k (X_t - X_{t-1})$	**41**
$I_t^n = I_t^g + I_t^p = S_t + (NR_t^e + RNI_t + ONT_t + \Delta NRV_t)$	**42**
$S_t = X_t - (C_t + G_t + CS_t)$	**43**
$CS_t = \rho c (X_t + M_t)$	**44**
$EG_t = \sigma_{gt} WGT_t$	**45**
$EG_t = (1 + r_{eg}) EG_{t-1}$	**46**
$EO_t = \alpha_E + \gamma_1 X_t + \gamma_3 TOT_t$	**47**
$EC_t = EG_t + EO_t$	**48**
$ES_t = \lambda_{es} EC_t$	**49**
$E_t = EC_t + ES_t$	**50**
$M_{ct} = \alpha_n + \nu_{n1} X_t + \upsilon_{n2} P_{mt}^n / P_d^t + \nu_{n3} M_{c\,t-1}$	**51**
$M_{ct}^i = \alpha_m + \nu_1^i X_t + \upsilon_2^i P_{mt}^i / P_d^t + \nu_3^i M_{c\,t-1}^i$	**52**
$Ms_t = \lambda_{sp} Mc_t$	**53**
$M_t = Mc_t + Ms_t$	**54**
$C_t + G_t + I_t^n + CS_t + E_t = X_t + M_t$	**55**
[DEMAND SIDE] [SUPPLY SIDE]	
$R_t = TR_t + NTR_t$	**56**
$TR_t = DTR_t + ITR_t$	**57**
$dtr_t = \alpha_{dt} + \sigma y_t$	**58**
$y_t = X_t / POP_t$, and $dtr_t = DTR_t / POP_t$	**59**
$ITR_t = CUS_t + VAT_t$	**60**
$CUS_t = \alpha_{cust} + \tau M_t$	**61**
$VAT_t = (NRVAT_t * V ATFC_{t-1} / RVAT_{t-1}) (F_t)$	**62**
$F_t = C_t + G_t + I_t^n$	**63**
$NTR_t = \omega_{ntr} (X_t)$	**64**
$BB_t = (DTR_t + ITR_t + NTR_t) - (WSA_t + GS_t + EFS_t + FOCS_t + GCO_t + PDS_t) - I_t^g$	**65**
$BB_t = \Delta PD_t$, When BB_t <Zero	**66**
$PD_t = PD_{t-1} + \Delta PD_t$	**67**
$PD_{t-1} = DD_{t-1} + ED_{t-1}$	**68**
$DD_t = p_{dd} (PD_t)$	**69**
$EDt = p_{ed} (PD_t)$	**70**
$RMD_t = \alpha_{md} + \Theta_1 GNI_t + \Theta_2 RINR_t + \Theta_4 SM_{t-1} + \varepsilon_t$	**71**
$BOT_t = E_t - M_t^n$	**72**
$CAB_t = BOT_t + NR^e_t + ONT_t$	**73**
$NR^e_t = (1 + r_e) NR^e_{t-1}$	**74**
$ONT_t = (1 + r_{on}) ONT_{t-1}$	**75**
$FIR_t = FIR_{t-1} + \delta_{fi} NCAPA_{t-1}$	**76**
$RNI_t = \alpha_{RI} + \eta NRV_{t-1}$	**77**
$CAPAB_t = RNI_t - FIR_t$	**78**
$BoPs_t = CAB_t + CAPAB_t$	**79**
$\Delta NRV_t = CAB_t + CAPAB_t = NRV_t - NRV_{t-1}$	**80**
$P^d_t = \alpha_{gov} + s G_t + \varepsilon_t$	**81**
$P^d_t = \alpha_{vm} + z (NX_t / M2_t) + \varepsilon_t$	**82**
$P^d_t = \alpha_m + q Pm_t^n + \varepsilon_t$	**83**
$P^d_t = \alpha_{mp} + q_1 Pm_t^i + \varepsilon_t$	**84**

4. The Interpretations of the Macro-Fiscal Model's Equations and Their Uses:

As it is a very well established economic fact that there would be quantitative development consequences and impacts of the likely GDP growth rate on the budget structure and balances, investment requirements and its saving balances/unbalances, balance of payments contents and movements, employment and productivities, to mentioned but a few. It is therefore imperative from economic equilibrium and development balancing and potentiality point of view to determine, objectively, through a well-structured and economically balanced mechanism, the growth rate of an economy rather than subjectively or politically predetermined rate. Accordingly, and in this circumstance, this has been approached, in modelling sense, by modelling and forecasting both; the production (the supply side) of the economy and the expenditure (the demand side) in the national economy of Bangladesh [**See** Al-Ali, Hashim (2012). *ibid*].

Equations **(1-5)** specified the reality that product is a function of the productive capacity available in the economy and productive capacity utilization rate. However, statistical data needs to be examined to determine whether there is full capacity utilization in various sectors of the economy. Results of less than full capacity utilization means that it is quite possible to increase production at a given sector and hence at the economy as a whole, by increasing the rate of capacity utilization, and without any additional increases in sectoral and/or total national investment. Given the above, the structure of these equation has been formulated in such a way to deriving and forecasting the product in the economy.

The Production capacity at any year, by and large, is equal to the total capital in the previous year, divided by the average capital-output ratio. That said the average capital-output ratio (**$\alpha\kappa$),** has been derived in Bangladesh economy and converged to be, almost, equivalent to the incremental capital-output ration (ICOR) of the economy.

It is an economic and quantitative fact that the gross domestic product for an economy is the sum of the national economy's various sector component products. Accordingly, equations **(6-12)** of the integrated model depicting these sectoral products relationship in the economy. Hence, deriving the economy growth rate as the weighted average of the various sectors rates of growth. By doing so the link between macroeconomic and sectoral activities and growth would be established and quantified.

Furthermore, we have attempted to bring together the different components of the production function: capital, labour and others. Equation **(13)** has defined such a production

function relationships. It is well acknowledge in the modelling literature that the basic production function adopted in most models is the constant elasticity of substitution (CES) function. This basic framework however, and in most of the empirical literature on economic growth, is a growth accounting approach which looks at the evolution of labour, capital and technological progress and their contribution to overall growth.

The total factor productivity **(TFP)** growth, which is dependent on factors such as technology, openness to international trade and institutional quality, has been introduced in this modelling equation and calculated as a Solow's residual [The Solow residual originated through the works of Robert M. Solow, an American economist and recipient of the Nobel Memorial Prize in Economic Sciences (1987).The Solow residual is a value that measures changes in productivity growth in a Solow growth model, which describes an entire economy's production function. Productivity growth refers to rising output occurring with constant labor and capital input.]. However, adjustment for the quality of the labour force (employment) and quality of the capital stock, variables that reflect measure of educational and skills attainment and new investment quality can be introduced in the production function formula. Hence, growth in output can be decomposed into output per worker and contribution of growth by capital per worker. However, this would reflect the contribution of the increase in education and the contribution of improvements in new investment and technological progress. This could be added to the model's calculation when the right information is available, within the economy.

However, growth in total-factor productivity (TFP) represents output growth not accounted for by the growth in inputs. Accordingly, it is a measure of the empirical productivity growth in an industry (sector) or in a total economy over comparable time periods, such as from year to year and decade to decade. The measure is deemed residual because its growth is not explained by capital accumulation or any increase in labor.

Given the above aggregated production function structure, solution and the contribution of labour and its productivity to the growth rate of the economy, we have modelled the labour requirements and its productivity in the national economy of Bangladesh. Equations **(14-20)** of the model have been structured and numerically solved to identify and obtain the employment, the size of demand on labour, the labour and labour force supply, labour productivity, productivity and labour growth rates and rate of the unemployment in the economy.

It is imperative to state that it is a fundamental development and growth alternative strategy to rely on labour market factors, such as; productivity and employment growth to derive

and forecasting the growth rate of the GDP for the economy, at a given point of time. Given the fact that Bangladesh has quite high international labour comparative advantage.

The demand (expenditure) side of the economy; this is the most comprehensive approach to forecast basic macroeconomic variables, and to project the GDP growth rate of the economy, during the coming medium term budgetary periods. The approach analyzes and forecasts the national products and its growth rate, through analyzing and forecasting the various final demand components of the economy. That said, These structured relationships, have been empirically articulated using a well derived and harmonized time series set of operational statistical data available in the economy. These data has been worked out to fit the modelling structural set of equations that have designed for each component of the final demand on gross domestic product in the national economy. Thus, by and large, the main observed component variables of the final uses of domestic product can be, in this phase of modelling efforts, presented as:

Household Final Consumption + Government Consumption Expenditures + Investment (Government and Private) + Changes in Stock + Exports – Imports = GDP.

This can be written as:

$$\mathbf{X_t = C_t + G_t + I_t + CS_t + E_t - M_t = GDP}$$

In our implemented integrated macroeconomic-fiscal model setting, equations **(21-54)** have been designed, structured and solved to quantify all the final demand components of the national economy. That said, equations **(22-27)** have quantified and solved for private consumption demand and its perspective. While equations **(28-37)**, have been structured and articulated to forecast for government recurrent expenditure, as part of the fiscal sector segment, in the economy, by its different items and uses. Furthermore, gross investment size and contents in the economy, together with its two main institutional (public and private sector) belonging, have been modelled and quantified, together with the investment-saving equilibrium/gap, these are all reflected through equations **(38-43)**. As a vital strategic development prerequisite is to sustain macroeconomic stability and fiscal sustainability in the economy, the financing domestic investment is considered to be an important policy issue and an integral part of the macroeconomic-fiscal modelling structure and policy variables for a developing economies, such as the Bangladesh economy. The primary objective is to **finance investment** through the national saving (and national resources). However, when national available saving is not sufficient to finance total required investment, and this, however, is the case in many developing

economies, with lack of endowment resources, and Bangladesh is not an exception. In this case, policy makers usually resort to adopting different policies and procedures, that need to be adopted, to supplement national saving, and to finance the required investment programme. These procedures, amongst others, should create the right environment to attract foreign direct investment **(FDI)**, issuing special stocks and bonds in the capital market and/or borrowing from financial market (financial and banking institutions other than the central bank). With this in mind, both equations; **(42)** and **(43)** have been structured and solved to shed a light on the status of the indigenous resources to finance the required investment in the economy. While equation **(44)** has dealt with likely changes in stocks. Nonetheless, the variable changes in stock would normally consider a host of items. These for example; a) main input material that using in production, b) output or commodities that are ready for marketing, and c) work in progress. However, the changes in stock is determined by factors such as the flows and circulations of the domestic supply which consist of domestic output and imports, sales forecasts and changes in factors that determine the overall demand on goods and services. That said, the intensity of stock accumulation depending on the economic systems in hand and its characteristics. Closed economies with restricted trade flexibilities characterized by increasing stock accumulation to prevent any negative impact on domestic production, supply and prices, while the stock accumulations in more open and liberal economies are quite relaxed in these type economies. The export component of the final demand as well as part of the external sector segment, has been handled, being export of garment or other types of export, including export of services [Service exports are defined to include shipping, insurance and transport received by Bangladesh companies and organizations including the expenditures of foreign travelers (tourists) and government in Bangladesh. However, services exports, on this occasion, are not related to the level of commodity exported by Bangladesh, rather it has been treated as exogenous, using a different methodology that relaying on historical time trends], by equations **(45-48)**. In addition, the imports side of the external sector segment of the economy, being a total import and import of different commodities into Bangladesh, have been quantified and identified by articulating and solving equations **(49-53)** of the integrated macro-fiscal model. This is the case, given the fact that imports into Bangladesh, are in general treated as supply factors rather than demand component, and hence imports are used to complement a domestic supply and/or closing a supply gap(s) within the national economy. Having said that, it is also imperative, and in order to achieve higher forecasting accuracy, in this applied model, we have adopted, modelled and solved for import requirements, not only for total import requirements rather this has been articulated on

group of homogenous commodities and/or individual commodity basis. However, it has to be mentioned that these import modelling equations, have distinguished between import of commodities and services imported [Imported services are meant to include payments to shipping, insurance and transportation of imported commodities into Bangladesh. This also includes expenditures of Bangladeshi travelers abroad and government services. This, however, has been calculated and forecasted as a given percentage of total imports into the economy]. That said, Moreover, and in order to establish the overall macroeconomic equilibrium of the economy, equation **(54)** has been structured and numerically characterized to stipulate the equilibrium conditions of the Bangladesh economy and the way its evolving through time. This, by and large, is imperative from macroeconomic stability conditions, where a balanced supply and demand within the national economy is adhered to, at each point of time. Such an equilibrium state in the economy is vital, and can be considered as a development prerequisite norm, to achieve, amongst others, general price stability, balancing aggregated saving with investment, a stabilized exchange rate, and fluctuation-free changes in commodity stocks.

Government revenue, as part of fiscal sector modelling segment; revenue forecasts are widely regarded as a key element for the design and execution of sound fiscal policies. Forecasts should be realistic and have a minimum margin of error otherwise large forecast errors can create significant budget and fiscal management problems, such as budget deficit and hindering the spending policy, and imposing a serious obstacle to the development of a meaningful medium-term budget framework. Moreover, unrealistic budget framework settings are inconsistent with basic principles of transparency and reduce accountability of fiscal operations. In developing countries, forecasting errors cannot be avoided entirely and in many cases revenue estimates have systematically deviated from actually realized revenue. However, the principle of sustainable government finances requires government spending to be covered by government revenue over the medium-term (around three to four years). A key element of prudent fiscal policy is that it helps create the conditions for maximizing sustainable economic growth. Importantly, it can contribute to national saving, facilitate a lower interest rate environment, promote steady and sustainable demand growth, provide a reasonable degree of stability and predictability of policy, and provide for efficient government taxation and spending systems [For further details of the equations' economic and other interpretations and fiscal policy orientations and directions, See Al-Ali, Hashim (2012)]. Given such economic and fiscal significance of having better and more realistic revenue forecasting, equations **(55-63)** of the macro-fiscal forecasting model, have been designed, structured and numerically solved to determine the likely revenues that can be flow into the government treasury, and hence, to determine the budgetary

resource envelop. These equations have been formulated and solved for tax, and non-tax revenue. Within the tax revenue they also being solved to determine the direct tax and indirect tax revenue. Furthermore, equations to forecast the outlook for income tax revenue, value-added tax (VAT) and customs revenue, have been formulated and empirically articulated. As the optimal objective of any developing economy is to achieve a nationally balanced budget, equation **(64)** was structured in such a way to determine the overall budget conditions in the country. Hence, whether there is going to be a public account or fiscal equilibrium in a given year or not. However, such equilibrium and/or surplus in the government account, could be very difficult to achieved, particularly, for developing countries with limited natural endowment resources, in a short to medium term. Given such prevailed reality in Bangladesh, for example, it looks quite challenging to fulfill a targeted balanced budget in the near future. Undoubtedly, in such a situation, the government has to resort to and adopt a borrowing policy in order to balance the nations' budget, and hence offsetting the likely budget deficit. Accordingly, equations **(65-67)** have been solved to identify, in quantitative sense, the volume of likely additional required annual borrowing to balance the public account. This borrowing has its both; domestic and external dimensions. Nonetheless, it is economically viable, in this case, as there is no development or budgetary reason preventing an occurrence of a public debt, as long as such debt is well calculated, to meet well defined needs, together with maximum efficiency in obtain and use. More importantly, such needed debt should be mobilized and acquired from different sources and means other than through the Bangladesh Bank (Central Bank). At this juncture, it is worth stating that public borrowing should be based on issuing treasury bills and government bonds, where the private banking systems, private sector institutions and individuals can contribute to such debt, using their access to liquidity, deposits and savings. This will, undoubtedly, leads to optimal mobilizing of financial resources, better utilization of idle savings (or hoardings), curtailing debt accumulation and enhancing economic growth and development.

The set of equations **(68)** depicts the **monetary aspect of the financial sector segment**. It captured money demand, supply, real interest rate and other related variables. That said, one of the strategies that should be considered by the Bangladesh Bank (BB), would be to develop an approach to a monetary target, that preserves the automatic stabilizing properties of unsterilized intervention to stabilize the prices, exchange rate and the like. Hence, this could give primacy to the exchange rate while monitoring base money as a source of information on development. Or in another word, could give primacy to the base money target, allowing the market exchange rate

to do more of the adjusting. In the near future, emphasizing money supply, money demand and exchange rate stability, to anchor inflation expectations, is almost unavoidable. With this in mind, the monetary aggregate characteristic of the Bangladesh economy, accordingly, has been modeled. It is a de facto, money demand in an economy is; determine by real income, interest rate and rate of inflation. In another word interest rate is, by and large, reflecting the opportunity cost of holding money. While inflationary measures, and the likely impact on domestic inflation rate, and price movements in Bangladesh economy, resulting from government recurrent expenditure, money supply and velocity of money, changing in the world commodity price and overall changes in Bangladesh imports price movements. These financial sector and monetary segment related inflation impacts are shown in equations **(78-81)** respectively.

Last but not the least, the complete external sector segment modelling and articulation, is postulated by the set of systems of equation **(69-77),** where the overall aggregate and detailed components of each of the balance of trade (BOT), current account balance (CAB), capital account balance (CAPAB) and balance of payments (PoBs), have all been specified, modelled and articulated using the disaggregated and indicated equations, (for further details please see Al-Ali, Hashim (2012) [The four segments modelling modules (real sector, fiscal, financial and external) have been structure, numerically articulated, implemented, documented and submitted, in November 2012.].

5. The Modelling Statistical Data Inputs, Sources and Valuation Settings

After designing and constructing the macro-fiscal forecasting model for the Bangladesh economy, the author has carried out a national data assessment and analysis. Resulting from these efforts, data gaps within the national economy have been identified, as well as the data requirements by the model on different segments of the economy and on various variables within each segments, have been specified and thoroughly defined [**See** for the detail data assessment and data requirement: Al-Ali, Hashim (2012) "Statistical Data Assessment and Data Requirements for the Macro-Fiscal Modelling Implementation", Technical Report No. -4-, MEW/MOF, Dhaka, March.].

The main purpose of this section of the report is to shed a light on and present the data input and the database that used to solve various model's equations, the source of these data and the data valuation and uses of different deflators for different type of variables, within the overall model's framework.

5.1 The Inputs Data and their Dimensions; obtaining, organizing and cleaning and structuring a complete macroeconomic database, with a substantive and statistically viable size of

observations (number of time series/historical years), was the most difficult, cumbersome and time consuming exercise during this assignment. However, the team was quite successful in handling this, with higher degree of statistical reliability and efficiency. After having identified the data requirement for applying the Bangladesh macro-fiscal forecasting model (BMFFM), and after the statistical gaps being delineated, we have embarked on the task to build an integrated macroeconomic database for the macroeconomic wing (MEW) of the finance division (FD) at the MOF. This was the case, with the planned outcome of this macroeconomic database, to be a complete set of data that required to calibrating our model. The final results of this lengthy exercise was a complete, gapless, consistent and clean Excel-based spreadsheets macroeconomic database. Such prepared, manipulated and used database, has covered, as inputs into the model, 22 years (1990-2011), and over 82 variables (columns). These statistical data inputs, have been structured and finalized to cover the real economy, fiscal, monetary, and external sector's variables and indicators.

5.2 The Main Sources of the Original Statistical Data; The main sources of the data that have been collected, manipulated, adjusted and finalized are, amongst others, the following:

- Bangladesh Bureau of Statistics (BBS)
- Bangladesh Bank (BB)
- Finance Division (FD), various Wings and Divisions, at the Ministry of Finance (MOF)
- National Board of Revenue (NBR)
- iBAS system at the MOF Project
- Export Promotion Bureau (EPB)

All the basic data by field and function have been collected from the related functional data sources above, on real, fiscal, financial and external sectors of the economy. These basic data being obtained through, among other means, published hard copies data, soft copies, from related organizations web-site, through field visits, joint meetings and conference calls.

5.3 The Valuation and Pricing System for the model and its Variables; All the data that we have collected, and those published by BBS, BB, FD and other data sources and data providers, are shown in nominal term. However, most of the real sector data, particularly, those related to GDP, on both supply and expenditure sides, are given in constant (real) 1995-96 prices as a base. This is besides the fact that BBS is regularly compiling and disseminating a number of indices on various economic variables. Notwithstanding, the first thing that we have contemplating, is to change and rebase the base year that used to derive various variable in constant prices from 1995-

96 to year 2005-06 as a base year. This has been done in order to reduce the price reference period, when carrying out the future forecasting and deriving the new outlook, to a shorter time gap, and hence reducing such price base gap by ten years. Accordingly, the process of rebasing the constant prices version of the model's variables, to 2005-06, has been restructured and applied [Assume: X_i^{tcur} : is the sector i^{th} value-added at year t and in current prices, and X_i^{tcon} : is the i^{th} sectoral value-added in year t at constant 1995-96 prices. Hence; the GDP price index (Deflator) by sectors for 1995-96 can be derived as:

$P_i^{95-96} = X_i^{tcur} / X_i^{tcon}$ .However, from the results of applying the above equation, a new price index for a selective new base-year can be restructured. This selected new base year is 2005-06. Accordingly, the new index would be derived as:

$P_i^{x05-06} = P_i^t / P_i^{05-06}$, where, P_i^t is the price index of sector i in year t with 1995-96 base-year, P_i^{05-06} is the sectoral price index in year 2005-06, the column vector, with 95-96 as a base-year, and P_i^{x05-06} is the sectoral Price index with 2005-06 as a base-year. Accordingly, we have re-valued GDP figures and by sector value-added and by final demand expenditure categories, with the new derived price index matrix based on 2005-06 base-year. Hence, obtaining the real GDP figures by sectors, based on constant price base of 2005-06. This can be derived as: $X_i^{05-06} = X_i^t / P_i^{x\,05-06}$, where, X_i^{05-06} is the real GDP by sector value-added in constant 2005-06 prices, and X_i^t and P_i^{x05-06} as defined above. Nonetheless, it has to be stated that, this is just a mechanical statistical approach to establish real GDP figures at latest year, i.e. 2005-06, as a base-year].

In the model, however, a part from the above indicators, indices and CPI, what is important to us in this respect, are the various implicit deflators, that have been derived and used, other than CPI. These derived implicit deflators are used, in an economically appropriate settings, to transforming the variety of the model's variables, from being nominal to real. These, by and large, can be defined, with their related functions, as:

- **National Accounts Deflators:** These are indices used national accounts estimation particularly for constant price estimate of gross value added and also for sectoral growth estimation. Instead of considering sectoral deflator, we used implicit GDP deflator (GDPD) for forecasting.

- **Consumer Price Index (CPI):** BBS has started to compute national CPI on 1985-86 as base year. The base year has been updated to 1995-96. For model purposes, CPI index has been rebased to 2005-06. We have used CPI for deflating the following variables:

  a. Private consumption
  b. Public consumption
  c. Government revenue
  d. Government expenditure
  e. Independent credit disbarment
  f. Money supply

- **Investment Deflator:** Investment deflator is taken from National Accounts Statistics. The base year 1995-96 has been rebased to 2005-06.

- **Export Deflator:** Two types of deflator have been used for estimating real exports. These are: 'Unit Price Index of Export' from National Accounts Statistics and 'Unit Price Index of Major Export Items' from Foreign Trade Statistics. The latter being used for BoPs purposes.

- **Import Deflator:** Similar to the export, the two types of import indices are 'Unit Price Index of Import' of National Accounts Statistics and 'Unit Price Index of Major Import Items' of Foreign Trade Statistics. Again, the latter being used for the BoPs account purposes.

- The nominal values of aggregate merchandise exports and merchandise imports are **deflated** by the unit price index of exports and imports respectively in order to obtain real exports and imports (using FTS).

- For export and import of services are also **deflated** by the unit price index of exports and imports respectively (using FTS).

- As price indices of commodity groups are not available, we therefore used corresponding group indices from World Economic Outlook.

Table -4-The Price Indices and Used Implicit Deflators (2005-06 = 100)

FY	Cost of Living Index CPI	Imports Price Index Pm	Exports Price Index Pe	Implicit GDP Deflator Px	Inflation Rate Measured with	
					Implicit GDP Deflator	CPI
1990	43.65	41.85	47.11	53.57	-	-
1991	47.27	49.03	58.27	57.11	6.60	8.31
1992	49.46	58.71	58.91	58.80	2.97	4.63
1993	50.78	51.18	63.08	58.97	0.29	2.67
1994	52.45	57.88	65.61	61.20	3.77	3.28
1995	57.10	54.95	68.23	65.95	7.77	8.87
1996	60.90	56.61	70.23	68.48	3.83	6.65
1997	63.31	60.32	70.85	70.59	3.09	3.96
1998	68.79	67.67	77.70	74.30	5.25	8.66
1999	73.65	72.23	79.64	77.77	4.68	7.06
2000	75.70	71.69	82.52	79.22	1.86	2.79
2001	77.17	77.08	84.50	80.48	1.59	1.94
2002	79.33	82.88	86.49	83.05	3.19	2.79
2003	82.80	89.30	88.66	86.81	4.53	4.38
2004	87.63	92.92	94.95	90.49	4.24	5.83
2005	93.31	96.21	98.05	95.08	5.08	6.48
2006	100.00	100.00	100.00	100.00	5.17	7.17
2007	107.22	103.64	104.85	106.79	6.79	7.22
2008	117.86	131.62	116.38	116.17	8.79	9.93
2009	125.71	140.57	125.18	123.75	6.52	6.66
2010	134.91	148.56	132.69	131.76	6.47	7.31
2011	146.78	166.77	146.47	141.68	7.53	8.80

6. The Integrated Macro-Fiscal Forecasting Model's Programming Components and Applied Solutions

In this section, the solution of the integrated version of the macro-fiscal forecasting model is presented. After running and solving the model in its entirety, with the **"base-case'** scenario settings, and for all types of equations, the results would be presented for all the equations' solutions in the form of coefficients and policy variables and parameters. However, the detailed econometric estimations of the equations, with their statistical characteristics and various significance measures, are obtained applying E-Views Statistical Package, using the collected, cleaned, normalized and processed Bangladesh historical data for the period 1990-2011. Besides, and for carrying out applications of alternative development scenarios, and deriving alternative solutions, reflecting the implications of alternative policy selections, the model, and for this aspects, has been solved using "V-Basic" programming, in order to support the, aimed at and achieved, interactive and alternative policy scenarios solutions of the model.

System's outline; the Model is subdivided into four components. Those components are:

- The Coefficients and their values
- The Parameters and Policy Variables
- The Model's Variables Definition
- Tabulation of the Results

A brief description of each of these components has shown below.

6.1 The Coefficients and their Estimated Values:

This module deals with the Coefficient definition and the value. There are 52 Coefficient and their values have already obtained through solving the model's equation using E-Views statistical package. The values of these coefficients cannot be changed manually. Hence, these coefficients values only changing when a new set of data became available and new estimations have to be worked out and fed into the integration version of the model, as specified here.

Table -5- shows the econometrically estimated values of the, already, defined model's coefficients:

Table -5-: The Model's Main Coefficients and the Constant Terms

No.	Symbol	Value	No.	Symbol	Value	No.	Symbol	Value
1	$\alpha\varkappa$	0.6672	19	ν_{1k}	0.9455	37	θ_1	0.1159
2	$1-\alpha\varkappa$	0.3328	20	ν_{2k}	0.1795	38	θ_2	0.0092
3	A_t	3.5879	21	ν_{3k}	0.7469	39	θ_3	0.9702
4	α_{lb}	-5.3104	22	α_{mr}	-29.6637	40	α_{gov}	-5.7549
5	l	0.6048	23	ν_{1r}	2.5775	41	s	0.8443
6	α_1	1.148	24	ν_{2r}	0.4988	42	α_{vm}	5.6982
7	β_1	0.3291	25	ν_{3r}	0.214	43	z	-1.2476
8	β_2	0.6798	26	α_{mc}	-12.1323	44	α_m	0.3619
9	α_g	-3.9941	27	ν_{1c}	1.1928	45	q	0.9105
10	μ_1	1.3195	28	ν_{2c}	0.0852	46	α_{mk}	0.6386
11	α_E	-9.8589	29	ν_{3c}	0.5583	47	q_1	0.871
12	γ_1	0.8097	30	α_{dt}	-9.145	48	α_{mr}	0.006
13	γ_2	2.0556	31	σ	1.5183	49	q_2	0.9841
14	α_m	-11.5477	32	α_{cust}	8.5279	50	α_{mc}	-0.3371
15	ν_{n1}	1.5859	33	τ	0.1918	51	q_3	1.0261
16	ν_{n2}	-1.4239	34	α_{ri}	4.7947			
17	ν_{n3}	0.0889	35	η	0.3211			
18	α_{mk}	-11.4383	36	α_{md}	-1.2498			

The full economic definitions of these resultant coefficients are given on table -2-, section (3.2).

6.2 The Main Model's Parameters and Exogenous Policy variables:

The model has been solved with the Bangladesh economic and statistical data of 1990-2011 financial years, and accordingly, a base-case scenario solution has been established for years 2012 to 2020. As the model design has been geared, in addition to its nature as forecasting model, towards use as a policy tool for carrying out alternative scenario implications, the model's built-in mechanism and the solution has been structured in such a way that the impacts of various changes in decision variable(s) can be determined and measured.

At this point in time, a number of policy variables, which are part of the model's fabrication and assumptions, can be selected, out of various derived and quantified parameters, and used as developmental instruments; hence the effects of any change and its impact on the economy can be realized.

This module of the programme deals with the Parameters definition and the value. There are 41 Parameters and policy Scenario variables where their values are already defined, to derive the best case solution as have been given in the model. The value of this policy variables, as it

mentioned above, would be the instruments that can be changed, to reflect policy choices and directions, and hence, the changed values would affect the next run of the model, and creating new solution reflect the new selected policy directions. Table -6- depicts various parameters and policy variables derived values and setting during the model's data period.

These policy variables, amongst others, are; taxation level and rates, different incremental capital-output ratio (for the economy as a whole and/or by sector), non-tax revenue, subsidies, wage level, garment exports, private sector investment, remittance growth from abroad, level and pattern of government expenditure, Sectoral structural changes, productivity growth rate, economic growth rate (imposing new and decision rate), labour productivity growth rate, and so on.

The quantitative impacts of changing the level and direction of any of these policy variables can be measured and traced, by the model's mechanism on a variety of macro and sectoral variables of the economy. For example; the impacts of a change in policy variables and developmental instruments on: GDP, investment requirements, import requirements, employment opportunities, balance of trade and current account balance situations, different sectors' output growth, etc. can be worked out, by the model's structured algorithm and its solution mechanism.

Table -6- : The Main Policy Variables and Exogenous Parameters [It is an evident from the derived values of both parameters, i.e. the productive capacity utilization factor (Ω) and the rate of capital depreciation (), that the capacity and the capital have been used intensively, and for a longer period, by keeping maintaining the machineries and equipment in order to prolong their uses. This is besides, the fact that the productive capacity available, is always being used, in most of industries and sectors, for more than two working shifts. That means getting more output from the same designed capacity. This is, indeed, resulting from low cost labour and scarcity of capital, that prevailing in the economy**]**

No.	Parameter	Value	No.	Parameter	Value
1	ICOR (k)	4.2	17	r_{pop}	0.016
2	d	0.043	18	p_{dd}	0.400
3	ι	1.295E-05	19	p_{ed}	0.600
4	φ_1	0.21	20	π_1	0.089
5	φ_2	0.25	21	π_2	0.012
6	φ_3	0.54	22	ρc	NA
7	p	0.019	23	σ_{gt}	0.024
8	Ω	1.87	24	r_{eg}	0.179
9	lsg	0.039	25	λ_{sp}	0.168
10	r_{wsa}	0.052	26	RVAT	0.15
11	λ	0.047	27	λ_{es}	o.139
12	r_{adp}	0.045	28	ω_{ntr}	0.018
13	r_{nadp}	0.089	29	r^{e}	0.181
14	$_{pes}$	0.092	30	r^{on}	0.159
15	δ_{os}	0.115	31	δ^{fi}	0.27
16	pro_{gco}	0.410	32	NRVAT	0.15
			33	VATFC	0.033

Accordingly, the model has incorporated quite few policy variables, as can be seen from the above table, which can be used as instruments and/or scenarios alternative variables' value, to measure the reaction of the economy to any change to the condition, in order of magnitude, of these policy variables. Hence, carrying out sensitivity analyses, which is related to the changes in any of these variables and their impacts on the economy as a whole, or on a given segment of the four segments of the national economy. However, **the policy variables, that are most relevant to Bangladesh economic conditions, and its stage of development, can be, amongst others, identified as: i)** budget Revenues mix-components, **ii)** taxation systems and rates, **ii)** private Sector Investment trends, **iv)** growth of garment exports, **v)** growth of remittance from abroad, **vi)** different incremental capital-output ratios (ICOR) for (different sectors) and/or for the economy as a whole, **vii)** growth rate of labour force and/or productivity, **viii)** subsidies pattern and proportional structure, **ix)** government employees wage level, **x)** government expenditure structure and pattern, by sector and/or line ministry, **xi)** change in sectoral structure within the economy (sectoral priorities), and **xii)** imports trend and/or commodity-mix.

Furthermore, these, and other, policy variables can be inputted, into the system as a percentage or absolute change. Hence, various scenarios can be ran, using the integrated model's systems solution's methodology.

6.3 Tabulation of the Selective Macro-Fiscal Forecasting Modelling Results:

Tabulation of the Results is the output of the model's application. The model when runs will generate tabulation of the Results start from 2011 to 2017. This being arrived at by using the modelling algorithms, together with the uses of the derived coefficients, parameters and policy variables, and in full interactions with the integrated behavioural and structural equations. The output is a excel sheet containing "base-case" scenario results.

At this point, the report will highlight some selective modelling results, whereby showing the likely behaviour of the most significant macroeconomic and fiscal variable, during the forecasting period (2011-2017). The following tables have depicted the model's results of some selected important macro-fiscal variables.

Table -7- : Demand Components and Supply Sources in the Bangladesh Economy during 2011-2017, in Tk billion (2005-06 Price)

	Demand Side of the Economy					Supply Side	
FY	**Private Consumption**	**Government Consumption**	**GFCF**	**Changes in Stock**	**Exports**	**GDP**	**Imports**
2011	4067.0	555.2	1421.1	-150.4	1239.3	5623.2	1509.0
2012	5121.7	764.3	1528.7	-1085.8	1541.0	6003.4	1866.5
2013	6048.9	887.7	1684.3	-1873.9	1790.5	6422.4	2115.1
2014	6908.6	1002.7	1803.6	-2526.8	2083.8	6871.1	2400.7
2015	7750.3	1122.4	1999.4	-3199.2	2429.0	7368.4	2733.5
2016	8605.1	1256.6	2123.5	-3812.9	2835.0	7896.6	3110.6
2017	9506.9	1417.5	2371.1	-4569.4	3313.1	8486.5	3552.7
The Compound Annual Growth Rate (%)	15.2	16.98.0	8.9	76.6	17.8	7.1[1]	15.3

Table -8-: Government Revenue by Main Components for the Years 2011-2017 in Tk billion

FY	**Total Revenue**	**Direct/Income Tax**	**Customs Duty**	**Value-Added Tax (VAT)**	**Non-Tax Revenue**
2011	537.6	175.0	73.3	199.1	90.2
2012	587.3	153.9	80.6	244.7	108.1
2013	650.3	169.1	82.6	283.0	115.6
2014	710.6	185.8	84.6	316.5	123.7
2015	775.6	204.9	86.7	351.3	132.6
2016	840.5	225.8	88.9	383.6	142.1
2017	914.9	249.8	91.2	421.1	152.8
Annual Growth Rate (%)	9.2	6.1	3.7	13.2	9.1

[1] It is worth mentioning here that the compound annual growth rate of the Bangladesh economy over the coming six financial years (2012-2017), measured according to the labour productivity and labour-force growth rates, that likely to be prevailed in the economy, according to the model solution and assumption, would be much lower than the growth rate generated through the, de facto, demand components, and their deduced growth based on their arrived at elasticities and related coefficients. This an economic reality that dominated most of developing economies where aggregate demand is over and above domestic productive capacity of the national labour market. Accordingly, the economy annual compound growth rate that can be brought about, through the combination of labour productivity and growth of the labour force in the economy, is driven as: $g_e = \{ L^s_t / L^s_0 \}^{1/n} - 1$

Where; g_e is the labour force growth rate in the economy, and L^s_t and L^s_0 are as defined before, labour force in terminal and base year respectively. While labour productivity growth (ρ_ℓ), can be aggregated and derived, by the model, as follows:

$$P^t_\ell = X_t / L_t \quad \text{and} \quad P^0_\ell = X_0 / L_0 \text{ , and hence; } \rho_\ell = \{ P^t_\ell / P^0_\ell \}^{1/n} - 1$$

Accordingly, and having forecasting and calculated the labour growth rate (g_e) and labour productivity growth rate (ρ_ℓ) in the economy, the growth rate of the GDP, (r), of the economy can be forecasted and derived as: $\ell og\ r = \ell og\ g_e * \ell og\ \rho_\ell$ .Therefore, the GDP growth rate (r) would be; $r = g_e + \rho_\ell$ Which would give an annual growth rate of (6.1) percent per annum, as was resulting from the MFFM solution, (i.e r= 0.023 + 0.039), during the model's period.

Table -9-: Government Expenditure by Types, for the Period 2011-2017 in Tk Billion

FY	Total Expenditure	Wages and Salaries	Goods and Services	Food Subsidies	Fuel and Energy Subsidies	ADP	Non-ADP	Public Debt Interest Paid	Other Govt. Expenditures[2]
2011	1053.2	137.0	69.91	92.7	80.0	236.0	32.1	156.2	249.2
2012	1045.9	144.2	73.19	103.4	51.1	246.7	35.0	164.8	227.6
2013	1183.6	151.7	76.63	115.2	70.3	257.8	38.1	160.5	313.4
2014	1290.4	159.5	80.23	128.5	77.4	269.4	41.5	188.8	345.1
2015	1386.8	167.8	84.01	143.3	80.8	281.5	45.2	223.9	360.3
2016	1485.3	176.6	87.95	159.7	82.3	294.1	49.2	268.8	366.7
2017	1597.1	185.7	92.09	178.1	82.4	307.4	53.5	330.7	367.3

Table -10- Bangladesh Commodities and Services Exports, 2011-2017 (in TK Billion)

FY	Garment Exports	Other Exports	Exports Services	Total Exports
2011	1014.4	100.0	124.9	1239.3
2012	1196.0	157.0	188.1	1541.0
2013	1410.1	161.9	218.5	1790.5
2014	1662.5	167.0	254.3	2083.8
2015	1960.1	172.5	296.4	2429.0
2016	2310.9	178.1	346.0	2835.0
2017	2724.6	184.2	404.3	3313.1
Annual Growth Rate (%)	17.9	10.7	21.6	17.8

Table -11- Bangladesh Commodities and Services Imports, 2011-2017 (in Tk Billion)

FY	Commodity Imports	Imports Services	Total Imports
2011	1296.7	212.3	1509.0
2012	1595.3	271.2	1866.5
2013	1807.8	307.3	2115.1
2014	2051.9	348.8	2400.7
2015	2336.3	397.2	2733.5
2016	2658.6	452.0	3110.6
2017	3036.5	516.2	3552.7
Annual Growth Rate (%)	15.2	16.1	15.4

Table -12- Bangladesh Labour-Force and Employment during the period 2011-2017 (in

[2] It can be seen from the runs and modelling results, that government recurrent spending needs to be curtailed and rationalized to reflect actual needs, priorities and to be in line with the overall required macroeconomic balance. Special emphasis should be given to rationalize the other government expenditure items.

million)

FY	Labour-Force	Employment	Rate of Unemployment (%)[3]
2011	58.08	54.95	5.4
2012	60.35	58.73	2.7
2013	62.70	61.17	2.5
2014	65.14	63.7	2.2
2015	67.68	66.43	1.8
2016	70.32	69.26	1.5
2017	73.07	72.32	1.1
Annual Growth Rate (%)	3.9	4.7	-23.2

Table -13- Bangladesh Workers' Remittance from Abroad, for the period 2011-2017 (in Tk billion)

FY	2011	2012	2013	2014	2015	2016	2017	Annual Growth Rate (%)
Amount in Tk billion	829.2	979.2	1156.5	1365.8	1613.0	1905.0	2249.7	18.1

Table - 14 -: Expected Public Debt during 2011-2017 in Tk billion[4]

FY	**Expected Public Debt**	**Change in Public Debt**	**Domestic Public Debt**	**External Public Debt**
2011	3212.2	241.7	1284.9	1927.3
2012	3750.5	538.3	1500.2	2250.3
2013	4413.0	662.5	1765.2	2647.8
2014	5232.4	819.4	2092.9	3139.4
2015	6281.8	1049.4	2512.7	3769.1
2016	7727.5	1445.7	3091.0	4636.5
2017	9939.9	2212.4	3975.9	5963.9

7. The Integrated Macro-Fiscal Model Features, Characteristics, Policy Uses and Future Directions -Concluding Remarks:

Under this section, a brief outlines of the main features, characteristic and envisaged uses of the model at the FD/MEW and other economic related institution in Bangladesh [The details of the model's characteristics and the main uses of the model in development planning and fiscal setting, are shown in the author's technical reports Nos. -3-, and -13- , submitted to MEW on January and December, 2012, respectively], have been illustrated.

[3] Calculated as $((L^s_t - L_t) / L^s_t) * 100$, with L^s_t is the labour-force and L_t is the employment in year t.

[4] The result is likely to hold acceptable until 2014, but not beyond as concerted efforts and rigorous measures need to be taken and applied to curtail the unnecessary government recurrent expenditures and enhance revenues, specially, through applying a clear and effective tax systems as well as strengthening the tax administration and increasing the tax collection efficiency and accountability.

7.1 The Principle Features of the Macro-Fiscal Forecasting Model:

The main principles of the model, in brief, are:

1. Develop a baseline ('As Is') forecast/solution for the Bangladesh economy.

2. Develop outlook and future forecast for various macro and fiscal variables and trends in the economy.

3. Introducing policy scenario alternatives and measure their likely impact for the Bangladesh economy.

4. Identify and determine priority sectors for investment and other government fund and expenditures allocation purposes.

5. Effective tool in establishing a medium term macroeconomic and fiscal framework (MTMFF), and creating the macro-sectoral links.

6. Provide an analytical framework for monitoring of the impact of the Budget, MTBF, DPs ….

7.2 Characteristics of Structuring and Articulation the Macro-Fiscal Modelling for Bangladesh Economy:

These main characteristics can be summarized as:

1. The Macro-Fiscal Model is a clear and interconnected, in a logical manner, sets of equations, variables, coefficients and parameters. All driven from the actual conditions of the Bangladesh economy.

2. The Macro-Fiscal Model is flexible, realistic, empirically articulated with minimal complexities and rigidities.

3. The Structured Macro-Fiscal Model is clear, well specified with all equations are stated in a consistent economic and mathematical manner. Hence the model is not a black box.

4. The Macro-Fiscal Model for Bangladesh is being solved and considered to complement viable economic analysis at FD/MEW and not for replacement of such analysis.

7.3 Some Selective Example of the Uses of the Macro-Fiscal Model for Economic Development and Decision-Making Purposes:

Amongst others, the following are examples of the economic, fiscal and policy uses of the model, in a Bangladesh context:

- Determining the optimal, feasible and realistic GDP and sectoral growth rates in the economy.

- Specifying and quantifying the needed magnitude of national productive capacity and related accumulation of the right type of investment.
- Ability to measure the movements and growth of various national expenditures and final demand components of the economy.
- Determining the overall equilibrium conditions at the national economy level and identifying the likely deviations.
- Deriving and estimating variety of demand elasticities, output and supply coefficients, impacts on inflation, labour productivity, investment and incremental capital-output ratios, and other economic related and useful ratios and coefficients.
- Measuring the impact on the growth, employment and economic prosperity of various scenario implications of different structures of government expenditures by type, agency and sector.
- Assess the impact of the shift in the composition of government expenditure, between recurrent and development fund allocations.
- Determine the national resources envelop and related scenario alternatives.
- Forecast various revenue components, trends, and delineate the strategic revenue development by each components and their respective impacts.
- Determining the total investment requirements to achieve growth and sustainable development.
- Assessing socio-economic impact of alternative scenarios of tax system, tax policy and type of taxation, including the impact of different rates of GST (VAT).
- Measure the trend in subsidies, and how to rationalize and curtail, through time, and the impact of such policies.
- Determining the public fiscal trends and balances, with sustainability and public debts aspects and likely development therein.
- Quantifying the economic impact of alternative sets of wages, salaries level and productivity growth patterns.
- Measure the impact of changing private consumption pattern and/or other final expenditure and demand categories on various macroeconomic variables.
- The model capability to project the import requirements and by commodity, hence can be used to simulate foreign exchange requirements, in the economy, through time.

- The results of the integrated model would give clear measure and warning signals on likely negative impact, of adopted policy measures, on inflation, unemployment rate and on the overall macroeconomic stability in the economy.
- Establishing the projections and sensitivity analysis of the flows of the remittances and their future outlook.
- Measuring and monitoring the trend in real demand for money in the economy and the factors affecting such a trends, including rate of interest, inflation and investment enabling environment.
- Projecting, measuring and establishing the balances of trade, current account balance, the overall balance of payments (BoPs) and the accumulative effect of the national reserve.

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