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Debt Sustainability in India: Empirical Evidence Estimating Time-Varying Parameters

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Abstract

We employed Fincke and Greiner's (2011, Studies in Nonlinear Dynamics & Econometrics) approach for testing sustainability of public debt in the case of India. Their approach was based on the framework of Bohn (1998) who showed how the primary surplus reacts to variations in debt and which has received great attention in economics literature recently. In this contribution, we applied that test to the India for the period 1970-2009, where we allowed for a time-varying reaction coefficient. We did not find the clear-cut result on the sustainability of public debt for the India during study period.

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1. Introduction

The recent financial crisis and the outstanding fiscal stimulus to drive the world economy out of recession, world markets have increasingly drawn their attention to the excessive debt of different economies of the world and India is not an exception of that. The debt burden particularly, external debt burden, of developing countries continues to be one of the key barriers to economic and social progress. Consequently, fiscal policies, sustainability and solvency have become important research areas in recent years. Sustainability of the government's interptemporal budget constraint (IBC), within a dynamically efficient economy, requires fiscal policies to satisfy the present value borrowing constraint i.e., the present value of outlays (current and future) equals the present value of revenues (current and future) (Legrenzi and Milas 2011). Legrenzi and Milas (2011) argued that this is equivalent to the imposition of a no-Ponzi game condition on the debt dynamics, preventing the government to pay interest on old debt by issuing new debt.

There has been enormous empirical literature on the testing for sustainability of public debt with the application of unit root tests applied to public debt, cointegration tests applied between government revenues and expenditures (for a survey see for example Quintos 1995 and Afonso 2005) and estimation of fiscal reaction functions (Bohn 2007). It is important to mention that Bohn (2007) has warned us against interpreting failure of stationarity and cointegration as evidence of unsustainable fiscal policy. Therefore, Greiner et al. (2007) applied the approach of Bohn (2007) which is based on the fiscal reaction function and conclude that both Portuguese and Italian public finances are sustainable. However, all above tests, nevertheless, are implicitly based on a linear model of continuous fiscal adjustment. As correctly pointed out by Bertola and Drazen (1993) that, due to difficulties in reaching necessary consensus for fiscal retrenchments, fiscal authorities initiate a corrective action only when the disequilibria reach a given trigger point, for instance when spending reaches levels high enough to be deemed critical. This allows us to use for time-varying coefficient approach. In a recent study Fincke and Greiner (2011) used a model of time-varying coefficients (on the grounds that any nonlinear model is approximated by a linear model with time-varying coefficients; see Granger, 2008) and found that that among EU countries, Greece and possibly Italy are fiscally unsustainable.

In the present contribution, we also follow the approach by Bohn (1998) and the way it was applied in Fincke and Greiner (2011). This is because Bohn's (1998) approach has received great attention in economics. In Bohn's (1998) approach we test for how the primary surplus relative to GDP reacts to variations in public debt relative to GDP. If this response of the primary surplus to public debt is positive and statistically significant a given fiscal policy can be shown to satisfy the inter-temporal budget constraint of the government. This test has a nice economic intuition: If the government runs into debt today it has to run primary surpluses in the future so that its fiscal policy remains sustainable (Fincke and Greiner 2011).

Fincke and Greiner (2011) mentioned three reasons for the allowances for time-varying parameters in the regressions. "The first is that the true data generating process is unknown and most likely nonlinear. Since any nonlinear model can be well approximated by a linear model with time-varying coefficients (see Granger, 2008), the estimation of a model with time-varying coefficients is more general than OLS estimation and gives an estimation result that comes closer to the true data generating mechanism. Second, applying that estimation strategy we are able to find whether the response of governments with respect to public debt have changed over time besides detecting whether the coefficient is positive at all. Thus, we intend to contribute to the literature that goes beyond OLS estimation in that area and that tries to find structural breaks,

thresholds or possible non-linearities (see for example, Bajo-Rubio et al. 2004; Martin 2000; Payne et al. 2008; or Westerlund and Prohl 2010). Finally, the third reason is that random coefficients make the short-run coefficients the expectation of the long-run coefficients. Hence, the estimation obtained in the short-run is the best estimate for the long-run coefficient that is decisive as regards sustainability". It is important to mention that following Fincke and Greiner (2011) we neglect the possibility that a government can use seignorage or inflation to reduce the stock of real public debt. This is because central bank is independent and governments should not rely on central bank to reduce public debt when deciding about debt and deficits.

The remainder of the paper is organized as follows. Section two briefly describes the India's scenario of public debt and third section describes the theoretical approach and the background of the test. Section four present the results of the empirical estimations and section five, summarizes the results.

2. India's scenario

After a decade of large fiscal deficits, India adopted a rules-based fiscal framework in the name of the Fiscal Responsibility and Budget Management Act (FRBMA) in 2003, with the objective of to ensure intergenerational equity in fiscal management and the fiscal sustainability. Simone and Topalova (2009) argued that the implementation of the FRBMA coincided with a decline in India's central government fiscal deficit by about 1.8 percent of GDP between its introduction and 2007/08. Nonetheless, they added, "the fiscal consolidation has since been fully reversed, owing to a combination of spending measures introduced prior to the onset of the global crisis, a soaring subsidy bill, fiscal stimulus packages in response to the crisis, and a cyclical downturn in tax revenue".

In order to design an appropriate stimulus package in the Indian scenario, where fiscal deficit (Combined centre and state with off budget items also included) in the year of 2008-09 is estimated to be more than 8 percent and the ratio of public debt to GDP around 73 percent, one of the essential questions is the sustainability of the high level of public debt. Importantly, in last few years the public debt to GDP ratio in India has exhibited a downward movement and the 12th Finance Commission had set the optimal ratio of public debt to GDP as 55 percent in 2004-05. Rangarajan and Shrivastava (2005) for the Indian economy has found for the period 1955-2000 that primary deficit was the core variable that led to increase in debt to GDP ratio. The public debt to GDP ratio, in the beginning of the first plan period (1950-51), was around 29 percent which had risen to the peak of around 83 percent in 2003-04.[1] Between 1991 and 2009, public debt has been in a range between 68 to 87 percent of GDP, with an average of 78 percent of GDP. The lowest point of 68 percent of GDP was reached in 1996/97 and the peak occurred in 2004. Since 1991, India has gone through two periods of substantial fiscal consolidation: (1) in the first half of the 1990s; and (2) after the introduction of the FRBMA in 2003 until 2007/08. In the first consolidation, the debt-to-GDP ratio was reduced from 79 percent in 1994/95 to 68 percent in 1997/98; in the second consolidation, the debt-to-GDP ratio declined from a peak of 87 percent in 2004/05 to 81 percent in 2007/08. However, fiscal consolidation was reversed in both of these episodes: in 1996/97 due to the economic slowdown and Fifth Pay Commission and presently due to a soaring subsidy bill, the Sixth Pay commission, the agricultural debt waiver and crisis-related fiscal measures.

[1] http://www.icrier.org/page.asp?MenuID=24&SubCatId=177&SubSubCatId=324

Large public deficits and high levels of public debt relative to GDP are important factors that affect the budget plan of a government. Without balanced budgets the ensuing deficits accumulate and lead to a rise of public debt in individual countries. Over the last decades a lot of European countries and India have suffered from very persistent and in part high public deficits. This trend has represented a serious problem from the economic and political point of view. Therefore, it is important to study the issue of sustainability of public debt.

An important aspect in this context is the question of whether Indian government is able to respond in a sustainable way to the above mentioned tendency of persistent budget deficits and growing levels of debt. Here, it is important to recall that the concept of sustainability is well compatible with indebtedness in the short run but it requires that the present value of debt converges to zero asymptotically. This raises the question of how governments react to higher debt levels, which options they have to respond and if these actions are still effective.

3. Theoretical Background[2]

Bohn (1998) was the first study to note that discounting public debt with a given interest rate may be crucial as to the result whether a given time path of public debt is sustainable or not. Since interest rates in the future are not known, tests on sustainability should be independent of the discount factor applied in computing the present value of public debt. One test that achieves this is to analyze, whether the primary surplus relative to GDP is a positive function of public debt relative to GDP, i.e., a positive function of the debt ratio. The idea behind this test is that such a policy makes the debt to GDP ratio a mean reverting process. Hence, rising debt ratios lead to higher primary surplus relative to GDP that exerts a tendency towards mean reversion. In order to see this we consider a deterministic economy in continuous time. The evolution of public debt, then, is given by

$$\frac{dB(t)}{dt} = r(t)B(t) + G(t) - T(t) = r(t)B(t) - S(t), \tag{1}$$

with $B(t)$ public debt, $r(t)$ the interest rate and $S(t)$ the primary surplus that consists of public revenues, $T(t)$, minus public spending, $G(t)$. All variables are real and continuous functions of time t. A given path of public debt is said to be sustainable if it satisfies the inter-temporal budget constraint,

$$\lim_{t\to\infty} B(t)e^{-\int_{t_0}^{t} r(\tau)d\tau} = 0 \Leftrightarrow B(t_0) = \int_{t_0}^{\infty} e^{-\int_{t_0}^{\tau} r(\mu)d\mu} S(\tau)d(\tau) \tag{2}$$

Now, assume that the primary surplus relative to GDP, S/Y, is given by,

[2] This section is largely based on the work of Fincke and Greiner (2011).

$$\frac{S(t)}{Y(t)} = \alpha + \beta(t)\left(\frac{B(t)}{Y(t)}\right) \tag{3}$$

with $\alpha \in IR$ a constant and $\beta \in IR$ the reaction coefficient that gives the reaction of the primary surplus to public debt relative to GDP, respectively, and that may be time varying. Using several assumptions Fincke and Greiner (2011) showed that the reaction of the government to the debt ratio may well be zero or even negative for some time periods; however, on average it must be positive. Otherwise, no sustainable debt policy is given.

4. Empirical Evidence

In this subsection we apply a test that is based on the theoretical considerations of the last section to data for the India during the period 1970-2009. [3] We analyze the correlation between the primary surplus and public debt all measured as ratios to GDP. For the India we estimate the reaction of the primary surplus to public debt, relative to GDP respectively, and present the results. Thereafter, we applied a positive reaction coefficient approach which implies mean reversion of the series of public debt and, thus, guarantees sustainability of public debt. To implement the test we estimate the following equation with annual data,

$$s(t) = \beta(t)b(t) + \alpha^T Z(t) + \varepsilon(t) \tag{4}$$

with $s(t)$ the primary surplus to GDP ratio and $b(t)$ the public debt to GDP ratio at time t. $Z(t)$ is a vector of variables that includes 1 in its first element, for the intercept, and additional variables in its other elements, that influence the primary surplus ratio. $\varepsilon(t)$ is an error term, which is assumed to be i.i.d.N(0, σ^2).

Inclusion of the other variables in $Z(t)$ is based on the strategy of Bohn (1998), which is particularly based on the tax smoothing hypothesis. This hypothesis implies that the public deficits should be used in order to keep tax rates constant which minimizes the excess burden of taxation. Therefore, normal expenditures should be financed by regular revenues and deficits should be incurred to finance unexpected spending. Hence, we include a business cycle variable, *YVar*, which accounts for fluctuations in revenues. It is calculated by subtracting the long term trend of GDP, which has been computed by applying the Hodrick-Prescott-Filter (HP-Filter) to the real GDP series, from its actual values. Further, it is important to mention that the deviations of real public expenditures from its long-run trend affect the primary surplus ratio, too. Therefore, we added another business cycle variable that accounts for fluctuations of public expenditures around its trend, denoted by $GVar(t)$, that is computed as realized values minus trend values with the latter again estimated by the HP-Filter. Moreover, for the estimation the lagged debt ratio $b(t-1)$ is used in order to take account of problems of endogeneity following Fincke and Greiner (2011). Thus, equation (4) can be written as,

$$s(t) = \alpha_0 + \beta(t)b(t-1) + \alpha_1 GVar(t) + \alpha_2 YVar(t) + \varepsilon(t) \tag{5}$$

[3] Data for all our analysis was obtained from Handbook of statistics of Indian economy except debt/GDP ratio measure which was accessed from Carmen Reinhart's website at the Peterson Institute of International Economics.

In order to estimate time-varying coefficients we resort to penalized spline estimation that is more robust than OLS estimation (for an introduction to penalized spline estimation please refer to Hasti and Tibshirani, 1999, or Ruppert et al., 2003 among others). This allows to estimate the reaction coefficient $\beta(t)$ in equation (5) as a function of time showing how that coefficient evolves over time.

First, we estimate equation (5) for India for the data from 1970 until 2009. The result of the estimation is presented in Table 1.

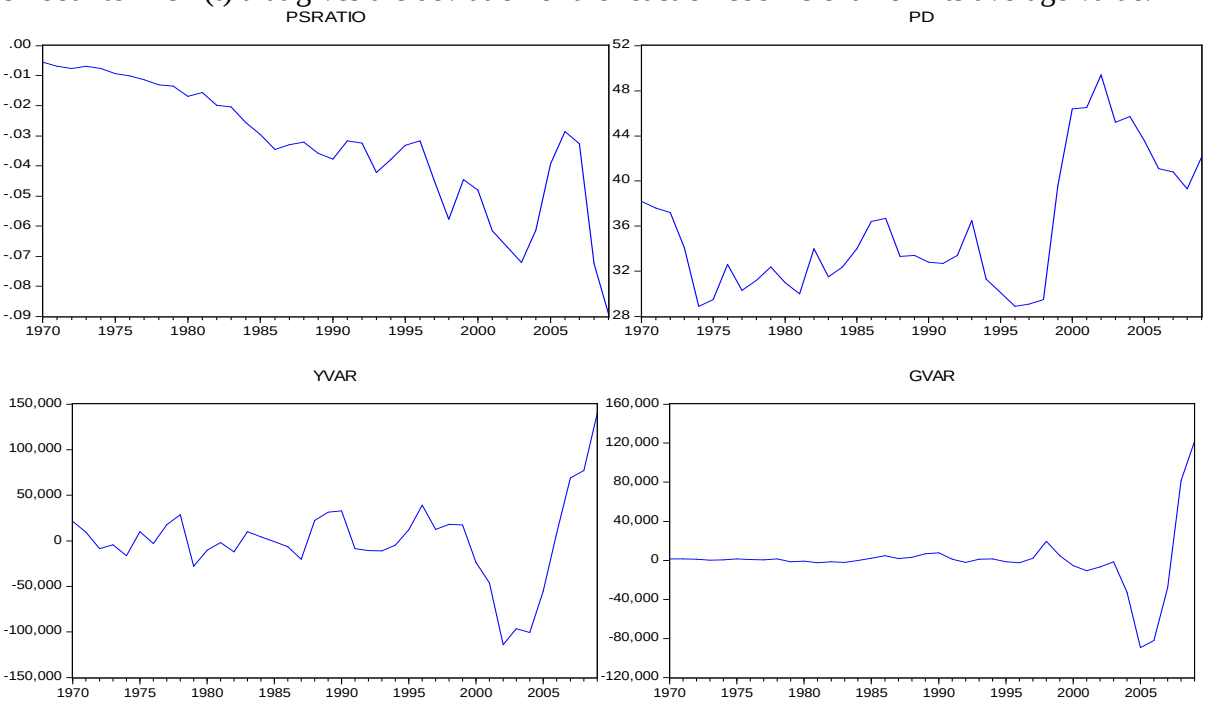
Table 1: Coefficients for equation (5) for with data from 1970-2009

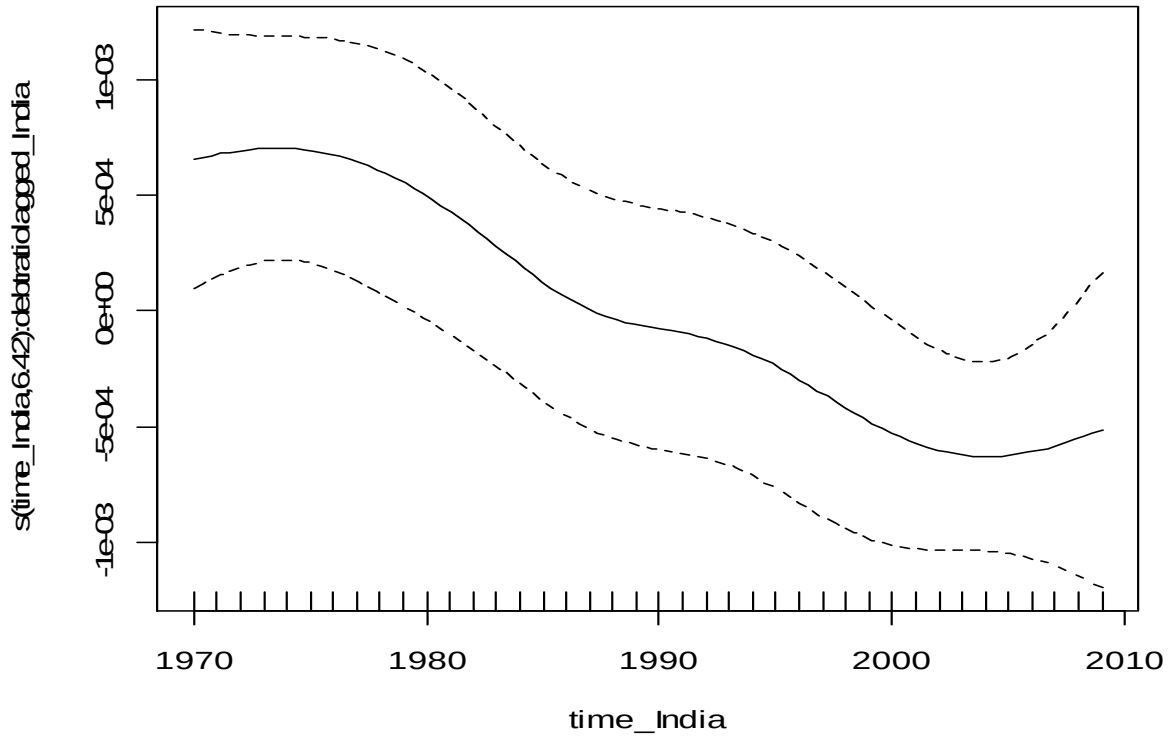
	Coefficient	Stand. error (t-stat)	Pr(>t)
Constant	-2.876e-02	9.268e-03 (-3.103)	0.00414
$b(t-1)$	-8.596e-05	3.113e-04 (-0.276)	0.78430
$GVar(t)$	-3.689e-07	2.720e-08 (-13.563)	2.37e-14
$YVar(t)$	9.461e-08	2.987e-08 (3.167)	0.00351
sm(t)	edf: 6.425	F: 86.22	p-value 2e-16
	R2(adj): 0.969	DW: 1.774857	
Source: Authors' calculation			

The estimation outcome shown in Table 1 demonstrates that the average reaction coefficient of the primary surplus relative to GDP to variations in the debt to GDP ratio takes a negative value of 0.008596 percent and is statistically insignificant even at the 10 percent level. This implies that the Indian government did not raise the primary surplus as government debt increased but rather reduced it. However, this reduction has been insignificant. Consequently, India's public debt has increased from 38.18 percent to 42.09 percent in the period under consideration. It can also be realized that the time-varying component of the reaction coefficient, denoted by sm(t) in the 5th row, is statistically significant, too, and the estimated degrees of freedom (edf) of about 6.42 indicate that the reaction coefficient is not constant but a time-varying function.

Further, to demonstrate this we show the graph of the smooth term where the graph is drawn such that a value of zero for the smooth term implies that the reaction coefficient just equals its average value. Thus, the actual value of the reaction coefficient at a certain point in time is equal to the average value plus the value of smooth term shown in the Figure 1 below. One can clearly recognize that the reaction coefficient has declined over the time period considered in our estimation which can explain the increase in the debt to GDP ratio in India. This also implies that Indian government put less weight on stabilizing public debt and therefore, explains the almost monotonously rising debt ratio to GDP over the considered time period. Further one realizes that the primary surplus declines when public spending is above its trend, due to the negative coefficient of *GVar*, as well as when GDP is below its trend because of the positive sign of the coefficient of the variable *YVar*, as one would expect from economic theory. Finally, the adjusted R^2 of 97 percent indicates a good overall fit of the model and the Durbin-Watson test statistics, DW, does not suggest that the residuals are autocorrelated.

Figure 1: The following figures present plots of the variables used in the estimation as well as the smooth term sm(t) that gives the deviation of the reaction coefficient from its average value.





5. Conclusion

In this paper we have analyzed whether India has followed sustainable debt policies during the period 1970-2009. We did this by analyzing the reaction of the primary surplus to GDP ratio to variations in the debt to GDP ratio which is a powerful test. We are unable to find clear-cut evidence on the sustainability of public debt. This is because, the coefficient of public debt is negative and insignificant and reaction coefficient has showed a declining trend over the time period studied.

It is important to mention that recent studies, in particular those that test how the primary surplus reacts to public debt, tend to conclude that debt policies are sustainable. However, this may be due to the differences in application of methodology applied as well as the result of stabilization policies adopted in India. Last but not least, from a methodological point of view the novelty of our paper consists in estimating time-varying parameters. Resorting to penalized spline estimations demonstrated that the reaction of the primary surplus to increases in public debt has not been constant in the India; instead, it has been characterized by variations over time.

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