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Public Expenditure and Economic Growth in India: VECM Estimation of the Causal Relationship

T. Lakshmanasamy*

Abstract *The relationship between public expenditure and economic growth is obvious, but the direction of causality is not clear. This paper analyses the relative impact of the different components of public expenditure on economic growth. Specifically, this paper examines whether the level of government expenditure is managed to accelerate economic growth or whether government expenditure is used excessively, which may hurt domestic economy because of increased taxes and/or high government borrowing. The vector error correction method is applied to the annual time series data for India from 1983 to 2020 for testing the long- and short-run causality. The pair-wise Granger causality test indicates one-way causality moving from gross domestic product to total government expenditure, and from gross domestic product to government revenue showing that the growth of the economy leads to an increase in both government revenue and expenditure. The estimated error correction coefficient is significantly negative, indicating that the speed of adjustment between the short-run dynamics and the long-run equilibrium is about 0.03%. The results show a stable long-run relationship between public expenditure and economic growth.*

Keywords *Public Expenditure, Economic Growth, Causal Relationship, Vector Error Correction Model (VECM)*

INTRODUCTION

Public expenditure plays a significant role in the functioning of an economy. The relationship between public expenditure and economic growth is obvious and has been extensively studied, both theoretically and empirically. The theoretical foundation of this relationship can be traced as far back as Wagner (1883) in his famous Wagner's Law. Wagner advanced his 'law of rising public expenditures' by analysing trends in the growth of public expenditure and in the size of the public sector. Wagner's law postulates that: (i) the extension of the functions of the states leads to an increase in public expenditure on administration and regulation of the economy; (ii) the development of modern industrial society would give rise to increasing political pressure for social progress and call for increased allowance for social consideration in the conduct of industry; and (iii) the rise in public expenditure will be more than a proportional increase in the national income, and thus result in a relative expansion of the public sector. Musgrave and Musgrave (1973), in support of Wagner's law, argue that as progressive nations industrialise, the share of the public sector continues to grow in the national economy.

The role of public expenditure in the economy is now well-grounded in the macroeconomic theory after the Keynesian revolution. The macroeconomic theory establishes that credit for public expenditure is not only in the determination of the level of income, but also in its distribution. Keynesian macroeconomics provides a theoretical basis for the developments in public expenditure programmes in developed economies. However, empirical studies on the relationship between government expenditure and economic growth arrive at different and even conflicting results. The direction of causality between public expenditure and economic growth is not always clearly established. Whether public expenditure causes economic growth or whether economic growth necessitates more government expenditure is a moot question. Some studies suggest that an increase in government expenditure on socio-economic and physical infrastructure impacts the long-run growth rate of the economy. For instance, government expenditure on health and education raises the productivity of labour and increases the growth of national output. Similarly, public expenditure on infrastructure such as roads, power, and so on, reduces production costs and increases private sector investment and profitability of firms, thus ensuring economic growth (Barro, 1990; Barro & Salai-i-Martin, 1992). There is also overwhelming evidence that fast-growing economies have heavily expanded their public investments. Some studies even suggest bi-directional causality between government expenditure and economic growth.

The main objective of this paper is to establish the direction of the causal relationship between public expenditure and economic growth. Specifically, this paper aims to analyse

* ICSSR Senior Fellow and Formerly Professor, Department of Econometrics, University of Madras, Chennai, Tamil Nadu, India. Email: tlsamy@yahoo.co.in

whether the level of government expenditure has been properly managed to accelerate economic growth or whether government expenditure has been used excessively, which may hurt domestic economy because of increased taxes and/or high government borrowing. This paper assesses the relative impacts of different components of public expenditure on economic growth. Empirically, this paper examines the relationship and the direction of causality among GDP, total government expenditure, inflation, and total revenue as a percentage of GDP in India. The annual time series data between 1983 and 2020 for India from the World Bank Indicators is used in the empirical analysis. Econometrically, the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for unit root, Granger causality test for the direction of causality, Johansen's cointegration test for cointegration, and vector error correction model (VECM) for testing the long- and short-run relationship between the variables are employed.

REVIEW OF LITERATURE

Adolph Wagner (1911) first developed the law of 'increasing state activity', that there is both an absolute and a relative expansion of the public sector that leads to economic growth at the cost of growth in the private sector. The expanding government accompanies social progress and rising incomes. Following the Great Depression of 1929, the magnum opus of John Maynard Keynes' (1936) *The General Theory of Employment, Interest and Money* has become the driving force for economic policy that has set the scene for the regulation of the economy, setting aside the neoclassical presumption of a liberal market economy and no government intervention in economic functions. Still, the macro growth models in the Keynesian tradition, like the Harrod-Domar model, relegate the role of government in the growth process, for economic growth is entirely dependent on capital formation via aggregate demand or aggregate supply, the determinants of which are exogenous.

Most analysis of long-run economic growth has for long been based on Solow (1956), which predicts that economic growth occurs as a result of exogenous technological change, and that income per capita of countries will converge to a steady-state level. Since it is presumed that all the determinants of growth are exogenous, the government policy cannot affect growth rates, except temporarily during the transition of economies to steady-state growth. Consequently, the significance of the government in the growth process is usually not investigated in standard neoclassical growth models.

In contrast to this, the new growth theories of Romer (1986; 1990), Lucas (1988), Barro (l990), Grossman and Helpmen (1990), and Rebelo (1991) formulate economic growth as endogenous via government spending on human capital formation, infrastructure, research and development, technology, and innovation. Both transition and steady-state growth rates are endogenous, implying that long-run economic growth rate is also endogenous, in which the government plays an active role in the growth process.

Dick Armey (1995), analysing the relationship between economic growth and size of government, finds a non-linear effect of government expenditure on economic growth, an inverse U-shape curve reflecting the law of diminishing returns. Based on the Armey Curve, Vedder and Gallaway (1998) formulate the relationship between economic growth and size of government as:

$$y = \alpha + \beta g - \gamma g^2 + \delta t + \varepsilon \quad (1)$$

Where, y is the output, g is the size of the government, and t represents the time trend. The positive sign on the linear term G is designed to show the beneficial effects of government spending on output, while the negative sign for the squared term means the variable measures any adverse effects associated with increased governmental size. Since the squared term increases in value faster than the linear term, the presence of negative effects from government spending will eventually outweigh the positive effects, producing the downward-sloping portion as output expands over time, for reasons unrelated to government size. With the passage of time, output grows as other growth-influencing factors like capital and human resources, and technology grow; however, the output grows below the time trend of GDP in years in which the unemployment rate is high. The study analyses the relationship between government expenditure and economic growth in the US for 51 years, from 1947 to 1997.

Rati Ram (1986) examines the relationship between economic growth and government expenditure, to optimise the growth and determine the optimal size of government, by dividing the economy into two sectors – government and non-government. The neoclassical type growth equation is specified as:

$$\frac{dy}{y} = \alpha\left(\frac{i}{y}\right) + \beta\left(\frac{dl}{l}\right) + \gamma\left(\frac{g}{y}\right) + \varepsilon \quad (2)$$

Where, dy/y is the GDP growth rate, i/y is the investment, dl/l is the population growth rate, and g/y is the ratio of government expenditure to GDP. The study uses Summers-Heston data for 115 countries for 21 years, from 1960 to 1980. The results show that the overall impact of government size on growth is positive, and the marginal externality effect of government size is generally positive.

Cheng and Tin (1997) examine the causality between government expenditure and economic growth along with money supply in a trivariate framework in South Korea for the period 1954-94, applying the vector error correction method. The study finds that there is bidirectional causality between government expenditure and economic growth in South Korea, and money supply affects economic growth as well.

Bagdigen and Cetintas (2004) examine Wagner's Law of the long-run relationship between public expenditure and GDP for Turkey over the period 1965-2000. The hypothesised relationship is that public expenditure is the outcome, not the cause, of growth in GDP. Therefore, the causality is from GDP to public expenditure. Using cointegration and Granger causality tests, they empirically find no causality in both directions. Thus, neither Wagner's Law nor Keynes's hypothesis is valid for Turkey.

Chude and Chude (2013) investigate the long- and short-run effects of public expenditure in education on economic growth in Nigeria from 1977 to 2012 using the error correction model. The results of the study indicate that total expenditure on education is statistically highly significant and has a positive effect on economic growth in Nigeria in the long run. Thus, it is concluded that economic growth is clearly impacted by factors both exogenous and endogenous to the public expenditure in Nigeria.

Alshahrani and Alsadiq (2014) analyse the short- and long-run effects of six types of government expenditure on economic growth in Saudi Arabia over the period 1969-2010, applying different econometric techniques. The vector error correction model estimates show that while private domestic and public investments, as well as healthcare expenditure, stimulate growth in the long run, openness to trade and spending in the housing sector boost short-run production.

Odo et al. (2016) study the long-run causal relationship between public expenditure and economic growth in South Africa from 1980 to 2014, employing the cointegration test, vector error correction mechanism, and Granger causality test. The estimated results show an insignificant negative relationship between total government expenditure and economic growth, a significant positive relationship between economic growth and total revenue, and a significant positive relationship between inflation and economic growth. The pair-wise Granger causality shows a one-way causality running from national income to total government expenditure that seems to support Wagner's theory. Thus, the study concludes that a stable long-run relationship exists between public expenditure and economic growth in South Africa, and that the growth in national income leads to an increase in government expenditure, as implied by Wagner's hypothesis, in South Africa.

In the Indian context, Gangal and Gupta (2013) analyse the impact of public expenditure on economic growth between 1998 and 2012, using the annual data of total public expenditure and GDP per capita from the World Economic Outlook and IMF. The study employs the ADF unit root, cointegration, and Granger causality tests. The econometric results reveal that there is a positive impact of total public expenditure on economic growth and there is a unidirectional relationship from total public expenditure to GDP in India.

Lhoungu et al. (2016) study the causal relationship between public expenditure and economic growth in India for 30 years, from 1980-81 to 2009-10, employing the Granger causality, ADF, and cointegration tests, as well as the ECM model. Empirically, the causality from GSDP to public expenditure is shown to be weak, while the causality from public expenditure to GSDP is strong. The ECM also reveals that there is strong bi-directional causality only between growth (GSDP) and public expenditure on social services in the long run.

Das and Kar (2016) employ an endogenous growth model to understand whether public expenditures in education, health, and physical infrastructure in India are conducive to rapid economic growth commensurate with the projected demographic dividends for India. They apply a structural vector autoregressive model on macroeconomic data from 1975 to 2012 for shares of public expenditure on education and health as the main pillars of growth of human capital in the country, per capita GDP growth rate, and working age population. The estimated results reveal that a rise in expenditure on health has a positive impact on working age population through greater participation. However, higher public expenditure for education and training draws workers away from the labour market, as the country has a large share of unskilled workers, and employment opportunities are mostly in the large informal sector.

DATA AND METHODOLOGY

In the empirical analysis, this paper uses annual time series data from 1983 to 2020 from World Bank Indicators (WDI) for India. The variables are GDP, total government expenditure, inflation, and total revenue as a percentage of GDP expressed in 2010 USD. The GDP is measured in constant price; general government final consumption expenditure includes all government current expenditures for purchase of goods and services, including national defence and security; inflation is measured by the consumer price index that reflects the annual percentage change in cost to the average consumer in acquiring a basket of goods and services; and revenue is measured by the cash receipts from taxes, social contributions, and other revenues such as fines, fees, rent, and income from property or sales. The econometric tests and models used in the analysis include the unit root test, Johansen cointegration test, Granger causality test, and the VEC model. Johansen's (1988) cointegration approach and VECM have been employed in this paper to investigate the causal relationship between public expenditure and economic growth in India. Before this, the stationarity of the time series and the co-relationship between the two series need to be checked.

Unit Root Test: The unit root test is to test the stationarity of the time series. There are two ways to test for stationarity using the unit root test in the time series: the ADF and PP unit root tests.

Augmented Dickey-Fuller Test: A variable is said to be stationary if it has a time-invariant mean, time-invariant variance, and the value of the covariance between the two time periods depends only on the distance or gap or lag between the two time periods and not the actual time at which the covariance is computed. The regression to be estimated for the application of the ADF test is:

$$\Delta y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta y_{t-i} + u_t \quad (3)$$

Where, y_t is the stationary series, Δy indicates the first difference of y_t, $\beta_2 t$ is the trend of time, and u_t is the error term. The null hypothesis is that the series has a unit root ($\delta = 0$), meaning that the series is non-stationary against the alternative hypothesis of the series being stationary. If a unit root (non-stationarity) exists, then δ would not be statistically different from zero. If the p-value of the coefficient of y_{t-1} is less than 0.05 at 5% level of significance, the null hypothesis is rejected, indicating that the series is stationary.

Phillips-Perron Test: The Phillips-Perron (PP) unit root test differs from the ADF test mainly in how they deal with serial correlation and heteroscedasticity in the errors.

Cointegration Test: If two time series data are non-stationary, there is a possibility that there exists a linear combination of the two variables, such that the error term is stationary. The two variables are said to be cointegrated if they have a long-term or equilibrium relationship between them. Therefore, the cointegration between the variables is to be tested using the Eigenvalue and trace statistic:

Trace Statistic: $Trace = -T \sum_{t=r+1,\ldots\ldots,\lambda_p^1} \sum Log(1-\lambda_t^1)$

(4)

Where, $\lambda^1_{r+1}, \ldots \ldots, \lambda^1_p$ are (p − r) number of estimated Eigenvalues.

Maximum Eigenvalue Statistic:

$$\lambda_{max}(r, r+1) = -TLog(1-\lambda_{r+1}^1) \quad (5)$$

H0: No cointegration (r = 0)

H1: presence of cointegration (r > 0)

Where, 'r' implies a cointegrating relation. If the absolute value of the computed trace and computed Eigenvalue statistics are greater than their respective critical values, then the null hypothesis is rejected at 5% level of significance, concluding that there exists at least one cointegrating relation between the variables. Then, the test for cointegration is:

H0: presence of one cointegrating relation (r = 1)

H1: presence of more than one cointegrating relation among the variables (r > 1)

Based on the value of the computed trace statistic and the Eigenvalue, the null hypothesis is either accepted or rejected.

If the two time series are cointegrated, then the direction of causality between them needs to be tested. The existence of a relationship between the variables does not show the direction of influence. The causal relationship between them may be short-run or long-run. The short-run causality is established by an analysis of the joint significance of the lagged explanatory variable, and movements of the deviations from the long-run path are explained by long-run causality.

Granger Causality Test: The Granger causality approach allows in determining the direction of the short-run relations between the variables. This model is expressed in two equations:

$$y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i \, y_{t-1} + \sum_{j=1}^{n} \beta_j \, x_{t-1} + u_{1t} \quad (6)$$

$$x_t = \mu_o + \sum_{i=1}^{n} \alpha_i \, y_{t-1} + \sum_{j=1}^{n} \delta_j \, x_{t-1} + u_{2t} \quad (7)$$

The null hypothesis is that one variable does not Granger-cause the other, against the alternative hypothesis which states that the variable Granger-causes the other. The coefficients are jointly tested for their significance. If their p-value exceeds 0.05 at 5% level of significance, the null hypothesis is rejected, indicating causality between the two variables, and no causality otherwise.

Vector Error Correction Model: Causality exists in at least one direction if the variables contain a cointegrating vector and the direction of a causal relationship is detected through the vector error correction model (VECM). Engel and Granger (1987) show that in the presence of cointegration, there always exists a subsequent error correction representation, captured by the error-correction term, which captures the long-run adjustment of cointegration variables. The VEC has cointegration relations built into specification so that it restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships, while allowing for short-run adjustment dynamics. The cointegrating term is the error correction mechanism (ECM), since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

The error correction term needs to be significant at 0.05 level for long-run causality, otherwise, there is no long-run causality from the independent variable(s) to the dependent variable. Apart from identifying the direction of causality, the incorporation of the error correction term in the VECM model helps analyse the long-term relationship between the variables. The error correction model is specified as:

$$\Delta LnRGDP_t = \sum_{j=1}^{p-1} \beta_1 \Delta LnRGDP_{t-j} + \sum_{j=1}^{p-1} \beta_2 \Delta LnGEXP_{t-1} + \sum_{j=1}^{p-1} \beta_3 \Delta LnREV_{t-1} + \sum_{j=1}^{p-1} \beta_4 \Delta LnINF_{t-1} + \alpha_1 ECT_{t-1} + u_t \quad (8)$$

Where, the first difference operator is represented as Δ and u_t is the white noise error term and j is the lag length. The error correction term is denoted by ECT, and the order of the VECM model is presented by p, which is translated to $p-1$ in the ECM. The term represents the pace of adjustment after the LnRGDP, LnGEXP, LnREV, and LnINF deviate from the long-run equilibrium in period $t-1$.

EMPIRICAL ANALYSIS

In the empirical analysis, the econometric model to be estimated is specified as:

$$Ln(RGDP)_t = \beta_0 + \beta_1 Ln(GEXP)_{t-1} + \beta_2 Ln(REV)_{t-1} + \beta_3 Ln(INF)_{t-1} + u_t \quad (9)$$

Where, RGDP represents the real gross domestic product, GEXP is the total government expenditure, REV refers to total revenue as a percentage of gross domestic product, INF refers to inflation, ut is the error term, and α0 … α3 are the parameters. Table 1 presents the descriptive statistics of the variables, to analyse the causal relationship between public expenditure and economic growth in India. All variables are expressed in USD at current prices. The GDP averages USD27.333 and varies between USD26.491and USD28.315, with a standard deviation of 0.560. INF averages 1.996 and ranges from 1.182 to 2.630; GEXP averages USD25.191 and varies from 24.304 to 26.0186. The mean of REV is USD2.518 and its variation is from 2.410 to 2.683.

Table 1: Descriptive Statistics of Variables in the Analysis of Public Expenditure and Economic Growth

	Ln (RGDP)	Ln (INF)	Ln (GEXP)	Ln (REV)
Mean	27.333	1.996	25.191	2.518
Median	27.289	2.167	25.229	2.518
Maximum	28.315	2.623	26.018	2.683
Minimum	26.491	1.183	24.304	2.411
Std. Dev.	0.560	0.432	0.5141	0.065

Table 2 reports the results of the Augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) unit root tests on the natural logarithms of the levels and first differenced forms of the variables. The guideline for testing the significance of the variable is that the t-statistics reported by the test should be less than the critical value at 5%, and the corresponding probability (p) values should be greater than 0.05 (or 5%). If the p-value is less than 0.05, then the null hypothesis is rejected and the alternative hypothesis is accepted.

Table 2: Augmented Dickey-Fuller and Phillips-Perron Unit Root Test

Variable	ADF Test		PP Test	
	At Level	At First Difference	At Level	At First Difference
Ln(RGDP)	2.149	−4.435*	4.204	−4.412*
Ln(INF)	−3.132*	−6.928*	−3.132*	−11.88*
Ln(GEXP)	0.726	4.511*	−0.674	−2.983*
Ln(REV)	−3.600*	−7.345*	−3.660*	−7.345*
Order of integration	I(1)		I(1)	

The Johansen cointegration test results are presented in Table 3. The trace and maximum Eigen statistics for the variables Ln(RGDP), Ln(REV), Ln(GEX), and Ln(INF) show that there are two statistically significant cointegrating vectors. In other words, the trace test indicates one cointegrating equation at the 0.05 level of significance and the max-Eigen value test also indicates one cointegrating equation.

Table 3: Johansen Cointegration Test Statistics

Hypothesised No. of CE(s)	Trace Test			Maximum Eigenvalue		
	Eigenvalue	Trace Statistic	Critical Value	Eigenvalue	Max-Eigen Statistic	Critical Value
None*	0.847	97.648	47.856	0.847	48.838	27.584
At most 1	0.464	31.811	29.797	0.464	17.672	16.132
At most 2	0.396	13.138	15.495	0.396	6.121	8.265
At most 3	0.0006	0.0170	3.841	0.0006	0.017	3.841
	Trace test indicates 1 cointegrating eqn(s) at the 0.05 level			Max-Eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level		
	*denotes rejection of the hypothesis at the 0.05 level			*denotes rejection of the hypothesis at the 0.05 level		

The result of the error correction model from the normalised cointegration equation presented in Table 4 indicates a long-run significant positive relationship between total revenue as a percentage of GDP and economic growth, showing as expected that an increase in government revenue leads to an increase in the growth of the economy.

Table 4: ECM from Normalised Cointegration Equation

RGDP	GEXP	REV	INF
1.000000	−0.841406	7.18E+09	2.85E+09

Table 5 presents the VECM estimation for LnGDP = f (LnREV, LnGEXP, LnINF). The Johansen cointegration test reveals two cointegrating equations for LnGDP, LnREV, LnGEXP, and LnINF, which have been specified while estimating the vector error correction model. The coefficient of ECM(−1) is −0.0029, and its p-value of 0.030 is less than the 5% (0.05) level of significance. If there is a long-term relationship between two or more variables, the Granger causality test is applied to detect the direction of the causal relationship (unidirectional or bi-directional). The null hypothesis is $\beta i = 0$; under the null hypothesis, x does not Granger-cause y. If the null hypothesis is rejected, it can be said that x Granger-causes y. Similarly, whether y Granger-causes x can be tested. However, the Granger test is sensitive to the lag selection, and hence four lag lengths are selected, considering the length of the time series.

Table 5: Vector Error Correction Model Estimates

Error Correction	Coefficient	Std. Error	T-Statistics	P-Value
ECT(−1)	−0.002903	0.001251	−2.320264	0.0300
D (RGDP(−1)) = C(2)	0.093701	0.483703	0.193716	0.8482
D (GEXP(−1)) = C(4)	0.105203	0.285151	0.368936	0.7157
D (REV(−1)) = C(6)	4.97E+08	7.16E+09	0.069428	0.9453
D (INF(−1)) = C(8)	−6.85E=09	3.78E+09	−1.813052	0.0835
C = C(10)	4.62E+10	1.87E+10	2.475108	0.0215
Adj. R-square	0.618715	F-statistics		3.226

Table 6 presents the results of the pair-wise Granger causality tests. The p-values are greater than 0.05, and thus the null hypothesis that there is no causality between the variables for various lag lengths cannot be rejected. The pair-wise Granger causality test of the variables indicates one-way causality moving from gross domestic product to total government expenditure. The causality from gross domestic product to government revenue also exists, showing that the growth of the economy leads to an increase in government revenue. Further, causality from inflation to gross domestic product exists, showing that inflation can lead to the growth of the economy in both the long- and short-run.

Table 6: Pair-Wise Granger Causality

Null Hypothesis	F-Statistic	Prob.
GEXP does not Granger-cause RGDP	2.98817	0.0666
RGDP does not Granger-cause GEXP	5.45824	0.0100
REV does not Granger-cause RGDP	0.22833	0.7973
RGDP does not Granger-cause REV	5.67526	0.0085
INF does not Granger-cause RGDP	10.0500	0.0005
RGDP does not Granger-cause INF	2.53160	0.0976
REV does not Granger-cause GEXP	0.01076	0.9893
GEXP does not Granger-cause REV	5.91778	0.0072
INF does not Granger-cause GEXP	5.40372	0.0104
GEXP does not Granger-cause INF	1.17228	0.3244
INF does not Granger-cause REV	6.28792	0.0056
REV does not Granger-cause INF	4.00496	0.0295
No. of observations	30	

CONCLUSION

The main objective of the paper is to examine the causal relationship between GDP, total government expenditure, inflation, and total revenue as a percentage of GDP in India. The paper uses annual time series data from 1983 to 2020 collected from the World Bank, and applies econometric methods of Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests for unit root, Granger causality test for the direction of causality, Johansen's cointegration test for cointegration, and vector error correction model (VECM) for testing the long- and short-run relationship between the variables. The unit root tests show that the variables are stationary after the first difference and the Johansen cointegration test reveals one cointegrating vector, suggesting that there exists a stable long-run equilibrium relationship between public expenditure and covariates. The direction of causality is detected using the Granger causality test. The vector error correction models are also used to analyse the long-run relationship in the economy. The error correction coefficient is negative and statistically significant, indicating that the speed of adjustment between the short-run dynamics and the long-run equilibrium is about 0.03%. The pair-wise Granger causality test indicates one-way causality moving from gross domestic product to total government expenditure, and from gross domestic product to government revenue, showing that the growth of the economy leads to an increase in both government revenue and expenditure. Thus, the results of this paper show a stable long-run relationship between public expenditure and economic growth in India.

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