Impact of Public Debt on Economic Growth: Evidence from Indian States

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Abstract

This study examines the impact of public debt on economic growth by taking other control variables like institutional credit and commercial electricity consumption. It uses panel data of 14 major (non-special category) States in India for the period 1980-81 to 2013-14. After establishing long-run relationship among the variables, panel long-run estimates are drawn using both DOLS and FMOLS methods. Results from both the methods suggest positive and statistically significant impact of all the variables on economic growth. To test causal relationships among the variables, Dumitrescu-Hurlin pairwise causality test is employed. The results indicate existence of bi-directional causality between public debt and economic growth. One way causality is revealed from economic growth to electricity consumption and from economic growth to credit. The policy implication is that, the sub-national governments in India should not think public debt as a burden but expand it for productive spending to reap higher economic growth.

Keywords: Public Debt, Economic Growth, Public Finance, Panel Analysis

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1. Introduction

The impact of public debt on economic growth has remained a key issue in the academia. Over the past decade and especially after the financial crisis in 2008, the level of public debt is expanding in international, national and sub-national level. Heavy dependence on public debt could retard investment and economic growth. The 'debt overhang' hypothesis mentions that if the anticipated external debt of a country is more than it's repayment ability, then the increased cost of servicing debt can impede investment (Krugman, 1988). If a major chunk of foreign capital is used for interest payments, then a meagre amount will remain to finance for investment that could constrain growth. This is regarded as the crowding-out effect of public debt (Diaz-Alejandro, 1981). However, another school of thought states that, if public debt is used in productive activities, then the economy may expand without creating any macroeconomic instability (Burnside and Dollar, 2000). As far as public debt is concerned, broadly it could be divided into types, one is external debt and the other is domestic debt. The two types of debt may have distinct impact on economic growth. The rationale behind dependence on domestic debt is that it saves the home country from the adverse external shocks and foreign exchange risk, and helps in the progress of domestic financial markets (Barajas and Salazar, 1999, 2000). But, Beaugrand et al. (2002) are of the view that the cost of domestic debt is more than the cost of external debt.

Most of the recent literature on public debt and growth nexus centered on non-linear (inverted U-shape) relationship between the two and estimation of the threshold limit of public debt share to GDP (See Smyth and Hsing, 1995; Blavvy, 2006; Reinhart and Rogoff, 2010; Reinhart et al., 2012; Kumar and Woo, 2010; Cecchetti et al., 2011; Checherita-Westphal and Rother, 2012; Furceri and Zdzienicka, 2012; Herndon et al., 2013; Chen et al., 2016). However, for a developing country like India and its underdeveloped states, our hunch is that the optimum level of public debt has not yet been reached. The average public debt to gross domestic product ratio across the major 14 states for different periods from 1980-81 to 2013-14, varies from 19.1% to 35.3%. Therefore, a positive relationship between public debt and economic growth is expected.

Earlier studies mainly focused on the impact of external debt in economic growth and therefore neglected the role of domestic debt. Further, the analysis is limited to cross-country analysis or time series analysis. Hence, this study will explore on the impact of domestic debt on economic growth along with other control variables by using a panel data set of 14 major states in India.

The present study tries to assess the impact of public debt on economic growth using a production function approach where other relevant inputs like credit and electricity are also taken as explanatory variables. Inclusion of the other relevant variables also helps in removing omitted variable bias. Using Dynamic OLS (DOLS) and Fully Modified OLS (FMOLS) the study gets positive and statistically significant impact of public debt, institutional credit and commercial electricity consumption on economic growth. For causality analysis Dumitrescu-Hurlin panel causality test is also employed.

The remainder of this study is as follows. Section 2 gives a brief overview of literature. Section 3 outlines the theoretical framework and data used in the study. Econometric methodology applied in the analysis is presented in Section 4. Section 5 outlines the results and finally section 6 provides the conclusion and policy implication of the study.

2. Brief overview of Literature

2.1. Public Debt and Economic Growth

Recent studies dealing with nexus between external debt and growth found that, the relationship between the two could be non-linear (inverted-U type shape). This means there could be threshold limit up to which debt can induce growth and thereafter higher debt can reduce growth. The threshold limit of external debt is estimated to be 38.4 percent of GDP by Smyth and Hsing (1995); 21 percent by Blavvy (2006); 85 percent by Cecchetti et al. (2011); 90-100 percent by Checherita-Westphal and Rother (2012); and 90 percent by Chen et al. (2016). On the other hand the study by Reinhart and Rogoff (2010) concludes that in advanced and emerging market economies (EMEs), debt to GDP ratio of about 90 percent is growth reducing. If the ratio is below 60 percent then it can retard economic growth in only EMEs. Subsequently, Herndon et al. (2013) try to replicate the study by Reinhart and Rogoff (2010). By making some correction they find that the relationship between debt ratio and economic growth is similar in the two situations. So far as causality between public debt and economic growth is concerned, Panizza and Presbitero (2014) do not find any causality between the two, whereas Puente-Ajovín and Sanso-Navarro get bi-directional causality between public debt and economic growth. Lof and Malinen (2014) get support of one way causality from growth to debt.

2.2.Credit and Economic Growth

It is well known that financial deepening results in higher growth through different channels like more credit with financial liberalization promotes investment and innovation resulting in more efficient investment and thereby growth. In the literature various studies are done to explore the relationship between financial development and economic growth.[3] One strand of studies including Goldsmith (1969), focuses to measure the strength of the relationship between the financial development and economic performance. Others try to identify the channels through which the two are related. Pioneering work of McKinnon (1973) and Shaw (1973) reflects that financial liberalization positively affects saving and therefore more investment culminating in higher economic growth. Later on various papers using the endogenous growth models take financial development as a physical capital generating technological progress and increasing the efficiency in investment (See Bencivenga and Smith, 1991; Greenwood and Jovanovic, 1990). But not all economists are convinced with the role of credit in generating growth. Robinson (1952) states that 'where enterprise leads, finance follows' which means economic growth creates the condition of financial arrangement and thereby financial development. Lucas (1988) is of the view that the role of financial development in growth is 'over stressed'.

Early papers find a positive relationship between financial development and economic growth using cross-country analysis (See King and Levine, 1993; Demirguc-Kunt and Maksimovic, 1996; Levine and Zervos, 1998; among others). But these studies do not deal with causality analysis and do not pays any attention to time series properties of the data. Ram (1999) gets evidence of weak negative relationship between financial development and economic growth and opines that cross-country studies have various limitations like heterogeneity issue in slope coefficients of various countries. Moreover, the results based on these type of analysis is sensitive to the sample of countries, computation method, frequency of data, functional form of the relationship etc. So the reliability of cross-country analysis is questioned by Khan and Senhadji (2003), Chua and Thai (2004), and Hassan et al. (2011) etc. Most of the time series studies get evidence of causality between credit and economic growth with no consensus on the direction of causality (See Demetriades and Hussein, 1996;; Luintel and Khan, 1999; Bell & Rousseau, 2001; Calderon and Liu, 2003; Bhattacharya and Sivasubramanian, 2003 and Liang and Teng, 2006 among others).

[3] See Levine for a detailed survey on financial development-growth nexus.

Few studies get no evidence of causality between the two (see Eng and Habibullah, 2011 and Mukhopadhyay et al., 2011).

To overcome the limitations of time series and cross-section analysis, various studies use panel data to assess the nexus between the financial development and economic growth (See Levine et al., 2000; Christopoulos and Tsionas, 2004; Beck and Levine, 2004; Hassan et al., 2011, Gaffeo and Garalova, 2014. etc.). Recent study by Kar et al. (2011) could not get any clear cut relationship between financial development and growth as the results are country specific in Middle East and North African (MENA) countries. However, two studies by Arestis et al. (2014) and Valickova et al. (2014) find evidence of positive relationship between financial development and economic growth by employing meta-analysis.

2.3.Electricity Consumption and Economic Growth

In the production process of an economy energy plays an important role. Among various energy variables electricity is most flexible form and a key infrastructural input for development. There are a number of studies exploring the relationship between consumption of electricity and economic growth. In studying the relationship between the two, the prime focus was on the causality issue since the publication of Kraft and Kraft (1978). The causality analysis is important in making policy decision because if unidirectional causality is found from growth to electricity consumption, then conservation policies can be implemented without hurting economic growth. In contrast to this if unidirectional causality runs from electricity consumption to growth, then any strategy to reduce electricity consumption may reduce growth. The causality from growth to electricity could be justified on the ground that demand for electricity will increase with upsurge in population, rapid urbanization and industrialization, and rise in standard of living. Similarly, the causality from consumption to electricity could be thought up as electricity is a major infrastructure and an input for production. Causality from economic growth to electricity is supported by many studies (see Kraft and Kraft, 1978; Ghosh, 2002; Narayan and Smyth, 2005; Mozumder and Marathe, 2007; and Jamil and Ahmad, 2010; Ciarreta and Zarraga, 2010; and Shahbaz and Feridun, 2012 etc.). On the other hand, the reverse causality from electricity consumption to growth is revealed by other empirical papers (see Hsiao, 1981; Stern, 1993; Aqeel and Butt, 2001; Shiu and Lam, 2004; Altinay and Karagol, 2005; Lee and Chang, 2005; Narayan and Singh, 2007; Yuan et al., 2007; Tang, 2008, Odhiambo, 2009; and Chandran et al., 2010 etc.). Some other find bidirectional causality between electricity consumption and growth (See Yang, 2000; Jumbe, 2004; Zachariadis and Pashourtidou, 2007; Lean and Smyth, 2010; Tang et al., 2013; Osman et al., 2016 among others). Some studies report no causality between the two (e.g. Ozturk and Acaravci, 2011; Yoo and Kwak, 2010; and Wolde-Rufael, 2006; etc.). Thus, the relationship between electricity consumption and economic growth is ambiguous.

3. Theoretical Framework and Data

In the growth literature, various schools of thoughts propose distinct relationships between public debt and economic growth. In the Classical sense, Ricardian Equivalence states that if a government borrows today, then, it has to repay this borrowing, in future by raising taxes above the normal level and the impact of debt on growth will be neutralized (Ricardo, 1817). In the Keynesian framework, foreign aid or foreign investment is required to fill the saving-investment gap (Todaro and Smith, 2003). Solow (1957) maintained that in the short-run fiscal policy can have some impact on level of per-capita income but in the long-run the impact is neutral. In a neo-classical set up Diamond (1965) formally brought the public debt as a variable explaining growth. He opines that internal debt reduces the available capital stock due to substitution of public debt for physical capital. As per the endogenous growth models, both fiscal and monetary policies play a crucial part in determining potential economic growth. Public debt can result in technical progress and thereby can influence growth (Villanueva, 1972). But Saint-Paul (1992) using the endogenous growth caveat states that higher debt is always associated with lower growth. The recently developed new growth theories explore the relationship of public debt and growth nexus by bringing utilization and governance aspects of public debt (See Zak and Knack, 2001 and Acemoglu and Robinson, 2006).

As per our objective, the study relies on recently developed panel data analysis as it has many advantages over the pure cross-sectional or time-series analysis as noted by Osman et al. (2016). The study employs annual data for the period 1980-81 to 2013-14 for 14 major non-special category states in India. The key variables in the study include Gross State Domestic Product (GSDP) proxy used for real income, real public debt, real institutional credit to private sector, and commercial consumption of electricity (in Gigawatt). All the variables are transformed into natural logarithms prior to estimation and respectively denoted as LRY, LRD, LRC, and LCCE. As State wise data on private investment is not available for India, commercial bank credit to private sector is taken as a proxy for private investment. Nominal values of public debt and credit to private sector by commercial banks are deflated by the GSDP deflators of the respective states to obtain real values of the concerned variable. All variables except electricity are in Rs. crore at 2004-05 prices. Real GSDP data is collected from National Account Statistics published by Central Statistical Organization. Public debt and Credit variables are collected from State Finance: A Study of Budgets, published by the Reserve Bank of India and electricity data is taken from EPWRF and indiastat database. Institutional credit to private sector is a proxy for financial development and electricity consumption is a proxy for energy use.

Table 1. Descriptive Statistics

	LRY	LRD	LRC	LCCE
Cross-section	14	14	14	14
Time Series	34	34	34	34
Observation	476	476	476	476
Mean	11.57	10.12	10.12	6.72
Median	11.53	10.05	9.97	6.70
Maximum	13.71	11.86	13.89	9.55
Minimum	10.04	8.22	7.58	3.86
Std. Dev.	0.74	0.80	1.18	1.15
Skewness	0.32	0.13	0.59	-0.02
Kurtosis	2.49	2.25	3.07	2.46

Note: Variables are in Natural Log.

Table 2. Correlation Matrix

	LYR	LRD	LRC	LCCE
LYR	1.000			

LRD	0.895	1.000		
	43.680	-----		
	0.000	-----		
LRC	0.953	0.816	1.000	
	68.392	30.690	-----	
	0.000	0.000	-----	
LCCE	0.915	0.801	0.905	1.000
	49.219	29.107	46.236	-----

	0.000	0.000	0.000	-----

Note: Figures are correlation, t-statistics and prob. respectively.

Table 1 depicts the descriptive statistics of all the logarithmic transformed variables. The standard deviation of all the variables are revealing that the data of all the series are dispersed around the mean. It permits us to move forward and use the data for further estimation.

Table 2 presents the correlation matrix. The correlation coefficient between all variables are very high and they are intertwined which provides us the clue to estimate their relationship.

4. Econometric Methodology:

4.1.The Model

Following, a neo-classical production function framework, the functional form of the proposed Model can be written as follows,

$$LRY = f(LRD, LRC, LCCE) \qquad (1)$$

Where, LRY = log of real GSDP,

LRD = log of real debt,

LRC = log of real credit and

LCCE = log of commercial consumption of electricity.

The Model can be written as:

$$LRY_{it} = \beta_0 + \beta_1 LRD_{it} + \beta_2 LRC_{it} + \beta_3 LCCE_{it} + \varepsilon_{it} \qquad (2)$$

Where, $\varepsilon_{it} = \mu_i + \vartheta_{it}$,

$\mu_i \sim (0, \sigma_\mu^2)$ and $\vartheta_{it} \sim (0, \sigma_\vartheta^2)$ are assumed to be independent of each other and among themselves. μ_i and ϑ_{it} signify country specific fixed effects and time variants effects, respectively. The subscripts i and t denote state $(i = 1 \ldots 14)$ and time period considered$(t = 1980/81 \ldots \ldots 2013/14)$, respectively.

The coefficients β_1, β_2 *and* β_3 are the long-run elasticity estimates of gross income with respect to public debt, credit, commercial electricity consumption, respectively. The coefficient of all the explanatory variables are expected to be positive.

Any inference done on regression analysis by applying non-stationary series could lead to spurious regression. Therefore, unit-root testing and co-integration analysis are useful tools for empirical analysis. If a linear combination of two or more non-stationary series is stationary, then long-run cointegration relationship can be established among the variables. Testing for unit-roots and cointegration in panel data is helpful in establishing relationships among variables. Maddala and Wu (1999) mention that testing unit-root and cointegration in panel data increases the power of the test as compared to the respective tests done in Time series data. This paper uses four steps in its analysis: 1. Check for stationary properties of the data using panel unit root test; 2. if the series are stationary then test for the cointegration relationship, 3. in case the series are cointegrated, FMOLS and DOLS Methods are applied to measure the elasticity of income with respect to public debt, credit, and electricity consumption. 4. Causality analysis using Dumitrescu-Hurlin procedure.

4.2.Panel Unit Root Test:

Panel unit-root test can be done with two types of specification, one with a common or homogeneous unit-root process and the other with an individual or heterogeneous unit-root process. The former specification can be implemented by Levin, Li and Chu (2002) (LLC), Breitung (2000), and Hadri (1998) panel unit root tests, while the latter specification can be fulfilled by Im, Pesaran and Shin (2003) (IPS), Fisher-ADF and Fisher-PP panel unit root tests (Maddala and Wu, 1999). This paper employs four methods of panel unit root tests that are LLC, Breitung, IPS and Fisher-PP Test i.e. two tests from each categories.

The ADF specification of LLC panel unit root test is given below.

$$\Delta Y_{i,t} = \alpha_i + \rho Y_{i,t-1} + \sum_{k=1}^{n} \varphi_k \Delta Y_{i,t-k} + \delta_i t + \emptyset_t + u_{it} \qquad (3)$$

This form allows two-way fixed effects i.e. the intercept varies over state as well as time period, captured by α_i and $\emptyset_t$ respectively. These two coefficients are basically $(i-1)$ state dummies and $(t-1)$ time dummies, respectively. The coefficient of lagged Y_i is constrained to be homogeneous across all units of the panel. The null hypothesis H_0 and alternative hypothesis H_1 are H_0: $\rho = 0$ and H_1: $\rho < 0$.

In making the relevant standardization, Breitung (2000) method is different from LLC in two counts. Firstly, it removes the autoregressive portion but not the deterministic portion of the ADF equation. Secondly, the proxies for standardization are transformed and de-trended. He considers the following form to estimate the panel unit root test.

$$Y_{it} = \alpha_{it} + \sum_{k=1}^{n+1} \beta_{ik} X_{i,t-k} + u_t \qquad (4)$$

With $H_0: \sum_{k=1}^{n+1} \beta_{ik} - 1 = 0$ (non-stationary) and $H_1: \sum_{k=1}^{n+1} \beta_{ik} - 1 < 0$ (stationary) for all i.

IPS (Im, Pesaran and Shin 2003) test allows heterogeneity on the coefficient of the lagged Y_i variable by extending the work of LLC. The IPS procedure of testing panel unit root is based on the following model.

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \sum_{k=1}^{n} \varphi_k \Delta Y_{i,t-k} + \delta_i t + \emptyset_t + u_{it} \qquad (5)$$

With $H_0: \rho_i = 0$ for all i and $H_1: \rho_i < 0$ for at least one i. The t-statistic, applicable for a balanced panel can be obtained by $t = 1/N \sum_{t=1}^{N} t_{\rho i}$. Here, $t_{\rho i}$ denotes an individual ADF t-statistic to test $H_0: \rho_i = 0$ for all i.

Another alternative method of panel unit root tests applies Fisher's (1932) results to develop tests which combine the p-values from individual unit root tests. This Method is suggested by Maddala and Wu, and by Choi.

If π_i is defined as the p-value from any individual unit root test for cross-section i, then under the null of unit root for all N cross section, the asymptotic result would be,

$$-2 \sum_{i=1}^{N} \log(\pi_i) \rightarrow \chi^2_{2N} \qquad (6)$$

In the present paper we have reported the asymptotic χ^2 statistics using Phillips-Perron individual unit root tests. Choi's result of standard normal statistics are not reported due to similarity of results. The null and alternative hypothesis for the Fisher-PP test are same as the IPS test.

The tests are done with model with intercept for all tests except the Breitung test. AIC criteria is followed to select lag length. Bandwidth is selected by taking Newey-West method using Barlett-Kernel spectral technique.

4.3.*Panel co-integration Test:*

Two varieties of co-integration test is done by following Pedroni (1999, 2004) and Kao (1999). Pedroni considers the following regression:

$$Y_{it} = \alpha_i + \delta_i t + \rho Y_{i,t-1} + \sum_{m=1}^{M} \beta_{mi} X_{mi,t} + \varepsilon_{it} \qquad (7)$$

In this model the X and Y are assumed to be stationary at first difference or $I(1)$. Pedroni test is a residual based test where the residual obtained from equation (6) is tested for stationarity by estimating the following auxiliary regression:

$$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + u_{it} \qquad (8)$$

Or, $$\varepsilon_{it} = \rho_i \varepsilon_{i,t-1} + \sum_{j=1}^{\rho_i} \omega_{ij} \Delta\varepsilon_{i,t-j} + v_{it} \qquad (9)$$

for each cross-section.

Co-integration statistics given by Pedroni is divided into two categories. The first category consists of Panel v-statistic, Panel rho-statistic, Panel PP-statistics, Panel ADF-statistics which are based on pooling along the 'with-in' dimension. It is done by pooling the autoregressive coefficients across the different sections of the panel for the unit-root test on the residuals. The second category is formed by Group rho-statistic, Group PP-statistic, Group ADF-statistic which are based on pooling the 'between' dimension. It is done by averaging the autoregressive coefficients for each member of the panel for the unit-root test of the residuals. The Kao cointegration test is also a residual based test. It distinguishes from the Pedroni test in specifying cross-section specific intercepts and homogeneous coefficients on the panel regressors.

4.4.Estimation of Panel Co-integration

Once a cointegrating relationship between the variables is established, it is useful to estimate the long-run parameters. In the presence of cointegration, OLS estimates give spurious coefficients. Therefore a number of alternative estimators are proposed such as DOLS and FMOLS among others. The major weakness of DOLS estimator is that it does not take care of the cross-sectional heterogeneity issue. Therefore, Pedroni (2000) suggested to use the FMOLS estimator that deals with the cross sectional heterogeneity, endogeneity and serial correlation problems. In small samples the FMOLS is believed to give consistent estimates. First we estimated the DOLS estimator and then to check the robustness of the results FMOLS estimator is applied.

Following, Mark and Sul (1999), the study applies a simple weighted DOLS estimator that permits for heterogeneity in the long-run variances. Similarly, feasible pooled (weighted) FMOLS estimator developed by Pedroni (2000) and Kao and Chiang (2000) is used which considers heterogeneous cointegrated panels with differences in long-run variances across cross-sections.

4.5.Dumitrescu-Hurlin causality test:

After getting long-run coefficient of three explanatory variables determining the real income, it is useful to draw information on the causal link between them which can have greater policy implications. Therefore, this study also attempts to explore on the causal link between the variables by applying Dumitrescu-Hurlin test. This test has two advantages over the Granger (1969) causality test in that in addition to the fixed coefficient accounted in Granger causality test, it considers two dimensions of heterogeneity. One for the regression model used to test Granger causality and the other is heterogeneity in the causal relationship. The detailed derivation of the Dumitrescu-Hurlin test can be found in Dumitrescu and Hurlin (2012).

5. Results and Implications

5.1. Panel Unit Root Test:

The empirical analysis starts with the testing of panel unit root in log-levels of real income, real public debt, real credit and electricity consumption by following four varieties of panel unit root tests viz. LLC, Breitung, IPS and Fisher-PP panel unit root test.

Table 3. Panel Unit Root Test

Variable		LLC (t-statistics)	Breitung (t-statistics)	IPS (W-Statistics)	Fisher-PP (Chi-square Statistics)
Levels	LRY	7.7235	2.9181	11.6800	0.0736
	LRD	-2.2760**	1.0919	1.7309	19.4651

	LRC	4.4096	1.6611	9.0721	0.4573
	LCCE	2.4438	3.6317	5.6921	20.6416
First Differences					
	LRY	-14.0529*	-3.3658*	-14.2520*	344.643*
	LRD	-6.8155*	- 7.2473*	-7.5748*	137.297*
	LRC	-6.0747*	-5.4904*	-5.4913*	186.949*
	LCCE	-16.1223*	-5.2121*	-17.1570*	337.172*

Note. 1. All tests are done on the model with an intercept except the Breitung test which is done for a model of intercept with trend. 2. Lag Lengths are set based on the AIC criterion. 3. For LLC and PP-Fisher test Barlet Spectral Method with Newey-West Bandwidth is applied. 4. * and ** depicts statistical significance at 1% and 5% level, respectively.

The results of panel unit root tests are reported in Table 3. It demonstrates that for the log-level series, the null of non-stationarity in variables could not be rejected for all the variables except the real debt variable. Real debt is found to be stationary in level by only the LLC test, which is refuted by other Panel Unit root tests. First difference of the log-levels variables are found to be stationary at 1 percent level of significance. Thus, the results indicate that the four variables contain a panel unit root in level.

5.2. Panel Co-integration:

As the panel unit root test results reveal that all the variables are difference stationary, we proceed to check the cointegration or long-run association of the variables by using Kao test and Pedroni Test. The model for Kao Test assumes no deterministic trend, while model for Pedroni Test assumes deterministic trend with intercept.[4] Lag length is set by AIC criteria and Barlett spectral estimation procedure is applied with Newey-West automatic bandwidth. Table 4 reveals that both the Kao and Pedroni Test of cointegration suggest long-run relationship among the four variables at 1% level of significance with the exception of group-rho (between dimension) statistic in Pedroni test.

Table 4. Panel Co-integration Tests: Kao Test and Padroni Test

Method		Statistic
Kao Residual Cointegration Test	ADF Stat.	- 6.645*
Pedroni residual cointegration test	Panel v-Statistic	8.151*
	Panel rho-Statistic	-2.410*

[4] We could also reject the null of no cointegration by Panel ADF-test (with-in dimension) and Group ADF statistics (between-dimension) using Pedroni cointegration test with the assumption of no deterministic trend.

Panel PP-Statistic	-6.315*
Panel ADF-Statistic	-6.625*
Group rho-Statistic	-0.223
Group PP-Statistic	-4.881*
Group ADF-Statistic	-6.676*

Note: 1. Trend assumption [Kao: no deterministic trend, Pedroni: Deterministic trend with intercept]; H_0: No Co-integration; 2. Newey–West automatic bandwidth selection and Bartlett kernel. 2. * depicts statistical significance at 1% level.

5.3. Panel Long-run Estimates

After establishing the cointegration relationship among the variables we proceed to estimate the long-run elasticity using DOLS and check the robustness by applying FMOLS method. In the DOLS method one lead and one lag is taken. Trend specification is set with no deterministic trend and the panel option is set as Pooled (weighted) in both the methods. The long-run variance weights are derived by Barlett-kernel method with Newey-west automatic bandwidth and NW automatic lag in both the method.

Table 5 depicts the results from DOLS estimates. It reveals that public debt, institutional credit and electricity consumption are significantly affecting income. The coefficients of explanatory variables are elasticity. The coefficient for public debt in explaining income is found to be 0.33 which can be interpreted as a 1% rise in public debt will increase the income by 0.33%. The positive relationship between the public debt and economic growth could be explained by the fact that, at State level, the threshold limit of debt to GSDP is not yet been reached. The coefficient for credit and electricity variables are found to be 0.34 and 0.07 respectively. It is noticeable that the impact of public debt and institutional credit on income is similar and the impact of electricity consumption is very low. This is due to the fact that the share of electricity consumption to GSDP in each State is quite small.

Table 5. Results from DOLS Estimation (Dependent variable LRY)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRD	0.3306	0.0346	9.5419	0.0000
LRC	0.3390	0.0320	10.6031	0.0000
LCCE	0.0729	0.0198	3.6836	0.0003
R-squared	0.9893		Mean dependent var.	11.5894
Adjusted R-squared	0.9841		S.D. dependent var.	0.7076
S.E. of regression	0.0891		Sum squared resid.	2.3111

Long-run variance	0.0129

Table 6 gives the estimated results obtained from FMOLS estimate. The results fairly resemble with the DOLS Method though the coefficients of various explanatory variables slightly differ. As compared to the DOLS, FMOLS assigns a slightly low coefficient to public debt variable and in turn the coefficients of the credit variable in explaining income has increased. All the explanatory variables are affecting income positively and significantly. In this case also the elasticity of income on commercial electricity consumption is low.

Table 6. Results from FMOLS Estimation (Dependent variable LRY)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LRG	0.2626	0.0097	26.9531	0.0000
LRC	0.3615	0.0115	31.4851	0.0000
LCCE	0.0734	0.0070	10.5364	0.0000

R-squared	0.9805	Mean dependent var	11.5950
Adjusted R-squared	0.9798	S.D. dependent var	0.7331
S.E. of regression	0.1041	Sum squared resid	4.8253
Long-run variance	0.0085		

5.4. Dumitrescu-Hurlin pairwise causality test:

The result of pairwise Dumitrescu-Hurlin panel causality test is reported in Table 7. The result suggests that bi-directional causality exists between public debt and economic growth which is in conformity with Puente-Ajovin and Sanso-Navarro (2015). Only, unidirectional causality is found from economic growth to credit at 10% level of significance. One way causality from economic growth to electricity consumption is also established.

Table 7. Results from Pairwise Dumitrescu-Hurlin Panel Causality Tests

Sample: 1980 2013	Lags: 2		
Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
LRD does not homogeneously cause LRY	3.9778	2.9063	0.0037
LRY does not homogeneously cause LRD	3.8930	2.7708	0.0056
LRC does not homogeneously cause LRY	2.7907	1.0084	0.3133
LRY does not homogeneously cause LRC	3.2070	1.6739	0.0941
LCCE does not homogeneously cause LRY	2.3116	0.2424	0.8085
LRY does not homogeneously cause LCCE	14.4135	19.5908	0.0000
LRC does not homogeneously cause LRD	3.4730	2.0992	0.0358

LRD does not homogeneously cause LRC	8.6022	10.2997	0.0000
LCCE does not homogeneously cause LRD	2.4535	0.4692	0.6389
LRD does not homogeneously cause LCCE	8.6784	10.4216	0.0000
LCCE does not homogeneously cause LRC	3.5864	2.2805	0.0226
LRC does not homogeneously cause LCCE	9.6580	11.9877	0.0000

6. Conclusion and Policy Implication

This study uses panel data of 14 major (non-special category) States in India during the period 1980-81 to 2013-14 to examine the influence of public debt on economic growth by controlling other relevant variables like institutional credit and commercial electricity consumption. After establishing long-run relationship among the variables, DOLS (pooled weighted) Method is applied to derive the elasticity of size of the economy (income) on public debt, credit and consumption of electricity. The study finds that economic growth is significantly and positively affected by public debt and credit. The impact of public debt and institutional credit are high and similar. The influence of electricity consumption is found to be low. To check for robustness, FMOLS (pooled weighted) estimates are also reported which give similar results. Dumitrescu-Hurlin pairwise causality test reveals existence of bi-directional causality between public debt and economic growth. One way causality is revealed from economic growth to electricity consumption and from economic growth to credit.

The analysis reveals that at State level, expansionary debt policy will be helpful for the economy in generating higher economic growth. High economic growth will further increase the provision of institutional credit to private sector and increase the demand for energy consumption for commercial purpose. One can expand the paper by exploring on the composition of public debt and its impact on economic growth.

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