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Abstract

This article utilizes the Bohn framework for panel data and penalized spline technique for testing public debt sustainability in 20 major Indian states during 2007-08 to 2018-19. The study shows that the primary surplus reacts positively to public debt only in 4 states, indicating debt sustainability in these states. Interestingly, the reaction coefficients are time-varying in 10 states, of which three are sustainable. Further, we descriptively verified whether the sustainable debt is welfare-enhancing as well during the study period. We found that debt is neither sustainable nor welfare-enhancing in the case of 12 states, so they need to take corrective actions.

Keywords: *Sustainable Debt, Indian States, Bohn Model, Penalized Spline*
JEL Codes: *E62, H63, H72, H74*

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P.S. Renjith

INTRODUCTION

Public debt sustainability issue has always been paramount in the macroeconomic analysis of fiscal policy. Conceptually, sustainable public debt is given as long as debt does not accumulate at a rate considerably exceeding the government's capacity to service it (IMF 2011). That is, it is basically about good housekeeping. There are three theoretical views on debt/deficit financing in the literature: (i) Classical (Ricardian equivalence theorem) view which asserts that fiscal deficit does not really matter except for smoothing the adjustment to expenditure or revenue shocks. Budget deficits today require higher taxes in the future when a government cuts taxes without changing the present or future public spending; (ii) Keynesian view that considers a growth stimulated effect of deficit financing. Debt does not pose a problem if the government runs into debt in the home country because public deficit implies a reallocation of resources from taxpayers to bondholders (Greiner and Fincke 2009); and (iii) Neo-classical view which considers that fiscal deficit is detrimental to investment and economic growth. Thus, there is no consensus among economists on whether deficit financing is good or bad or neutral for an economy (Rangarajan and Srivastava, 2005).

To evaluate the debt sustainability, past studies followed the traditional approach and utilized the popular Domar (1944) condition, which states that "as long as the real economic growth is greater than the real interest rate, the government can have a positive primary deficit such that its debt will not rise and so the debt is sustainable." Later, this approach was extended with additional indicators like liquidity, creditworthiness, fiscal burden, fiscal space, etc., and renamed as "Indicator Approach" (see Blanchard *et. al.* 1991; Pattnaik *et. al.* 2003; Rajaraman *et. al.* 2005; and Kaur *et. al.* 2014). However, many criticized the traditional approach as it is applied on a year-on-year basis. It does not validate whether the government's intertemporal budget is satisfied.

After the seminal contribution by Hamilton and Flavin (1986), three alternative empirical approaches have emerged in the literature: (i)

Unit Root approach, which suggests that debt is sustainable if it is a stationary series (Trehan and Walsh 1991; Uctum *et. al.* 2006); (ii) *Co-integration approach* that requires that public debt and primary surplus variables or public revenue and public expenditure variables need to be co-integrated (Hakkio and Rush 1991; Jha and Sharma 2004);[1] and (iii) *Bohn's model-based approach,* which considers that a government needs to take corrective actions in future by increasing its primary surplus if it has a considerable deficit today. Otherwise, the debt is not sustainable (Greiner and Fincke 2009). The advantage of this approach is that it provides a straightforward and powerful method to conduct nonstructural empirical tests (D'Erasmo *et. al.*,2016). This test uses the time series data on the primary balance, debt, and control variables and estimate linear/nonlinear fiscal reaction functions, which map the response of the primary balance to change in public debt, conditional on the control variables.

Asper the Bohn model, if the response of primary balance to public debt is positive and statistically significant, the debt is sustainable. This means that the initial stock of debt is equal to the sum of present discounted values of primary balances. The Intertemporal Budget Constraint (IBC)[2] is satisfied if the discounted sum of end-period debt converges to zero. The positive reaction coefficient ensures this convergence. Among three time-series approaches, the Bohn model became popular because of its nice statistical property. This approach has later been extended to include time-varying coefficients (estimated using the penalized spline technique),[3] panel data context, etc. Many researchers have widely used the Bohn model and its extended versions to test whether public debt policies in different countries are sustainable or not (e.g., Bohn (1998) for USA, Haber and Neck (2006) for Austria, Greiner and Kauermann (2008) for European countries, Greiner and Fincke (2009) for USA, Euro countries and developing countries, Abiad and Ostry (2005) for 31 emerging economies using panel framework and Tiwari (2012) for India). See Fincke and Greiner (2011) and D'Erasmo *et. al.* (2016) for a review of these studies.

As the debt sustainability issue is also relevant for sub-national governments like states/provinces, a few studies have dealt with debt sustainability at the sub-national level. For instance, Fincke and Greiner (2011) use the Bohn framework (time series data) and spline technique to evaluate the debt sustainability of individual states in Germany. Employing a panel version (fixed effects model and not spline technique) of Bohn framework, Mahdavi (2014) analyzes the debt sustainability of 48 American states during 1961 to 2008.Table 1 summarizes some of the existing empirical evidence (using Bohn model) on debt sustainability.

Table 1: Some Existing Empirical Evidence (using Bohn model) on Debt Sustainability

Study	Country	Data Period	Methodology	Sustainability?
Bohn (1998)	US	Annual; 1916-1995	OLS	Sustainable
Abiad and Ostry (2005)	31Emerging countries	Annual; 1990-2002	Panel GLS, Arellano Bond	Sustainable
Bohn (2005)	US	Annual; 1792-2003	OLS	Sustainable
Haber and Neck (2006)	Austria	Annual; 1960-2003	OLS	Sustainable
Greiner *et. al.* (2007)	US and 4 EU countries	Annual; 1960-2003	OLS	Sustainable (except US)
Kia (2008)	Iran and turkey	Annual ; 1970-2003 and 1967–2001	OLS	Not sustainable
Greiner and Kauermann (2008)	Germany and Italy	Annual; 1960-2003	p-spline	Sustainable (only Germany)
De mello (2008)	Brazil (central and sub-national)	Monthly (1995:1-2004:7)	OLS	Sustainable
Adams *et. al.* (2010)	33 countries	Annual; 1990-2008	panel GLS	Sustainable
Doi *et. al.* (2011)	Japan	Quarterly; 1980:I - 2010:I	markov-switching	Not sustainable
Fincke and Greiner (2011a)	Euro countries	Annual; 1971-2009	p-spline	Sustainable (except Greece and Italy)

Study	Country	Data Period	Methodology	Sustainability?
Fincke and Griener (2011b)	11 German federal states	Annual; (1975-2006)	p-spline	Sustainable (except Berlin)
Tiwari (2012)	India	Annual; 1970-2009	p-spline	Not Sustainable
Kaur and Mukherjee (2012)	India	Annual;1980-81 to 2012-13	OLS	Sustainable
Jose (2013)	India	Annual; 1983-2010	OLS	Sustainable
Mahdavi (2014)	48 US states	Annual; 1961-08	Panel FE	Sustainable
Kaur *et. al.* (2014)	20 Indian states	Annual; 1980-2013	Panel FE	Sustainable
Shastri and Sahrawat (2015)	India	Annual; 1980-2013	ARDL	Not sustainable
Belguith and Gabsi (2017)	Tunisia	Annual; 1965-2013	p-spline	Sustainable
Ranjith and Shanmugham (2018)	Indian States	Annual; 2004-05 to 2015-16	Panel FE	11 states are Sustainable

A few earlier studies like Dholokia *et. al.* (2004), Rajaraman *et. al.* (2005) and Maurya (2015) used the traditional indicator approach to evaluate debt sustainability of Indian states. Kaur *et. al.* (2014) use the panel data for 20 major Indian states during 1980-81 to 2012-13 and find evidence of the sustainable debt position of all states together (on average). Renjith and Shanmugam (2018) explored the public debt sustainability issue of 20 major Indian states using the Bohn framework and regular panel data estimation procedures for the period 2005–06 to 2014–15. The study results indicated that debt policies are successful in sustaining the debt situation of Indian states as a whole; however, at the disaggregate level, debt is sustainable only in 12 states.

Nevertheless, the debt situation in each state may vary over time. For instance, the debt relative to GSDP (Gross State Domestic Product) was 16.93 percent in Maharashtra and 49.30 percent in Jammu

and Kashmir in 2018-19, while it was 16.52 percent in Chhattisgarh and 51.07 percent in Himachal Pradesh in 2007-08. Therefore, it is essential to analyze the time-varying response of primary balance ratio to debt ratio of the individual states. This study is an attempt to analyze the debt sustainability at the individual state level in India with time-varying effects.

The main contribution of this paper is that it utilizes the panel data version of the Bohn model ("within" specification) and the penalized spline (p-spline) estimation procedure for time series for testing sustainability of public debt of each of 20 Major Indian states during 2007-08 to 2018-19. It is worth noticing that most of the earlier studies extended the basic Bohn model either by employing penalized spline technique (capturing non-linearity) or broaden the observations with panel framework, but so far, no study attempted to club both extensions together. Here lies the scope of this paper. This is done because the data supported the fixed effects panel data model which is in general estimated with Ordinary Least Squares (OLS) method. Further, it shows how the time-varying coefficients or reaction coefficients associated with the debt-GSDP ratio of each sample state evolve over time, [4]with the use of the p-spline estimates procedure.

The rest of this paper proceeds as follows. The next Section briefly describes the debt scenarios of the Indian states. The following two Sections explain the model, the data and the estimation procedures used in the study and the empirical results. The final section provides the concluding remarks of the study.

PUBLIC DEBT SCENARIO OF INDIAN STATES

Indian Constitution (1950) has provided for a two-tier federal system of Governments: centre and states and assigned separate tax powers and expenditure responsibilities to them. As it allocates all mobile and more buoyant taxes to the centre and more expenditure functions to the

states, the excess central revenues relative to its responsibility and a corresponding deficit in the states accounts where expenditures exceed own revenues are referred to as the vertical fiscal gap (Rangarajan and Srivastava 2008). Recognizing this vertical imbalance, the Indian Constitution has already facilitated the transfer mechanisms to transfer resources from the centre to the states in the form of tax devolution, grant-in-aid and centrally sponsored schemes (Rao 2005).

Both Governments borrow when their revenues are not enough to meet the growing expenditure needs. Since the state governments have constraints over borrowing sources, they face an inconsistency between the borrowing requirements and debt servicing. Compared to the centre, states in general borrows from internal sources, which include market loans and bonds, ways and means advances from the central bank, loans from banks and other institutions, provident funds etc., while external debts of the states are subject to a ceiling and approval from the centre.

On the other side, the annual debt requirements lie in the interest obligations on the accumulated debt. The extent of these commitments in every year is the reflection of primary balance. It is basically the amount of additional borrowings that are required to meet expenses other than the interest payments (primary deficit) or the pressure of the government on the interest commitments on previous borrowings (primary surplus). Therefore, primary balance is the root cause for all forms of deficits, and it reveals whether the fiscal situation of a government is improved or worsened along with the actual debt requirements.

In some years, governments use fiscal stimuli, often financed by excess borrowing, to expand their activities above the trend levels in India. There are two motivations for this. The first one is to play a countercyclical role to minimize the impact or volatility of the cyclicality of growth, while the second one derives from the government's

expansionary intervention for a political motive. That is, the first is a response to economic cycles, and the second is a cause of the political cycle driven by the timing of elections (Srivastava 2012). Trends in primary deficit relative to GDP and public debt relative to GDP since independence shown in many past studies indicate the cyclical nature of the former and the secular upward nature of the later (Rangarajan and Srivastava 2005).

Since the second half of the nineties, there has been a sharp deterioration in the debt-deficit situations of both centre and state governments in India, mainly because of the revision of pay scales for government employees (Rajaraman *et. al.* 2005). To improve the fiscal situation, the centre adopted a rule-based fiscal framework called the Fiscal Responsibility and Budget Management (FRBM) Act in 2003-04. It specifies a complete elimination of revenue deficit and reduction of fiscal deficit to 3 percent of the GDP with an annual reduction rate of 0.3 percent and 0.5 percent respectively and target should be achieved within a given time period (initially by 2008-09).Following the centre, most states also enacted their own FRBM rules during 2003-07. Although these efforts brought some initial success, the situation again worsened after the global slowdown in 2007-08.

The success was witnessed in the primary balance account. All states together had a primary surplus of 0.36 percent of GDP in 2006-07. Of course, other fiscal consolidation measures were also favored. For instances, (i) Debt Swap Scheme introduced by the centre mitigated the burden of interest payments on the states, which allowed them to swap high-cost loans against open market borrowings and small savings during 2002-03 to 2004-05; (ii) Debt Consolidation and Relief Facility, which is the combination of two subsidiary schemes i.e., debt consolidation and debt write-off, based on the recommendations of 12th Finance Commission during 2005-06 to 2009-10;[5]and (iii) Debt ceilings in terms of GSDP by all the states in pursuance of 13th Finance Commission recommendations.

But in 2009-10, all states' primary deficit was -1.22 percent of GDP,and the combined primary deficit of states and centre was -4.53 percent. The total liabilities of the states increased from Rs. 13283 billion in 2008 to Rs 52584 billion in 2020 (RBI 2021). Although the aggregate debt position of the state governments recently improved significantly in line with the FRBM Review Committee (2017) recommendation of targeting debt to GDP ratio of 20 percent for the state governments, in many states, the debt-GSDP crossed 25 percent level in 2019-20.[6] Slow economic growth in recent years, introduction of Goods and Services Tax (GST), implementation of Seventh Pay Commission's recommendations, etc already added fuel to the debt accumulation process in each state and it seems that the debt situation in those states may deteriorate further in coming years. Given the above trend on deficit and debt, it is essential to check whether state government debts are on a sustainable path in India.

MODEL, DATA AND ESTIMATION

To test the debt sustainability of Indian states, this study specifies the following fiscal reaction function based on Bohn Framework:

$$s_{it} = \phi_0 + \psi\, d_{it-1} + \phi_1 yvar_{it} + \phi_2 gvar_{it} + \lambda_i + \mu_t + \epsilon_{it} \quad (1)$$

where s_{it} is the primary balance to GSDP ratio in i^{th} state in year t, d_{it-1} is the debt to GSDP ratio of state i in $t-1$ year (the lagged debt ratio is used to avoid the endogeneity issue). This model is based on tax smoothing hypothesis, which implies that public deficits are used to keep tax rates constant, minimizing the excess burden of taxation. Therefore, the regular expenditures of the government can be financed by government revenues, while deficits can be used to finance unexpected expenditures. Hence, a business cycle variable, namely $yvar$ which

accounts for fluctuations in revenues and another business cycle variable and $gvar$ which accounts for fluctuations in primary expenditures are considered as non-debt determinants of primary balance, as in other studies. $yvar$ is calculated by subtracting the long-term trend of GSDP, which is computed using the Hodrick-Prescott (HP) Filter to the real GSDP series from its actual values. Similarly, $gvar$ is computed as realized value minus trend value of real primary expenditure with later again estimated by the HP Filter. λ_i is unobserved heterogeneity of the i^{th} state and μ_t is time (year) effects, and they control state specific and time specific factors which may influence the dependent variable.

This model is also based on the fact that discounting public debt with a given interest rate is crucial to test whether a given time path of debt is sustainable. As future interest rates are unknown, the debt sustainability tests need to be independent of the discounting factor used to compute the present value of debt. If the primary surplus to GSDP ratio is a positive function of debt to GSDP ratio, then the above condition is met indirectly. The idea behind this test is that such policy makes the debt to GSDP ratio a mean-reverting process.

The above panel version of the Bohn model can be estimated using either fixed effects or random effects estimation techniques. The choice of the technique is based on the Hausman statistics. In the initial analysis, the Hausman statistics (=34.3) supports the fixed effects model, and so the equation is specified equivalently with "within" specification as:

$$s_{it} - \overline{s_i} = \psi\,(d_{it-1} - \overline{d_i}) + \phi_1\ (yvar_{it} - \overline{yvar_i}) + \phi_2(gvar_{it} - \overline{gvar_i}) + \epsilon_{it} - \overline{\epsilon_i} \quad (2)$$

where all variables are in their mean differences. This within estimation has wiped out the individual and time effects, and it can be estimated using OLS. The estimation parameter ψwill give us on an average

whether the debt situation in all states is sustainable or not. Many Past studies hence used this approach. Since our objective is to evaluate the debt sustainability in each state, equation (2) can be modified as:

$$s_{it} - \bar{s_i} = \sum \psi_{it} \ (d_{it-1} - \bar{d}_{\text{i}}) * D_i + \phi_1 \ (yvar_{\text{it}} - \overline{yvar_{\text{i}}}) + \phi_2 \ (gvar_{\text{it}} - \overline{gvar_{\text{i}}}) + \in_{it} \quad (3)$$

where D_i's are state-specific dummies. D_i= 1 if state *i and 0* otherwise. As respective state dummies are allowed to interact with debt variables, we can get state-specific debt co-efficient, ψ. Besides, we would like to obtain the time-varying ψ for each state. Therefore, we can estimate equation (3) using the p-spline (which is more robust than OLS) procedure.[7]Thus,with this innovative approach which mix panel within specification and penalized spline procedure, we can get state-specific and time-varying response coefficient ψ_{it}. It is also noted that the lagged debt variable avoids endogeinity problem evolved over time for each state.

The data for the period 2007-08 to 2018-19 are drawn from various published sources. The GSDP data (real and nominal) for 20 major Indian states are compiled from the Central Statistical Organization (CSO), while other fiscal variables from Comptroller and Auditor General (CAG) of India Audit Reports and Finance Accounts of the sample states. The total observations included in the final analysis are 240.

It is noted that the sample states account for more than 90 percent of the population of India.[8]The choice of this latest time period is due to the following facts. Firstly, this period represents a fiscal control era due to the enactment of the FRBM act. Secondly, availability of a comparable new base (2011-12) GSDP series restricts us to use the data after 2000. Thirdly, as debt is an accumulation of fiscal deficit (net debt) every year, the recent trend is more relevant. Finally, many past studies have used a few years' data when employing a panel framework.

The descriptive statistics of the study variables are shown in Column 2 of Table 2 where the real values of the fiscal variables are computed using the GSDP deflator of the respective states and both Levin, Lin, Chu (LLC) and ImPesaran Shin (IPS) panel unit root tests confirm that all variables used in the study are stationary, i.e., they are I(0).

Table 2: Penalized Spline Estimation Results of Fiscal Policy Reaction Function for the Indian States during 2007-08 to 2018-19

Variables	Mean (S.D)	Coefficient (t-value)	Smooth Term	edf.	F (p-value)
(1)	(2)	(3)	(4)	(5)	(6)
s_{it}	-0.7457 (1.564)	-	-	-	-
$s_{it} - \bar{s_i}$	-0.00001 (1.365)	-	-	-	-
d_{it-1}	27.8815 (10.315)	-	-	-	-
$d_{it-1} - \bar{d}_i$	0.0231 (5.376)	-	-	-	-
$yvar$	-1086.8240 (17858.510)	0.00001 (2.899)	-	-	-
$gvar$	-191.1497 (5612.579)	-0.0001 (-11.324)	-	-	-
$(d_{it-1} - \bar{d}_i)$ × *Dummy for AP*		0.0653 (1.422)	*sm(t)*:AP	2.926	2.708 (0.040)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for ASM*		1.2100 (2.164)	*sm(t)*: ASM	8.133	3.004 (0.002)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for BIH*		0.0650 (2.320)	*sm(t)*:BIH	1.500	8.355 (0.022)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for CHA*		0.5545 (0.787)	*sm(t)*: CHA	5.279	2.276 (0.038)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for GUJ*		0.0005 (0.014)	*sm(t)*: GUJ	1.500	0.001 (0.999)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for HAR*		-0.2140 (-1.013)	*sm(t)*: HAR	2.757	2.354 (0.084)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for HP*		-0.9257 (-1.735)	*sm(t)*: HP	8.850	10.605 (0.000)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for JK*		0.1049 (1.402)	*sm(t)*: JK	1.500	0.435 (0.447)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for JHA*		-0.3982 (-0.678)	*sm(t)*: JHA	5.255	2.331 (0.092)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for KAR*		0.0106 (0.052)	*sm(t)*: KAR	1.500	0.481 (0.660)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for KER*		0.1192 (1.218)	*sm(t)*: KER	1.500	0.751 (0.307)

Variables	Mean (S.D)	Coefficient (t-value)	Smooth Term	edf.	F (p-value)
(1)	(2)	(3)	(4)	(5)	(6)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for MP*		0.0784 (2.333)	*sm(t)*: MP	1.500	2.144 (0.121)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for MAH*		0.3085 (0.775)	*sm(t)*: MAH	3.129	0.524 (0.609)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for ODI*		0.1122 (3.977)	*sm(t)*: ODI	1.500	10.809 (0.002)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for PUN*		0.0515 (0.896)	*sm(t)*: PUN	1.658	0.831 (0.486)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for RAJ*		0.0594 (0.313)	*sm(t)*: RAJ	3.739	2.415 (0.097)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for TN*		-0.0705 (-0.589)	*sm(t)*: TN	1.500	0.649 (0.606)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for UP*		0.0710 (0.640)	*sm(t)*: UP	2.285	0.325 (0.691)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for UTK*		-0.0999 (-0.473)	*sm(t)*: UTK	2.269	0.292 (0.739)
$(d_{it-1} - \bar{d}_i)$ × *Dummy for WB*		-0.0424 (-1.674)	*sm(t)*: WB	1.500	0.439 (0.446)
(Intercept)		-0.0109 (-0.122)			
Adj.R^2 (GCV)	0.630 (0.9887)				
D-W Stat.	2.0201				

EMPIRICAL RESULTS

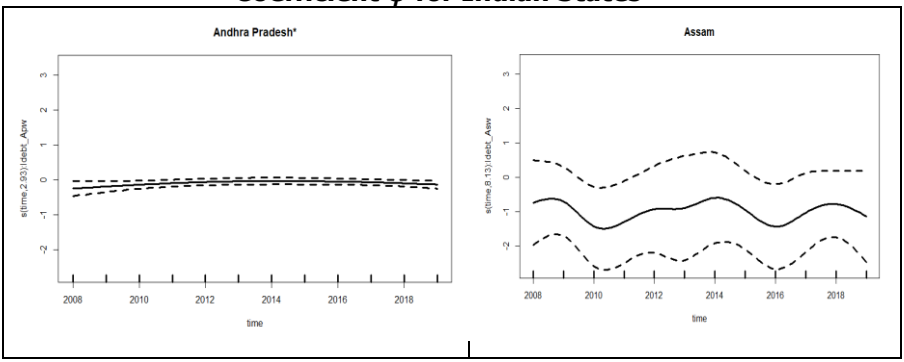
Column 3 of Table 2 shows the penalized spline estimation results of the fiscal policy reaction function (3). As expected, the primary expenditures variable $gvar$ has a negative coefficient, and the business cycle variable $yvar$ has a positive coefficient. Both these coefficients are statistically significant at 1 percent level. These results imply that, on average, the primary spending above its normal value has reduced the primary surplus of the Indian states while the GSDP growth above normal value has increased the primary surplus.

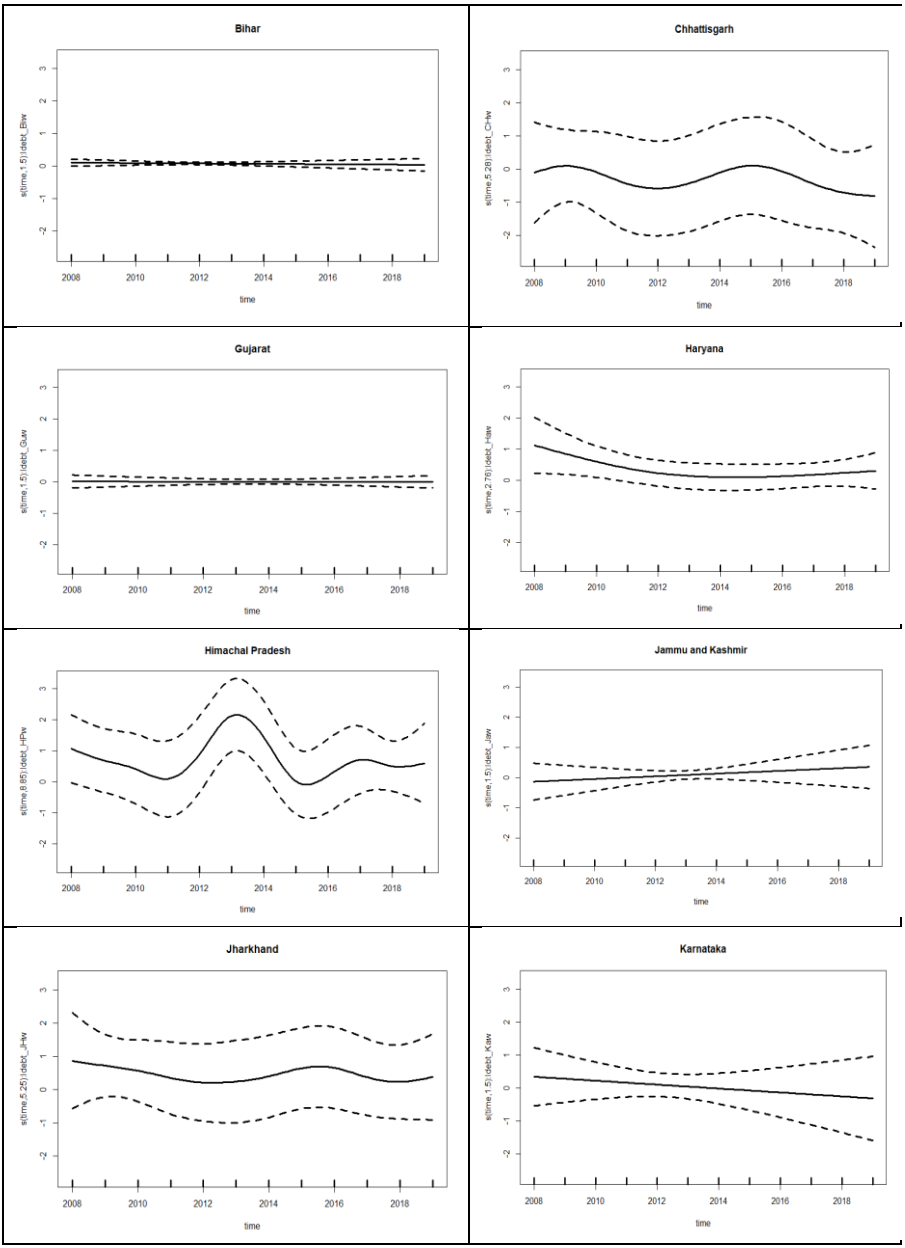
The variable of our interest is the debt-GSDP ratio. As expected, this reaction coefficient is positive and statistically significant for four states (Assam (ASM), Bihar (BIH), Madhya Pradesh (MP) and Odisha (ODI) at 5 percent level. These results indicate that the public debt is sustainable in these 4 Indian states. For Himachal Pradesh (HP) and West Bengal (WB), the reaction co-efficient is negative and significant only at 10 percent level. For Andhra Pradesh (AP), Chhattisgarh (CHA), Gujarat (GUJ), Jammu and Kashmir (JK), Karnataka (KAR), Kerala (KER), Maharashtra (MAH), Punjab (PB), Rajasthan (RAJ) and Uttar Pradesh (UP), the reaction coefficient is positive but not statistically significant even at 10 percent level. In Haryana (HAR), Jharkhand (JHA), Tamil Nadu (TN) and Uttarakhand (UTK) this coefficient is negative but not statistically significant even at 10 percent level. Thus, the debt is not sustainable in these 16 states. These 16 states deserve policy attention.

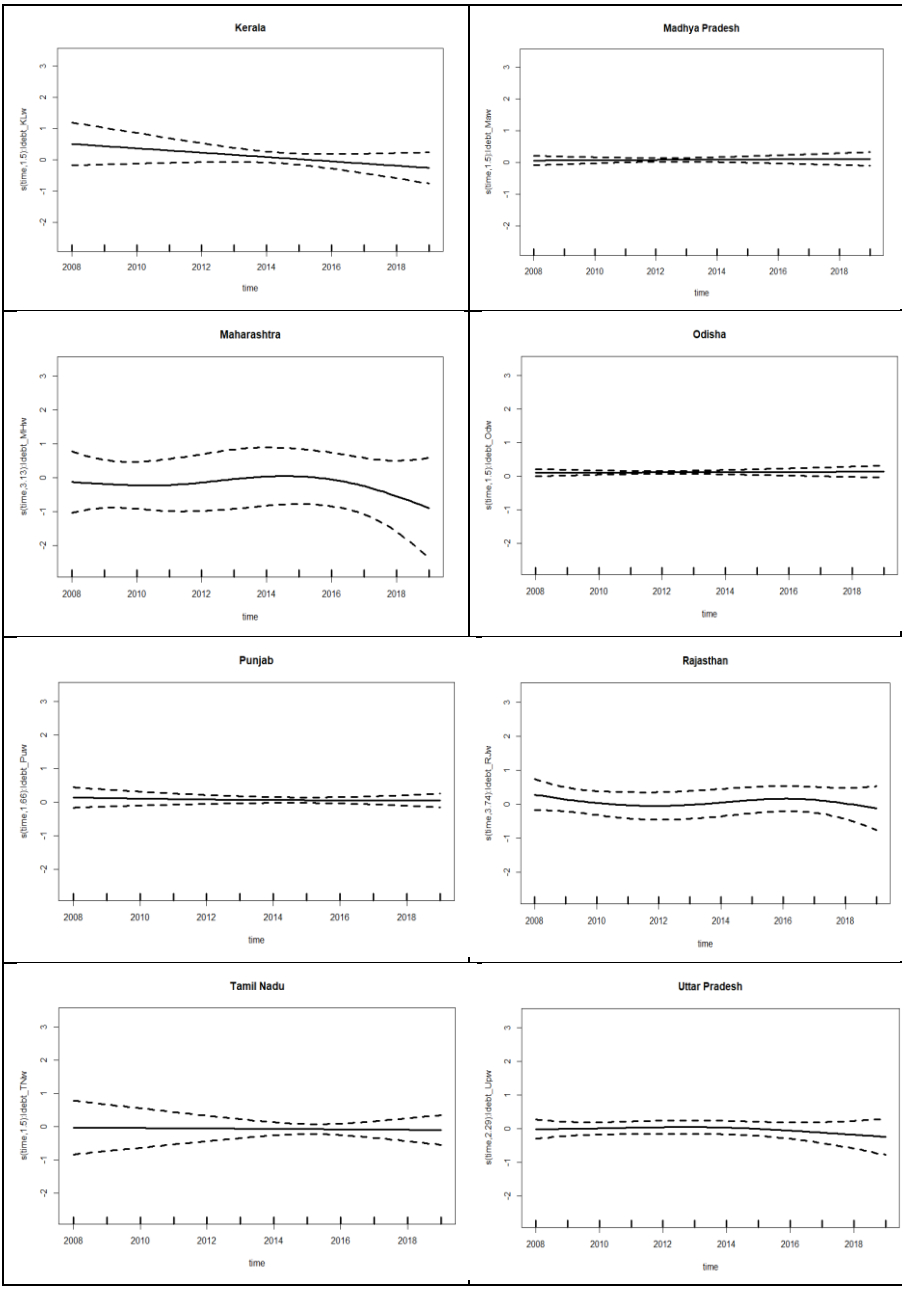
The smooth interaction term, *sm(t)* with the state dummy variable, shows the deviations from the mean coefficient of the state over time. The estimated degrees of freedom *edf,* of *sm(t),* provides information on possible time dependencies in each state. These details, given in Columns (4-5) of Table 2, indicate that in 9 Indian states, the reaction coefficient has not stayed overtime. For instance, Himachal Pradesh, the edf=8.133, and the smooth term is significant at 1 percent level, thereby implying time-varying reaction coefficient. Similarly, for Andhra Pradesh, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Jharkhand, Odisha, and Rajasthan, the smooth term is statistically significant at 5 percent level and their reaction coefficients are time-varying. For Gujarat, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh, Uttarakhand, and West Bengal, the smooth parameters are time-invariant. The goodness of fit (Adj.R-sq.) is 0.630, indicating a good fit of the model, and the Durbin Watson test statistic does not imply a correlation of the residuals.

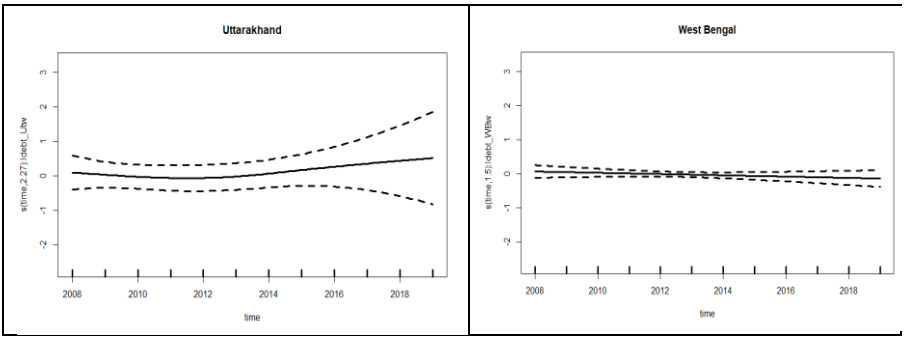
Chart 1 shows the path of the smooth terms for all 20 Indian states.[9] The two stashed lines show the 95 percent confidence interval and the solid line shows the point estimate of the smoothed term over time. The curve is drawn such that the values larger (smaller) than zero indicate that the coefficient was above (below) its average value shown in Table2 for a state. The actual reaction coefficient of a state in a certain year is the sum of the average coefficient of that state plus the value of the curve of that state for that year. For instance, for Andhra Pradesh, the average reaction coefficient is 0.0653 and the difference is below0 in 2007-08. Therefore, the actual value of the coefficient in that year is 0.0653- (-0.02) = 0.0853. One may also observe that for Assam, the reaction of primary balance to public debt started rising over the years. However, it is noted that for Andhra Pradesh, the reaction coefficient in Table 1 is not significant, i.e., debt is not sustainable. For Assam, Bihar, and Odisha, the time-varying reaction coefficients started rising after a point, while for Chhattisgarh, Haryana, Himachal Pradesh, Jharkhand, and Rajasthan, the time-varying coefficients started declining after a point. Thus, a lot of variations in the path of reaction coefficients are mainly due to various policy initiatives of the states.

Chart 1: Deviations of sm(t) from the respective Average Coefficient ψ for Indian States




Bihar
s(time,1.5):ddebt_Bihr
Chhattisgarh
s(time,5.26):ddebt_Chhv
Gujarat
s(time,1.5):ddebt_Guj
Haryana
s(time,2.76):ddebt_Hary
Himachal Pradesh
s(time,8.85):ddebt_HPrv
Jammu and Kashmir
s(time,1.5):ddebt_Jav
Jharkhand
s(time,5.25):ddebt_Jhkv
Karnataka
s(time,1.5):ddebt_Karv
2008
2010
2012
2014
2016
2018
time


Kerala
s(time,1.5):debt_Klw
Madhya Pradesh
s(time,1.5):debt_Mdw
Maharashtra
s(time,3.13):debt_Mhw
Odisha
s(time,1.5):debt_Odw
Punjab
s(time,1.66):debt_Puw
Rajasthan
s(time,3.74):debt_Rjw
Tamil Nadu
s(time,1.5):debt_TNw
Uttar Pradesh
s(time,2.29):debt_Upw
time



The unsustainable debt path of 16 Indian states may be due to the following reasons: (a) the late implementation of FRBM legislation in states like West Bengal, Jharkhand, Jammu and Kashmir, etc. (b) transfer dependency, particularly central grants and unconditional bailouts, that undermine states' incentives to control deficits (in the case of Assam, Gujarat, Jammu and Kashmir, Rajasthan and Uttarakhand) (c) growing trend in the committed liability in states like Andhra Pradesh, Karnataka, Kerala, Punjab etc. (d) less capital disbursements than the budget estimates in states like Haryana, Uttar Pradesh etc. (e) sizable reduction in the state own revenue collection in case of Gujarat, Himachal Pradesh, Jharkhand, Madhya Pradesh, Tamil Nadu and West Bengal (f) yearly debt receipts are remarkably higher than the yearly debt repayment in the case of Maharashtra and Tamil Nadu (g) the revenue component in fiscal deficit is high in states such as Kerala, Punjab, Uttar Pradesh and Tamil Nadu and (h) persistence of huge outstanding liabilities in the case of Jammu and Kashmir, Punjab, Rajasthan, Uttar Pradesh and West Bengal.

Despite the debt unsustainability situation, one may argue that higher debt may lead to higher welfare (See Ghosh, 1998 and Greiner and Fincke, 2015)[10] if the states use the borrowed amounts for investment purposes which may yield revenues in future. According to the FRBM legislation, states' net debt each year should not exceed 3 percent of GSDP, and this must be utilized for investments. To check

whether the debt is welfare-enhancing, Table 3 compares the aggregate capital expenditures with public debt receipts over the study period for each state.

Accordingly, we have categorized the sample states into four groups considering the sustainability as well as welfare effects. Among these, A group of states is fiscally sound as they are both sustainable and welfare enhancing. In B group of states, although debt is sustainable, it is not welfare enhancing. If this trend continues, they may be in trouble in the long run. For C group of states, debt is not sustainable, but it is welfare enhancing. So, these states need to cut their borrowings such that they attain sustainability. The major concern is D group of states as their debt is neither sustainable nor welfare enhancing. Hence, they deserve policy attention.

Table 3: Welfare Effects of Debt Policies of Indian States (2003-04 to 2014-15)

State	Borrowed Funds/ Capital Expenditure
(A) Both sustainable and welfare-enhancing	
Odisha	0.4418
Chhattisgarh	0.6158
Bihar	0.7313
(B) Not sustainable but welfare-enhancing	
Karnataka	0.7870
Uttar Pradesh	0.7974
Jharkhand	0.8047
Madhya Pradesh	0.9309
(C) Sustainable but not welfare-enhancing	
Assam	1.2197
(D) Neither sustainable nor welfare-enhancing	
Gujarat	1.2214
Andhra Pradesh	1.2950
Maharashtra	1.3775
Rajasthan	1.4539
Uttarakhand	1.5194
Tamil Nadu	1.6187
Jammu and Kashmir	1.6569
Himachal Pradesh	1.8956
Haryana	2.7693
Kerala	3.8913
West Bengal	8.9574
Punjab	9.7758

CONCLUSION

To evaluate the debt sustainability of major Indian states during 2007-08 to 2019-20, this study has employed the combination of panel version of Bohn model and p-spline estimation procedure. The results imply that in only four states, the debt is sustainable. Of these, only in 3 states'

reaction coefficient is time-varying. In 16 states, the debt is not sustainable and they need to take corrective action to improve their debt situation. Only in 6 out of these 16, the reaction coefficient is time-varying and in 10, they are time in-varying. The variations in the path of reaction coefficients are due to various policy initiatives of the states. Although the FRBM act suggests 3 percent of ceiling of net borrowing every year and too for investment purposes, and the FRBM review committee recommends 20 percent of state liabilities, many states violate the norms. The central government also bails out some states based on the recommendations of various finance commissions. This may be a disincentive for states to maintain fiscal discipline and control debt. Another fact is that the finance commissions use a traditional approach to suggest sustainable debt level for each state. For instance, according to the 13th Finance Commission, the debt is sustainable in more states. Our model-based results contradict them. The Finance commissions should consider the model-based approach so that the states would get reliable estimates of debt sustainability.

This study has also verified whether the debt is welfare-enhancing during the study period and for that in Andhra Pradesh, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Maharashtra, Kerala, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, and West Bengal, the debt is neither sustainable nor welfare enhancing. These states need policy attention. It is our hope that these results are useful for policymakers, academicians, international agencies, and other researchers to make appropriate strategies to improve the debt situations of Indian states where debt is not sustainable and not welfare enhancing.

Notes

1. See Afonso (2005) for a survey of analyses that tested debt sustainability using classical empirical approaches, Unit root and Cointegration.

2. The IBC is $d_t^* = \sum_{j=1}^{\infty} \frac{1}{(1+r)^j} E_t \left[s_{t+j}\right]$, i. e,Where $d_t^* = (1+r_t)$. d_{t-1} is the stock of debt-output ratio in the beginning of period t, $E_t[.]$ denotes the expectation operator conditional on the information available at time t and s_t is the primary surplus-GDP ratio.The IBC of the government requires that the present value of public debt asymptotically converges to zero which guarantees a sustainable debt policy.
3. Bertola and Drazen (1993) argue that as fiscal authorities, in general, initiate corrective actions only when the disequilibria reach a given trigger point, for instance, when public spending reaches levels high enough to be deemed critical, we need to use the time-varying coefficients approach. Fincke and Greiner (2011) used a penalized spline approach as any nonlinear model can be well approximated by a linear model with time-varying coefficients.
4. Fincke and Greiner (2011) provide justifications for using time-varying coefficients as: (i) the true data generating process is unknown and most likely nonlinear and any nonlinear model can be approximated by a linear model with time varying coefficients which is more robust than OLS and gives an estimation result that comes close to the true data generating mechanism; (ii) this will facilitate to check whether the response of the government with respect to debt has changed over time; (iii) random coefficients make the short term coefficients the expectation of the long-run coefficients and so they are the best estimate for the long-run coefficient.
5. Debt consolidation provided for the consolidation of all central loans contracted by the states into fresh loans for 20 years to be repaid in 20 equal instalments carrying a lower interest rate, subject to the condition that the state government concerned enacted its FRBM Act. Repayments due from states during the period 2005-06 to 2009-10 on these loans were eligible for a write-off. The quantum of debt write-off was linked to the

absolute amount by which the revenue deficit was reduced in each successive year during the award period. The debt write-off Scheme also offered a complete write-off to states with zero revenue deficit in 2008-09 on debt repayment by states to centre and concession on interest rate etc, with a set of conditionalities (RBI 2013).

6. Andhra Pradesh (32.14), Assam (21.73), Bihar (33.72), Chhattisgarh (14.76), Gujarat (24.83), Haryana (20.59), Himachal Pradesh (41.25), Jammu and Kashmir (48.49), Jharkhand (23.56), Karnataka (17.71), Kerala (27.94), Madhya Pradesh (26.70), Maharashtra (19.66), Odisha (22.17), Punjab (34.57), Rajasthan (30.57), Tamil Nadu (18.92), Uttar Pradesh (35.36), Uttarakhand (22.83) and West Bengal (40.89).
7. It is noted that the relationship between primary balance to GSDP and debt to GSDP may not be linear, and the linear model with time-varying coefficients can approximate any nonlinear relation. The approximation is good if it changes smoothly and so the estimation resorts to spline. For estimation purposes, it considers the parametric form: $f(d_t) = d_t \beta_d + Z(d_t)\gamma$, where Z is a high dimensional basis in d (for instance, a cubic spline basis) and γ is a corresponding coefficient. The high dimensionality restricts the use of OLS. So, it imposes a penalty term on γ, shrinking its value to 0. It obtains estimates by minimizing penalized OLS criteria: $\Sigma\{s_t - d_t \beta_d - Z(d_t)\gamma\}^2 + \lambda \gamma^T P \gamma$; where λ is smoothing the penalty parameter and $\gamma^T P \gamma$ is a penalty. P matrix is chosen in accordance with the basis (see Ruppert *et. al.*, 2003 for details). λ basically steers the amount of smoothness of the function (if it is zero, then the model becomes unpenalized OLS). The fitted functions (f^*) can be written as $f_1^*(d) = H(\lambda)$, where H is the smoothing matrix. To obtain reliable fit, λ should be chosen data-driven. One possibility is the use of Generalized Cross-Validation (GCV) criterion as$GGV = \sum \left[\frac{st - f(dt)}{1 - tr(H)/n}\right]^2$; A suitable choice of λ is achieved by minimizing

GCV. This procedure is same if the time varying coefficients are estimated (See Greiner and Kauermann, 2007 for more details).

8. There are about 10 other smaller states and Union Territories (UTs). The Finance Commission uses special formulae for smaller states in allocating transfers and thereby they enjoy constitutional support. For UTs, the centre meets all the deficits. So, we are not considering these in our analysis. Also, we used unified Andhra Pradesh data in our study as the state of Andhra Pradesh was bifurcated into Andhra Pradesh and Telangana in 2014
9. The standard time series spline can be estimated using Mixed GAM Computation Vehicle (MGCV) package with Automatic Smoothness Estimation in R software. In particular, Generalized Additive Model (GAM) attempts to find the appropriate smoothness for each applicable model term using prediction error criteria or likelihood-based methods and will produce the results for a single entity. Since we are pooling the data for all 20 states, we code the estimation (mod) as GAM of the dependent variable followed by non-debt explanatory variables(*yvar and gvar)* plus state-wise dummy interaction of debt variable followed by the smooth term *s* of time multiplied by dummy interaction of the stimulus (debt) variable for each state in order to get the individual-specific reaction coefficients i.e. mod =*gam(primary balance ~ yvar + gvar +*d_{it-1}× Andhra Pradesh (K_1)+ …..+ d_{it-1}× West Bengal(K_{20}) + *s(time, by =* K_1*)+….+ s(time, by =* K_{20}*)*on R console. Accordingly, we have generated the nonlinear effects of the reaction coefficient and plots for each of 20 States without any additional coding.
10. Greiner and Fincke (2015), using simulation technique, states that a scenario where public debt grows at the same rate as output yields smaller growth and welfare in the long run compared to the scenario where debt grows but less than output. That isa scenario where debt grows, but less than production leads to higher welfare than the balanced budget scenario.

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