Working Paper 311

Is India's Public Debt Sustainable?

Krishanu Pradhan

ISBN 978-81-7791-167-1

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IS INDIA'S PUBLIC DEBT SUSTAINABLE?

Krishanu Pradhan[1]

Abstract

The paper assesses the sustainability of public debt in India based on historical time series data on non-monetized liabilities/GDP, revenue/GDP and expenditure/GDP of combined Union and State governments. The assessment based on unit root analysis of non-monetized liabilities/GDP, and co-integrating analysis of expenditure/GDP and revenue/GDP shows the sustainability of public debt, mainly on account of accelerating GDP growth, lower cost of government borrowing, favorable currency composition and longer maturity profile of debt.

Key Words: Unit root, Co-integration, Error Correction Mechanism

JEL Code: C22, C32, C51, C52

Introduction

A sustained increase in deficits and debt raises question about fiscal sustainability, solvency of government and efficacy of fiscal policy in restoring macroeconomic stability. In the recent past, concern about fiscal sustainability has resurfaced in India due to high levels of debt, persistently high fiscal and revenue deficits, lower growth and unprecedented external imbalance. For instance, concerns over public debt sustainability were raised by the Twelfth Finance Commission in 2004 as debt was rising faster than GDP from 1996 to 2003. Since 2004, the concern modestly eased due to comfortable foreign exchange reserves of around US$ 300bn in 2009-10, and robust economic growth exceeding 7.5% per annum during 2004 to 2008. The resulting revenue buoyancy helped both Union and State governments to reduce the combined gross fiscal deficits to below 4% of GDP by 2007-08 (Government of India, 2012). However, the quantum jump in fiscal deficits to over 8% of GDP since 2008-09 due to the expansionary fiscal policy to protect the economy from the global financial crisis and the significant slowdown since 2011-12 have raised concern about sovereign rating downgrades and the sustainability of fiscal policy in India. Besides, the current level of debt/GDP (around 70%) in India is far higher than the different Finance Commissions' long-term target of debt/GDP below 60% mark and poses significant risk to macro stability. The record current account deficit (CAD) of over 5% of GDP in 2012-13 is considered to have been the direct outcome of persistently high fiscal deficits since 2008-09 in India. The major challenge to policy makers at present in India is to revive high growth. But high growth can not be revived without macro stability and macro stability can not be had with high debt and deficits. Thus, sustainability of fiscal policy emerges as a prerequisite for macro stability and robust growth in India. Given the importance of macroeconomic stabilization and the potential destabilizing effects of

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[1] Research Scholar at Centre of Economics Studies and Policy, Institute for Social and Economic Change (ISEC), Bangalore, India. Email- krishanup@gmail.com

The present paper is based on the ongoing PhD at the "**Institute for Social and Economic Change (ISEC)**", under the supervision of Prof. M R Narayana on the **ICSSR institutional doctoral fellowship** scheme.

Grateful thanks are due to Dr Urjit R Patel, Dr M Devendra Babu and Ms B P Vani for valuable comments and suggestions on earlier version of the paper. However, usual disclaimers apply.

high public debt and fiscal deficits on the Indian economy, the key question of this study is to empirically verify whether public debt in India is sustainable given the historical time series data.

Pioneering research on empirically examining the sustainability of public debt in a global context has been done by Hamilton and Flavin (1986), Wilcox (1989), Trehan and Walsh (1988), Bohn (1998), Afonso (2005), IMF (2002) and ADB (2010). The empirical techniques used to assess debt or fiscal sustainability are application of time series unit root test to discounted and un-discounted debt series, co-integration test to revenue and government expenditure series and estimating fiscal or primary balance response function.

In the Indian context, macro stability and debt sustainability became important research aspects since the mid 1970s or early 1980s due to hardening interest rates, expansion of public sector and consequent increase in deficits and debt/GDP (Seshan 1987; Rangarajan *et al.* 1989, Khundrakpam 1998, Rajaraman and Mukhopadhay 1999, Chelliah 1996). The above studies mentioned the appropriate measurement of deficits and stock of debt while doing debt sustainability analysis due to inter-governmental flow of resources and liabilities between different levels of government and RBI's monetization of deficits.

The study of Buiter and Patel (1992; 1993) on debt sustainability and solvency of government in the Indian context incorporated non-monetized liabilities of Union and State governments, long-term loan liabilities of central public sector undertaking (CPSUs) excluding nationalized commercial banks and external liabilities by correcting the forex reserves of the RBI. According to Buiter and Patel (1992), empirical testing of sustainability of public debt requires that debt/GDP series should not have positive stochastic or deterministic trend. The finding of non-stationarity of both present discounted value (PDV) of debt and debt/GNP based on formal time series unit root testing applied to the discounted and un-discounted debt series led to the conclusion that despite fiscal adjustment, the solvency of Indian public sector was not ensured. Their findings also highlighted that maximal use of seinorage would not be enough to close the solvency gap. However, there are some limitations of debt sustainability analysis based on solvency criteria which uses the discounted debt series. Discounted debt series is highly sensitive to the choice of discount rate, and in India where a number of interest rates exist, selection of a particular interest rate is problematic. The requirement of non-positive discounted value of debt at terminal point and generating primary surplus under the assumption of dynamic efficiency [cost of borrowing(r) strictly not less than growth rate of economy(g) i.e. $r \geq g$)] make discounted debt series analysis a *weak solvency criterion* (Buiter and Patel, 1992). Instead it is better to focus on *strong and practical* aspects that determine solvency and fiscal stability like unit root analysis of debt/GDP and co-integration analysis of revenue/GDP and expenditure/GDP.

Rajaraman and Mukhopadhay (1999) applied structural time series modeling (STM) to study the sustainability of domestic public debt without incorporating external liabilities and public sector undertakings. Their study constructed the first unbroken series for non-monetized debt of Centre and States taken together from 1951 to 1998. Applying STM, they suggested that the best fitting structure of their data was the stochastic level and fixed slope with structural break in 1974. A secular increase in forecasted debt/GDP as obtained by them reinforced the findings of Buiter and Patel that the debt/GDP path would not be stabilized automatically unless adequate fiscal correction is pursued. Jha and Sharma

(2004) looked at the issue of sustainability of domestic debt applying the co-integration technique to the expenditures and revenues of Central government in both pre and post independence periods. They found that both expenditure and revenue series is trend stationary (i.e. I(0)) with structural breaks and conclude that the public debt of the Central government is sustainable.

Dholakia *et al.* (2005) studied whether the union government's debt has become unsustainable using decomposition analysis which separates out the effects of GDP growth and the government's past behavior on fiscal deficits and debt level. Assuming a nominal GDP growth around 11 percent and interest payments on government borrowing at around 8.25percent, they argued that if the present government behavior continues, the union government's debt would be stabilized below 56 percent as targeted by the Eleventh Finance Commission at the end of 2009-10. Rangarajan and Srivastava (2005) in this context highlighted the adverse effects of high deficits and debt level of both Union and State governments on GDP growth and stress the need of bringing down the debt/GDP from 80 percent to a sustainable level of 56 percent for long-term macro stability.

Based on the key objective and review of literature, the following are the focus of the present study.

(1) The non-monetized liabilities of both Union and State governments along with external liabilities evaluated at historical exchange rates have been considered in the present context.

(2) As the issue of debt sustainability in India became an important research aspect since the mid 1970s, the study period for unit root analysis of debt/GDP is considered from 1974 to 2011. As the unit root analysis is highly sensitive to the specification of functional form, trend and detection of structural break, the present study addresses these issues carefully.

(3) However, due to lack availability of data on combined Union and State government revenue and expenditure with netting-out of inter-governmental flow of resources and liabilities, the study period for co-integration and error correction analysis of revenue/GDP and expenditure/GDP is considered from 1980 to 2011.

The rest of the paper is organized as follows. Section 2 provides a brief description of the evolution of debt/GDP, expenditure/GDP and revenue/GDP over the years in India. The theoretical background of assessment of debt sustainability is in section 3, while section 4 provides the empirical framework. Section 5 is devoted to empirical results on structural break, unit root, co-integration test and error correction mechanism. The major conclusions and implications are summarized in section 6.

Evolution of Debt/GDP, Revenue/GDP and Expenditure/ GDP in India

Looking at Exhibit.1, it is clear that there are four distinct phases of evolution of debt/GDP from 1952 to 2011. The period from 1968 to 1974 and 2005 to 2011 showed downward movement while the period from 1952 to 1968 and 1974 to 2004 revealed rapid increase in debt/GDP. Exhibit.2 shows three components of APD/GDP – the Central government's non-monetized domestic debt (CDD), the State governments' non-monetized domestic debt (SDD) and outstanding external debt (OED) computed at historically given exchange rates. The evolution of APD/GDP is shaped by the movement of these three components together. The upward movement of APD/GDP during 1952 to 1968 and 1974 to 2004 has been largely shaped by the rapid increase in OED/GDP and, CDD/GDP and SDD/GDP respectively. The

decline in APD/GDP since 2004 onwards is mainly due to the decline in CDD/GDP and SDD/GDP. The OED/GDP, which started declining after 1992, continued to decline. The CDD and SDD comprises the total non-monetised internal government liabilities in India. The important components of CDD are internal debt, which incorporates market loans, bonds and treasury bills, and other liabilities which include differet types of small savings, provident funds, reserve funds and deposits. The important components of SDD are market loans and bonds, small savings, provident funds, insurance & pension funds, loans from banks and other institutions, reserve funds, deposits and advances. Exhibit.2 provides how the different components of APD/GDP have evolved over time.

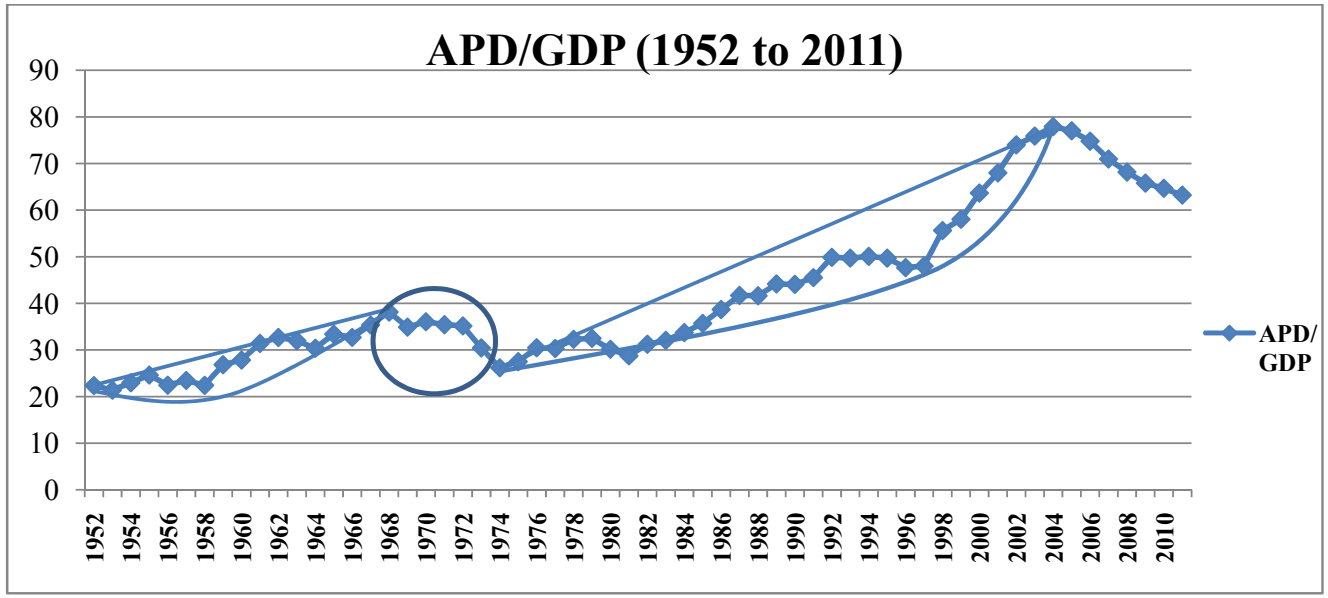
The movement of combined Union and State government's revenue/GDP and expenditure/GDP from 1980 to 2011 as revealed in Exhibit.1 shows the co-movement of the two series. Though the expenditure/GDP had exceeded revenue/GDP, the gap between the two never grew explosively during 1980 to 2011. Such evolution of expenditure/GDP and revenue/GDP perhaps has largely defined the movement of debt/GDP in India.

Table 1: Descriptive statistics of APD/GDP (1952 to 2011)

	Mean	Median	Maximum	Minimum	Std.Dev	Skewness	Kurtosis	Jarque-Bera	Prob.	Observations	Time Period
APD/GDP	42.2	33.4	77.9	21.4	16.6	0.81	2.41	7.35	0.025	60	1952 to 2011
Ln (APD/GDP)	3.7	3.6	4.4	3.1	0.37	0.34	2.03	3.55	0.17	60	1952 to 2011
APD/GDP	49.5	47.8	77.91	77.91	26.2	0.28	1.7	3.01	0.22	38	1974 to 2011
Ln (APD/GDP)	3.8	3.9	4.4	3.3	0.34	-0.06	1.7	2.8	0.25	38	1974 to 2011

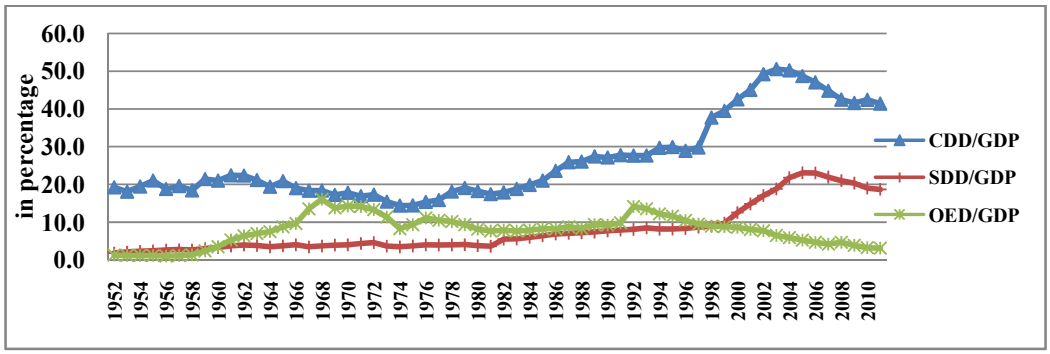
Source: Author

Exhibit 1: Aggregate of public debt/GDP (1952 to 2011)



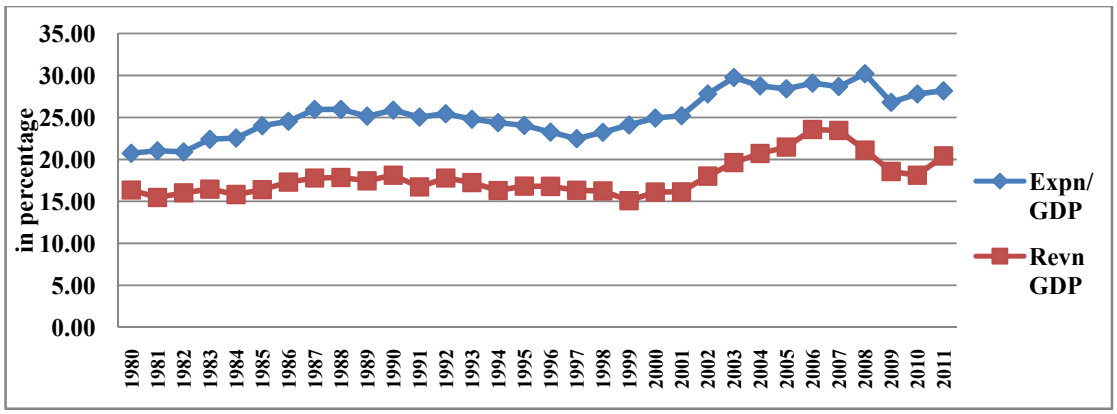
Source: Author

Exhibit 2: Central government domestic debt, State governments' debt and External debt



Source: Author

Exhibit 3: Movement of combined Central and State governments' expenditures and revenue



Source: Author

Assessment of debt sustainability – theoretical background

Following Hamilton and Flavin (1986), Wilcox (1989) and Buiter and Patel (1992), the inter-temporal budget constraint of government (IBC) can be developed by assuming the following. Let D_t and D_{t-1} be the stock of debt at period t and t-1. Y_t, r_t, g_t and P_t are the nominal GDP, nominal interest rate on government borrowing (i.e. bond yield), nominal GDP growth rate and primary deficits, respectively. The inter-temporal budget constraint is written as

$D_t = (1+r_t)D_{t-1} + P_t$ ..... (1).

If we write (1) by dividing GDP, we have $dt = \{(1+r_t)/(1+g_t)\}d_{t-1} + p_t$ .....(2).

Expressing (1) and (2) with forward looking recursive substitution, we have,

$$D_{t-1} = \prod_{j=0}^{N}(Z_{t+j}).\ D_{t+N} - \sum_{i=0}^{N}\{\prod_{j=0}^{i}(Z_{t+j})\ P_{t+j}\} \quad \ldots\ldots\ldots\ (3)\text{for finite period}$$

And

$$D_{t-1} = \prod_{j=0}^{\infty}(Z_{t+j}).\ D_{t+N} - \sum_{i=0}^{\infty}\{\prod_{j=0}^{i}(Z_{t+j})\ P_{t+j}\} \ \ldots\ldots\ldots\ldots(4)\text{for infinite period, Z=1/(1+r)}$$

Similarly for (2), we can write

$$d_{t-1} = \prod_{j=1}^{N}(Z_{t+j}).\, d_{t+N} - \sum_{i=0}^{N}\{(\prod_{j=0}^{i} Z *_{t+j})\, p_{t+j}\} \ldots\ldots\ldots\ldots (5) \text{ for finite period.}$$

$$d_{t-1} = \prod_{j=1}^{\infty}(Z_{t+j}).\, d_{t+N} - \sum_{i=0}^{\infty}\{\prod_{j=0}^{i}(Z *_{t+j})\, p_{t+j}\} \ldots\ldots\ldots\ldots (6) \text{ for infinite period, where } Z^* = (1+g)/(1+r)$$

D_{t+N} and d_{t+N} are the stock of debt and debt/GDP at the beginning of t+N period. The debt sustainability requires that PDV of all future primary surpluses (PS) should not be less than that of debt at present. That is, in terms of our equations, second term of RHS both (3) & (4) and (5) & (6) should be at least equal to the LHS of respective equations.

$$D_{t-1} = -\sum_{i=0}^{N}\{(\prod_{j=0}^{i} Z_{t+j})\, P_{t+j}\} \ldots\ldots\ldots\ldots (7) \text{ for finite period.}$$

$$D_{t-1} = -\sum_{i=0}^{\infty}\{(\prod_{j=0}^{i} Z_{t+j})\, P_{t+j}\} \ldots\ldots\ldots\ldots (8) \text{ for infinite period,}$$

$$d_{t-1} = -\sum_{i=0}^{N}\{(\prod_{j=0}^{i} Z *_{t+j})\, P_{t+j}\} \ldots\ldots\ldots\ldots (9) \text{ for finite period.}$$

$$d_{t-1} = -\sum_{i=0}^{\infty}\{(\prod_{j=0}^{i} Z *_{t+j})\, P_{t+j}\} \ldots\ldots\ldots\ldots (10) \text{ for infinite period,}$$

In all the cases minus sign (-) of deficits is PS.

The essential implications for this are that first term of RHS of (3), (4), (5) and (6) are either non-positive or set to zero. This implies that PDV of net debt is zero at terminal point under dynamic efficiency.

$$\prod_{j=0}^{N}(Z_{t+j}).\, D_{t+N} = D_T(Say) \leq 0 \ldots\ldots\ldots\ldots (11)\text{for finite period.}$$

$$\prod_{j=0}^{\infty}(Z_{t+j}).\, D_{t+N} = 0 \ldots\ldots\ldots\ldots (12)\text{for infinite period.}$$

$$\prod_{j=0}^{N}(Z *_{t+j}).\, d_{t+N} = d_T \leq 0 \ldots\ldots\ldots\ldots (13)\text{for finite period.}$$

$$\prod_{j=0}^{\infty}(Z *_{t+j}).\, d_{t+N} = 0 \ldots\ldots\ldots\ldots (14)\text{for infinite period.}$$

Four different transversality conditions.

Less than zero refers to super solvency

and equal to zero is *exact-solvency*.

If the aforementioned conditions are not strictly satisfied by the current and future fiscal policy behavior, fiscal policy is said to be un-sustainable under a theoretical setup. However, in practice, as it is difficult to know the future time path of debt and primary surplus, the researchers apply time series econometric techniques to the historically given time series data on primary surplus (or deficits), public debt or revenue and expenditures for fiscal or debt sustainability analysis (Buiter and Patel 1992; Hamilton and Flavin 1986; Wicox 1989; Bohn 1998). As the time series econometric analysis is based on historically given information on relevant variables, it is called backward looking approach to fiscal or debt sustainability (HM Treasury, 2008). The backward looking approach implicitly assumes that the historically given trends and patterns of the relevant variables and empirical results will prevail in future and accordingly the issue of debt sustainability is addressed.

Empirical Framework

To assess the sustainability of public debt in India, the unit root test applied to APD/GDP with structural break, co-integration analysis of expenditure/GDP and revenue/GDP and consequently the error correction mechanism (ECM) have been used. Before approaching unit root and co-integration and ECM analysis, it is better to specify the empirically estimable equations with theoretically derived and predicted sign conditions of parameters. Details of such exercise have been put forward in the following sections.

1. Unit root, Co-integration and Error Correction Mechanism

In the present study, as Exhibit.1 shows exponential trend for aggregate public debt to GDP ratio (APD/GDP) since 1974 with a downward break in trend in 2005, the uni-variate representation of debt/GDP with drift, trend and time dummy to take care of change in trend can be written as

$$\text{Ln(APD/GDP)} = \alpha_1 + \alpha_2 \mathbf{t} + \beta\ \text{Ln(APD/GDP)}_{t-1} + \text{D1T} + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (15).$$

Equation (15) is an AR(1) representation with intercept (α_1), trend components (α_2) and trend dummy (D1T), while μ_t is the errors which are *iid* with zero mean and constant variance. The testing of unit root in (15) implies testing whether the coefficient of Ln(APD/GDP)_{t-1} (i.e. β=1) is equal to one. That is null hypothesis: **H_0; β =1, against the alternative hypothesis H_1 ; $\beta \neq 1$**. If $\beta \neq 1$, it implies either $\beta > 1$ or $\beta < 1$. The case $\beta > 1$ is ruled out, as it is the case related to explosive series. Thus, only case $\beta < 1$ or $\beta = 1$ has meaningful implication in unit root analysis.

The equivalent way of expressing (15) is

$$\Delta\text{Ln(APD/GDP)}_t = \alpha_1 + \alpha_2 \mathbf{t} + \eta\text{Ln(APD/GDP)}_{t-1} + \text{D1T} + \mu_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (16)$$ Or,

$$\Delta\text{Ln(APD/GDP)}_t = \alpha_1 + \alpha_2 t + \eta\text{Ln(APD/GDP)}_{t-1} + \sum_{i=1}^{m} \theta_i\, \Delta\text{Ln(APD/GDP)}_{t-i} + \text{D1T} + \mu_t \ldots\ldots\ldots\ldots (17)$$

The value of m in (17) is the lag length of the differenced of Ln(APD/GDP) and needs to be determined empirically to take care of auto-correlation problem. Equation (16) and (17) are Dickey – Fuller (DF) and Augmented Dickey – Fuller (ADF) representation of (15). Testing of $\beta = 1$ in (15) is equivalent of testing $|\eta| = 0$ in (16) or (17). Thus, the re-defined null and alternative hypotheses are

expressed as, **H_0; η =0, as against H_1; η < 0.** Sustainability of debt in the present context requires rejection of null-hypothesis in the presence of downward trend break.

For co-integration test between Expn/GDP and Revn/GDP, one needs to estimate the following regression equation.

$Expn/GDP_t = \alpha + \beta\ Revn/GDP_t + \xi_t$, ……(18), where ξ_t is the error term.

According to Jha and Sharma (2004) and Afonso (2005), a meaningful co-integration analysis between Expn/GDP and Revn/GDP for debt sustainability requires estimated β from (18) should be statistically significant and strictly not greater than one. That is either β to be less than one (i.e. $\beta < 1$) or equal to one (i.e. $\beta = 1$). In brief, the sign condition of estimated would be $\beta \leq 1$.

Co-integration test used to detect long-term relationship between two variables doesn't rule out the possibility of short-term error or disequilibrium (Engel and Granger, 1987). Therefore, ξ_t, in (18) is called equilibrium error. Thus if co-integration is found between expenditure/GDP and revenue/GDP, their relationship can be represented as Error Correction Mechanism (ECM). For ECM, one needs to estimate the following equation.

$\Delta(Expn/GDP)_t = \lambda + \Phi\Delta(Revn/GDP)_t + \Psi\xi_{t-1} + \epsilon_t$ ……(19).

In (19) Δ denotes the first difference, ϵ_t denotes random error term and ξ_{t-1} denotes one period lagged value of the error from the co-integration regression from equation (18). The parameter Ψ in (19) is the adjustment parameter and it decides how quickly the equilibrium is restored. Thus statistical significance of Ψ will denote a meaningful ECM representation. The null-hypothesis of ECM representation of (19) is **H_0; $\Psi = 0$, against H_1; $\Psi \neq 0$.**

2. Technique of estimation

To test whether Ln(APD/GDP) is stationary or not, we follow a couple of steps. In the **first step**, visual inspection from Exhibit.1 reveals that there is downward structural change in trend in 2005. The econometric test for structural change also supports it. The result of structural break analysis is given in Table.3. Thus directly, the unit root test cannot be applied without incorporating break. The **second step** is to check the correlogram statistics. As there are structural changes, the correlogram diagram and statistics would be misleading. Due to this limitation, the correlogram statistics and diagram have not been reported here. The **third** step is to check whether Ln (APD/GDP) is stationary or not by applying Augmented Dickey Fuller (ADF). In the presence of structural break, ADF test cannot be applied directly. Instead the data series needs to be *de-trended* by estimating the regression equation (20).

$Ln(APD/GDP)_t = \alpha_1 + \alpha_2\,\mathbf{t} + D1T + \mu_t$ ……(20)

Let's denote the residuals de-trended equation as Ln $(\overline{APD/GDP})_t$ and test whether de-trended residuals are stationary by estimating the equation (21) or (22)

$\Delta Ln\ (\overline{APD/GDP}) = a_1 Ln\ (\overline{APD/GDP})_{t-1} + e_t$ ……(21) Or,

$$\Delta \text{Ln}\,(\overline{\text{APD/GDP}}) = a_1 \text{Ln}\,(\overline{\text{APD/GDP}})_{\text{t-1}} + \sum_{\text{i=1}}^{\text{m}} \theta_{\text{i}}\, \Delta \text{Ln}(\overline{\text{APD/GDP}})_{\text{t-i}} + \text{e}_{\text{t}} \ldots\ldots\ldots\ldots (22)$$

The equation (21) and (22) are the DF and ADF representations respectively. The modified null hypothesis is that **H_0;** a_1 **=0, as against H_1;** a_1 **< 0.**

To test the existence of long run equilibrium relationship between government expenditure/GDP (Expn/GDP) and revenue/GDP (Revn/GDP), it is important to check whether they are individually I(0) i.e. stationary or not. If they are individually I(0) series, then public debt is strongly sustainable. If both the series are I(1), for testing co-integration, one needs to conduct Engel – Granger (EG) or Augmented Engel – Granger (AEG) of (18). The **first step** of EG or AEG of (18) is to estimate the β from (18) and check whether estimated β is statistically significant and its value of estimated β≤1. The **second step** is to collect estimated residuals errors to test whether errors are serially co-related. The **third step** is to either perform the unit root test of estimated residual errors. After co-integration, following Engel and Granger (1987), the relationship between them can be represented as Error Correction Mechanism (ECM) by estimating equation (19).

3. Data and variables description

Table 2: Measurement and data sources of variables

Variable	Description	Data sources
CDD	Central governments' internal liabilities which exclude securities issued to international financial institutions and all monetized components. Internal liabilities consist of internal debt and other liabilities.	From 1952 to 1997 (Rajaraman and Mukhopadhay, 1999) and 1998 onward from various issues of Indian Public Finance Statistics (IPFS), Government of India.
SDD	Aggregate non-monetized liabilities of States' – Centre's loans and advances given to State governments.	From 1952 to 1981 (Rajaraman and Mukhopadhay, 1999) and 1982 onward RBI's Hand Book of Statistics on Indian Economy, 2012.
OED	Outstanding external public debt evaluated at historical exchange rates prevailing at the end of each financial year.	Various issues of Indian Public Finance Statistics
APD /GDP	(CDD+SDD+OED)/market value of GDP at current prices. Nominal GDP has been used as denominator to arrive at the debt ratios as the debt stock are nominal in nature.	For GDP, RBI's data base on Indian Economy, 2012
Expenditure /GDP	Combined expenditures of Centre and states after correcting inter-governmental transfer.	Data on expenditure and revenue from 1980 to 2011 from various issues of Indian Public Finance Statistics, Government of India.
Revenue /GDP	Combined revenue receipts of Centre and states after correcting inter-governmental transfer.	
GDP	Gross Domestic Product at current market prices with base year 2004-05.	RBI Hand Book of Statistics on Indian Economy, 2012.

Source: Author

Exhibit 1 shows that the debt/GDP has increased very rapidly from 1974 to 2004-05. Thus the issue of debt sustainability has its roots since the mid 1970s and justifies the time period considered in the present study. Exhibit.1 shows that exponential increase in debt/GDP since 1974 warrants the incorporation of exponential trend to have a better fit of the data. The descriptive statistics in Table.1 show that debt/GDP expressed with exponential trend produces better fit of data than linear trend due to a substantial decline in standard deviation and Jarque – Bera (JB) statistic to indicate normality in the distribution of data.

Results

1. Test for structural change in APD/GDP

To test the visual inspection of downward trend break in APD/GDP since 2005, a simple dummy variable technique is used in equation (18) and the statistical significance of estimated coefficient of trend dummy shows that the data generating process of debt/GDP has indeed entered into a new regime. The estimated results of equation (18) are reported in Table.3.

Table 3: Test for structural change

Test for structural break at 2005				
Regression equation: $Ln(APD/GDP)_t = \alpha_1 + \alpha_2 T + D1T + \varepsilon_t$, where D1 = 1 after 2005 and 0 otherwise				
Dependent variable Ln(APD/GDP). Time from 1974 to 2011. N = 38				
Variable	**Coefficient**	**t-Statistic**	**Prob.**	**R^2 = 0.939**
Constant	**3.217350**	**100.7650**	**0.0000**	**Adj R^2 = 0.936**
Trend	**0.033795**	**19.39383**	**0.0000**	**F= 272.6**
Trend dummy	**-0.005074**	**-3.507223**	**0.0013**	**Prob. of F = 0.000**

Source: Author's compilation from the estimated regression equation 20.

2. Testing stationarity of Ln (APD/GDP) using unit root test

The result of unit root testing with a structural break at 2005 is reported in Table.4. Based on SBC and AIC criteria, the value of lag length has been determined to take care of auto-correlation problem and specification issue. The 't' value of $Ln(APD/GDP)_{t-1}$ indicates that the null hypothesis of unit root or $\mathbf{H_0; a_1 = 0}$ is rejected at 5 percent level of significance. That is the null hypothesis of non-stationarity of Ln(APD/GDP) during the period of 1974 to 2011 with trend break since 2005 being rejected. The minimum value of AIC (-3.16) and SBC (-2.98) when $\Delta Ln(\overline{APD/GDP})_{t-1}$, $\Delta Ln(\overline{APD/GDP})_{t-2}$ and $\Delta Ln(\overline{APD/GDP})_{t-3}$ are added ensures that the model specification is correct.

Table 4: Unit root test for structural change at 2005.

Dependent variable: ΔLn $(\overline{\text{APD/GDP}})$				
Variables	**Ln$(\overline{\text{APD/GDP}})_{t-1}$**	**ΔLn$(\overline{\text{APD/GDP}})_{t-1}$**	**ΔLn$(\overline{\text{APD/GDP}})_{t-2}$**	**ΔLn$(\overline{\text{APD/GDP}})_{t-3}$**
Value	**-0.464**	**1.052**	**-0.99**	**0.366**
't' value	**-3.46***	**3.41**	**-2.52**	**2.11**
SBC= -2.98	**AIC= - 3.16**	**R^2=0.33**	**Adj. R^2 = 0.26**	

* = Null hypothesis of unit root rejected at 5 percent significance level.

Source: Author's compilation from the estimated regression equation 22.

3. Testing Co-integration and Error Correction Mechanism (ECM) between government expenditure/GDP and revenue/GDP

The reported result of test of stationarity of Expn/GDP and Revn/GDP at level reported in Table.5 shows that both Expn/GDP and Revn/GDP are non-stationary i.e. I(1) series. The test statistics of ADF, P-P and KPSS test failed to reject the null-hypothesis of non-stationarity of Expn/GDP and Revn/GDP at level. However, both Expn/GDP and Revn/GDP become stationary i.e. I(0) after first difference as ADF and P-P test statistics reject the null-hypothesis of non-stationarity. Thus both Expn/GDP and Revn/GDP being I(1) are ideal for co-integration analysis.

Table 5: Results of stationarity of Expn/GDP and Revn/GDP

Intercept and Trend				**Intercept and Trend**		
Variables	**ADF test**	**P-P test**	**KPSS test**	**Variables**	**ADF test**	**P-P test**
Expn/GDP	-2.038$	- 2.12$	0.072@	ΔExpn/GDP	-5.92***	-5.91***
Revn/GDP	-2.62$	-2.15$	0.098@	ΔRevn/GDP	-3.8**	-3.47*

Note: $ = Null hypothesis of unit root not rejected at 1 percent significance level. ***, ** and * = Null hypothesis of unit root rejected at 1, 5 and 10 percent level significance. @ = Null hypothesis of trend stationarity is not rejected at 1 percent significance level.

Source: Author's compilation from the unit root test of expenditure/GDP and revenue/GDP.

The estimated regression of (18) is given below.

$(\overline{\text{Expn/GDP}})_t = 7.66 + 0.991\ (\text{Revn/GDP}_t)$ ..... (23)

'τ' values (3.56*) (8.27*). R^2 = 0.69, * indicates significance at 1 percent level.

As the estimated value of β is less than one, it suggests, following Afonso (2005), that both Expn/GDP and Revn/GDP are meaningfully co-integrated for inter-temporal debt sustainability. However, since both Expn/GDP and Revn/GDP are individually I(1), there may be a possibility of spurious regression. Conducting unit root test on estimated residuals from (23), the following results are obtained.

$\overline{\Delta\bar{\xi}_t} = -0.401\bar{\xi}_{t-1}$ ..... (24)

'τ' values (-3.13*) R^2 = 0.24, AIC = 2.93, SBC = 2.98

The DF 1 percent critical **'τ'** value is (-2.58). Since computed **'τ'** value (-3.424) is much more negative than this, the conclusion is that estimated residuals from the regression of Expn/GDP on Revn/GDP from (22) are I(0).

The estimated ECM representation of Expn/GDP and Revn/GDP can be represented as

$\Delta(\overline{\text{Expn/GDP}})_t = 0.16 + 0.587\Delta\ (\text{Revn/GDP})_t - 0.28\ \bar{\xi}_{t-1}$ ..... (25)

'τ' values (0.92) (3.57*) (2.18*),

R^2 = 0.33, DW = 2.15. * indicates statistically significant at 5 percent level.

Statistically significant and expected negative sign of equilibrium error ensures the stability of the model and suggests that Expn/GDP adjusts by 0.28 to change in Revn/GDP in the next period. The positive and statistically significant coefficient of $\Delta(\text{Revn/GDP})_t$ suggests that short run change in Revn/GDP has a positive impact on Expn/GDP by 0.587. That is, in the short run, if Revn/GDP increases by one unit, the Expn/GDP increases by 0.587 units. Thus one can interpret the value of 0.587 of $\Delta(\text{Revn/GDP})_t$ and 0.991 of Revn/GDP as the short-term and long-term impact of Revn/GDP on Expn/GDP respectively.

The evidence obtained from the results of unit root analysis of Ln(APD/GDP), co-integration relation and consequent ECM representation of Expn/GDP and Revn/GDP suggests that public debt in India during the study period had been sustainable. The sign condition and statistical significance of estimated parameters are consistent with theoretical prediction. The diagnostic checks suggest that the specification of the model under unit root test, co-integration test and ECM representation are consistent for model stability.

Conclusion and Implications

The major conclusions of the present study are:

Firstly, assessment based on unit root analysis of non-monetized liabilities/GDP, and co-integrating analysis of expenditure/GDP and revenue/GDP shows that public debt in India had been sustainable during the study period. The conclusion of the present study based on empirical results differs from the existing studies by Buiter and Patel (1992; 1993). Statistical test suggests that the underlying time series of debt/GDP in the Indian context during the study period is stationary as opposed to the findings of non-stationarity (i.e. unit root) by Buiter and Patel. The findings of trend stationarity with downward break since 2005 indicate that public debt in India is not un-sustainable. The meaningful co-integration between expenditure/GDP and revenue/GDP and subsequent error correction representation with expected sign and statistical significance of co-integrating and adjustment parameters too support that public debt in India had been sustainable.

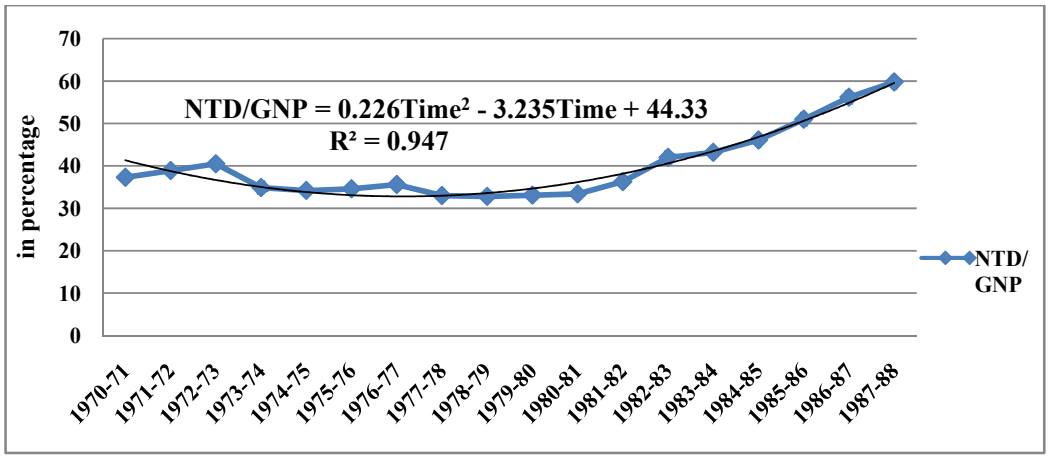
Secondly, the present study also provides an explanation different explanation to the findings of public sector insolvency as obtained by Buiter and Patel (1992). Quadratic trend specification of their data series and statistical significance of positive deterministic trend support their conclusion of

government insolvency rather than the finding of stochastic trend based on linear specification as reported by them.

However, the findings do not suggest that debt/GDP would come down automatically from its current level any time soon to the optimal level of 56 percent as set by different finance commissions (FCs) when some fiscal corrections are implemented as mentioned in the reports of different FCs. However, although the current debt/GDP ratios are higher than the FC's target, public debt in India is sustainable mainly on account of high GDP growth, lower cost of government borrowing, favorable currency composition and longer maturity profile of debt.

Appendix

Apendix 1: Net total public debt/GNP



Source: Buiter and Patel (1992)

Estimated quadratic polynomial regression

ΔNTD_t	=	37.27	- 3.11T	+ 0.207T^2	- 0.78NTD_{t-1}
't' values		(3.93*)	(-3.89*)	(4.37*)	(-3.98*)

R^2 =0.77, Adj. R^2 0.72, DW = 2.2, AIC = 3.8768 and SBC = 4.07289. All coefficients are significant at 5 percent level of significance. * indicates that the null hypothesis of non-stationarity with quadratic trend is rejected at 5% level of significance. For tabulated critical value of quadratic trend, see MacKinnon (2010, p15). Thus, Buiter and Patel's (1992) finding of non-stationarity of debt/GDP to establish un-sustainable debt/GDP is refined by the findings of trend stationarity. That is, the finding of un-sustainability of debt/GDP is still valid with a refinement of trend stationarity rather than unit root.

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Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: lekha@isec.ac.in; Web: www.isec.ac.in