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Structural modeling of fiscal structure for policy analysis: A case study of India

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Abstract. *Sustainability is a term that has been used with increasing frequency in the academic literature and recent multilateral policy discussions. Taking note of the crises in different countries heading for a debt trap it is necessary to look at the right combination of fiscal parameters and growth to achieve sustainability and stable development. Fiscal prudence involves exercise of good judgment, common sense, and even caution in the conduct of fiscal policies especially on the expenditure front. Fiscal consolidation is a process where government's fiscal health is getting improved and is indicated by reduced fiscal deficit. Through some of policy measures like improved tax revenue realization and better aligned expenditure fiscal consolidation can be attainable. This paper empirically analyses the relationship between growth and debt and measures for fiscal consolidation using an empirical model. The period of study is from 1980 to 2016 and study is on central government of India.*

Keywords: sustainability, fiscal consolidation, Debt-GDP.

JEL Classification: E61, E62, E65.

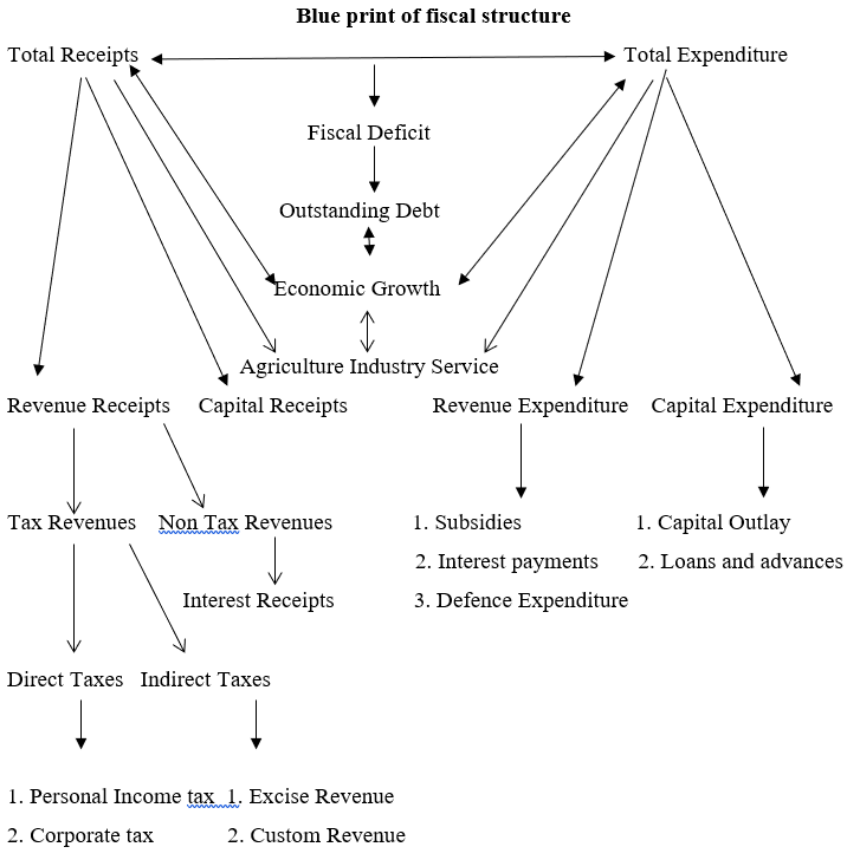
1. Introduction

In the second half of the 1990s, policymakers around the world have been increasingly concerned about the high debt in many developing countries. These are perceived to be limiting growth and development because higher debt levels imply high repayment costs reducing the availability of resources for public investment and other policy initiations (Patillo, 2004). Public debt is a major consequence of expansionary fiscal policy, as it arises from persistent accumulation of fiscal deficit over time. No wonder, high fiscal deficit has been of much concern for many countries over the recent decades. Sustainability, solvency and macroeconomic implications of debt with their feedback effects on inflation, growth, exchange rate movements and investments have obviously been widely discussed. Taking note of the crises (Fiscal Monitor, 2018 – IMF, Washington) in different countries heading for a debt trap[(1)], it is necessary to look at the right combination of debt and growth scenarios to achieve sustainability and stable development. Prudence involves exercise of good judgment, common sense, and considerable caution in the conduct of fiscal policies especially on the expenditure front. The major objective of this paper is to empirically analyse the relationship between growth and debt, using an empirical structural model.

2. Review of the fiscal structure

Public expenditure and taxation are the two-major instruments of fiscal policy to attain different objectives of growth, distribution and stability for the country. India is a developing country where one has to incur deficit to be able to undertake public investment to promote growth. Thus, if deficit is incurred on account of higher investment, it may lead to higher growth which in turn may lead to reduction in Debt-GDP ratio. Thus higher growth can be achieved by either increasing the tax rates or by increasing deficit leading to alternative policy patterns. On the receipts side we have revenue receipts and capital receipts. Revenue receipts are further dived into tax revenues and non-tax revenues which includes interest receipts. Tax revenues comprises of direct taxes and indirect taxes. Major component of non-tax revenues is interest receipts. Direct taxes comprises of personal income tax and corporate tax. Indirect taxes comprises of excise and custom duties. The major component of capital receipts is market borrowings.

Total expenditure is divided into capital expenditure and revenue expenditure, Capital expenditure comprises of capital outlay which is combination of developmental and non-developmental outlay and loans and advances. Revenue expenditure or committed expenditure comprises of subsidies, interest payments and defence expenditure. In layman terms fiscal deficit is defined as the difference between the total expenditure (Revenue + Capital) and the total revenue, while outstanding debt is the fiscal deficit of all the previous years. Debt leads to growth up to a certain threshold as it is determined by three major sectors i.e. agriculture, industry and services. The figure below shows the interlinkage of different fragments i.e. receipts and expenditure of the fiscal system influencing deficit, public debt and growth. In this context the basic objective now is to build a structural model linking the total revenue, total expenditure, deficit, debt and growth.



3. Major empirical approaches

Structural modelling is motivated by two objectives: forecasting and more significantly, policy analysis. According to Pandit (2000) every model must ideally satisfy four criteria. First and foremost, it must fit into a theoretical framework. Second, the actual specification of the model must reflect a clear understanding of the contextual framework within which policies are formulated and executed along with an envisaged process of adjustment. Third, it is essential that the model is built on a firm and adequately rich data base and, finally, the estimated structural model must adequately utilise the rigors and sophistications of econometric methodology. In this chapter we have made an attempt to satisfy these criteria's to the extent possible.

The first attempt at building macroeconometric models was made by Tinbergen as early as 1939. However, a serious and sustained contribution in this direction was made only during the fifties by Klein (1950) and Klein and Goldberger (1955). Macroeconometric modelling in India has had one of the longest histories amongst all countries, particularly those in the developing world (Desai, 1973; Krishnamurty and Pandit, 1985; Pandit and Sharma, 1990; Krishnamurty, 1995 and Marwah, 1995).

Nearly all macroeconometric models for India have had a clear policy focus. For developed industrial economies the most widely used fiscal policy instrument relates to direct taxes and typically to tax rebates which influence effective demand. Given the predominance of the public sector in this economy as a corollary of the process of planned development the policy variable usually in focus happens to be government's current consumption expenditure and capital formation.

Another distinctive feature of most developing economies including India is the greater reliance on indirect taxation for revenue generation. This is of some analytical significance because the impact of direct taxes is more straight on the level of activity whereas indirect taxes would have a greater visible effect on the price level. Some of the studies e.g., Bhattacharya (1984) and Bhattacharya et al. (1994) which are exclusively focused on government finances and related issues have a detailed model of government receipts and expenditures with most of the items endogenously determined. Some of the structural model analysed in case of Government finances which form the bases for this study are Krishnamurthy and Pandit (1985), Naastepad (1999), Pandit and Krishnamurthy (2004) Srivastava et al. (2009), Mundle et al. (2011) and Bhanumurthy (2015).

4. Proposed analytical framework

Originated in 1930s macroeconomics theory, focused on the processes that determine changes in income, employment and prices which had been receiving considerable attention since the turn of the twentieth century. The preceding theories were mainly concerned with microeconomic questions like individual prices, expenditures and supply behavior. The world depression that began in 1929 added urgency to policies dealing with macroeconomic questions. The results of this research led to different theories and policy prescriptions for stabilizing economic activity. Instability of output, variations in the rate of inflation, growth slowdown and implications of deficits and surpluses are some of the central questions dealt within macroeconomic theory. In this section we outline the underlying policy issues as related to the articulation of fiscal management and the related monetary framework. Alternative approaches to the underlying theories focused on fiscal policy, are also dealt with.

In the present context it is advantageous as well as relevant to work with a simple Keynesian theory which is explained below. During the early forties Keynesian theory of macroeconomics emerged in the backdrop of great depression the first global economic crisis of the industrial society. Keynes fundamental contribution was his systematic focus on demand side of the macroeconomic system was to derive equilibrium output and income determination. In the national income accounts, GNP can be viewed as flow of either product or income. In either case the total value (at market prices) of goods and services produced in the economy is the same, we have the basic GNP identity

$$C + I + G + (X-M) = GNP = C + S + T + R_f \quad (1)$$

C – total value of consumption expenditure;
I – total value of investment expenditure;
G – government purchases of gods and services;

(X – M) = Net exports of goods and services;
S – gross private saving (business saving + personal saving + depreciation);
T – net tax revenues (tax revenues minus domestic transfer payments;
R_f – total private transfer payments to foreigners.

Here G, Y and T are the variables which this study is focused on, though all the other variables in the equilibrium condition are interlinked. Increase in government expenditure may lead to creation of capital assets or may lead to increase in consumption though employment generation programs. Both will lead to increase in income or GDP. This is the as government expenditure multiplier. Increase in taxes leads to decrease in consumption and this in turn will lead to decrease in demand and income. This is called tax multiplier. When a government adopts a balanced budget policy it spends only as much as it collects through taxation. That is, in balanced budget policy, T = G and ΔG = ΔT. The effect of the balanced budget policy on the national income is measured through the balanced budget multiplier (refer to chapter 2). For all other cases we have,

$$Y = C(Y - T(Y)) + I + G \quad (2)$$

$$y = c(y - t(y)) + i + g \quad \text{in real terms} \quad (3)$$

$$dy = c'(dy - t'\,dy) + di + dg \quad (4)$$

$$dy = c'(1 - t')dy + di + dg \quad (5)$$

$$1 - c'(1 - t')dy = di + dg \quad (6)$$

$$dy = \frac{di+dg}{1-c'(1-t')} \quad (7)$$

Equation (7) implies that increase in investment (i) and expenditure (g) will lead to increase in income. Decrease in mpc (c') will lead to increase in savings as y – c = s which will in turn cause a decrease in growth of income. Increase in t' will imply decrease in disposable income which will lead to decrease in consumption which in turn will imply decrease in growth of income under the Keynesian framework we are adopting. We use this simple theoretical framework for determining GDP at a disaggregate level. On the receipts side we model the direct and indirect tax which is determined by GDP which explain the concept of tax buoyancy(2). The expenditure side is determined by interest rates, inflation and total receipts. This implies theoretically that higher inflation and interest rates lead to higher revenue expenditure. The main source of expenditure is total receipts which imply higher receipts and higher expenditure.

The linkage between growth and expenditure is implicit in Keynesian framework as clarified earlier. The difference between expenditure and revenue is deficit and debt is the accumulation of deficit. This is how we link receipts expenditure, deficit and growth. The target variable in our analysis is the Debt-GDP ratio. Our objective here is to model all four aspects of fiscal structure at both aggregate and disaggregate levels and estimate Debt-GDP ratio. As part of the simulation exercises we discuss the issue of sustaining the Debt-GDP ratio with various policy prescriptions.

5. Structural modeling for fiscal policy a disaggregate model

In this section we will estimate the disaggregate framework which discusses the framework of receipts, expenditure, deficit and debt at a disaggregate level. The Keynesian framework is used in the disaggregate model. The estimated model is used for policy implications. To start up we have disaggregate total GDP into output of agriculture, industry and services. Similarly we have disaggregated direct taxes into personal income tax and corporate tax. Indirect taxes are disaggregated as customs and excise duties. Moving to expenditure, revenue expenditure is disaggregated into subsidies and interest payments. Capital expenditure is estimated at an aggregate level. An attempt has also been made to model exports and imports to incorporate the vital external influences. The variables and the notations used in the model are given in the Appendix.

5.1. Empirical results

The extended model is formally specified as follows with expected signs in all cases

1. AGRCON = *f* (TOTEXP, AGRNFCS, TOTPROD, INDCON)

(+) (+) (+) (+)

2. INDCON = *f* (INDNFCS, TOTEXP, PFCE, SERCON)

(+) (+) (+) (+)

3. SERCON = *f* (PFCE, TOTEXP, SERNFCS, INDCON)

(+) (+) (+) (+)

4. PERINTAX = *f* (NONAGRGDP)

(+)

5. CTX = *f* (NONAGRGDP)

(+)

6. CUSTOM = *f* (IMP, TOTGDP)

(+) (+)

7. EXCISE = INDCON

(+)

8. DOMINTPAY = *f* (WRGS, INTNDEBT)

(+) (+)

9. EXTINTPAY = *f* (EXTDEBT, LIBOR)

(+) (+)

10. SUB = *f* (AGRCON, INDCON, GDPFCDEF)

(-) (-) (+)

11. CAPEXP = f (WRGS, TOTGDP, TOTREC, GDPFCDEF)

(-) (+) (+) (+)

12. IMP = f (EXPORTS, TOTGDP, EXCH)

(+) (+) (-)

13. EXPORTS = f (TOTGDP, EXCH, WORLDGDP)

(+) (+) (+)

The sample period for the analysis is starting on an annual basis and covering the period, 1981 through 2016. The model covers only the central government of India. All the variables are at constant 2011-2012 prices and are in terms of growth rate. Each of them has been checked for stationarity.(3) The methodology used is simple OLS applied to each equation in the proposed structural model. Lags are used, depending upon Akaike criterion. Dummy variables also appear in each equation to capture the outliers for unusual years as explained below. All the major statistics like t-statistic, R-square, DW statistic and F-statistic are quite significant in all equations. Throughout the estimation process we have used the necessary identities. The stationarity test results are mentioned below.

Dummy variables. Dummy variables are incorporated in all the equations of the model to capture the outliers. Following are the years for which we use dummy variables to capture certain events which are explained below:

1984-1985: Year experienced political turmoil and GDP was also low.
1988-1990: Experienced the beginning of crisis indicated by some indicators like deficit, debt, expenditure were high while revenues and GDP was low.
1991-1994: The effects of the start-up of New Economic Policy.
1997-1999: East Asian crisis.
2002-2004: Adoption of FRBM act, introduced to curtail deficit which was very high in 2001-2002.
2008-2010: International Financial crisis.

Stationarity for each variable is tested using the ADF tests with the following results

Table 1. *Stationarity tests using Augmented Dickey Fuller (ADF) Test*

Variables	Levels		Inference
	t-statistics	P-Value	
AGRCON	-9.73	0.00	I(0)**
AGRNFCS	-6.60	0.00	I(0)**
CAPEXP	-6.50	0.00	I(0)**
CAPEXP	-6.50	0.00	I(0)**
CTX	-4.40	0.00	I(0)**
CUSTOM	-5.29	0.00	I(0)**
DIRTAX	-5.79	0.00	I(0)**
DOMINTPAY	-3.90	0.02	I(0)**
EXCH	-4.71	0.00	I(1)**
EXCISE	-4.20	0.01	I(0)**
EXPORTS	-5.18	0.00	I(0)**
EXTDEBT	-4.43	0.00	I(0)**
EXTINTPAY	-4.22	0.01	I(0)**
GDPFCDEF	-6.30	0.00	I(2)**

Variables	Levels		Inference
	t-statistics	P-Value	
IMP	-7.16	0.00	I(0)**
INDCON	-4.97	0.00	I(0)**
INDNFCS	-5.28	0.00	I(0)**
INDTAX	-4.58	0.00	I(0)**
INTNDEBT	-5.73	0.00	I(0)**
INTPRIC	-6.37	0.00	I(1)**
LIBOR	-4.80	0.07	I(1)**
NONAGRGDP	-4.17	0.00	I(0)**
PERINTAX	-6.74	0.00	I(0)**
PFCE	-5.91	0.00	I(0)**
REVEXP	-3.60	0.00	I(0)**
SERCON	-3.88	0.02	I(0)**
SERNFCS	-5.99	0.00	I(0)**
SUB	-4.26	0.00	I(0)**
TOTEXP	-5.81	0.00	I(1)**
TOTGDP	-5.58	0.00	I(0)**
TOTNFCS	-6.45	0.00	I(0)**
TOTPROD	-8.70	0.00	I(0)**
TOTREC	-5.09	0.00	I(0)**
TRADEDEF	-8.12	0.00	I(0)**
WRGS	-3.67	0.00	I(1)**

** indicates stationarity at 1% level of significance.

5.2. Disaggregate model estimates

5.2.1. GDP estimates

The first three equations determine growth of consumption GDP which results in output in the three sectors of the economy namely, agriculture, industry and services. Agricultural GDP depends on agriculture capital stock, total expenditure, total production and industrial GDP. Agricultural capital stock is affecting agricultural GDP at one year lag, which means that investment in previous year influences output next year. Total Expenditure is stationary at first difference other variables are at stationary levels. Agriculture is also dependent on industrial GDP which is having a positive impact at one lag. All have positive relations as expected on the basis of to economic analysis. Industrial GDP is dependent on service GDP, industrial capital stock which is significant with one lag effect. The other independent variables are total expenditure and private final consumption expenditure. All the variables except total expenditure are stationary at levels and are positive in keeping with the standard outlook. GDP in the services sector is dependent on industrial GDP, service capital stock, total expenditure is at one lag and private consumption expenditure. All the variables except total expenditure are stationary at levels.

1) AGRCON = -1.85 + 0.19 * Δ(TOTEXP) + 0.31 * AGRNFCS(-1) +

(2.15) (1.88)

+ 0.44 * TOTPROD + 0.28 * INDCON(-1) + 7.69 * DUMAGR

(4.02) (1.94) (5.87)

$\bar{R}^2$ =0.63 DW=2.43 F statistic: 9.93 Dum (1983,84,88,92,97)

(1,-1, 1, 1,-1)

2) INDCON = -3.34 + 0.21 * INDNFCS(-1) + 0.12 * Δ(TOTEXP) + 0.40 * PFCE

(1.77) (1.71) (1.92)

+ 0.89 * SERCON + 5.81* DUMIND

(3.62) (5.98)

$\bar{R}^2$ =0.68 DW=1.76 F statistic =12.03 Dum (1994, 97,98, 2001, 08)

(All years -1 except 1994)

3) SERCON = 4.01+ 0.21 * PFCE + 0.09 * Δ(TOTEXP(-1)) + 0.07 * SERNFCS +

(2.37) (3.00) (1.82)

+ 0.26 * INDCON + 2.67 * DUMSER

(4.96) (6.00)

$\bar{R}^2$ =0.77 DW=1.79 F statistic =18.69 Dum (1994,97,99, 2003,05)

(All years +1 except 1994)

5.2.2. Total receipts

The major source of revenues for the government as in all countries is from taxes. In India the taxes are listed under three heads i.e. center list, state list and concurrent list. Centre list includes all the tax revenues received by center to be used only by the central government. These include items like income tax, excise and customs. State list relates to taxes levied by the state and to be used only by the respective state government. These include items such as property tax and stamp duties. In concurrent list tax is levied by center but the revenue received through taxes will be shared between center and state governments. Currently the government wants to replace the Indian Income tax Act (1961) to DTC (Direct tax code) and it has replaced all indirect taxes levied on goods and services by the central and state governments with GST (Goods and Service Tax).

As mentioned earlier this is a disaggregate model. We first take up the revenue receipts which are divided into direct tax and indirect tax. Direct tax has two components personal income tax and corporation tax. Direct and indirect taxes are dependent on non-agricultural GDP. In general when there is increase in GDP there is increase in all the tax revenues, which shows the tax buoyancy. Indirect tax has two components custom revenue and excise revenue. Customs revenue is dependent on imports of all commodities and total GDP at one lag. Excise revenue is dependent on industrial GDP.

All the variables are statistically significant and theoretically true. We may note that each equation includes a dummy variable to take care of outliers due to a number of factors not included in the model. D signifies first difference and DD signifies second difference.

The equations and identities of the receipts side of the model are given below as the components given do not match to the total so we have taken the residual as others (otr) for revtax, dirtax and indtax.

4) PERINTAX = -15.93 + 3.30 * NONAGRGDP + 78.70* DUM1

(1.78) (9.80)

$\bar{R}^2$ =0.75 DW=2.23 F statistic = 48.11 Dum (1988,89,94,98,2000)

(All years +1 except 1989)

5) CTX = -10.58 + 2.55 * NONAGRGDP + 25.48 * DUMCTX

(3.76) (7.00)

$\bar{R}^2$ =0.63 DW statistic=1.92 F statistic: 27.57 Dum (1991,2000,02,03)

(All years +1 except 2000)

6) EXCISE = -1.00 + 0.77 * INDCON + 25.82 * DUMEXCISE

(2.01) (7.15)

$\bar{R}^2$ =0.64 DW =1.88 F statistic = 28.99 Dum (2000,08)

(+1, -1)

7) CUSTOM = - 7.01 + 0.30 * IMP + 1.56 * TOTGDP + 29.54 * DUMCUSTOM

(3.53) (2.12) (7.04)

$\bar{R}^2$ =0.64 DW=2.11 F statistic = 17.91 Dum (1985,90,97,2000,08)

(All years - 1 except 1985)

5.2.3. Total expenditure

A typical budget in India has generally three broad categories of expenditures; namely general, social, and economic. The general category consists of items including general administration, interest payments and pensions. The social services include expenditures on items such as education, health, water supply and sanitation, and the social security programmes. The economic services include agriculture, industry, roads, energy, transport etc. There is also the distinction made in some data sources between development and non-development expenditures. By convention, all expenditures on social and economic heads are considered developmental while that on general services are considered non-developmental. There is also the important distinction between plan and non-plan expenditure. Plan expenditure is taken to be incremental development expenditures while non-plan expenditures are committed expenditures. Let us now look at the expenditure side of the fiscal system.

Major components in revenue expenditure are subsides and interest payments we have taken defence expenditure as exogenous. In interest payments we have domestic debt service and international debt service. Domestic debt service is dependent on internal debt and interest rate. Interest on weighted average of government securities is taken as the proxy for interest rate which is stationary at first difference. We have used auto regressive as an independent variable to account for auto correlation among the errors. International debt service is dependent on libor (proxy for international interest rate) and external debt.

Libor is stationary at first difference and is significant at one lag. Subsidies are dependent on agriculture GDP, industrial GDP which has a negative relationship because if agriculture and industrial GDP is good subsidies need not increase. Other independent variables are GDP deflator (proxy for inflation) which has a positive relationship. Industrial GDP is stationary at first difference and GDP deflator is stationary at second difference.

Capital expenditure is dependent on total receipts which has a positive relationship which implies higher receipts higher expenditure. The other independent variable is GDP deflator which implies higher inflation lead to higher capital expenditure. GDPDEF is stationary at second difference and significant at one lag. The other independent variable is weighted average interest rate of government securities which is stationary at first difference. It has a negative relationship which implies that higher interest rates reduces capital expenditure through borrowing process as it cannot decrease revenue expenditure because it is committed expenditure while capital expenditure can be postponed. The last independent variable is total GDP of all sectors which has a positive relationship.

We have even modelled imports and exports. Imports depends on exports, total GDP and exchange rate. Exchange rate has a negative relationship which implies as exchange rate depreciates imports decreases and exports increases while others have a positive relationship. Exports are dependent on total GDP, exchange rate and world GDP. World GDP, total GDP and exchange rate has a positive relationship with exports. All the variables are statistically significant and theoretically true. We may note that each equation includes a dummy variable to take care of outliers due to a number of factors not included in the model. D signifies first difference and DD signifies second difference.

The identities and equations used in the expenditure side are given below. As the components do not sum up to the total we have introduced a residual variable called others (OTR) in revenue and capital expenditure identity.

8) DOMINTPAY = 7.60 + 2.63 * Δ(WRGS) + 0.14 * INTNDEBT +

(3.52) (2.03)

+ 8.62 * DUMDOMINTPAY

(5.68)

$\bar{R}^2$=0.55 DW=1.47 F statistic =12.55 Dum (1989,94,95,2004)

(1, 1, -1, -1)

9) EXTINTPAY = - 1.67 + 0.39 * EXTDEBT + 2.44 * Δ(LIBOR(-1)) +

(3.36) (2.19)

+ 23.09 * DUMEXTINTPAY

(5.28)

$\bar{R}^2$=0.60 DW=1.62 F statistic =14.73 Dum (1984,87,92,2003)

(All years +1 except 2003)

10) SUB = 13.28 -1.42 * AGRCON - 1.18 * Δ(INDCON) + 4.09 * Δ^2(GDPDEF) +
(-3.23) (-2.51) (2.60)
+ 30.86 * DUM5
(6.33)
$\bar{R}^2$=0.64 DW=1.77 F statistic = 12.76 Dum (1987,88,91, 2008)
(-1, 1, -1, 1)

11) CAPEXP = - 10.27 - 4.57 * Δ(WRGS) + 1.46 * TOTGDP + 1.11* TOTREC
(-2.10) (2.10) (3.26)
+ 3.71 * Δ^2(GDPFCDEF(-1)) + 25.31 * DUMCAPEXP
(2.62) (7.96)
$\bar{R}^2$=0.86 DW=1.90 F statistic = 32.92 Dum (1999, 2005,07,08)
(All years -1 except 2007)

12) IMP = -8.50 + 0.48 * EXPORTS + 2.20* TOTGDP - 1.68* Δ(EXCH)
(2.20) (2.07) (-1.83)

+ 40.52* DUM10
(7.09)
$\bar{R}^2$=0.78 DW statistic=1.82 F statistic = 20.01 Dum (1990, 1992)
(All years +1)

13) EXPORTS = -5.88 + 0.94 * TOTGDP(-1) + 0.58 *Δ(EXCH) + 3.56 * WORLDGDP
(1.80) (1.18) (3.32)
+ 17.82 * DUMEXPORTS
(5.70)
$\bar{R}^2$=0.60 DW statistic=2.09 F statistic = 10.97 Dum (1985,93,97)
(All years -1 except 1993)

5.3. An overview of the model

The lists of exogenous and endogenous variables are shown in the table. The identities used to solve the structural model are also shown below.

Table 2. *List of endogenous and exogenous variables*

Exogenous		Endogenous	
Dum1	Dumcustom	agrcon	indcon
Dumctx	Dumdomintpay	nonagrgdp	sercon
Dumexcise	Dumextintpay	totexp	totgdp

Exogenous		Endogenous	
Dum5	Dumcapexp	perintax	excise
Dum10	Dumagr	ctx	sub
Dumser1	Dumind	custom	intpayr
agrnfcs	pfce	imp	subr
indnfcs	wrgs	domintpay	intpay
sernfcs	intndebt	extintpay	domintpayr
totprod	extdebt	capexp	extintpayr
gdpfcdef	libor	totexpr	revrecr
defexpr	intpric	capexpr	taxrevr
otrrevexpr	exch	revexpr	dirtaxr
disinvr	nontaxr	otrtaxrevr	indtaxr
otrgfdrecr	otrdirtaxr	perintaxr	ctxr
nlr	otrindtaxr	gfdrecr	customr
otrgfdexpr	cor	gfdexpr	exciser
intndebtr	otrtotdebtr	gfdr	totdebtr
dumexports	extdebtr	debtgdp	totrecr
worldgdp		caprecr	totgdpr
		subr	indconr
		agrconr	nonagrgdpr
		serconr	exports

Identities

gdpfcdef = (((gdpfcdefinf) / 100) + 1) * gdpfcdef(-1)

totgdpr = agrconr + indconr + serconr

nonagrgdpr = serconr + indconr

agrconr = ((agrcon / 100) + 1) * agrconr(-1)

indconr = ((indcon / 100) + 1) * indconr(-1)

serconr = ((sercon / 100) + 1) * serconr(-1)

totexpr = capexpr + revexpr

totexp = ((totexpr - totexpr(-1)) / totexpr(-1)) * 100

revexpr = defexpr + intpayr + subr + otrrevexpr

intpayr = domintpayr + extintpayr

revrecr = taxrevr + nontaxr

taxrevr = dirtaxr + indtaxr + otrtaxrevr

dirtaxr = perintaxr + ctxr + otrdirtaxr

indtaxr = customr + exciser + otrindtaxr

gfdrecr = revrecr + disinvr + otrgfdrecr

gfdexpr = revexpr + cor + nlr + otrgfdexpr

gfdr = gfdexpr - gfdrecr

totdebtr = totdebtr(-1) + gfdr + otrtotdebtr

debtgdp = (totdebtr / totgdpr) * 100

totrec = ((totrecr - totrecr(-1)) / totrecr(-1)) * 100

totrecr = revrecr + caprecr

perintaxr = ((perintax / 100) + 1) * perintaxr(-1)

ctxr = ((ctx / 100) + 1) * ctxr(-1)

exciser = ((excise / 100) + 1) * exciser(-1)

customr = ((custom / 100) + 1) * customr(-1)

domintpayr = ((domintpay / 100) + 1) * domintpayr(-1)

extintpayr = ((extintpay / 100) + 1) * extintpayr(-1)

intndebtr = ((intndebt / 100) + 1) * intndebtr(-1)

extdebtr = ((extdebt / 100) + 1) * extdebtr(-1)

subr = ((sub / 100) + 1) * subr(-1)

capexpr = ((capexp / 100) + 1) * capexpr(-1)

5.4. Reliability of the model and its policy implications

We subject the estimated model for counterfactual simulation experiments under alternative policy scenarios so as to understand the policy implications of the estimates structural model. For this we first solve the model and obtain the baseline solution. Let us now present the complete disaggregate fiscal model. As mentioned earlier, this runs in terms of three equations on output side, four on receipts side and five on expenditure side.

AGRCON = - 1.85 + 0.19 * Δ(TOTEXP) + 0.31 * AGRNFCS(-1) + 0.44 * TOTPROD + 0.28 * INDCON(-1) + 7.69 * DUMAGR

INDCON = - 3.34 + 0.21 * INDNFCS(-1) + 0.12 * Δ(TOTEXP) + 0.40 * PFCE + 0.89 * SERCON + 5.8 * DUMIND

SERCON = 4.01 + 0.21 * PFCE + 0.09 * Δ(TOTEXP(-1)) + 0.07 * SERNFCS + 0.26 * INDCON + 2.67 * DUMSER

PERINTAX = - 15.93 + 3.30 * NONAGRGDP + 78.70 * DUM1

CTX = - 10.58 + 2.55 * NONAGRGDP + 25.48 * DUMCTX

CUSTOM = - 7.01 + 0.30 * IMP + 1.56 * TOTGDP(-1) + 29.54 * DUMCUSTOM

EXCISE = - 1.00 + 0.77 * INDCON + 25.82 * DUMEXCISE

DOMINTPAY = 7.60 + 2.63 * Δ(WRGS) + 0.14 * INTNDEBT + 8.62 * DUMDOMINTPAY

EXTINTPAY = - 1.67 + 0.39 * EXTDEBT + 2.44 * Δ(LIBOR(-1)) + 23.09 * DUMEXTINTPAY

SUB = 13.28 - 1.42 * AGRCON - 1.18 * Δ(INDCON) + 4.09 * Δ^2(GDPFCDEF)) + 30.86 * DUM5

CAPEXP = - 10.27 - 4.57 * Δ(WRGS) + 1.46 * TOTGDP + 1.11 * TOTREC + 3.71 *

Δ^2(GDPFCDEF(-1))) + 25.31 * DUMCAPEXP

IMP = - 8.50 + 0.48 * EXPORTS + 2.20 * TOTGDP - 1.68 * Δ(EXCH) + 40.52 * DUM10

EXPORTS = - 5.88 + 0.94 * TOTGDP(-1) + 0.58 * Δ(EXCH)) + 3.56 * WORLDGDP + 17.82 * DUMEXPORTS

However, to ensure validity of the model, as it stands we first check its accuracy. For this we first solve the model and obtain the baseline solution. For testing accuracy, we use the base line solution in relation to actual figures to obtain Root mean square percentage error (RMSPE) for the selected endogenous variables. They are presented in the Table 3 below

RMSPE and Theil's U Statistic is calculated as follows

$$RMSPE = \frac{1}{n}\sqrt{\left[\sum \frac{(y^s - y^a)^2}{(y^a)^2}\right]}$$

$$U_1 = \frac{\left[\sum_{i=1}^{n} (P_i - A_i)^2\right]^{1/2}}{\left[\sum_{i=1}^{n} A_i^2\right]^{1/2}}$$

Table 3. *Model Accuracy: RMSPE from 1984-1985 through 2016-2017*

Variables	RMSPE	THEILS U Stat
DEBTGDP	0.07	0.03
PERINTAX	2.81	0.24
CTX	3.38	0.26
EXCISE	3.55	0.27
CUSTOM	2.24	0.32
DOMINTPAY	3.89	0.17
EXTINTPAY	2.10	0.36
SUB	3.01	0.30
EXPORTS	3.91	0.23
IMP	2.81	0.22
CAPEXP	2.44	0.19

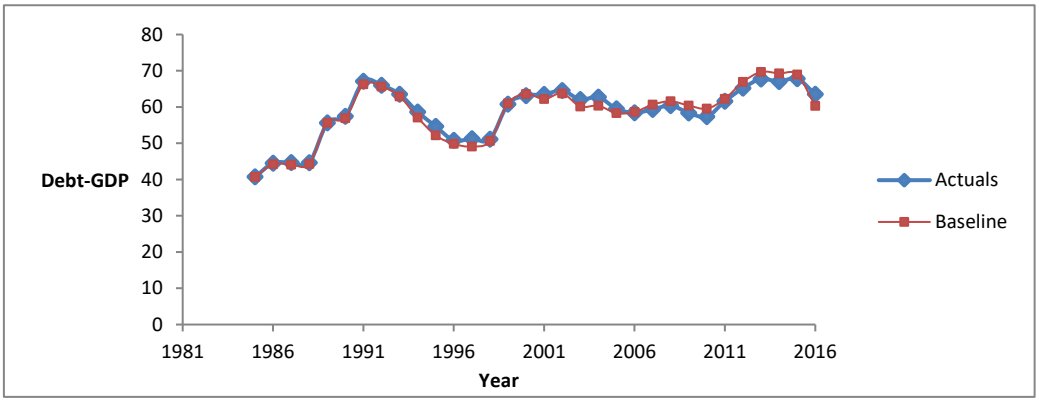
The chosen variables in the table above are the most vital once for economic policy. The foregoing table shows the RMSPE values for important endogenous variables are acceptable. This clearly indicates that the predictive performance of the model is fairly good and it should capture adequately the movements and turning points in the dependent variables. To verify this, we validate the baseline solutions for important endogenous variables against their actual values.

Table 4. *Actual vs. baseline solutions for Debt-GDP*

Year	Actuals	Baseline	Year	Actuals	Baseline
1985	40.74	40.71	**2001**	63.48	62.19
1986	44.53	44.25	**2002**	64.55	63.76
1987	44.67	44.13	**2003**	62.06	60.15
1988	44.64	44.31	**2004**	62.72	60.37
1989	55.62	55.65	**2005**	59.53	58.31
1990	57.46	56.92	**2006**	58.43	58.62
1991	67.13	66.29	**2007**	59.33	60.67
1992	66.01	65.64	**2008**	60.42	61.57
1993	63.55	62.91	**2009**	58.39	60.41
1994	58.64	57.10	**2010**	57.37	59.55
1995	54.66	52.17	**2011**	61.59	62.26
1996	50.81	49.84	**2012**	65.20	66.94
1997	51.25	49.09	**2013**	67.73	69.68
1998	51.15	50.65	**2014**	67.02	69.27
1999	60.78	60.97	**2015**	67.83	68.95
2000	63.13	63.60	**2016**	63.52	60.31

While comparing actual and baseline results we could see that for some years, the baseline solutions are slightly off the mark. Nevertheless, the model as a whole performs reasonably well for the entire sample period and appears to be reliable for policy analysis. In particular, the turning points in the dependent variables are very well captured by the model. Baseline solutions for the entire sample period along with its actual values are presented above.

Figure 1. *Actual and baseline solutions for Debt-GDP*



5.5. Policy simulations

Given the forgoing results which appear to be reliable, we carry out eight independent simulation exercises. For this purpose the model is solved. Incorporating changes in the independent variables which in different ways imply part of the policy initiatives. Further the values of Debt -GDP are obtained from the structural model for the chosen period to examine the impact of changes. Thus we are looking at the difference between baseline values of Debt-GDP and those under respective simulation exercises. For the subsequent exercises we focus meaningfully on the post 2000 period onwards. Table 5 and Table 6 present the difference between the stimulated values and the baseline solution for 2006 through 2016.

Simulation 1	Increase in Interest rate by 0.25 basis points
Simulation 2	Increase in Inflation by 3%
Simulation 3	Increase in World GDP by 2%
Simulation 4	Increase in Exchange Rate by 2%
Simulation 5	Increase in Investment by 3%
Simulation 6	Increase in Tax revenues by 5%
Simulation 7	Increase in Capital Expenditure by 5%
Simulation 8	Decrease in Revenue Expenditure by 2%

Table 5. *Baseline vs. simulation for Debt-GDP*

Year	DEBTGDP Baseline	WRGS by 0.25	INF by 3%	WORLD GDP by 2%	EXCH by 2	INVEST by 3%
2000	63.60	63.60	63.60	63.60	63.60	63.60
2001	62.19	62.19	62.19	62.19	62.19	62.19
2002	63.76	63.76	63.76	63.76	63.76	63.76
2003	60.15	60.15	60.15	60.15	60.15	60.15
2004	60.37	60.37	60.37	60.37	60.37	60.37
2005	58.31	58.31	58.31	58.31	58.31	58.31
2006	58.62	62.44	59.99	54.66	61.11	58.19
2007	60.67	65.02	62.34	56.69	63.45	58.82
2008	61.57	68.45	66.06	59.61	66.64	60.09
2009	60.41	67.48	65.35	58.32	65.36	57.04
2010	59.55	68.13	66.59	58.42	65.78	55.38
2011	62.26	72.06	71.35	62.05	69.56	57.34
2012	66.94	73.95	74.30	63.55	71.39	57.09
2013	69.68	77.14	78.81	66.03	74.35	57.78
2014	69.27	77.90	80.23	66.26	74.9	56.53
2015	68.95	78.93	81.08	66.61	75.70	55.50
2016	60.31	73.23	74.88	60.37	69.76	48.81

Table 6. *Baseline vs. simulation for Debt-GDP*

Year	DEBTGDP Baseline	DEBTGDP 5% Increase in TAXREV	Year	DEBTGDP Baseline	DEBTGDP 5% Increase in CAPEXP	DEBTGDP 2% Decrease REVEXP
2000	57.97	57.97	**2000**	61.85	61.85	61.85
2001	58.91	58.91	**2001**	62.43	62.43	62.43
2002	59.17	59.17	**2002**	62.90	62.90	62.90
2003	56.50	56.50	**2003**	60.05	60.05	60.05
2004	58.61	58.61	**2004**	62.36	62.36	62.36
2005	56.29	56.29	**2005**	59.62	59.62	59.62
2006	56.04	58.06	**2006**	59.38	58.91	58.83
2007	57.29	58.06	**2007**	61.00	60.10	59.75
2008	59.93	58.88	**2008**	63.75	62.61	61.62
2009	59.20	56.05	**2009**	62.30	60.93	58.99
2010	59.89	54.04	**2010**	62.01	60.34	57.37
2011	64.54	56.03	**2011**	65.11	63.27	59.12
2012	67.06	55.53	**2012**	65.77	63.77	58.29
2013	70.35	55.35	**2013**	67.28	65.02	58.04
2014	71.77	53.37	**2014**	66.78	64.42	55.93
2015	73.78	52.03	**2015**	67.03	64.50	54.57
2016	68.95	43.75	**2016**	60.82	58.05	46.63

Figure 2. *Simulation 1: Impact of increase in interest rate by 0.25 basis points on Debt-GDP*

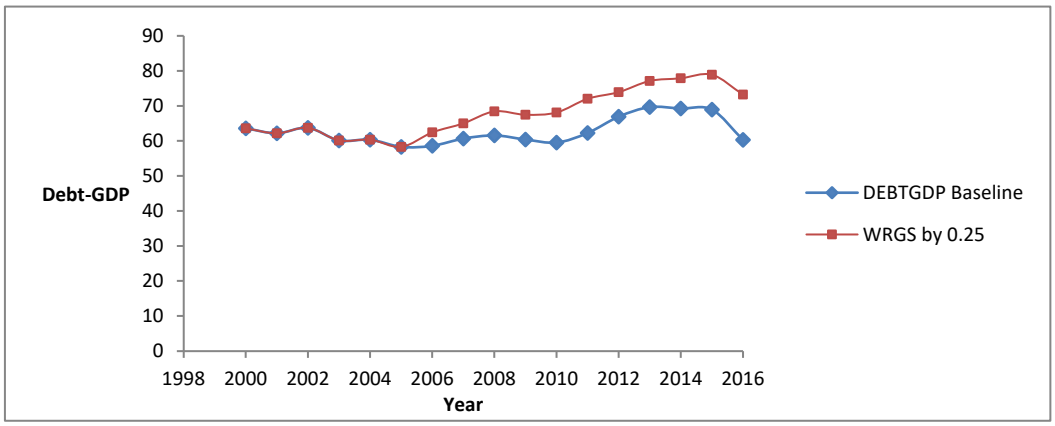


Figure 3. *Simulation 2: Impact of increase in inflation by 3% on Debt-GDP*

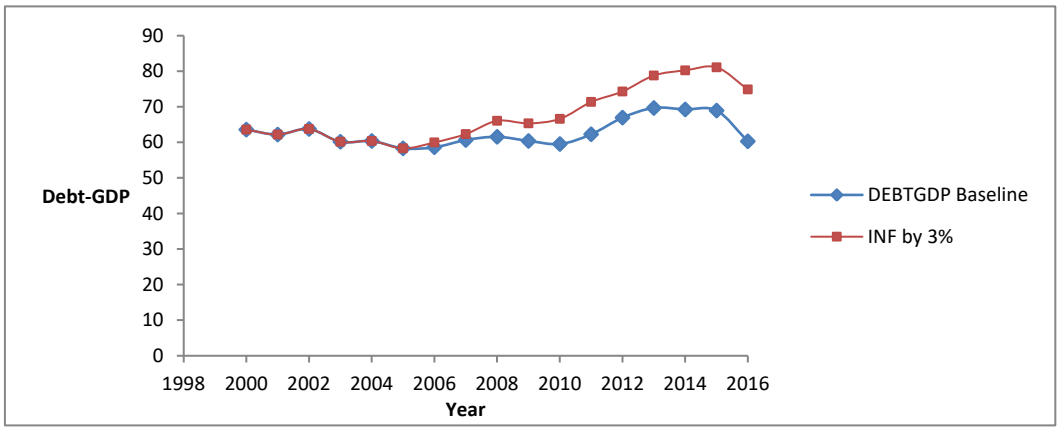


Figure 4. *Simulation 3: Impact of increase in world GDP by 2% on Debt-GDP*

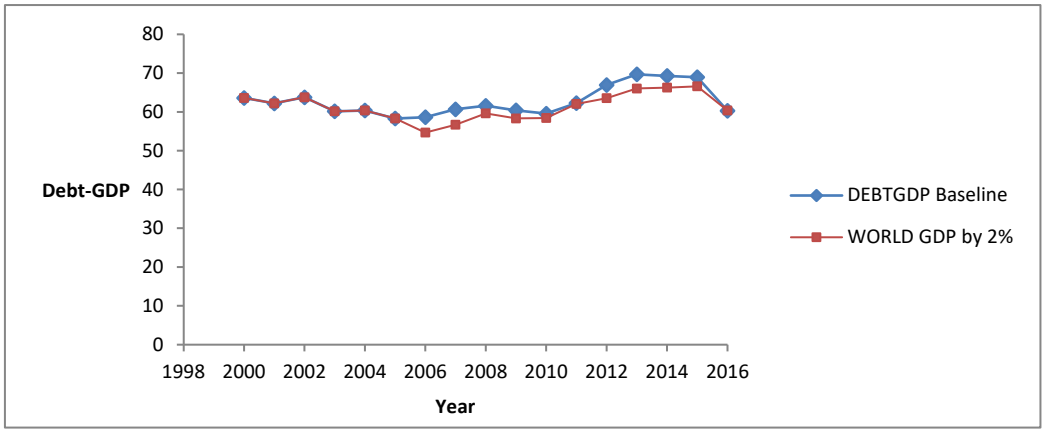


Figure 5. *Simulation 4: Impact of increase in exchange rate by 2 on Debt-GDP*

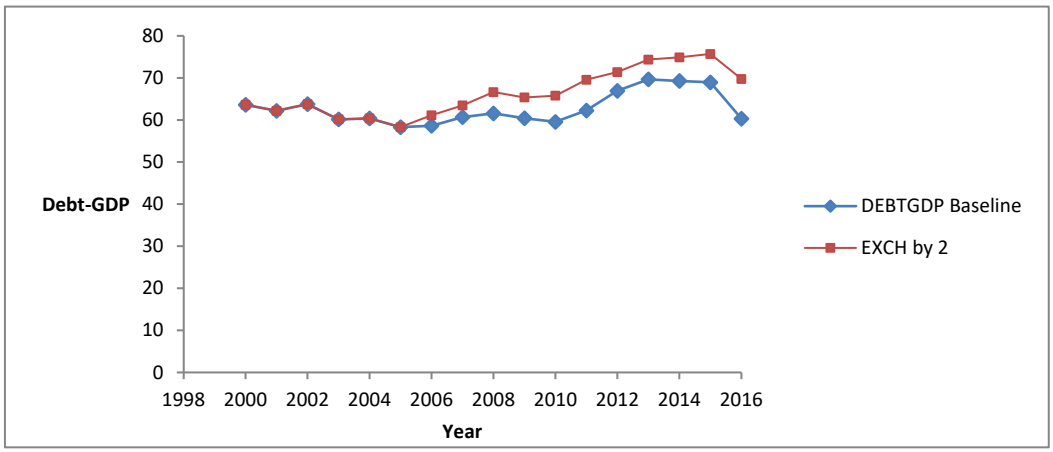


Figure 6. *Simulation 5: Impact of increase in investment by 3% on Debt-GDP*

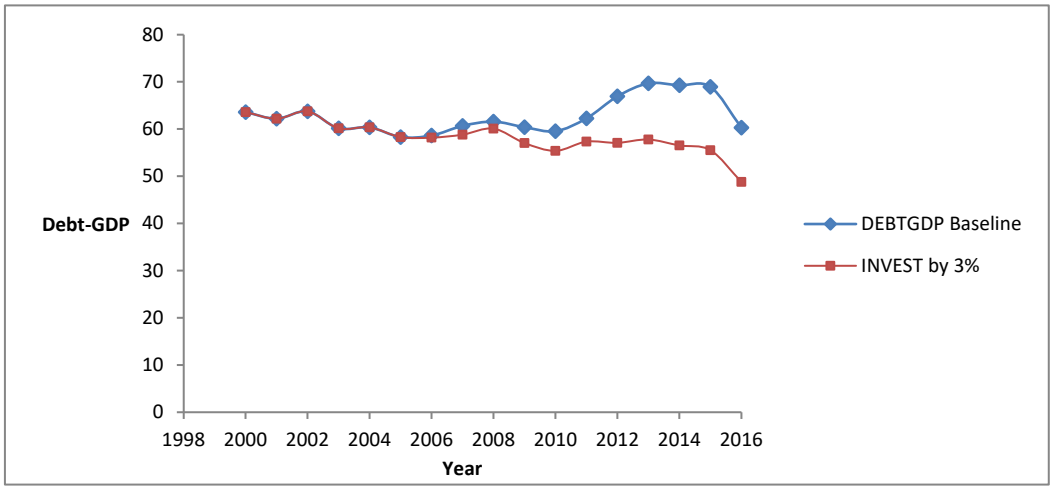


Figure 7. *Simulation 6: Impact of increase in tax revenues by 5% on Debt-GDP*

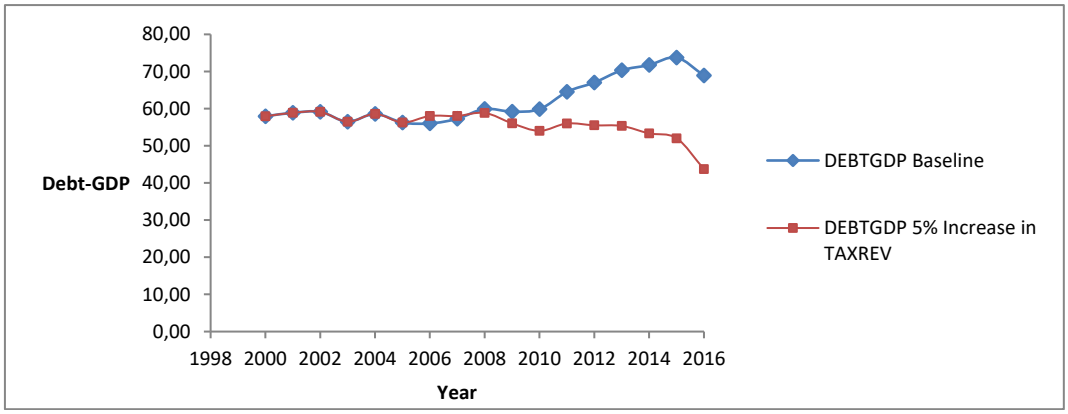


Figure 8. *Simulation 7: Impact of increase in capital expenditure by 5% on Debt-GDP*

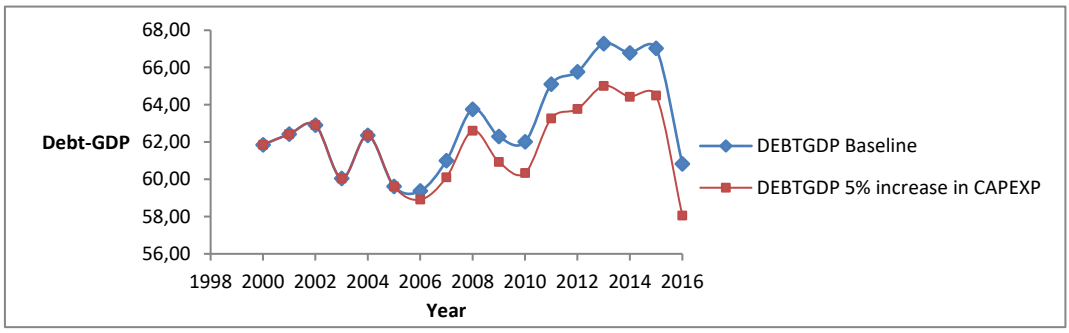
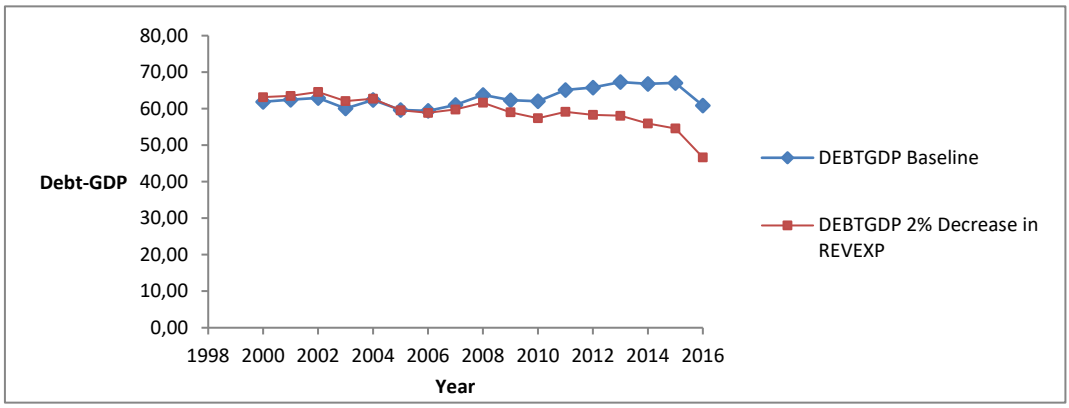


Figure 9. *Simulation 8: Impact of decrease in revenue expenditure by 2% on Debt-GDP*



6. Policy implications from the disaggregate model and summing up

Increase in interest rate (WRGS) by 2 percent will lead to increase in cost of borrowing which will in turn reduce investments and growth. Decrease in growth will to increase in Debt-GDP ratio. Increase in Inflation by 3% will lead to increase in expenditure through higher interest payments which will in turn increase deficit and debt. Increase in World GDP by 2% will lead to increase in exports which will lead to increase in revenues and decrease in deficit and debt. Increase in Exchange Rate by 2 will make our imports costlier as we are net importers and increase our oil bill which in turn will increase our deficit and debt. Increase in Investment by 3% especially the private investment will lead to higher growth and reduce the Debt-GDP ratio. Increase in Tax revenues by 5% will lead to decrease in deficit and debt. Increase in Capital Expenditure by 5% will lead to higher growth and reduces Debt-GDP ratio. Finally decrease in Revenue Expenditure will lead to decrease in deficit and debt. Following are the policy implications from the model

- Inflation targeting should be a major policy decision to achieve growth and reduce debt.
- Productive Investment and increase in capital expenditure in all the sectors will lead to greater benefits than any other policy measure.
- Exchange rate and Interest rate have to be maintained within a bandwidth to attract greater investment from private sector and abroad.

- Better targeting of subsidies will lead to reduction in revenue expenditure.
- Tax reforms i.e. direct and indirect taxes can lead to reduction in deficit and borrowing.

Going by the definition of fiscal consolidation which says it is a process where government's fiscal health is getting improved and is indicated by reduced fiscal deficit. Improved tax revenue realization and better aligned expenditure are the components of fiscal consolidation. Through some of these policy measures mentioned above fiscal consolidation can be attainable. It is also necessary to look into the right combination of debt and growth scenarios to achieve sustainability and stable development.

Notes

(1) A situation in which the debt is so high that it is difficult or impossible to repay, typically because high interest payments prevent repayment of the principal.
(2) It must be noted that increase in GDP leads to increase in tax revenues.
(3) The two sources for data are *Handbook of Statistics* (Reserve Bank of India) and *National Account Statistics* issued by Central Statistical Organisation.

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Appendix

Notations for aggregate and disaggregate model	
Notation	**Variable**
AGRCON	Agricultural GDP at Factor Cost
AGRNFCS	Agriculture Net Fixed Capital Stock
CAPEXP	Capital Expenditure
CAPREC	Capital Receipts
CO	Capital Outlay
CTX	Corporate Tax Revenues
CUSTOM	Custom Revenues
Δ	First Difference
Δ^2	Second Difference
DEBTGDP	Debt GDP Ratio
DEFEXP	Defence Expenditure
DIRTAX	Direct Tax Revenues
DISINV	Disinvestment Receipts
DOMINTPAY	Domestic Interest payments
DUM	Dummy
DUM	Prefix Dum refers dummy for the dependent Variable in the equation
EXCH	Exchange Rate
EXCISE	Excise Revenues
EXPORTS	Total Exports
EXTDEBT	External Debt
EXTINTPAY	External Interest Payments
GDPFCDEF	GDP at Factor Cost Deflator
GFD	Goss Fiscal Deficit
GFDEXP	Gross Fiscal Deficit Expenditure
GFDREC	Gross Fiscal Deficit Receipts
IMP	Total Imports
INDCON	Industrial GDP and Factor Cost
INDNFCS	Industrial Net Fixed Capital Stock
INDTAX	Indirect Tax Revenues
INTNDEBT	Internal Debt
INTPRIC	US Wholesale Price Index
LIBOR	London Inter-Bank Offer Rate
NL	Net Lending
NONAGRGDP	Non Agricultural GDP
NONTAX	Non Tax Revenues
OTR	Prefix OTR refers other
PERINTAX	Personal Income Tax Revenues
PFCE	Private Final Consumption Expenditure
R suffix	Absolute values at constant prices otherwise in Growth Rates
REVEXP	Revenue Expenditure
REVREC	Revenue Receipts
SERCON	Service GDP at Factor Cost
SERNFCS	Service Net Fixed Capital Stock
SUB	Subsidies
TAXREV	Tax Revenue
TOTDEBT	Total Debt
TOTEXP	Total Expenditure
TOTGDP	Total GDP
TOTNFCS	Total Net Fixed Capital Stock
TOTPROD	Total Production in Agriculture
TOTREC	Total Receipts
TRADEDEF	Trade Deficit
WRGS	Weighted Average Interest Rates of Government Securities