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Public Debt and Primary Surplus of the State Governments in India: Cointegration and VECM Analysis

Amir Abdou[1], D.S. Leelavathi[2]
[1]*Ph.D candidate, Department of Studies in Economics and Co-operation*
University of Mysore, Mysore, India.
[2]*Professor of Economics (Retd), Department of Studies in Economics and Co-operation*
University of Mysore, Mysore, India.

Abstract: *This paper aims to examine the fiscal stance of the State Governments in India by analyzing responsiveness of the primary surplus of Indian state governments to increases in the debt to GDP ratio. Public debt of state governments in India has been on an overall rising trend since the 1980s, while primary balance was in deficit over the past three decades expect for only two years. Public debt to GDP and primary surplus were tested for unit root and were found to be I(1), hence cointegration and error correction models were used to estimate the long-run and short run relationship between the two variables over the period 1980-2018. It was found that primary surplus and public debt are cointegrated and have a long-run equilibrium, but only at 10 per cent level of significance. In the short-run, the effect of public debt on primary surplus is negative; suggesting that rising public debt in the state governments is not followed by an immediate increase in primary surplus. On the contrary, primary deficit increases. The impulse response function shows that a one standard deviation shock to public debt decreases the primary surplus in the year following the shock, before the latter starts to increase in the second and third years, and then in the fourth and fifth years the effect of the shock on the primary balance diminishes. Therefore one can say that, at 10 per cent level of significance, the public debt of state governments in India appear to be sustainable in the long-run. However the recent increases in public debt of state governments highlights the need for a more prudent fiscal policy in the near future.*

Key Words: *Primary Surplus, public debt, fiscal reaction function, cointegration, VECM, IRF.*
JEL Classification: H50, H63, C22.

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I. Introduction

Public Debt sustainability has attracted a great deal of attention in the past few decades. Rising levels of governments' debt in developed and developing countries, present a challenge for economists and policy makers. In India the public debt to GDP ratio of state governments has been on an increasing trend since the eighties reaching critical levels in 2003. However, after the implementation of Fiscal Responsibility Legislations (FRL) debt ratio started to decline. But in recent years, especially after introducing Ujwal DISCOM Assurance Yojana (UDAI), debt position of state governments started to deteriorate again. Hence there is a need to analyse the fiscal stance of state governments.

In the public finance context, satisfying the inter-temporal budget constraint is a crucial element for a prudent fiscal policy. If the present value of future primary surpluses is equal to, or larger than, the initial public debt, then the government is solvent and debt can be deemed sustainable.

To ensure solvency and a strong active fiscal policy, a government is expected to increase its revenue and/or reduce the non-interest expenditure in an attempt to reverse increases in debt levels. In other words, when primary surplus (non-interest fiscal surplus) increases as debt to GDP ratio rises, the government is showing that it is actively trying to reduce the debt burden. The reason behind considering primary balance when examining public debt is because it can keep debt from growing at a rate $(1+r)$ with r being the interest rate on government debt (Bohn, 2007).

The relationship between primary surplus and public debt was explored by Bohn (1998) by regressing primary surplus on public debt to GDP and other determinants in the U.S economy. Responsiveness of governments to changes in public debt ratios through primary balance was estimated in developed and developing economies with various degrees of modifications of Bohn's model to suit the specific characteristics and nature of the economy under consideration. A number of econometric tools have been applied such as cointegration, ARDL models, OLS regression, etc.

In this paper the relationship between primary surplus and public debt in India was examined at the state level using cointegration, a vector error correction model, and an Impulse Response Function (IRF).

Assessing the sustainability of fiscal policy of state governments in India is very important for policy makers when it comes to drawing future fiscal policy. Because the primary balance of state governments has been in deficit since 1980, expect for only two years, and also the recent increase in primary deficit between 2011 and 2016, doubts started to rise about the responsiveness of state governments to increases in public debt. Especially after the debt to GDP ratio of state governments started to rise again in 2014. Hence, this study attempts to explore the relationship between primary surplus and public debt at the state level in India to examine the sustainability of public debt.

This paper is organized as follows: Section 1 presents the theoretical and empirical basis of the relationship between primary surplus and public debt, in addition to some relevant research work in different countries including India. After that, in section 2 a brief analysis of the historical trend of major fiscal variables of the Indian states in total in the past few decades has been attempted. Then, data and the statistical methodology followed in this paper are presented in section 3. Section 4 includes the results of the econometric analysis, followed by policy suggestions and conclusion in section 5.

II. Literature Review

If current level of public debt is equal to the present value of future primary surpluses, then the government is solvent and debt can be deemed sustainable.

The relationship between public debt and primary surplus stems from the government Inter-temporal Budget Constraint (IBC):

$$D_t = (1 + r)D_{t-1} + G_t - T_t \quad (1)$$

Where:

D_t : public debt at time t,

r : the nominal interest rate on government borrowing,

T_t : tax revenue, and

G_t : non-interest government expenditure.

Equation 1 means that the public debt at period t is equal to the past debt plus interest payment and government expenditure minus taxes. Since primary surplus S_t is equal to tax revenue minus government expenditure, equation 1 can be re-written as:

$$D_t = (1 + r)D_{t-1} - S_t \quad (2)$$

In a growing economy public debt and primary surplus become more pertinent when scaled by GDP. In fiscal behaviour literature, the purpose of estimating a fiscal reaction function (FRF) is to assess whether a government reacts to rising levels of debt through it budgetary tools or not. Thus Bohn tried to estimate:

$$s_t = \alpha_0 + \rho.d_t + a.Z_t + \varepsilon_t \quad (3)$$

Where:

s: primary surplus to GDP ratio,

d: public debt to GDP ratio,

ρ: represents the response of primary surplus to changes in public debt to GDP ratio,

Z: other determinants, and

ε_t: is an error term.

Equation 3 is a fiscal reaction function which is a regression of primary surplus (fiscal surplus net of interest payment) on debt and non-debt determinants. Based on Barro's (1979) tax smoothing model, Bohn included government revenue and a business cycle indicator to the right-hand side of the regression. See equation 4.

$$s_t = \alpha_0 + \rho.d_t + \alpha_1 g + \alpha_2.ygap_t + \varepsilon_t \quad (4)$$

Bohn argued that a sufficient condition for the intertemporal budget constraint to be satisfied would be that the primary balance reacts positively to changes in debt to GDP ratio either by reducing non-interest expenditure and/or raising government revenues. Thus the coefficient ρ represents the responsiveness of primary surplus to changes in debt.

Bohn also questioned the properties of the variables *ps* and *pd* and argued that they were stationary in the U.S. Bohn stated that if both primary surplus and public debt time series have unit roots, cointegration

regression can be used. Interestingly enough, Bohn (2007) criticized unit root and cointegration tests and argued that they are unable to reject sustainability. However, Bohn also noted that error-correction mechanism is similar to a reaction function.

On the cointegration condition of Trehan and Walsh (1991), Bohn (2007) wrote: "*Trehan and Walsh's condition implies an error-correction mechanism that can be interpreted as a fiscal reaction function, this providing a bridge to the literature on fiscal behaviour*". The analysis in this paper is based on the work of Bohn (1998) and Trehan and Walsh (1991).

For over two decades a large number of empirical studies have adopted the fiscal reaction function in different variations. Although the application of the FRF has been widespread worldwide, in the Indian context the fiscal reaction function was not widely explored.

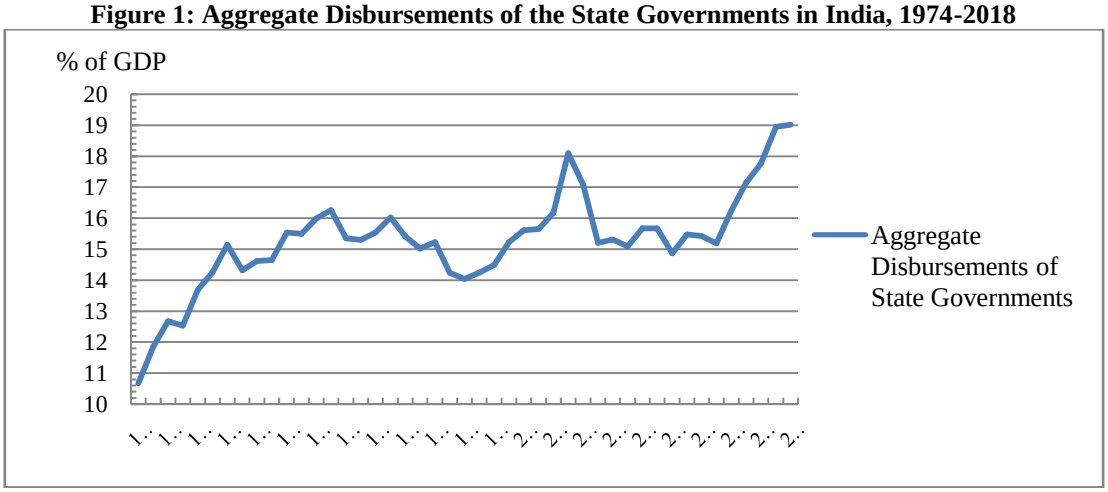
Abiad and Ostry (2005) explored the primary surplus in 31 emerging economies between 1990 and 2002. They found that the primary surplus increases in response to increases in debt to GDP ratio. However, when debt ratio exceeds 50 per cent of GDP, the responsiveness of primary surplus becomes marginal. Building on Penalver and Thwaites (2004), Abiad and Ostry (2005) and Rigobon (2005), Celasun, Debrun, and Ostry et al (2006) studied the primary surplus behavior in emerging economies. The fiscal reaction function was estimated over the period 1990-2004 for 34 countries. The primary balance was found to be responding positively to rising debt to GDP ratios. De Mello (2008) estimated the fiscal reaction function in Brazil over the period 1995-2004 using monthly data. He concluded that there exists a strong positive relationship between primary balance and public debt to GDP ratio in Brazil. Using a sample of 23 advanced countries, Burger, Stuart, Jooste, and Cuevas (2011) ran a fiscal reaction function for South Africa between 1946 and 2008 using OLS and other estimation methods. They concluded that there was an overall positive response by the government to increases in public debt to GDP ratio by raising primary balance, and that in times when real interest rates and growth rates differences were unfavorable for a sustainable debt, the fiscal policy became more active compared to periods when the differences were favorable. Medeiros (2012) explored the relationship between primary balance and lagged debt to GDP ratio. Ghosh, Kim, Mendoza, Ostry, and Qureshi (2013) estimated a fiscal reaction function over the period 1970-2007. They found that the function is non-linear as the positive response of primary balance declines when debt to GDP ratio becomes in the 90 to 100 per cent range which would indicate a "fiscal fatigue" scenario. An evidence of fiscal Fatigue was spotted for 15 European countries when debt to GDP ratios reached the 80 to 90 per cent range, after which the positive response of primary balance to changes in lagged debt to GDP ratios started to decline. Using data between 1995 and 2015, Saima and Uddin (2017) applied cointegration and VECM techniques to study the relationship between public debt and budget deficit in Bangladesh. They concluded that there is a cointegration relationship between the two variables and that there is a short-run causality running from public debt to budget deficit.

In India a number of studies examined the fiscal reaction function. Buiter and Patel (2010) warned about the deterioration in the primary balance and highlighted the importance of improving the Indian fiscal balances otherwise the debt to GDP ratio would reach thresholds and lead to lower growth rates. Nguyen (2013) estimated a fiscal reaction in India between 1981 and 2011 using government revenue to GDP as a proxy for government reaction to rising debt to GDP levels. Nguyen found a positive relationship between government revenue and debt levels implying a commitment on the side of the government to repay its debt. Shastri and Sehrawat (2015) assessed the central government's fiscal sustainability in India. In addition to applying cointegration technique on revenue and expenditure, they used ARDL method to estimate the fiscal reaction function and concluded that the primary deficit does not response to lagged values of debt to GDP. Shastri, Giri, and Mohapatra (2017) assessed public debt sustainability in five Asian economies including India between 1985 and 2014. They found that primary balance rises as debt increase. Renjith and Shanmugam (2018) examined the sustainability of public debt in 20 states in India between 2005 and 2014. They came to a conclusion that primary balance reacts positively to public debt. They also found debt to be unsustainable in eight states. For 20 states, (Narayan 2017) Kaur, Mukherjee, and Ekka (2018) estimated a fiscal reaction function between 1980 and 2015 and found that the states governments respond positively to increases in their public debt to GDP, and that at the same time some states suffered from unsustainable debt levels and could not achieve their debt targets.

III. Primary Surplus and Public Debt of The State Governments in India

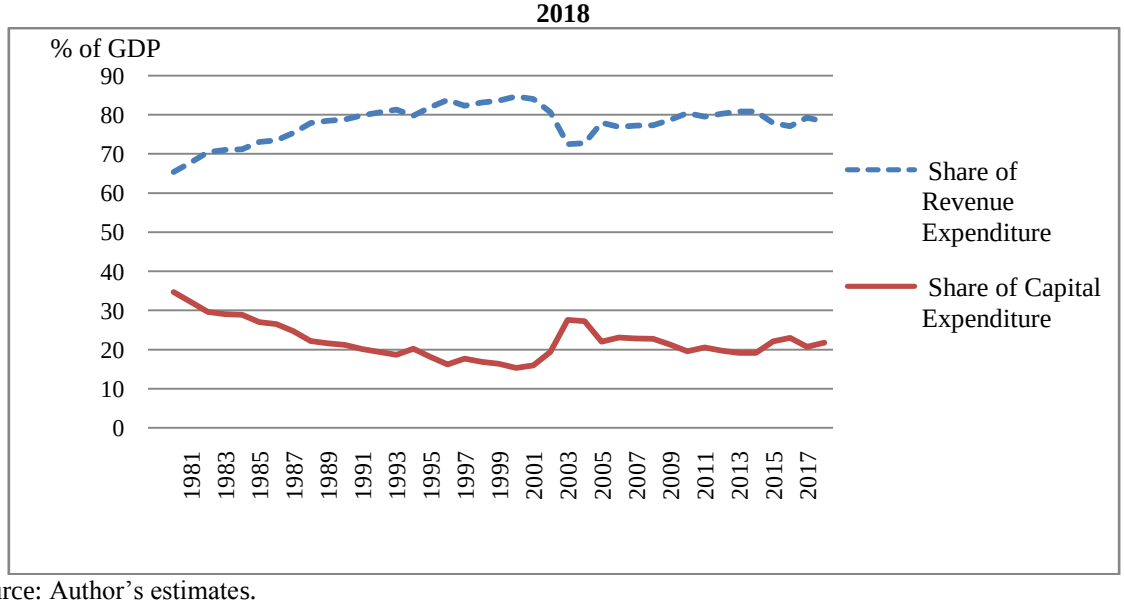
The relatively large economic development burden the Indian government had to undertake in order to build the Indian economy in the decades following Independence had clearly put pressure on the budget. The aggregate expenditure of state governments has witnessed an overall increase from 10.66 to 19.01 per cent of GDP between 1974 and 2018. See Figure 1 below.

Figure 1: Aggregate Disbursements of the State Governments in India, 1974-2018



Source: RBI Handbook of Statistics, 2018.

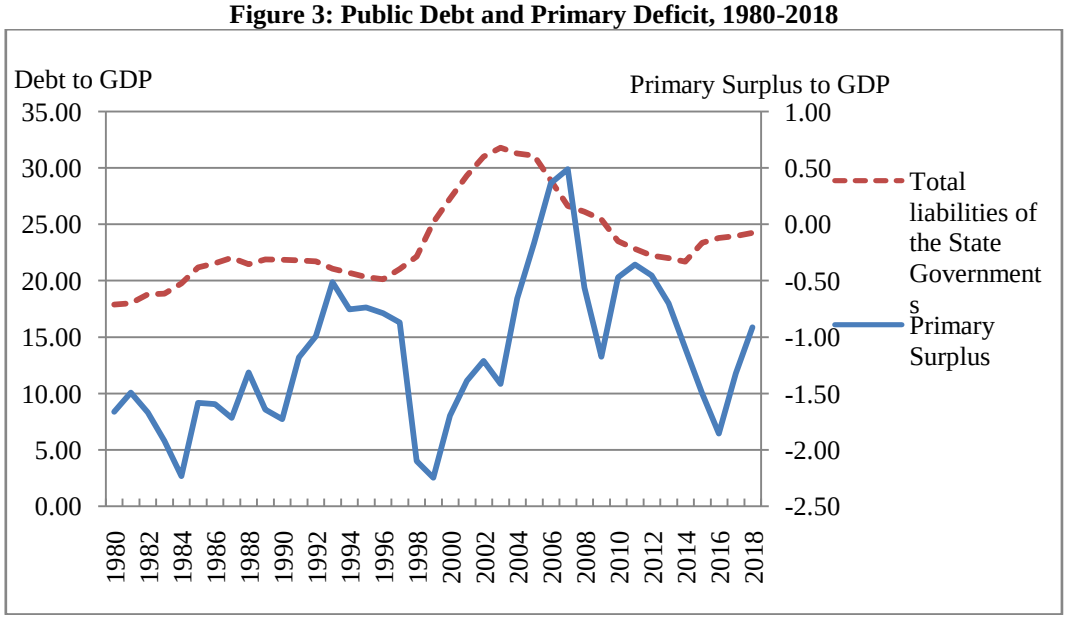
Figure 2: Shares of Revenue and Capital Expenditure in Total Expenditure of State Governments, 1980-2018



Source: Author's estimates.

The Shares of revenue and capital expenditure in the total expenditure of state governments is depicted in Figure 2. The share of revenue expenditure is worrisome, as it grew from 65 per cent of the total expenditure in 1980 to cross the 80 per cent level in 1992. In 2018 the share of revenue expenditure stood at 78 per cent. The small share of capital expenditure, 22 per cent, reflects low tendency towards productive investments that plays a significant role in increasing government revenue which in turn reduces the budget deficit. In addition productive expenditure is crucial to raise national income and therefore helps in reducing the public debt to GDP ratio.

Figure 3: Public Debt and Primary Deficit, 1980-2018



Source: RBI Handbook of Statistics, 2018.

As for public debt and primary surplus, both variables have experienced volatility in the past 39 years. Public debt to GDP and primary surplus to GDP ratios of the state governments are depicted in Figure 3 over the period 1980-2018. Public debt appears to have an overall growing trend since 1980. The public debt of state governments grew from 17.9 per cent in 1980 to a peak of 31.79 per cent in 2003. However after the enactment of Fiscal Responsibility Legislations (FRL), the debt position of state government had improved and he debt to GDP ratio declined to 21.69 in 2014. But after that, debt ratio started to rise again reaching 24.25 per cent of GDP in 2018. Primary surplus, on the other hand, was fluctuating between 1980 and 2018. The primary balance of state governments was in deficit throughout the whole period except for two consecutive years (2006 and 2007). Between 2011 and 2016, primary balance declined from -0.36 to -1.86 per cent of GDP before increasing slightly to -0.91 in 2018.

IV. Data and Methodology

The data for this paper are annual data collected from the RBI Handbook of Statistics. The study covers the period 1980 to 2018. Longer time series could not be obtained for the debt to GDP ratio. The term public debt refers to the total liabilities of the state governments. Primary surplus is the difference between government revenue and government expenditure (excluding interest payment).

Since the data used are times series data, a test for stationarity is performed first. The unit root test applied here is the Augmented Dickey-Fuller test, through which the order of integration of public debt and primary surplus is determined. If both variables are integrated of the same level, we can proceed to test whether the two variables are cointegrated using Johansen cointegration method. If the two variables are proved to have a cointegration relationship, then an error correction model will be estimated which incorporates the long-run as well as the short-run relationships debt and primary surplus have. After that, an Impulse Response Function (IRF) is run to measure the potential impact of a shock to public debt on primary surplus.

V. Estimation and Results

Before estimating whether primary surplus and public debt have a long-term cointegration relationship, it is important to confirm the level of integration of the two time series. If both the variables are I(1) (integrated of order 1), the next step is running a cointegration test.

Unit Root Test

Both the primary surplus (*ps*) and public debt (*pd*) were tested for unit root using Augmented Dickey-Fuller test. As for the ADF regression, two specification are adopted here, namely with constant only, and with constant and trend. The results are shown in table 1.

Table 1: Augmented Dickey-Fuller Unit Root Test for the State Governments In India, 1980-2018

Variable	Level		First Difference	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept
pd	-2.6149* [0.0993]	-2.9334 [0.1646]	-3.50451** [0.0141]	-3.54172* [0.0512]
ps	-2.82554* [0.0644]	-3.2992* [0.0821]	-4.89503*** [0.0003]	-4.83944*** [0.0021]

Note:
Asterisks (***, **,*) indicate significance at 1%, 5%, and 10% levels respectively. Probability values are in brackets. Mackinnon (1996) one-sided p-values. Lag length: Akaike Info Criterion.

At levels, public debt is stationary at 10 per cent level of significance only when testing for a drift, but not stationary when testing for a drift and trend. After taking the first difference, *pd* becomes stationary at 5 per cent level of significance considering only a drift. When testing for unit root, assuming a drift and trend, *pd* is stationary at 10 per cent level the 5 per cent, however the computed statistical value was (-3.54172) which seems to be a borderline value as the 5% critical value for the ADF test, with a drift and trend, is (-3.55297).

On the other hand, primary surplus is stationary at levels only at 10 per cent level of significance, and after first differencing it becomes stationary at 1 per cent level of significance when applying the ADF test with a drift and trend.

From above, *pd* and *ps* appear to show stationarity characteristics at levels at 10% level of significance. Giving the low power of unit root tests with small sample size, it is better to be conservative and consider both the variables to be difference stationary or I(1). It is worth noting that when testing for unit root using Phillips-Perron test, both variables are not stationary at levels, but are stationary after taking first difference.

Cointegration Test

Since primary surplus and public debt are I(1), the next step is to test the existence of a long-run relationship between the two. But first, the appropriate lag length should be determined. For that two VAR models are estimated. According to the following information criteria: Akaike information criterion, Schwarz information criterion, and Hannan-Quinn information criterion, the lag length selected was 2 (Table 2).

Table 2: Lag Length According AIC, SC, and HQ, 1980-2018

Lag	AIC	SC	HQ
0	7.401781	7.489754	7.432486
1	3.384725	3.648645	3.47684
2	3.204224*	3.644090*	357749*
3	3.294697	3.91051	3.509632

* indicates lag selected by the criterion.

The cointegration results between public debt and primary surplus are reported in Table (3). The test is implemented assuming no trend in the cointegration equation and no constant in the VAR.

Table 3: Johansen Cointegration Test on Public Debt and Primary Surplus of the State Governments In India, 1980-2018

Null Hypothesis	Trace Statistic	5% Critical Value	10% Critical Value	Prob.
None	19.60961*	20.26184	17.98038	0.0613
At most 1	4.497901	9.164546	7.556722	0.343
	Max-Eigen Value			
None	15.11171*	15.8921	13.9059	0.066
At most 1	4.497901	9.164546	7.556722	0.343

Asterisks (***, **,*) indicate significance at 1%, 5%, and 10% levels respectively. The null hypothesis refers to the hypothesized number of cointegration equations. MacKinnon-Haug-Michelis (1999) p-values.

At 5 per cent level of significance the null hypothesis of no of cointegration between primary balance and public debt could not be rejected because Trace statistics and Max-Eigen values are smaller that the critical values. However, at 10 per cent level, the null hypothesis of no cointegration equation between public debt and

primary surplus was rejected since the Trace statistic (19.60961) is greater than the 10 per cent critical value (17.98038). Max-Eigen value is also significant only at 10 per cent level. Therefore, the null hypothesis of no cointegration relationships between *pd* and *ps* is rejected at 10 per cent level. Hence public debt and primary surplus of the state governments in India are cointegrated.

Since public debt and primary surplus are cointegrated, Vector Error Correction model (VECM) is estimated. It captures the long-run and the short-run dynamics between public debt and primary surplus. A dummy variable that represents the 1991 financial crises in India is included as an exogenous variable. The dummy variables take the values (0) for the years leading to, and including, 1991, and from 1992 the dummy variable takes the values (1). The VECM results are shown in equation (5).

$$d(ps) = \underset{(0.17944)}{-0.9331*ECT_{t-1}} + \underset{(0.133853)}{0.4411*d(ps_{t-1})} - \underset{(0.089243)}{0.287*d(pd_{t-1})} + \underset{(0.104284)}{0.4456*dum\_91} \quad (5)$$

In equation 5 the coefficient of the error correction term is significant and negative (-0.9331) indicating the existence of a long-run relationship between public debt and primary surplus in the state governments in India. The error correction term reflects the speed of adjustments when there are short term deviations from the long-run equilibrium. On the other hand, the coefficients of $d(ps_{t-1})$ and $d(pd_{t-1})$ represent the short-run relationship between these two variables and the dependent variables $d(ps_t)$. The differenced public debt in the period *(t-1)* appear to have a significant, but negative relationship with *d(ps).* It indicates that in the short-run, an increase in public to GDP ratio is associated with a decline in the primary surplus in the short-run. In other words, primary surplus does not seem to increase in response to increases in public debt in the short-run. The positive and significant dummy variable implies that the state governments have increased their primary surplus after the liberalization, globalization, and privatization in 1991. Wald test showed that there is a causality running from public debt to primary surplus, but not the other way around. In other words, public debt granger causes primary surplus, but primary surplus does not granger cause public debt.

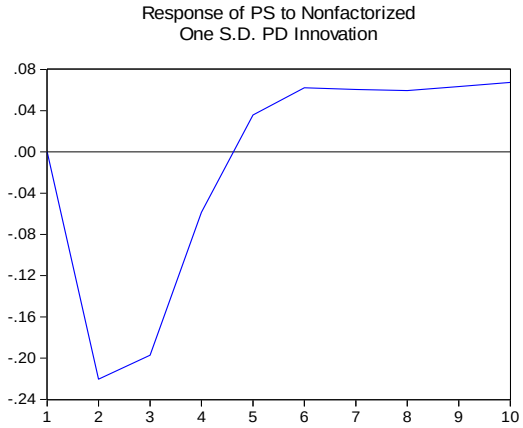
Table 4: VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: d(ps)			
Excluded	Chi-sq	df	Prob.
d(pd)	10.34075	1	0.0013
All	10.34075	1	0.0013

Dependent variable: d(pd)			
Excluded	Chi-sq	df	Prob.
d(ps)	0.438313	1	0.5079
All	0.438313	1	0.5079

Impulse Response Functions (IRFs) can be used to illustrate how shocks to the i^{th} variable spread across time to other variables. Eviews can generate impulse response function from the VECM system we estimated. The IRF can help explain how shocks to public debt to GDP ratio of state governments can affect primary surplus levels. Figure 4 illustrates that a one standard deviation (S.D) shock to public debt to GDP ratio causes a sharp decline in primary surplus in the first period. After that, *ps* gradually increases. Variance decomposition shows that by the 10^{th} year around 80 per cent of variations in primary surplus are explained by public debt.

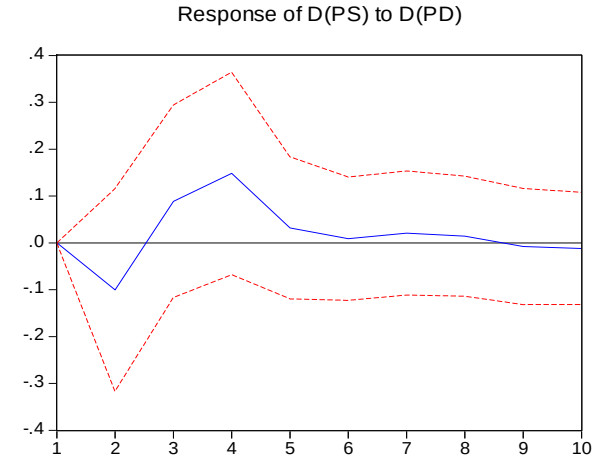
Figure 4: Impulse Response Function - VECM Model



Source: Author's estimation.

The Impulse Response Function generated based on the VECM system in Eviews is point estimate, so in order to quantify the uncertainty in the IRF and introduce confidence bands an Impulse Response Function was generated based on a VAR system in which public debt and primary surplus are in first difference form, since they are I(1). The optimal lag length was 3 lags according to AIC and HQ, and 1 lag according to SC. The order of lags selected is 3. The VAR is stable as all the roots lie inside the unit circle. The residuals were normally distributed according to Jarque-Bera test, and the null hypothesis of the LM serial autocorrelation test could not be rejected, up to 12 lags, at 5 per cent level of significance. A dummy variable for the year 1991 was not included because it did not affect the outcome of the VAR. The results of the IRF generated based the VAR system is depicted in Figure 5. Monte Carlo method was used to generate the standard errors with 10,000 repetitions.

Figure 5: Impulse Response Function - VAR



Source: Author's estimation.

From Figure 5 it can be seen that a one standard deviation shock to public debt causes primary surplus to decline in the first year. However *d(ps)* picks up and increase reaching a peak by the end of the third year. After that the upward trend in primary surplus is reversed and dies out and converges to zero after the 8th year.

VI. Policy Suggestions and Conclusion

Primary balance of state governments in India appears to respond to changes in public debt. The adjustment is negative in the first year, but in the medium term, primary surplus increases. That indicates that the fiscal policy of state government is robust. However, according to the Reserve Bank of India, the total

liabilities of state governments have grown at double-digit rate between 2015 and 2018. In addition, the guarantees provided by state governments to State Public Sector Enterprises (SPSEs) can negatively impact the debt position of state governments especially the states which are experiencing fiscal stress. .Empirical evidence shows that beyond certain levels primary balance response to increases in public debt starts to decline (Ghosh et al, 2013), therefore it is important to limit off-budget liabilities and insure public debt to GDP ratio does not increase to levels beyond which state governments are unable to adjust their primary balance sufficiently.

VII. Conclusion

Primary Surplus and Public Debt to GDP of the states in India were tested for unit root and found to be non-stationary at levels. The Johansen cointegration test revealed that *ps* and *pd* are cointegrated at 10 per cent level of significance, but not at 5 per cent level. After that a VEC model was estimated to shed light on the long-run and short-run relationships between primary surplus and public debt of the Indian states. The state governments' primary surplus appears to have a long-run relationship with public debt to GDP ratio. In the short-run, however, an increase in the lagged differenced public debt has a negative effect on differenced primary surplus, indicating a negative relationship between primary surplus and public debt. That can also be seen in the impulse response function, in which a one-standard deviation shock to public debt to GDP triggers a downward shift in primary surplus in the following year. Nonetheless, primary surplus reverse the downward trend and starts to increase in the second and third years after the shock, before the effect of the shock on primary surplus begins to diminish in the fourth and fifth years. Therefore it can concluded that in the short-run, public debt has a negative effect on primary surplus; however since they have a long-term relationship, the state governments run a prudent fiscal policy as primary surplus to GDP eventually returns to its long-run equilibrium with public debt to GDP. But it is important to note that the cointegration exists between public debt and primary surplus only at 10 per cent level of significance and not at 5 per cent level. Also, giving the overall growing trend of public debt to GDP ratio of state governments since the 1980s, policy makers should be cautious when drawing future fiscal policies since larger debt burden could put unfavourable pressure on the budget and drain public revenue of state governments.

Appendix

Variance Decomposition of Primary Surplus of State Governments

Period	Period	S.E.	PS	PD
1	1	0.340839	100	0
2	2	0.496338	89.29528	10.70472
3	3	0.53223	83.24428	16.75572
4	4	0.534089	82.70859	17.29141
5	5	0.537025	82.65626	17.34374
6	6	0.540991	82.19263	17.80737
7	7	0.54465	81.75889	18.24111
8	8	0.54866	81.3851	18.6149
9	9	0.553424	80.99403	19.00597
10	10	0.558707	80.56162	19.43838

Cholesky Ordering: PS PD

VECM Estimation Results Public Debt and Primary Surplus, 1980-2018

Variables	Coefficient	Std. Error	t-Statistic	Prob.
ECT_{t-1}	-0.933104	0.17944	-5.200097	0.0000
$d(ps_{t-1})$	0.441051	0.133853	3.29505	0.0024
$d(pd_{t-1})$	-0.286979	0.089243	-3.215704	0.0029
dum_91	0.445631	0.104284	4.273269	0.0002
Determinant residual covariance	0.103612			
R-squared	0.497366	Mean dependent var		0.015676
Adjusted R-squared	0.451672	S.D. dependent var		0.460287
S.E. of regression	0.340839	Sum squared resid		3.833641
Durbin-Watson stat	2.288991			

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