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Dynamics of public debt sustainability in major Indian states

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ABSTRACT

This study empirically tests whether the public debt is sustainable or not at 22 major Indian states during 2006–07 to 2015–16. It employs the Bohn model for panel data, five alternative specifications and p-spline technique to analyze the issue at aggregate and disaggregate levels. While the results indicate that the debt is sustainable at the aggregate level, it is sustainable only in about 11 states. The results suggest that the fiscal reaction function is linear and the central grant-in aid is an important and a significant undermining factor of sustainability. If the grant-in-aid is excluded from the primary balance, there remain significant positive responses at the aggregate level. However, at the disaggregate level it is significant in only 11 states. Further, the most sustainable states fail to meet the no-Ponzi condition and so the policy intervention is required to improve the debt situation of the states where debt is unsustainable.

KEYWORDS

Public debt; primary balance; sustainability; Indian states; Bohn model for panel data

1. Introduction

Increased budget deficit and mounting public debt are the two major policy concerns for many countries for the last two decades. Particularly, in federal countries, these are the two severe issues as both the national and the sub-national governments continuously borrow. In most of the federal nations, the sub-national governments cannot amass debt forever without consequences, even though they are partially backed up by the national government (Fincke and Greiner 2011a). Moreover, as their share of the total debt is relatively high in many nations, the debt financing situation of sub-national level cannot be ignored from the macroeconomic analysis of fiscal policy.

India, being a federal nation, comprises a national (centre) government and about thirty sub-national (states) governments. While the Constitution of India has accorded a separate but limited tax power to states, it has entrusted them with greater expenditure responsibilities. These Constitutional allocations have led to vertical as well as horizontal fiscal imbalances. Realizing these imbalances, the Constitution further facilitates a revenue-sharing mechanism (i.e. tax devolution) between the centre

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and the states and the equalization grants through various channels. Further, it allows the states to borrow from various sources. As the states rely more on fiscal transfers/ debt, in addition to their own revenue generation through their limited taxes and non-tax sources, they can have perilous fiscal health which nullifies all fiscal consolidation measures.

The debt profile of the states (aggregate) had remained comfortable till late 1990s. It started increasing perceptibly after that and reached a peak level of 31.4 percent in 2003–04. At the same time, the central government finances also deteriorated significantly and so to improve the overall fiscal situation, the centre adopted a rule-based fiscal framework, called the 'Fiscal Responsibility and Budget Management' (FRBM) Act (2003–04). Subsequently, the states also enacted their own FRBM Acts. This Act requires a state to maintain a zero-revenue deficit, a sustainable level of fiscal deficit, i.e. 3% of GDP (Gross Domestic Product)) and a sustainable level of debt. This effort was complemented with other fiscal consolidation measures such as the Debt Swap Scheme(DSS) during 2002–03 to 2004–05, the Debt Consolidation and Relief Facility (DCRF) during 2005–06 to 2009–10 and the Debt ceilings in 2009–10 based on the recommendations of various Finance Commissions (RBI 2013).

While most Indian states adhere to the debt targets set by the 13th Finance Commission(FC) for the period 2010–2015, some states are way off the markand continue to maintain an unsustainable debt position. Further, states that have achieved the FRBM targets are in doubt about their solvency. The recent slowdown of the economy, the volatility in the financial markets, the revision of pay scales due to the 7th pay commission, the on-lending of funds by the centre to states sourced from international agencies, the grant-in-aid dependency of few states, the poor performance of state public sector enterprises etc. have added fuel to the adverse debt positions of the state governments in India.

In this context, a major question is whether the public debt is sustainable or not in the Indian states? Conceptually, the public debt is 'sustainable' as long as the debt levels do not accumulate at a rate considerably exceeding the government's capacity to service it (IMF 2011). While the literature provides four alternative approaches, namely – the indicator approach, the stationarity approach, the co-integration approach and the model-based approach to measure sustainability, the model-based approach pioneered by Bohn (1998) gained importance due to its nice economic intuition and robust statistical properties. It tests whether the primary surplus relative to GDP is positive and at least, a linearly rising function of the debt to GDP ratio. If this property holds, a given debt policy of the government is sustainable (Greiner and Fincke 2015).

The Bohn approach has later been extended by many researchers by (i) adding other non-debt determinants of primary balance (Haber and Neck 2006), (ii) incorporating the unobserved heterogeneity factors using the country level or the state-level panel data (Abiad and Ostry 2005; Mahdavi 2014) (iii) specifying the non-linearity and the time-varying coefficients in the model (Greiner and Kaurmann 2008) etc. In the Indian context, a few attempts were made (for instances, see Tiwari 2012; Kaur et al. 2014). But most of these studies deal with the centre's/combined debt, except in Kaur et al. (2014). While Kaur et al. (2014) has analysed the public debt sustainability

of Indian states using Bohn model, it has not given much attention to (i) the inter-state variations, (ii) undermining factors of sustainability, (iii) the non-linearity and (iv) the solvency considerations. Therefore, the primary focus of this study is to analyse the public debt sustainability issue of the Indian states using the Bohn framework addressing all these issues.

This study differs from the other past studies in the following aspects: (i) It is the first study testing the sustainability of debt using the Bohn model for panel data in each of 22 major Indian states, (ii) It is the first study exploring the undermining factors of sustainability, (iii) It is the first attempt to estimate a non-linear fiscal reaction function capturing time-varying response at the sub-national level; (iv) The study checks the robustness of the results by assessing the relationship between the adjusted primary balance (after excluding the fiscal transfers from the primary balance) and public debt as in Potrafke and Reischmann (2015) and finally, (v) It explores whether Indian states are solvent enough to avoid a no-Ponzi condition[1]as in Nguyen (2013).

The rest of this study proceeds as follows. Section 2 provides a brief note on public debt scenario of Indian states. Section 3 presents a brief review of the literature. While the model, the data, and the estimation procedures are discussed in section 4, the empirical results are presented and discussed in section 5. The final section 6 concludes the study.

2. The Indian scenario

The Indian Constitution - 1950 provided for a two-tiered system of governance: the centre and the states. The Indian states vary in terms of geographical features, population, area, natural resources and socioeconomic characteristics. They also vary in their size of the government, the quantity and the quality of public goods, needs for the central transfers etc. As states' tax powers are limited, the Constitution allows for intergovernmental transfers in the form of tax devolution, grant-in-aid and centrally sponsored schemes (Rao 2005). However, the growing expenditure commitments compel the state governments to run deficit budgets.[2]This puts pressure on their borrowing requirements, thereby exacerbating the public debt. Unlike the centre, the state's debt is restricted to the market loans and bonds, the ways and means advance from RBI, the loans from banks and other institutions, the provident funds etc. The states can only borrow from the external sources with a ceiling and approval of the centre.[3]

Among the deficit indicators, the primary balance, in general, shows the dynamic effects of the government's various policy initiatives as well as the attainments of the government's fiscal performance. As a subset of fiscal balance, it indicates the amount of government borrowings that are required to meet the expenses other than the interest payments (primary deficit) or the amount of borrowings required to meet the netted interest commitments on previous borrowings (primary surplus). The primary balance is, therefore, the root cause of all types of deficits and reflects in the total debt requirements. During the last two decades, the growth of state-level debt in India has become a central issue in various policy discussions and in academic research. However, the enactment of FRBM legislation and other fiscal consolidation

Table 1. Profile of public debt at centre, states and combined level in India.

	Public debt (Rs. billion)		
Year	Centre	States	Combined[a]
2006–07	26371 (61.40)	12416 (28.91)	32065 (74.66)
2007–08	29355 (58.86)	13283 (26.63)	35628 (71.44)
2008–09	33001 (58.62)	14702 (26.11)	40655 (72.21)
2009–10	36452 (56.27)	16487 (25.45)	45736 (70.60)
2010–11	40596 (52.16)	18290 (23.50)	51062 (65.00)
2011–12	46701 (53.46)	19939 (22.82)	58846 (67.36)
2012–13	52253 (52.55)	22103 (22.23)	66278 (66.65)
2013–14	58593 (52.16)	24713 (22.00)	75332 (67.06)
2014–15	64112 (51.51)	27038 (21.73)	83006 (66.70)
2015–16[b]	70982 (51.88)	31741 (23.21)	93870 (68.61)

Source (Basic data): RBI, 2016–17.
[a]Central loans to states are netted out; figures in parentheses are debt-GDP ratio.
[b]Revised estimates.

measures like DSS, DCRF, debt ceiling etc. have somehow helped states to improve their fiscal situations.

The debt-deficit profile of the centre, the states and the combined level since 2006–07 are exhibited in Table 1. The aggregate debt of all the states rose from Rs. 12416 billion in 2005–06 to Rs. 31741 billion in 2015–16 (the post FRBM period) and the debt to GSDP (Gross State domestic Product) ratio reached to about 23 percent in 2015–16. These indicate that even after various fiscal consolidation measures the state-level debt position does not show any significant improvement. If this trend continues, many states will undergo some adverse effects i.e. to face long-term sustainability issues in the fiscal discipline and the repercussions of economic growth in future.

At the disaggregated level, the debt-GSDP ratios vary in different states. For instance, in Jammu and Kashmir it was 46.47% in 2015–16 while in Chhattisgarh, it was 14.5% (see Figure 1 for details).

As indicated earlier, the recent growth slowdown and the volatility in the financial market, 7th pay implementation, on-going structural issues, rolling out of GST, etc. would add fuel to the debt positions of the state governments, in the near future (Kaur et al. 2014).

3. Literature review

There are three broad theoretical views on debt/deficit financing in the literature: (i) Classical (Ricardian equivalence theorem) view asserts that the fiscal deficit does not really matter except for smoothing the adjustment to the expenditure or the revenue shocks. The budget deficits today require higher taxes in the future when a government cut taxes without changing the present or the future public spending; (ii) Keynesian view 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 the public deficit implies a reallocation of resources from the taxpayers to the bondholders (Greiner and Fincke 2015), and (iii) Neo-classical view considers that the fiscal deficit is detrimental to the investment and the economic growth. Thus,

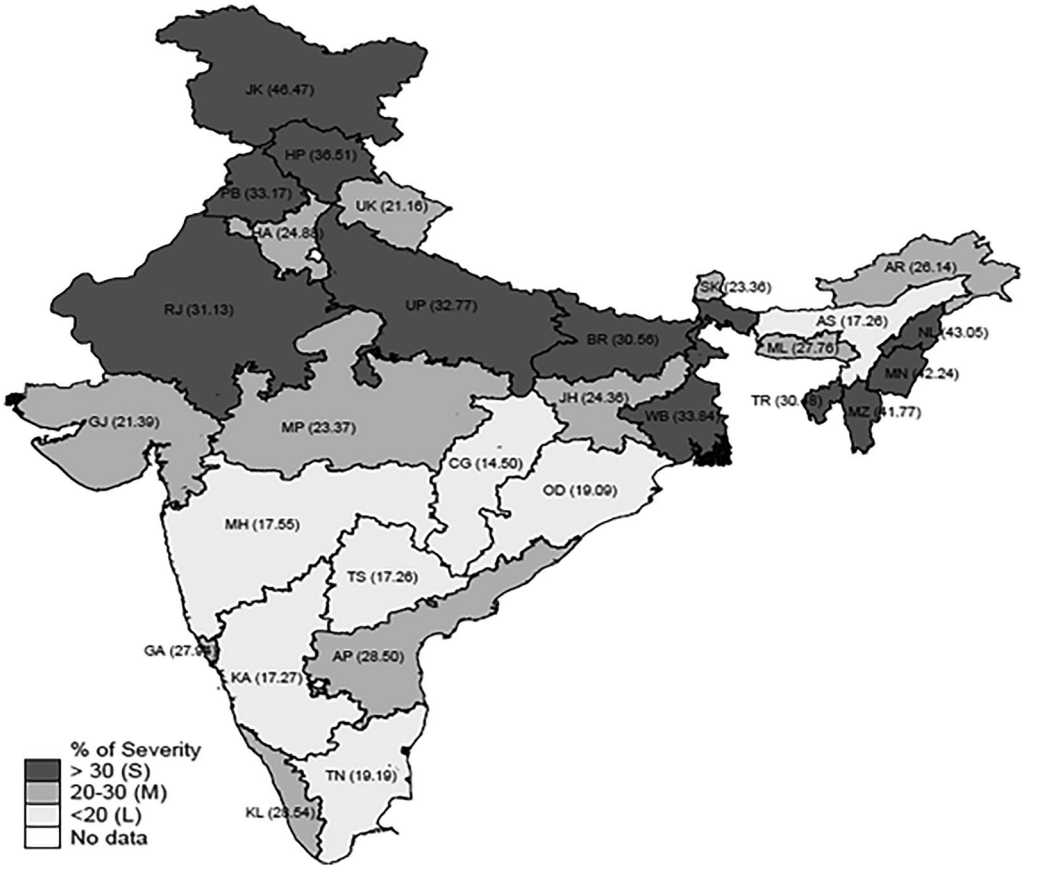

Figure 1. Debt to GSDP Ratio among Indian States (2015–16). Source (Basic data): Finance Accounts of respective states. Note: AP: Andhra Pradesh, AR: Arunachal Pradesh, AS: Assam, BR: Bihar, CG: Chhattisgarh, GA: Goa, GJ: Gujarat, HR: Haryana, HP: Himachal Pradesh, JK: Jammu and Kashmir, JH: Jharkhand, KA: Karnataka, KL: Kerala, MP: Madhya Pradesh, MH: Maharashtra, MN: Manipur, ML: Meghalaya, MZ: Nagaland, OD: Odisha, PB: Punjab, RJ: Rajasthan, SK: Sikkim, TN: Tamil Nadu, TS: Telengana, TR: Tripura, UP: Uttar Pradesh, UK: Uttarakhand, WB: West Bengal.

there is no consensus among the economists on whether the deficit financing is good or bad or neutral for an economy (Rangarajan and Srivastava 2005).

When the Keynesian approach was popular in the third and the fourth quarter of the 20th century, the public debt rose considerably in many countries. The increase in public debt was even larger than the growth rate of GDP in many countries. The mounting of public debt, without proper checks and control, eventually raised doubt about the debt sustainability in these countries. Domar (1944) had pioneered the work on assessing debt sustainability using the post-Second World War US data. The study derived a necessary condition for debt sustainability from the basic debt accumulation equation as:

$$d_t = (1 + \gamma_t).d_{t-1} - s_t \tag{1}$$

where, $D_t/Y_t = d_t(=D_t/Y_t)$ is the debt (D_t) to GDP (Y_t) ratio, $\gamma_t = (1 + i_t)/(1 + g_t)$, $s_t =$ primary surplus to GDP ratio. $\gamma_t = (1 + i_t)/(1 + g_t) - 1 \cong i_t - g_t$ is the gross

Table 2. Summary results of existing studies on debt sustainability (using Bohn model).

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, Koller, and Semmler (2007)	US & 4 EU Countries	Annual; 1960–2003	OLS	Sustainable
Greiner and Kauermann (2008)	Germany & Italy	Annual; 1960–2003	p-spline	Sustainable (only Germany)
De Mello (2008)	Brazil	Monthly; 1995:1–2004:7	OLS	Sustainable
Adams, Ferrarini, and Park (2010)	33 Asian Countries	Annual; 1990–2008	Panel GLS	Sustainable
Ghosh et al. (2013)	23 Advanced Economies	Annual; 1970–2007	Panel (OLS, FE, PCSE)	Sustainable
Fincke and Greiner (2011a)	11 German federal states	Annual; 1975–2006	p-spline	Sustainable (ex. Berlin)
Fincke and Greiner (2011b)	Euro Countries	Annual; 1971–2009	p-spline	Sustainable (ex. Greece & Italy)
Tiwari (2012)	India	Annual; 1970–2009	p-spline	Not Sustainable
Burger et al. (2012)	Annual (1974–2008)	South Africa	OLS, TAR SSM VECM	Sustainable
Kaur and Mukherjee (2012)	India	1980–1981 to 2012–2013	OLS	Sustainable
Mahdavi (2014)	48 US states	Annual; 1961–2008	Panel FE	Sustainable
Kaur et al. (2014)	20 Indian states	Annual; 1980–2013	Panel FE	Sustainable
Shastri and Sahrawat (2012)	India	Annual; 1980–2013	ARDL	Not sustainable

Source: Author's construction.

return on public debt (i.e. i is the real interest rate on debt, and g is the real rate of growth of GDP). The debt is unsustainable when $g_t=i_t$ or $g_t<i_t$, because d_t grows linearly when $g_t=i_t$ and explosively when $g_t<i_t$. It is sustainable when $g_t>i_t$.[4] Since this approach applied the condition on a year-on-year basis and was not sufficient to validate whether the inter-temporal budget constraint (IBC) of the government was satisfied or not, the sustainability analysis was later linked to the IBC (Greiner and Fincke 2015). That is, the outstanding debt today must be equal to the present value of future primary surpluses of a government. In other words, as long as a country generates the debt stabilizing primary balance to cover its debt in future, then the country's current debt level is sustainable.[5]

As a result, a large number of studies have attempted to test whether the IBC is satisfied or not in various contexts. The initial attempt in the empirical front has begun by Hamilton and Flavin (1986) for the US, using the unit root approach. According to them, the debt is sustainable if the stock of government debt follows a statistical reversion towards mean value after temporary disturbances. Further, Trehan and Walsh (1991) extended it with cointegration analysis. That is, if the government debt is quasi-difference stationary and the public debt and the primary surpluses are co-integrated, then the public debt is sustainable (Greiner and Fincke 2015).[6] See Afonso (2005), for a survey of analyses that tested debt sustainability using these two classical empirical approaches. However, these two approaches were criticized later on various grounds (Uctum, Thurston, and Uctum 2006; Bohn 2007; Mahdavi 2014).[7]

Criticizing the deterministic IBC framework of stationary and cointegration approaches, Bohn (1995) constructs a stochastic version of IBC. Following this stochastic framework, he proposed an alternative test for debt sustainability. It suggested that, if the primary surplus relative to GDP is a positive function of the debt to GDP ratio, the given debt policy is sustainable. Accordingly, Bohn (1998) developed a feedback rule or fiscal (policy) reaction function as:

$$s_t = \rho.d_t^* + \mu_t \tag{2}$$

where μ_t is the composite of non-debt determinants of primary balance. Here Bohn considers that a stable and strictly positive feedback d_t^* to $s_t, (\rho > 0)$ which is consistent with the stochastic version of IBC, is a sufficient condition for sustainability. This has received great attention in the literature because of its nice economic intuition and robust statistical properties. That is, in economic point of view, if the governments run into debt today they have to take corrective actions in the future by increasing the primary surplus, while in statistical point of view, the positive response of primary surplus to government debt implies a mean-reverting process i.e. an increase in the primary surplus relative to GDP makes the debt ratio decline and return to its mean (Greiner and Fincke 2015). Accordingly, the empirical version (regression framework) of Equation (2) is re-written as:

$$s_t = \alpha + \rho.d_t^* + \delta.Z_t + \in_t \tag{3}$$

where, $\mu_t = a + \delta.Z_t + \in_t$; Z_t is a set of other determinants of the primary surplus to the GDP ratio and $\in_t$ is the error term. Here, in order to avoid the omitted variable bias and inconsistent estimates problem by simply using the co-integrating regression (between the debt and the primary surplus) or to capture the effect of μ_t, Bohn (1998) adopted Barro's (1979) 'tax-smoothening model' and it's time-series application.[8]Originally, the Bohn model was estimated using the OLS method. Subsequently, it is extended to incorporate the unobserved heterogeneity factors using the panel data framework (see Abiad and Ostry 2005; Adams, Ferrarini, and Park 2010). Further, in order to capture the nonlinearity, time-varying coefficients are estimated using the penalized spline techniques.[9] Table 2 provides a summary result of past studies (selective).

In the Indian context, earlier studies like Rangarajan, Basu, and Jadhav (1989), Pattnaik, Misra, and Prakash (2003) etc. used the traditional indicators approach. Studies like Buiter and Patel (1992), Pradhan (2014) etc. employed the Unit Root approach while Jha and Sharma (2004) and Tronzano (2013) used the Co-integration approach. Tiwari (2012), Kaur and Mukherjee (2012), Shastri and Sahrawat (2012) applied the Bohn framework, using time series data.

At the state level, Rajaraman, Bhide, and Pattnaik (2005), Mishra and Khundrakpam (2009) used the indicator approach for analyzing sustainability. Kaur et al. (2014) employed the Bohn model and the panel data of 20 Indian states during 1980–81 to 2012–13 along with other sustainability approaches. It is the only study which dealt with the sustainability assessment at the state level using fiscal policy reaction function. However, this study did not pay much attention to (i) the interstate

variations (ii) the undermining factors of sustainability (iii) the solvency considerations etc. The present study is an attempt to fill this research gap in the literature.

4. Model, data and estimation

To test the debt sustainability of the Indian states, the study specifies the following fiscal reaction function:

$$s_{\mathrm{it}} = \phi_0 + \psi d_{\mathrm{it}-1} + \ \phi_1 yvar_{\mathrm{it}} + \phi_2 gvar_{\mathrm{it}} + \lambda_{\mathrm{i}} + \mu_{\mathrm{t}} + \ \epsilon_{\mathrm{it}} \tag{4}$$

where, s_{it} is the primary surplus-GSDP ratio for i^{th} state in t^{th} time period, $d_{\mathrm{it}-1}$ is the debt-GSDP ratio for i^{th} state in $t\text{-}1^{\mathrm{th}}$ period, $yvar_{\mathrm{it}}$ and var_{it} are business cycle variables to account for fluctuations in GSDP and primary public spending respectively. They are calculated by subtracting the long-term trend of GSDP (real) from its realized values and the long term trend of primary spending of government (real) from its realized values. The long-term trend of the respective variable is computed using the Hodrick-Prescott (HP) filter. λi and μt are individual (states) effects and time effects (year) respectively. It is noticed that the lagged debt ratio is used to take into account the endogeneity issue. If $\psi > 0$ and statistically significant, the debt is sustainable.

Equation (4) can be estimated using the standard panel data methodologies: fixed effects (FEs) and random effects (REs) methods. The former posits that the unobserved heterogeneity factors, λi, and time effects, μt, are correlated with other explanatory variables in the equation, while the latter assumes that they are not. The choice of a relevant model depends on the Hausman statistics. If it supports the FEs model, then OLS can be used to estimate Equation (4) by incorporating λi and μt with the state and year dummies. If the time dummy coefficients are jointly zero, then the model is a one-way FEs model. If the Hausman supports the REs model, the feasible GLS estimation procedure can be used. In that case λi and μt are treated as random errors and added with regular residual.

Then, in order to control the other undermining factors of sustainability, we incorporate other state-specific attributes (X) in Equation (4). The interest payment on previous debt (effective interest rate), i_{it}, can affect the primary surplus ratio, although it does not affect the primary surplus ratio directly. However, as the government cannot run the overall deficit arbitrarily, the interest payment will also affect the primary surplus individually (Greiner and Fincke 2015). We also include fiscal transfer (central grants),c_{it}, because debt is often subsidized due to the inter governmental transfers i.e. instead of going for debt financing the states can approach the centre to provide more grants. A state, believing it will receive large transfers, might increase its total revenue but will reduce its own revenue effort. Therefore, we expect that the primary surplus to increase with the transfer variable.

Further, in order to control inflation, we consider GSDP deflatorπ_{it} for each state and expect a positive association with primary balance. As political factors often affect the government's functions and policy formulations, we allow the election year ρ_i to interact with debt variable, in order to get possible effects of the year of election for a state legislative assembly, where ρ_i takes value one if there is an election for the

legislative assembly and zero otherwise. After controlling these state-specific attributes, ψ will tell us whether the debt is sustainable or not, at Indian states as a whole.

We also resort to penalized spline (p-spline) estimation as in Greiner and Fincke (2015) in order to capture the nonlinearity in the Equation (4), which can be rewritten as: $s(t) = \phi_0 + \psi(t)d(t-1) + \phi_1 yvar(t) + \phi_2 gvar(t) + \varepsilon(t)$, neglecting for a moment that the data come from different (states or) countries and treating the whole sample as one data set. This allows estimating the reaction coefficient as a function of time showing how that coefficient evolved over time. While $\psi(t)$ represents the mean of the reaction coefficient in the p-spline estimation, *sm(t)* shows the deviation from that mean over time. The estimated degrees of freedom, *edf*, of *sm(t)* provides information about possible time-dependencies.[10]

To check whether the debt is sustainable in each sample state, we allow d_{it-1} to interact with each of the state dummies (K_i) in Equation (4) to get:

$$s_{it} = \phi_0 + \sum\nolimits_i \psi_i(t) K_i * d_{it-1} + \phi_1 yvar_{it} + \phi_2 gvar_{it} + \lambda_i + \mu_t + \epsilon_{it} \tag{5}$$

The coefficients associated with these interaction terms (ψ' s) would directly reveal whether the debt is sustainable in each state or not.

Further, it is possible that ignoring fiscal transfers in the empirical tests of debt sustainability gives rise to misleading conclusions. In particular, when a government with a dismal fiscal performance receives a transfer, the empirical tests may predict that the government's fiscal policy is sustainable because of the transfer but not because of the government's sound fiscal policy (Potrafke and Reischmann 2015). Therefore, to evaluate the Indian states discretionary fiscal policy, we exclude federal transfers (i.e. Grant-in-aid from centre) to states from the revenue side (primary balance adjusted), M_{it}, which will indicate us whether the fiscal transfers have implicitly subsidized the debts. In other words, if the fiscal transfers are not included in the primary surplus, the Indian state governments pursue sustainable fiscal policies or not.

Finally, from the IBC, the government borrows and collects own revenue through tax and non- tax means to finance its current spending and service the previous period's debt. If the government wants to avoid the Ponzi scheme i.e. borrowing today is not for servicing previous debt, the state's own revenue receipts will be used to service the past debt and should be positively correlated with past debt. That means, if the previous period's public borrowing increases, the government should raise more revenue to repay its debt (Nguyen 2013). This was theoretically backed by Davig and Leeper (2011). Accordingly, the following panel data equation is estimated.

$$\tau_{it} = \gamma_0 + \delta d_{it-1} + \gamma_1 \Delta y_{it} + \gamma_2 e_{it} + \lambda_1 + \mu_1 + \epsilon_{it} \tag{6}$$

where primary balance to GSDP ratio is replaced with the state's own revenue to GSDP Ratio τ_{it}, *yvar* with Δy_{it} (the real output (GSDP) growth) and *gvar* with, e_{it}, the government purchase (primary)-to-GSDP ratio as in Davig and Leeper (2011).[11]We may expect a positive association of all three with the response variable at both aggregate and disaggregate level.The link between the three dependent variables is expressed below.

Table 3. Descriptive statistics of the study variables (2006–07 to 2015–16).

Definition	Variables	Mean	Standard deviation
Primary balance (Rs. billion)	S_{it}	−25.30	56.81
Primary balance-GSDP ratio (%)	s_{it}	−0.43	1.53
Primary balance [Adj.] (Rs. billion)	Z_{it}	−100.37	95.46
Primary balance [Adj.] -GSDP ratio (%)	z_{it}	−4.58	5.22
State's own revenue (Rs. billion)	T_{it}	285.71	280.43
State's own revenue-GSDP ratio (%)	τ_{it}	7.87	1.86
Public debt (Rs. billion)	D_{it}	891.04	782.13
Debt-GSDP ratio (%)	d_{it}	27.81	9.50
Lagged debt-GSDP ratio (%)	d_{it-1}	28.86	10.19
Nominal GSDP (Rs. billion)	ny_{it}	3608.42	3454.55
Real GSDP (Rs. billion)	ry_{it}	3513.36	3094.42
Real GSDP growth (%)	Δy_{it}	7.81	4.19
Real GSDP gap (Rs. billion)	$yvar_{it}$	0.0001	86.19
GSDP deflator	π_{it}	0.99	0.23
Primary expenditure (Rs. billion)	E_{it}	500.16	431.91
Primary expenditure-GSDP ratio (%)	e_{it}	16.34	5.96
Real primary expenditure (Rs. billion)	RE_{it}	486.35	375.36
Real primary expenditure gap (Rs. billion)	$gvar_{it}$	−0.032	39.79
Effective Interest Rate	i_{it}	0.85	7.93
Grants from the Centre-GSDP ratio	c_{it}	4.16	5.21

Primary Balance = [state's own revenue + state's share in union taxes and duties + grants in aid from government of India] – [(revenue expenditure-interest payment) + capital expenditure + disbursement of loans and advances]

Primary balance adjusted = [state's own revenue + state's share in union taxes and duties] – [(revenue expenditure-interest payment) + capital expenditure + disbursement of loans and advances]

State's own revenue = Tax revenue (taxes on agricultural income + taxes on sales, trades etc. + state excise +taxes on vehicles + stamps and registration fees + land Revenue and other taxes) + Non-tax revenue (interest recipes + others)

In this study, we have used the data drawn from various published sources. The collected data related to 22 major Indian states, which account for more than 95 percent of the population of the country during 2005–06 to 2015–16. The choice of this time period is due to the following facts. Firstly, this period represents a fiscal control era due to the enactment of the FRBM Act and other associated policy initiatives by 12th and 13th Finance Commissions. Secondly, as the debt is an accumulation of fiscal deficit (net debt) every year the recent trend is more relevant than the distant past. Thirdly, the comparable GSDP data with the new base year 2011–12 and the usage of a balanced panel model restrict us to use the data for the latest period.[12]

The state-wise GSDP data (real and nominal) are compiled from the Central Statistical Organization (CSO), while all other fiscal variables from Comptroller and Auditor General (CAG) of India Audit Reports and Finance Accounts of the various state governments. The total observations included in the final analysis are 220 (22 states × 10 years due to lagged debt variable). The descriptive statistics of the study variables are shown in Table 3.

5. Empirical results

Table 4 shows the panel unit root tests using Levin, Lin and Chu (Levin, Lin, and Chu 2002) hypothesis and Im, Perresan and Shin (Im, Pesaran, and Shin 2003) results. While the LLC assumes that there is a common unit root process across the relevant cross-sections, the IPS assumes individual unit root processes. Both tests results confirm that all the variables used in the study are stationary i.e. they are I (0) except primary expenditure to GSDP ratio (where it is stationary only in LLC).

5.1. Bohn's sustainability analysis results (aggregate)

Table 5 presents the estimation results of Equation 4 (Model 1). The Chow test and the Hausman statistics support the one-way fixed effects (FEs) model. As expected, the business cycle variable *yvar* is positive and statistically significant at 10 percent level and as expected, the primary expenditure gap variable *gvar* has a negative coefficient and it is statistically significant at 1 percent level, implying that the output

Table 4. Results of panel unit root tests.

Variables	LLC *t* statistics	IPS *w* statistics
s_{it}	−18.451**	−2.039 *
d_{it-1}	−8.398**	−3.210**
M_{it}	−12.364**	−1.839*
τ_{it}	−11.372**	1.835*
Δy_{it}	−14.153**	−3.258**
$yvar_{it}$	−12.381**	−2.377**
$gvar_{it}$	−15.055**	−2.278**
e_{it}	−7.900**	−1.41
i_{it}	−15.147**	−2.137**
c_{it}	−8.986**	−2.040*

Notes: LLC - Levin, Lin, and Chu test; IPS - Im, Peseran, and Shin test.
** and * indicate rejection of the null hypothesis of the panel containing unit roots (non-stationarity) at the 1 percent and 5 percent levels of significance, respectively.

Table 5. Estimation results of various fiscal policy response functions (Aggregate).

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
d_{it-1}	0.147*** (9.30)	0.188**(2.038)	0.107***(4.21)	0.097*** (5.15)	0.010 (0.78)
$yvar_{it}$	0.00002* (1.69)	0.00001*(1.76)	0.00002* (1.93)	0.00002** (2.06)	–
$gvar_{it}$	−0.0001***(−7.54)	−0.0002***(−8.27)	−0.0002***(−7.71)	−0.0002*** (−7.51)	–
i_{it}	–	–	0.135 (0.93)	–	–
c_{it}	–	–	0.204**(2.46)	–	–
$d_{it-1} \times \rho_i$	–	–	0.006 (1.03)	–	–
π_{it}	–	–	−0.695 (−1.08)	–	–
Δy_{it}	–	–	–	–	−0.010 (−0.68)
e_{it}	–	–	–	–	0.216*** (6.08)
$(intercept)$	−3.894*** (−7.72)	−0.006(0.93)	−3.671** (−2.13)	−4.067*** (−6.79)	5.718 ***(8.79)
f–stat	9.08	4.416(e): 2.035	8.45	134.65	42.45
Hausman stat	53.69***	–	12.13**	17.70***	13.78***
Observations	220	220	220	220	220
R-square	0.528	0.417	0.553	0.943	0.839
No. of state	22	–	22	22	22
No. of year	10	–	10	10	10

Source: Author's construction; *t* statistics in parentheses.
Notes: Dependent variable (Model 1, 2 &3): primary balance to GSDP ratio; dependent variable (Model 4): primary balance (adjusted) to GSDP ratio; dependent variable (Model 5): State's own revenue to GSDP ratio.
***, **,* indicate levels of significance at 1%. 5% and 10%, respectively

growth above normal value has increased the primary surplus ratio while the primary spending above its normal value has reduced it. The variable of interest is d_{it-1}. Its coefficient is positive and statistically significant at 1 percent level, indicating the sustainability of public debt in Indian states as a whole. It is noticed that the dependent variable is the primary balance (which may be positive or negative) and when on average the debt-GDP ratio increases by 1 unit, the primary balance-GDP ratio increases by 0.147 unit. Thus, the latter is a linear and positive function of the former, which is a required condition for debt sustainability.

Model 2 in Table 5 shows the penalized spline (p-spline) estimation results. The estimated parameter of interest associated with the debt ratio is ψ. It represents the mean of this coefficient and the smooth term *sm(t)* shows the deviation from that mean over individual and time-varying coefficients. The results indicate that for Indian states, the reaction coefficient has been positive on average and statistically significant at 5 percent level so that the sustainability of public debt is achieved. The sign and the significance of *yvar* and *gvar* are the same as in Model 1. The estimated degrees of freedom, *edf*, of *sm(t)* provides information on possible time and state dependencies. As the estimated value of edf = 2.035 and the smooth term sm(t) is not significant at 5 percent level, we may conclude that the reaction coefficient has stayed constant across states and over time. Since the non-linearity is not captured in the p-spline model, the regular panel (linear) approach is fit for the data.

In Model 3, we have incorporated a set of additional explanatory variables to the basic Bohn model. Among these variables, c_{it} is statistically significant. As its coefficient is positive, we may infer that higher grants are associated with higher realization of primary surplus (0.204). This indirectly implies that the grant-in-aid may be an undermining factor of debt sustainability. The results of the other regular Bohn variables are almost the same as in Model 1.

In order to evaluate the Indian states discretionary fiscal policy, we have excluded the fiscal transfers (grants-in-aid from the centre) to states from the revenue side (to get primary balance adjusted) and ran the regression. In Model 4 of Table 5, the estimation results with adjusted primary balance as the dependent variable are shown. As the debt coefficient is 0.097 which is less than 0.147 in Model 1, it implies that even after subsidizing factor i.e. grants, Indian state governments pursue the sustainable fiscal policies (on an average).

Finally, the Model 5 presents the estimation results of state's own revenue Equation (6) considering a different set of the explanatory variable (real GSDP growth and primary expenditure to GSDP ratio) along with lagged debt. While the debt coefficient is positive, it is not significant even at 10 percent level, indicating that on an average, the Indian states are not solvent enough to avoid the no-Ponzi condition. The included real GSDP growth is also not significant. However, but the primary expenditure to GSDP variable is significant at 1 percent level with a positive coefficient.

5.2. Debt sustainability results for the individual states

In order to check whether the public debt is sustainable in each of the Indian states or not, we estimate the Equation (5) by allowing d_{it-1} variable to interact with the

Table 6. Fiscal policy response function for the Indian states during 2006–07 to 2015–16.

Variables	(1) Model 1	(2) Model 2	(3) Model 3
d_{it-1} × Andhra Pradesh (K_1)	0.054 (0.39)	−0.057 (−0.39)	0.026 (0.33)
d_{it-1} × Assam (K_2)	0.176 (2.05) **	0.160 (1.79)*	0.120 (2.47)**
d_{it-1} × Bihar (K_3)	0.096 (2.71)***	0.069 (1.85)*	−0.065 (−3.21)***
d_{it-1} × Chhattisgarh (K_4)	0.302 (3.26)***	0.352 (3.63)***	−0.001 (−0.02)
d_{it-1} × Goa (K_5)	0.042 (0.51)	0.044(0.51)	0.066 (1.33)
d_{it-1} × Gujarat (K_6)	0.079 (0.76)	0.062 (0.57)	0.022 (0.38)
d_{it-1} × Haryana (K_7)	0.653 (4.29)***	0.692 (4.35)***	0.608 (7.09)***
d_{it-1} × Himachal Pradesh (K_8)	0.124 (2.68)***	−0.077(−1.60)	0.075 (2.86)***
d_{it-1} × Jammu & Kashmir (K_9)	0.112 (0.59)	−0.807 (−4.09)***	−0.482 (−4.50)***
d_{it-1} × Jharkhand (K_{10})	0.218 (1.68)*	0.365 (2.54)**	−0.120 (−1.51)*
d_{it-1} × Karnataka (K_{11})	0.390 (1.18)	0.352 (1.02)	0.261 (1.40)
d_{it-1} × Kerala (K_{12})	0.496 (1.88)*	0.450 (1.64)*	−0.178 (−1.20)
d_{it-1} × Madhya Pradesh (K_{13})	0.121 (1.89)*	0.134 (2.00)**	−0.023 (−0.62)
d_{it-1} × Maharashtra(K_{14})	0.064 (0.53)	0.0122 (0.10)	0.090 (1.32)
d_{it-1} × Odisha (K_{15})	0.181 (4.53)***	0.200 (4.78)***	−0.014 (−0.61)
d_{it-1} × Punjab (K_{16})	0.233 (3.03)***	0.199 (2.47)**	0.292 (6.70)***
d_{it-1} × Rajasthan (K_{17})	0.220 (4.66)***	0.232 (4.71)***	0.012 (0.43)
d_{it-1} × Tamil Nadu (K_{18})	0.262 (0.98)	0.224 (0.80)	0.064 (0.42)
d_{it-1} × Tripura (K_{19})	0.326 (4.32)***	−0.099 (−1.26)	−0.037 (−0.87)
d_{it-1} × Uttar Pradesh (K_{20})	0.094 (1.72)*	0.130 (2.26)**	−0.130 (−4.16)***
d_{it-1} × Uttarakhand (K_{21})	0.047 (0.62)	−0.198 (−2.52)**	0.044 (1.00)
d_{it-1} × West Bengal (K_{22})	0.006 (0.08)	0.075 (0.96)	−0.009 (−0.21)
$yvar_{it}$	0.00001 (1.54)	0.00002 (2.17)**	–
$gvar_{it}$	−0.0002 (−8.15)***	−0.0002 (−9.38)***	–
Δy_{it}	–	–	−0.016 (−1.33)
e_{it}	–	–	0.146 (4.57)***
$(intercept)$	−1.759 (−0.55)	−0.560 (−0.17)	6.368 (3.50)
Hausman stat	63.10	56.50	148.65
f-stat	6.13	103.11	43.09
Observations	220	220	220
R-square	0.613	0.963	0.918
Number of states	22	22	22
Number of years	10	10	10

Source: Author's construction; *t* statistics in parentheses.
Notes: Dependent variable (Model 1): primary balance to GSDP ratio; dependent variable (Model 2): primary balance (adjusted) to GSDP ratio; dependent variable (Model 3): State's own revenue to GSDP ratio.
***, **,* indicate levels of significance at 1%. 5% and 10%, respectively.

state-specific dummies. The Chow test and the Hausman statistics support the fixed effects model. The estimated results are shown in Table 6 (Model 1). Among the control variables, *yvar* is not statistically significant and *gvar* has a negative and statistically significant at 1 percent level. The debt interaction term is positive and statistically significant (at 5 percent level) in the cases of Assam, Bihar, Chhattisgarh, Haryana, Himachal Pradesh, Odisha, Punjab, Rajasthan and Tripura. For these nine Indian states, public debt is sustainable. In the cases of Jharkhand, Kerala, Madhya Pradesh and Uttar Pradesh, the debt-interaction term is positive but statistically significant only at 10 percent level implying that the debt is sustainable in these four states too with less significance. For Andhra Pradesh, Goa, Gujarat, Jammu Kashmir, Karnataka, Maharashtra, Tamil Nadu, Uttarakhand and West Bengal, the debt interaction coefficient is positive but not statistically significant even at 10 percent level. Therefore, the debt is not sustainable in these nine states and so they need to take corrective actions to make their debt sustainable.

When the fiscal transfer is excluded from the primary balance variable i.e. the primary balance adjusted, the results have changed significantly in Model 2. The debt is

now unsustainable in the following 11 states: Andhra Pradesh, Goa, Gujarat, Himachal Pradesh, Jammu and Kashmir, Karnataka, Maharashtra, Tamil Nadu, Tripura, Uttarakhand and West Bengal. In Assam, Bihar, Kerala, the debt is sustainable with 10 percent level. In the remaining 8 states, the debt is sustainable. These results deserve policy attention.

In Model 3 of Table 6, we provide results using the state's own revenue as the dependent variable. This shows that except Assam Haryana, Himachal Pradesh and Punjab, all other states are not solvent enough to avoid theno-Ponzi condition.

6. Conclusion

This study has empirically analyzed the public debt sustainability in 22 major Indian states during 2006–07 to 2015–16, using the extended Bohn sustainability framework for panel data. Basically, it employed five fiscal policy response models: (i) the panel fixed effects model to test whether the public debt is sustainable in the Indian states as a whole; (ii) the penalized spline method (non-parametric) to obtain the non-linear response of primary balance to change in debt; (iii) the panel fixed effects model with state-specific explanatory variables in order to capture the undermining factors of debt sustainability; (iv) use of adjusted primary balance to find out whether the state debts are subsidized or not; (v) use of state's own revenue, a subset of primary balance as the dependent variable to test whether the sustainable states are solvent too. Further, we extended the above models by incorporating the debt-state dummy interaction terms to apprehend the state-specific results.

The results indicate that the primary balance of the state governments in India reacts positively to high public debt which implies that debt policies are in general successful in sustaining the debt situation of states as a whole. However, the situation differs in the individual state. Only in 11 out of 22 states, public debt is sustainable. In 2 states, the central grant-in-aid stands as an undermining factor of sustainability as it failed to show any positive and significant association with the primary balance adjusted. Further, only 2 states are sustainable as well as solvent.

One similarity we find in the 11 states, where debt is unsustainable is that although the debt GSDP ratio is decreasing they are not in sustainable line and their absolute amount of the public debt is relatively high. Although FRBM stipulates 3 percent ceiling of net borrowing every year, some of these states are not in a position to meet. Hence, the objective of the states to strictly adhere the debt-deficit targets at least from 2018 to 2019 onwards. The existing bailout policy of central government based on the recommendations of the FCs may be a disincentive for states to maintain fiscal discipline and control the debt. Also, the fiscal transfers provide perverse incentives to the own revenue effort of some states. Hence, the fiscal transfer mechanism and bail-out policies needs to be incentive-compatible and politically sustainable. Another fact is that the FCs uses the traditional approach to suggest the sustainable debt level for each state. Since traditional approaches are not reliable due to its well-known limitations, the FC should consider the fiscal policy reaction function approach, which would provide reliable estimates of debt sustainability of states.

Otherwise, it may misguide states in terms of their sustainable level. We hope these findings are useful to policymakers, academicians and other stakeholders in taking appropriate measures to improve the debt situation of Indian states with unsustainable levels of debt. The Indian experience demonstrated in this study may also be useful for other federal nations.

Notes

1. The no-Ponzi condition is such that the public debt growth rate has to be lower than the real interest rate. It ensures solvency since the funding of interest payments are not made from the new debt issuances. In other words, the existing debt can be serviced with own revenue effort and hence no additional borrowing is required (Azizi et al. 2012).
2. There are three broad measures of deficit at state level in India *viz.* the revenue deficit (=excess of revenue expenditures over revenue receipts), the fiscal deficit (=total expenditure – revenue receipts – non-debt capital receipts) and the primary deficit (=fiscal deficit – interest payments).
3. Article 293 of the Indian Constitution stipulates that the state governments do not have unrestricted power to borrow as long as they are indebted to the Centre and also prohibited direct borrowing from abroad with some exceptions.
4. This condition has been extended by adding various other indicators like growth, liquidity, creditworthiness, fiscal burden, fiscal space etc. and renamed as 'Indicator approach' (Blanchard et al. 1990; Rajaraman, Bhide, and Pattnaik 2005; Mishra and Khundrakpam 2009; Kaur et al. 2014)
5. The IBC is $d_t^* = \sum_{j=1}^{\infty} \frac{1}{(1+r)^j} E_t\ [s_{t+j}]$, where $d_t^* = (1 + r_t)$. d_{t-1} is the stock of the debt-output ratio at the beginning of period t, $E_t\ [\cdot]$ 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.
6. One can also assess sustainability by seeing the co-integrating relationship between the public revenues and the public expenditure (Hakkio and Rush 1991; Afonso 2005) i.e. $R_t = \alpha + \beta\ E_t + \ \upsilon_t$; where R and E are revenues and expenditure respectively and $I(1)$, while υ is $I(0)$.
7. Born (2007) warned against interpreting failure of the stationarity and the co-integration as an evidence of debt sustainability while others criticized as both are not informative about model-based sustainability conditions, statistical failures during structural breaks, ergodicity problem etc.
8. The tax-smoothing hypothesis implies that public deficits are used to keep the tax rates constant which minimizes the excess burden of taxation. Therefore, the regular public expenditure can be financed by government revenues, while the deficits can be used to finance the unexpected expenditures. One can yield primary balance equation from tax-smoothing model by subtracting the primary expenditure to GDP from the Tax revenue to GDP (Barro 1979)
9. Fincke and Greiner (2011b) provide justifications for using the 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 the OLS and gives an estimation result that comes close to the true data generating mechanism
10. For estimation purpose, p-spline 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 criterions: $\sum\{s_t - d_t\ \beta_d - Z\ (d_t)\ \gamma\}^2 + \lambda\ \gamma^T P\gamma$; 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, Wand, and Carrol 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 smoothing matrix. To obtain a 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 the same if the time-varying coefficients are estimated (Greiner and Kauermann 2008)

11. There are two-way the response variable is differenced with Davig and Leeper (2011) model: (i) instead of tax to GDP we have used state's own revenue to GSDP by adding non-tax revenue in the state context; (ii) instead of revenue receipts as such we subtracted tax share and grants from it, in order to account for the own revenue effort of the states.
12. The GSDP data is converted into single base (2011–12) using growth rate splicing method

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References

Abiad, A., and J. Ostry. 2005. "Primary Surpluses and Sustainable Debt Levels in Emerging Market Countries." *IMF Working Papers* 5(6):1–18. doi:10.5089/9781451861259.001.

Adams, C., B. Ferrarini, and D. Park. 2010. "Fiscal Sustainability in Developing Asia." *Asian Development Bank Economics Working Paper Series* 205:1–39.

Afonso, A. 2005. "Fiscal Sustainability: The Unpleasant European Case." *FinanzArchiv* 61(1): 19–44. doi:10.1628/0015221053722532.

Azizi, K., N. Canry, J.-B. Chatelain, and B. Tinel. 2012. "Are no-Ponzi Game and Transversality Conditions Relevant for Public Debt? a Keynesian Appraisal." *PERI Working Paper* 296:1–18.

Barro, R. J. 1979. "On the Determination of the Public Debt." *Journal of Political Economy* 87 (5): 940–971.

Blanchard, O., J.-C., Chouraqui, R. Hagemann, and N. Sartor. 1990. "The Sustainability of Fiscal Policy: New Answers to Old Questions." *Economic Studies* 15(Autumn):1–36.

Bohn, H. 1995. "The Sustainability of Budget Deficits in a Stochastic Economy." *Journal of Money, Credit and Banking* 27(1):257–271. doi:10.2307/2077862.

Bohn, H. 1998. "The Behavior of US Public Debt and Deficits." *The Quarterly Journal of Economics* 113(3):949–963. doi:10.1162/003355398555793.

Bohn, H. 2005. "The Sustainability of Fiscal Policy in the United States". CEFifo Working Paper No. 1446.

Bohn, H. 2007. "Are Stationarity and Cointegration Restrictions Really Necessary for the Intertemporal Budget Constraint?" *Journal of Monetary Economics* 54(7):1837–1847. doi:10.1016/j.jmoneco.2006.12.012.

Buiter, W., and U. Patel. 1992. "Debt, Deficits, and Inflation: An Application to the Public Finances of India." *Journal of Public Economics* 47(2):171–205. doi:10.1016/0047-2727(92)90047-J.

Burger, P., C. Jooste, A. Cuevas, and I. Stuart. 2012. "Fiscal Sustainability and the Fiscal Reaction Function for South Africa: Assessment for the Past and Future Policy Applications." *South Africa Journal of Economics* 80 (2): 209–227.

Davig, T., and E. M. Leeper. 2011. "Monetary-fiscalPolicy Interactions and Fiscal Stimulus." *European Economic Review* 55(2):211–227. doi:10.1016/j.euroecorev.2010.04.004.

De Mello, L. 2008. "Estimating a Fiscal Reaction Function: The Case of Debt Sustainability in Brazil." *Applied Economics* 40(3):271–284. doi:10.1080/00036840500461873.

Domar, E. D. 1944. "The "Burden of the Debt" and the National Income." *American Economic Review* 34(4):798–827.

Fincke, B., and A. Greiner. 2011a. "Debt Sustainability in Germany: Empirical Evidence for Federal States." *International Journal of Sustainable Economy* 3(2):235–254. doi:10.1504/IJSE.2011.039442.

Fincke, B., and A. Greiner. 2011b. "Debt Sustainability in Selected Euro Area Countries: Empirical Evidence Estimating Time-Varying Parameters." *Studies in Nonlinear Dynamics & Econometrics* 15(3):1–21. doi:10.2202/1558-3708.1777.

Ghosh, A. R., J. I. Kim, E. G. Mendoza, J. D. Ostry, and M. S. Qureshi. 2013. "Fiscal Fatigue, Fiscal Space and Debt Sustainability in Advanced Economies." *The Economic Journal* 123(566):F4–F30. doi:10.1111/ecoj.12010.

Greiner, A., and B. Fincke. 2015. *Public debt, sustainability and economic growth*. Switzerland: Springer International Publishing Media.

Greiner, A., and G. Kauermann. 2008. "Debt Policy in Euro Area Countries: Evidence for Germany and Italy Using Penalized Spline Smoothing." *Economic Modelling* 25(6): 1144–1154. doi:10.1016/j.econmod.2008.02.006.

Greiner, A., U. Koller, and W. Semmler. 2007. "Debt Sustainability in the European Monetary Union: Theory and Empirical Evidence for Selected Countries." *Oxford Economic Papers* 59(2):194–218. doi:10.1093/oep/gpl035.

Haber, G., and R. Neck. 2006. "Sustainability of Austrian Public Debt: A Political Economy Perspective." *Empirica* 33(2–3):141–154. doi:10.1007/s10663-006-9012-1.

Hakkio, C. S., and M. Rush. 1991. "Is the Budget Deficit Too Large?" *Economic Inquiry* 29(3): 429–445. doi:10.1111/j.1465-7295.1991.tb00837.x.

Hamilton, J. D., and M. Flavin. 1986. "On the Limitations of Government Borrowing: A Framework for Empirical Testing." *American Economic Review* 76(4):808–819.

IMF (International Monetary Fund). 2011. "Modernizing the Framework for Fiscal Policy and Public Debt Sustainability Analysis." Policy Paper. https://www.imf.org/external/np/pp/eng/2011/080511.pdf

Im, K. S., M. A. Pesaran, and T. Shin. 2003. "Testing for Unit Root in Heterogenous Panels." *Journal of Econometrics* 115: 53–74.

Jha, R., and A. Sharma. 2004. "Structural Breaks, Unit Roots, and Cointegration: A Further Test of the Sustainability of the Indian Fiscal Deficit." *Public Finance Review* 32(2):196–219. doi:10.1177/1091142103260858.

Kaur, B., and A. Mukherjee. 2012. "Threshold Level of Debt and Public Debt Sustainability: The Indian Experience." *RBI Occasional Papers* 33(1–2):1–32.

Kaur, B., A. Mukherjee, N. Kumar, and A. Prakash Ekka. 2014. "Debt Sustainability at the State Level in India." *RBI Working Paper Series* 2014(7):1–34.

Levin, A., C. F. Lin, and C. S. J. Chu. 2002. "Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties." *Journal of Econometrics* 108: 1–22.

Mahdavi, S. 2014. "Bohn's Test of Fiscal Sustainability of the American State Governments." *Southern Economic Journal* 80(4):1028–1054. doi:10.4284/0038-4038-2012.223.

Misra, B. M., and J. K. Khundrakpam. 2009. "Fiscal consolidation by central and state governments: The Medium Term Outlook." Staff Studies, Reserve Bank of India, Mumbai. https://rbidocs.rbi.org.in/rdocs/Content/PDFs/SSBMM280509.pdf

Nguyen, T. 2013. "Estimating India's Fiscal Reaction Function." *Australia South Asia Research Centre Working Paper* 2013(5):1–33.

Pattnaik, R. K., B. S. Misra, and A. Prakash. 2003. "Sustainability of Public Debt in India: An Assessment in the Context of Fiscal Rules." In 6th Workshop on Public Finance Organized by Banca d' Italia, Perugia, Rome, April 1–3. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2070718

Potrafke, N., and M. Reischmann. 2015. "Fiscal Transfers and Fiscal Sustainability." *Journal of Money, Credit and Banking* 47(5):975–1005. doi:10.1111/jmcb.12231.

Pradhan, K. 2014. "Is India's Public Debt Sustainable?" *South Asian Journal of Macroeconomics and Public Finance* 3(2):241–266. doi:10.1177/2277978714548637.

Rajaraman, I., S. Bhide, and R. K. Pattnaik. 2005. *A Study of Debt Sustainability at State Level in India*. Mumbai: Reserve Bank of India. https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/66733.pdf

Rangarajan, C., A. Basu, and N. Jadhav. 1989. "Dynamics of Interaction between Government Deficit and Domestic Debt in India." *Reserve Bank of India Occasional Papers* 10(3): 163–220.

Rangarajan, C., and D. K. Srivastava. 2005. "Fiscal Deficits and Government Debt: Implications for Growth and Stabilization." *Economic and Political Weekly* 40(27): 2919–2934.

Rao, G. 2005. *Changing Contours in Fiscal Federalism in India*. National Institute of Public Finance and Policy: New Delhi. http://www.econ.hit-u.ac.jp/~kokyo/APPPsympo04/PDF-papers-nov/Rao-Final2.pdf

RBI (Reserve Bank of India). 2013. "State Finances: A Study of Budgets -2012–13." https://www.rbi.org.in/Scripts/Annual Publications.asp?head=State+Finance+%3a+A+Study+of+Budgets

Ruppert, R., M. P. Wand, and R. J. Carrol. 2003. *Semiparametric Regression*. Cambridge: Cambridge University Press.

Shastri, S., and M. Sahrawat. 2012. "Fiscal Sustainability in India: An Empirical Assessment." *Journal of Economic Policy and Research* 10(1):97–112.

Tiwari, A. K. 2012. "Debt Sustainability in India: Empirical Evidence Estimating Time-Varying Parameters." *Economics Bulletin* 32(2):1133–1141.

Trehan, B., and C. E. Walsh. 1991. "Testing Intertemporal Budget Constraints: Theory and Applications to US Federal Budget and Current account Deficits." *Journal of Money, Credit and Banking* 23(2):206–223. doi:10.2307/1992777.

Tronzano, M. 2013. "The Sustainability of Indian Fiscal Policy: A Reassessment of the Empirical Evidence." *Emerging Markets Finance and Trade* 49(supl 1):63–76. doi:10.2753/REE1540-496X4901S105.

Uctum, M., T. Thurston, and R. Uctum. 2006. "Public Debt, the Unit Root Hypothesis and Structural Breaks: A Multi-Country Analysis." *Economica* 73(289):129–156. doi:10.1111/j.1468-0335.2006.00451.x.