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Governance and Economic Growth in India: Vector Autoregression Estimation of the Effect of Government Size on Public Spending

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Abstract: This paper tries to understand whether the size of government spending is leading to optimal marginal returns to governance in India. The effect of government size on economic growth in an endogenous growth framework is examined. The relationship between gross value-added output, combined government spending and gross capital formation in India is estimated for the period 2000-01 to 2023-24 by the VAR and SVAR methods. The estimated results show that government expenditure negatively affects economic growth with a three-year lag and a non-linear inverted U-shaped Dick Armey Curve in India. The results suggest that India has already achieved the highest attainable growth for the given size of government and is operating at the negative part of the curve with diminishing returns to public expenditure. The government should cut down its expenditure for positive effects of governance on the economy, in view that this expenditure will affect growth only after some years from now.

Keywords: Governance, government size, government expenditure, economic growth, endogeneity, causality, vector autoregression

INTRODUCTION

The significance and role of government are always important for growth and development in any economy. Where the private markets exist on a large scale, the government regulates them. Where the private sector market fails, the government provides a market there. The government operates with the aim to protect the interest of the citizens of the country and work for people's welfare. If the level of governance is too low, the private firms exploit the markets and consumers and if the government role is too high, it becomes too restrictive and hampers the function of the markets and growth of the economy. There is an optimal level of governance at which a government can operate in order to achieve the highest attainable growth given its resources. But, what is the optimal size and the role of government in a liberal economy for achieving efficient and sustained economic growth is not clear. Even if there exists an optimal government expenditure for economic growth, it is poorly understood or misunderstood.

Milton Friedman (1997), in a comparison of the United States with Hong Kong, notes that: "Government has an essential role to play in a free and open society. Its average contribution is positive, but I believe that the marginal contribution of going from 15% of the national income to 50% has been negative". Friedman suggests that the threshold where the government's role in economic growth is probably somewhere between 15 and 50% of the national income or output. Therefore, it is very important to decide the exact level of governance a country should be operating at in order to achieve higher growth. While the government's role in the economy is extensively studied, both theoretically and empirically, the size of government is not clearly defined and well understood. Generally, it is understood that the size of the government is not the number of employees on the government payroll but the level of governance or public expenditure in an economy. Therefore, the effect of government expenditure on economic growth is the analytical approach to studying the government size and growth relationship.

In India, government spending contributes almost 30% to the growth of the economy. As a developing country whether India's economic growth is positively or negatively related to the size of government or negatively is not yet clearly identified. An analysis of the size of the government and its effects on the economy is useful to understand what India should do with its public spending in order to achieve higher economic growth or whether India has already achieved the optimum and sustainable level of governance at some point in time at a particular level of public spending. Determining the returns to government expenditure is very important given the sizable public expenditure.

Therefore, this paper attempts to understand whether the size of government spending is leading to positive or negative marginal returns to governance. The paper attempts to identify the optimal government size i.e. government expenditure for sustained economic growth in India and estimate the causal relationship between public expenditure and economic growth in an endogenous framework. The period of the analysis is from 2000-01 to 2023-24. In the estimation, the vector autoregression (VAR) and structural VAR (SVAR) techniques are used in order to estimate the effect of government expenditure on economic growth in India considering the endogeneity of the variables.

LITERATURE REVIEW

Adolph Wagner (1911) first developed the law of 'increasing state activity'. The law states that the absolute and relative expansion of the public sector leads to economic growth at the cost of private sector growth. The expanding government accompanies social progress and rising incomes. Following the Great Depression of 1929, the magnum opus of John Maynard Keynes' (1936) General Theory became the driving force for economic policy that set the scene for regulation of the economy, setting aside the neoclassical presumption of 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.

The Solow (1956) type neoclassical growth model that favours little state intervention in the market economy, posits that economic growth comes from the exogenous technical change and that per capita income will converge to a steady-state level in the long run. As all the determinants of growth are exogenous in the neoclassical liberal world, the government has little role to play and as the market forces adjust to any policy change, there is no real influence of government or policies on the growth rate of the economy. At the most, the government expenditure may have some effect on growth during the temporary period of transition to steady-state growth. Therefore, the role of government in the growth process is insignificant and hence is not subjected to critical analysis in the standard neoclassical growth models.

In contrast, the endogenous 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. In the endogenous growth models, public investments on social and economic overheads generate externalities and technical change is itself endogenously determined. Hence not only the transition and steady-state growth rates are endogenous, but also the long-run economic growth rate. As the entire economic system functions endogenously, the government's role is active and inevitable in the process of economic growth.

Dick Armey (1995) in an analysis of the nexus between government size and economic growth in the US for 51 years from 1947 to 1997 finds that the effect of government expenditure on economic growth is nonlinear, an inverted U-shape curve reflecting the law of diminishing returns. The size of the government is measured by the ratio of government expenditure to the GDP of an economy. Based on the Armey Curve, Vedder and Gallaway (1998) formulate the government expenditure- economic growth relationship as:

$$y = \alpha + \beta g - \gamma g^2 + \delta t + \varepsilon \tag{1}$$

where y is the output, g is the government size and t represents the time trend. The expected sign of β is positive as an increase in government expenditure carries some beneficial effects on the output of the economy and as further increments in government size adversely affect the functioning of the economy, the sign of the γ is to be negative. Note that the squared term increases faster in value than the linear term of public expenditure. Hence, the beneficial effects of government spending will eventually be wiped out by the adverse effects, ultimately leading to a downward-sloping part of the Armey curve as output grows due to growth in the other growth influencing factors like capital and human resources, and technological change that are unrelated to government size.

Rati Ram (1986) attempts to determine the optimal size of government to optimise growth in a framework of a two-sector economy, the government and non-government. The neoclassical type growth equation is specified as:

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

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

Cheng and Lai (1997) use a trivariate framework that includes economic growth, government expenditure and money supply for South Korea over the period 1954-94 applying the vector error correction method. The study finds that the causality between government expenditure and economic growth is bidirectional and economic growth and that money supply plays a significant role in economic growth in South Korea.

Alshahrani and Alsadiq (2014) analyse the short-run and long-run effects of six categories of public expenditure on economic growth during 1969-2010 in Saudi Arabia applying different econometric estimation methods. The vector error correction model estimates show that public investments and healthcare expenditure, along with private domestic investment, positively influence long-run economic growth. In the short-run trade openness and government spending on the housing sector increase production.

In India, Das and Kar (2016) use an endogenous growth model in order to understand the effect of public expenditures in education, health and physical infrastructure on economic growth from 1975 to 2012 applying the structural vector autoregression model. The study tries to find whether such investments are commensurate with the demographic dividend in India as the shares of public expenditure on education and health are the base for human capital growth in the country, quantity and quality of the workforce and ultimately the growth rate of the GDP per capita. The estimated results reveal that an increase in public health expenditure has a positive effect on the labour force participation of the working-age population. But, higher public expenditure on education and training drives workers away from the labour market.

DATA AND METHODOLOGY

This study focuses on the causal relationship between government size and economic growth in order to optimise economic growth in India. This study follows the theoretical approach of Rati Ram, in which economic growth is related to investments, labour growth and government expenditure. Empirically, this study uses secondary data over the period 2000-01 to 2023-24 and the structural vector autoregression estimation method. Economic growth is measured by the total value of the output of the economy and the size of government is measured by the combined government expenditure of the centre and states. The data on gross value added (GVA) output is obtained from the Economic Survey of India, Ministry of Finance. The data on the combined government expenditure (CGE) and gross capital formation (GCF) are obtained from the Indian Public Finance Statistics, Ministry of Finance, Government of India.

THEORETICAL MODEL

The model proposed by Rati Ram (1986) consists of a two-sector production function, the government sector (g) and the non-government sector (n), the outputs (y) of both of which are functions of capital (k) and labour (l). In addition, the government sector output acts as an externality on the outputs in the other sectors. The production functions are as specified as:

$$y_g = f(k_g, l_g) \tag{3a}$$

$$y_n = m(k_n, l_n, g) \tag{3b}$$

The total inputs are given as:

$$k = k_g + k_n \tag{4a}$$

$$l = l_g + l_n \tag{4b}$$

The outputs of the two sectors sum to the total output (y) of the economy:

$$y = y_g + y_n \tag{5}$$

Let λ be the deviation of the ratio of marginal factor productivity in the two sectors:

$$\frac{f_k}{m_k} = \frac{f_l}{m_l} = (1+\lambda) \tag{6}$$

If the input productivity is higher in the government sector, λ will be positive. Without the externality of the government expenditure, given a set of prices, λ=0 means an efficient allocation of resources that optimises the output. However, the marginal productivity in the non-government sector is likely to be higher as they operate in a highly competitive environment. However, the non-government sector faces a lot of regulations imposed by the government. The government sector is inefficient because it is plagued by many issues like corruption, red tape, lack of funds, etc.

Totally differentiating the total output (y) function:

$$dy = dy_g + dy_n = (f_k dk_g + f_l dl_g) + (m_k dk_n + m_l dl_n + m_g dg) \tag{7}$$

where m_g indicates the marginal externality effect of government activities on non-government sectoral output. The change in capital stock is the investment and therefore total investment of the economy is the horizontal summation of investment made in the two sectors:

$$i = i_g + i_n \tag{8}$$

Therefore, the change in the total output of the economy is given by:

$$dy = m_k dk_n + m_l dl_n + m_g dg + f_l\, dl_g + f_k i_g \tag{9}$$

$$= m_k dk_n + m_l dl_n + m_g dg + m_l\,(1+\lambda)dl_g + m_k\,(1+\lambda)i_g$$

$$= m_k dk_n + m_l dl_n + m_g dg + m_l dl_g + m_l dl_g + mki_g + \lambda m_k i_g$$

$$= m_k\,(i_n + i_g) + m_l\,(dl_n + dl_g) + m_g dg + \lambda(m_l dl_g + m_k + m_k i_g)$$

$$= m_k i + m_l dl + m_g dg + \lambda(m_l dl_g + m_k + m_k i_g) \tag{10}$$

Also, $dg = m_k\,(1+\lambda)i_g + m_l\,(1+\lambda)dl_g = (1+\lambda)(m_k i_g + m_l\, dl_g)$ (11)

Therefore, $(m_k\, i_g + m_l dl_g) = [dg\,/\,(1+\lambda)]$ (12)

Hence, $$y = m_l dl + m_k i + m_g dg + \lambda\left[\frac{dg}{(1+\lambda)}\right] \tag{13}$$

$$= m_l dl + m_k i + \left\{\left[\frac{\lambda}{(1+\lambda)}\right] + m_g\right\}dg \tag{14}$$

Following Bruno (1968), let the real marginal productivity of labour is linearly related to output per capita per labour:

$$m_l = \beta(y/l) \tag{15}$$

Denoting $m_k = \alpha$, the change in the output of the economy can be written as:

$$dy = \alpha\left[\frac{i}{y}\right] + \beta\left(\frac{dl}{l}\right) + \left\{\left[\frac{\lambda}{(1+\lambda)}\right] + m_g\right\}dg \tag{16}$$

A more convenient specification to analyse the effect of the size of government on growth is to use the ratio measure (g/y) (Rubinson, 1977; Landau, 1983). After some manipulations, Rati Ram finally specifies the growth equation as:

$$\frac{dy}{y} = \alpha\left[\frac{i}{y}\right] + \beta\left(\frac{dl}{l}\right) + \gamma\left[\frac{g}{y}\right] \tag{17}$$

where dy/y is the growth rate of GDP, i/y is the investment, dl/l is the growth rate of population and g/y is the ratio of government expenditure to GDP. Thus, economic growth is a function of investment, labour growth and the ratio of government expenditure to output.

EMPIRICAL SPECIFICATION

Assuming that economic growth depends only on government expenditure and capital stock of government and economic growth is inclusive of growth in labour, none of the growth determinants is exogenous. Therefore, as the variables are interdependent and hence the estimating structural equations consist of all endogenous variables. The structural vector autoregressive (SVAR) model is specified as:

$$\begin{aligned} y_t &= b_{10} + b_{12}g_t + b_{13}k_t + c_{1i}y_{t-i} + d_{1i}g_{t-i} + f_{1i}k_{t-i} + \psi_{et} \\ g_t &= b_{20} + b_{21}y_t + b_{23}k_t + c_{2i}y_{t-i} + d_{2i}g_{t-i} + f_{2i}k_{t-i} + \varepsilon_{gt} \\ k_t &= b_{30} + b_{31}y_t + b_{32}g_t + c_{3i}y_{t-i} + d_{3i}g_{t-i} + f_{3i}k_{t-i} + \varepsilon_{kt} \end{aligned} \tag{18}$$

where ε_{yt}, ε_{gt} and ε_{kt} are white noise error terms which are pure innovations or shocks with standard deviations σ_y, σ_g and σ_k respectively. The error terms of each equation also contain the indirect contemporaneous effect of the other two variables if their coefficients are not zero.

In matrix notation, the SVAR model is specified as:

$$\begin{bmatrix} 1 & b_{12} & b_{13} \\ b_{21} & 1 & b_{23} \\ b_{31} & b_{32} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ g_t \\ k_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \\ b_{30} \end{bmatrix} \begin{bmatrix} c_{1i} & d_{1i} & f_{1i} \\ c_{2i} & d_{2i} & f_{2i} \\ c_{3i} & d_{3i} & f_{3i} \end{bmatrix} \begin{bmatrix} y_{t-i} \\ g_{t-i} \\ k_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{gt} \\ \varepsilon_{kt} \end{bmatrix} \tag{19}$$

Or
$$Bx_t = \Gamma_0 + \Gamma_i x_{t-i} + \varepsilon_t \tag{20}$$

where x denotes the three endogenous variables and i denotes the lag length. The reduced form VAR model for this endogenous system can be specified as:

$$x_t = B^{-1}\Gamma_0 + B^{-1}\Gamma_i + \varepsilon_t \tag{21}$$

The estimating equations are specified as the lagged values of all endogenous variables:

$$y_t = \alpha_{10} + \beta_{1i}y_{t-i} + \beta_{1i}g_{t-1} + \beta_{1i}k_{t-i} + \psi_{et}$$

$$g_t = \alpha_{20} + \beta_{2i} y_{t-i} + \beta_{2i} g_{t-1} + \beta_{2i} k_{t-i} + \varepsilon_{gt} \tag{22}$$

$$k_t = \alpha_{30} + \beta_{3i} y_{t-i} + \beta_{3i} g_{t-1} + \beta_{3i} k_{t-i} + \varepsilon_{kt}$$

where the error terms are a composite of three shocks and specified as:

$$\varepsilon_{1t} = \frac{\varepsilon_{yt} - b_{12}\varepsilon_{gt} + b_{13}\varepsilon_{kt}}{1 - b_{12}b_{21} - b_{13}b_{31}},\ \varepsilon_{2t} = \frac{\varepsilon_{gt} - b_{21}\varepsilon_{yt} + b_{23}\varepsilon_{kt}}{1 - b_{12}b_{21} - b_{13}b_{23}},\ \varepsilon_{3t} = \frac{\varepsilon_{kt} - b_{31}\varepsilon_{yt} + b_{32}\varepsilon_{kt}}{1 - b_{13}b_{31} - b_{13}b_{23}} \tag{23}$$

Since ε_{yt}, ε_{gt} and ε_{kt} are white noise error terms, ε_{1t}, ε_{2t} and ε_{3t} are also white noise error terms.

EMPIRICAL ANALYSIS

Table 1 presents the descriptive statistics of the variables in the empirical analysis of the causal relationship between government size and economic growth in India. The mean value of GVA is about Rs.25 lakh crores. Both central and state government expenditures combined have contributed more than a quarter to the growth of the economy. On average, the state and central government have spent about 28% on the growth of the economy over time. The gross capital formation has also increased during the period with the combined private and public sector capital formation contributing about 34% to the economic growth of India.

Table 1: Descriptive Statistics of Variables

Variable	*Description*	*Mean*	*Std. dev.*
GVA	Gross value added is the total output of the government, measured as the total output of the economy minus the intermediate consumption (Rs.crores)	25011591	2886242
CGE	Combined government expenditure is the total expenditure incurred by the centre and state governments, measuring the size of government (Rs.crores)	709122.3	820425.8
GCF	Gross capital formation is the net increase in the physical assets of the private and public sectors (Rs.crores)	856705.5	1076514

Before econometric estimation, as the data is time series, there are certain statistical tests to be performed on the data.

Stationarity Test: As the series has a linear trend at the levels form and hence are not stationary series. The Augmented Dickey-Fuller (ADF) test is used to test for the unit root in the series of variables. The null hypothesis for the ADF test is that the series has a unit root and the alternative hypothesis is that the series doesn't have a unit root. The presence of a unit root in the series means the autocorrelation coefficient is one and therefore the series is considered to be autocorrelated and therefore non-stationary. The ADF test at levels prestned in Table 2 shows that the probability values are very high at the 95% confidence level and hence the series are non-stationary in their levels form. At first difference, the null hypothesis of the presence of unit root is rejected as the probability values are less than 5%, and all the series have become stationary, hence all the series are I(1) i.e. integrated of order (1).

Table 2: ADF Unit Root Test

Variable	*At level**	*At first difference**
lnGVA	0.962	0.026
lnCGE	0.804	0.000
lnGCF	0.822	0.000

Note: * P-values at 5% significance level.

Cointegration Test: Next, the variables are to be checked for the presence or not of any long-run equilibrium relationship between the variables. The Johansen cointegration test is used to check for cointegration. First, the hypothesis tests for none of the equations are cointegrated, and if the equations are cointegrated, then how many equations are cointegrated is checked by the probability values. Since the variables are I(1) process and if there is cointegration, then vector error correction mechanism (VECM) has to be used in order to check for the short-run disequilibrium. If the series are not cointegrated, then the vector autoregression (VAR) is used in order to estimate the contemporaneous effect of variables. Table 3 presents the Johansen cointegration test results. Both the trace statistics and maximum eigen value statistics for the hypothesis of none of the equations being cointegrated are very high at the 95% confidence level. Hence, there is no cointegration between the three variables, and the VAR estimation method is to be used.

Table 3: Johansen Cointegration Test

Hypothesied no. of CE(s)	*Trace statistics*			*Maximum eigen statistics*		
	Eigen value	*Trace statistic*	*0.05 critical value*	*Eigen value*	*Maximum eigen statistic*	*0.05 critical value*
None*	0.752	66.632	29.797 (0.000)	0.752	41.795	21.132 (0.000)
At most 1*	0.484	24.838	15.495 (0.001)	0.484	19.830	14.265 (0.006)
At most 2*	0.154	5.009	3.841 (0.025)	0.154	5.009	3.841 (0.025)

Note: Unrestricted cointegration rank test. * Rejection of null hypothesis at the 0.05 level. MacKinnon-Haug-Michelis (1999) p-values in parentheses.

Optimal Lag Length Selection: Before proceeding with estimation, lag length selection is to be done. It suggests how many autoregressive terms should be included in the model so that the model is fit for the estimation. If too many lags are included, the degrees of freedom decrease and too few lags give rise to specification bias. Therefore, selecting the appropriate lag length is very important and the optimal lag length is revealed by some information criteria like the LR test, sequential modified LR test, final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn (HQ) information criterion. The results of lag length criteria are presented in Table 4. All the lag length criteria show that the suggested lag length is 4, except the AIC criteria. Therefore, the set of equations including 4 lags makes the model fit for estimation.

Table 4: Lag Length Selection Tests

Lag	lnL	LR	FRE	AIC	SIC	HQ
0	17.902	-	1.18e-05	-1.028	-0.886	-0.983
1	156.631	239.188	9.40e-09	-9.975	-9.409	-9.797
2	167.262	16.130	8.60e-09	-10.087	-9.097	-9.777
3	180.330	17.124	6.89e-09	-10.368	-08.953	-9.924
4	207.634	30.128	2.19e-09*	-11.630	-9.791*	-11.054*
5	218.207	9.479	2.43e-09	-11.738*	-9.475	-11.030

Note: * Lag order selected by the criterion.

Causality Test: The Granger causality test is used to find the directional relationship i.e. whether there exists unidirectional or bidirectional causality between the variables. The Granger causality test results presented in Table 5 show that CGE Granger cause GVA, and GVA as well as CGE Granger cause GCF at the 95% confidence level. And 90% level of confidence, even GCF Granger cause GVA.

Table 5: Granger Causality Test

Null hypothesis	*F-statistic*	*Prob.*
CGE does not Granger cause GVA	7.164**	0.0008
GVA does not Granger cause CGE	0.646	0.638
GCF does not Granger cause GVA	1.942***	0.141
GVA does not Granger cause GCF	3.824**	0.017
GCF does not Granger cause CGE	2.451	0.078
CGE does not Granger cause GCF	3.061**	0.039

Note: **. *** Significant at 5, 10% levels.

VAR Estimates: The VAR model consists of the lagged values of all the endogenous variables in the system. The estimating equations are specified as:

$$lnGVA_t = \alpha_{10} + \beta_{11}\, lnGVA_{t-1} + \beta_{12}\, lnGVA_{t-2} + \beta_{13}\, lnGVA_{t-3} + \beta_{14}\, lnGVA_{t-4} + \beta_{15}\, lnCGE_{t-1} + \beta_{16}\, lnCGE_{t-2} + \beta_{17}\, lnCGE_{t-3} + \beta_{18}\, lnCGE_{t-4} + \beta_{19}\, GCF_{t-1} + \beta_{110}\, GCF_{t-2} + \beta_{111}\, GCF_{t-3} + \beta_{112}\, GCF_{t-4} + \varepsilon_{1t} \quad (24)$$

$$lnCGE_t = \alpha_{10} + \beta_{11}\, lnGVA_{t-1} + \beta_{12}\, lnGVA_{t-2} + \beta_{13}\, lnGVA_{t-3} + \beta_{14}\, lnGVA_{t-4} + \beta_{15}\, lnCGE_{t-1} + \beta_{16}\, lnCGE_{t-2} + \beta_{17}\, lnCGE_{t-3} + \beta_{18}\, lnCGE_{t-4} + \beta_{19}\, GCF_{t-1} + \beta_{110}\, GCF_{t-2} + \beta_{111}\, GCF_{t-3} + \beta_{112}\, GCF_{t-4} + \varepsilon_{2t} \quad (25)$$

$$lnCGF_t = \alpha_{10} + \beta_{11}\, lnGVA_{t-1} + \beta_{12}\, lnGVA_{t-2} + \beta_{13}\, lnGVA_{t-3} + \beta_{14}\, lnGVA_{t-4} + \beta_{15}\, lnCGE_{t-1} + \beta_{16}\, lnCGE_{t-2} + \beta_{17}\, lnCGE_{t-3} + \beta_{18}\, lnCGE_{t-4} + \beta_{19}\, GCF_{t-1} + \beta_{110}\, GCF_{t-2} + \beta_{111}\, GCF_{t-3} + \beta_{112}\, GCF_{t-4} + \varepsilon_{3t} \quad (26)$$

As the lagged values of the variables are exogenous and error terms are serially uncorrelated, the estimation of the specified set of equations is by the method of ordinary least squares treating each equation as a single equation.

The estimated VAR results presented in Table 6 show that the first and second lags of GVA and the first, third and fourth lags of CGE have a significant impact on current gross value added, This shows that economic growth in the current year is affected by the economic growth of the previous two years and combined government expenditure in previous years. The combined government expenditure is influenced by its own previous year's value and by the first and fourth-lagged values of GCF, implying that CGE depends on gross capital formation over the years. However, the lagged values of GVA do not affect the current level of central and state government expenditures. The current level of gross capital formation is determined by both the GVA and CGE in previous years. Capital formation today carries the impact of the previous year's economic growth, the previous year's combined government expenditure and capital formation two years back.

The stability and stationarity of the VAR model are calculated by the characteristic roots, presented in Table 7 and Figure 1. The stability condition requires characteristic roots of a sequence to lie outside the unit root circle. If this holds true then after n iterations and the sequence has finite and time-invariant mean and variance. With the inverse of characteristic roots of the autoregressive

Table 6: VAR Estimates of GVA, CGE and GCF

Variable	*Gross Value Added*	*Combined Government Expenditure*	*Gross Capital Formation*
$lnGVA_{t-1}$	1.291* (5.866)	-0.793 (1.491)	2.299* (2.528)
$lnGVA_{t-2}$	-0.569** (2.145)	-0.204 (0.318)	-2.869** (2.623)
$lnGVA_{t-3}$	-0.142 (0.539)	0.626 (0.987)	-1.251 (1.154)
$lnGVA_{t-4}$	0.090 (0.528)	-0.432 (1.056)	1.971* (2.818)
$lnCGE_{t-1}$	-0.004*** (0.053)	0.754* (3.929)	0.768** (2.338)
$lnCGE_{t-2}$	0.168 (1.402)	-0.479 (1.660)	-0.586 (1.188)
$lnCGE_{t-3}$	-0.302** (2.201)	0.273 (0.827)	-0.581 (1.027)
$lnCGE_{t-4}$	0.303* (3.722)	0.089 (0.455)	0.706** (2.102)
$lnGCF_{t-1}$	0.026 (0.381)	0.311*** (1.907)	0.322 (1.153)
$lnGCF_{t-2}$	0.063 (1.023)	0.201 (1.363)	-0.555** (2.188)
$lnGCF_{t-3}$	0.021 (0.386)	-0.026 (0.196)	-0.175 (0.760)
$lnGCF_{t-4}$	0.036 (0.605)	0.498* (3.454)	-0.096 (0.391)
Constant	0.792** (3.310)	3.744* (4.528)	-0.730 (0.516)
R-square	0.98	0.98	0.98

Note: Absolute t-values in parentheses. *, **, *** Significant at 1, 5, 10% levels.

polynomial, all the roots are expected to lie within the unit root circle. As Table 7 and Figure 1 show all the characteristic roots of each polynomial equation lie within the unit root circle. Therefore, the VAR model achieves stability and hence each sequence y_t (GVA) g_t (CGE) and k_t (GCF) has finite and time-invariant mean and finite and time-invariant variance.

Table 7: Inverse Roots of AR Characteristic Polynomial

Root	*Modulus*
0.993	0.993
0.931-0.3345	0.992
0.931+0.887	0.992
0.273-0.887	0.928
0.273+0.887	0.928
-0.766-0.523	0.928
-0.766+0.523	0.928
-0.756-0.528	0.922
0.756+0.528	0.922
0.783	0.783
-0.115-0.688	0.698
-0.115+0.688	0.698

Note: No root lies outside the unit circle. VAR satisfies the stability condition.

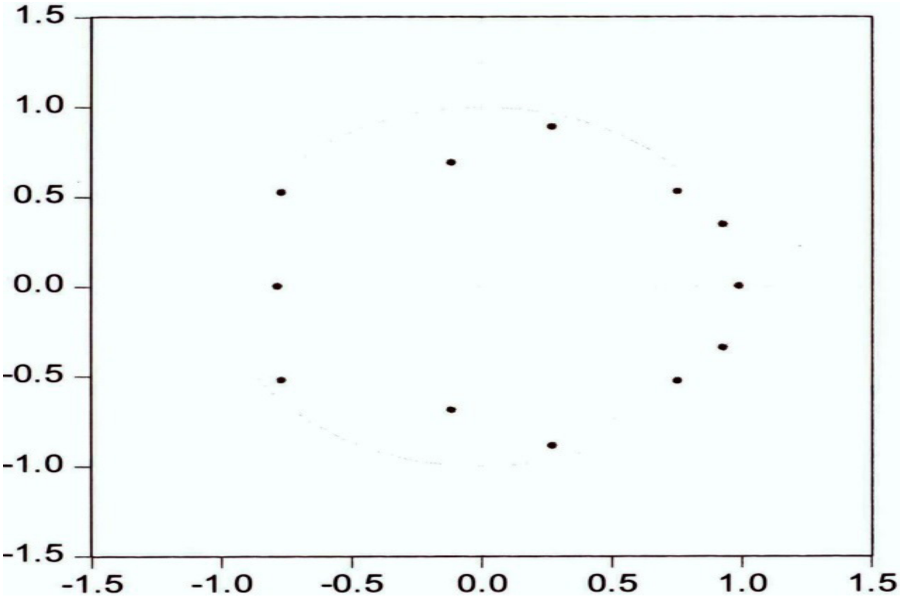

Figure 1: Stability of the VAR Model
Inverse Roots of AR Characteristic Polynomial

Residual Test: The residual heteroskedasticity test and correlogram are presented in Table 8 and Figure 2. The null hypothesis is that the residuals are not heteroskedastic and the alternative hypothesis is that the residuals are heteroskedastic. Table 8 shows that the null hypothesis is not rejected at the 5% level of significance. The correlogram presented in Figure 4 shows that all the spikes lie within the two dotted lines and therefore we can say that the residuals ε_{1t}, ε_{2t} and ε_{3t} are pairwise and serially uncorrelated. Therefore, the residuals are homoscedastic and are uncorrelated.

Table 8: Residual Heteroskedasticity Test

Residual	*R-square*	*F-value*	*Prob.*	*Chi-square*	*Prob.*
res1*res1	0.828	1.005	0.558	24.850	0.414
res2*res2	0.774	0.715	0.740	23.232	0.508
res3*res3	0.905	1.974	0.232	27.137	0.298
res2*res1	0.830	1.019	0.550	24.910	0.411
res3*res1	0.916	2.280	0.183	27.489	0.282
res3*res2	0.846	1.145	0.486	25.383	0.385
Joint chi-square test		150.274	Prob.	0.343	

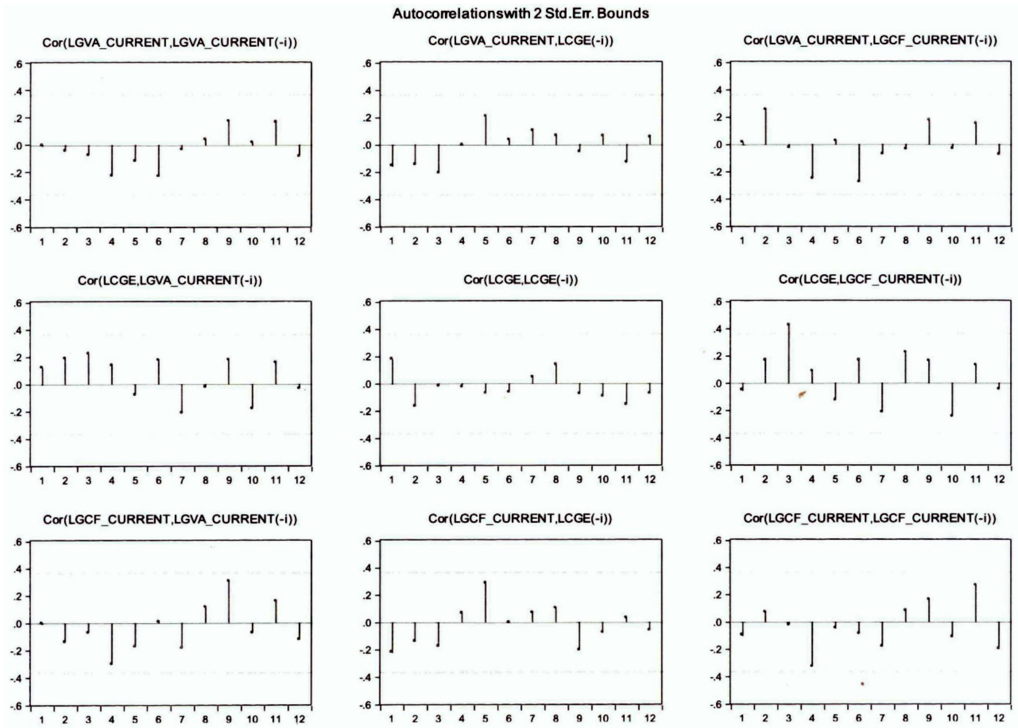

Figure 2: Correlogram of GVA, CGE and GCF Residuals

SVAR Estimates: As each equation in the VAR model is estimated by the OLS method, the same cannot be done for equations in the SVAR model because the variables carry a contemporaneous effect and residuals also carry indirect contemporaneous effects. Hence, the estimation procedure has to impose some restrictions. The VAR model estimation has 45 parameters, 39 coefficients, 3 variances and 3 covariances, whereas the SVAR system has to estimate 48 parameters, 3 intercept terms, 36 autoregressive coefficients, 6 feedback coefficients and 3 standard deviations. Therefore, 48 parameters in the structural equations cannot be estimated using 45 parameters in reduced-form equations. So, three restrictions should be imposed on structural equations in order to estimate the SVAR system. Only by restriction of three parameters, the SVAR system is identified, otherwise, it is an under-identified system. Imposing three restrictions makes the system exactly identified, and if more than three restrictions are imposed, the system is over-identified. The restrictions can be imposed from causality results or using $[(n^2 - n/2)]$ where n is the number of endogenous variables.

The three restrictions imposed on the SVAR system are based on causality results. Since GCF does not Granger cause GVA and GVA and GCF do not Granger cause CGE, β_{13}=0, β_{21}=0 and β_{23}=0. Therefore, the residual structure can be specified as:

$$\varepsilon_{1t} = \varepsilon_{yt} - \beta_{12}\varepsilon_{gt}, \varepsilon_{2t} = \varepsilon_{gt}, \varepsilon_{3t} = \varepsilon_{kt} + \beta_{31}\varepsilon_{yt} + \beta_{32}\varepsilon_{gt} \tag{27}$$

The restrictions manifest that ε_{yt} and ε_{gt}, the unobserved structural innovations or shocks affect the contemporaneous value of y_t, whereas ε_{yt} ε_{gt} ε_{kt} shocks affect the contemporaneous value of g_t. Only ε_{gt} shocks affect the contemporaneous value of g_t. Therefore, y_t does not have any contemporaneous effect on g_t. Similarly, g_t does not have any contemporaneous effect on other variables and k_t has a contemporaneous effect on both y_t and g_t. The observed value of ε_{21} is completely attributable to pure shocks of g_t sequence. The estimated SVAR results are presented in Table 9, which is the contemporaneous effect of variables on each other. With restrictions on three parameters, β_{13}=β_{21}=β_{23}=0, only β_{12}, β_{31} and β_{32} are estimated. Out of the three estimates, only β_{13} is statistically significant, and therefore only GVA has a contemporaneous effect on GCF. CGE does not have a contemporaneous effect on either GVA and or GCF.

Table 9: SVAR Estimates of GVA, CGE and GCF

Equation	*Coefficient*	*Std. error*	*z-statistic*	*Prob.*
C(1)	0.011	0.182	0.063	0.950
C(2)	2.323*	0.183	12.723	0.000
C(3)	0.006	0.461	0.014	0.989
Log-likelihood	-82.758			
LR test chi-square	546.251		Prob.	0.00

Note: * Significant 1% level.

Impulse Response Function: The dynamic causality analysis by the Impulse Response Functions (IRF) traces the time path of reactions to shocks given to the variables in the VAR system. In Figure 4, the IRFs are shown for 10 years, when one standard deviation shock is given to the log of variables and how they react. When GVA is given one standard deviation shock, the GVA series initially increases and then decreases after the 3rd period, but it does not become negative. The CGE series responses to a one standard deviation shock given to GVA is an inverted U shape. The GCF series remains constant to a one standard deviation shock given to GVA until three periods and then starts decaying, becoming negative in the 9^{th} period and turning positive immediately in the 10^{th} period. For one standard deviation of a shock given to the CGE series, the GVA series remains zero at first and thereafter starts increasing, the CGE series declines but does not become negative and the GCF series fluctuates and becomes zero in the 9^{th} period and turns negative in the 10th period. When one standard deviation shock is given to the GCF series, the GVA series starts from zero and keeps on increasing, the CGE series increases at first and then starts declining, while the GCF series declines gradually.

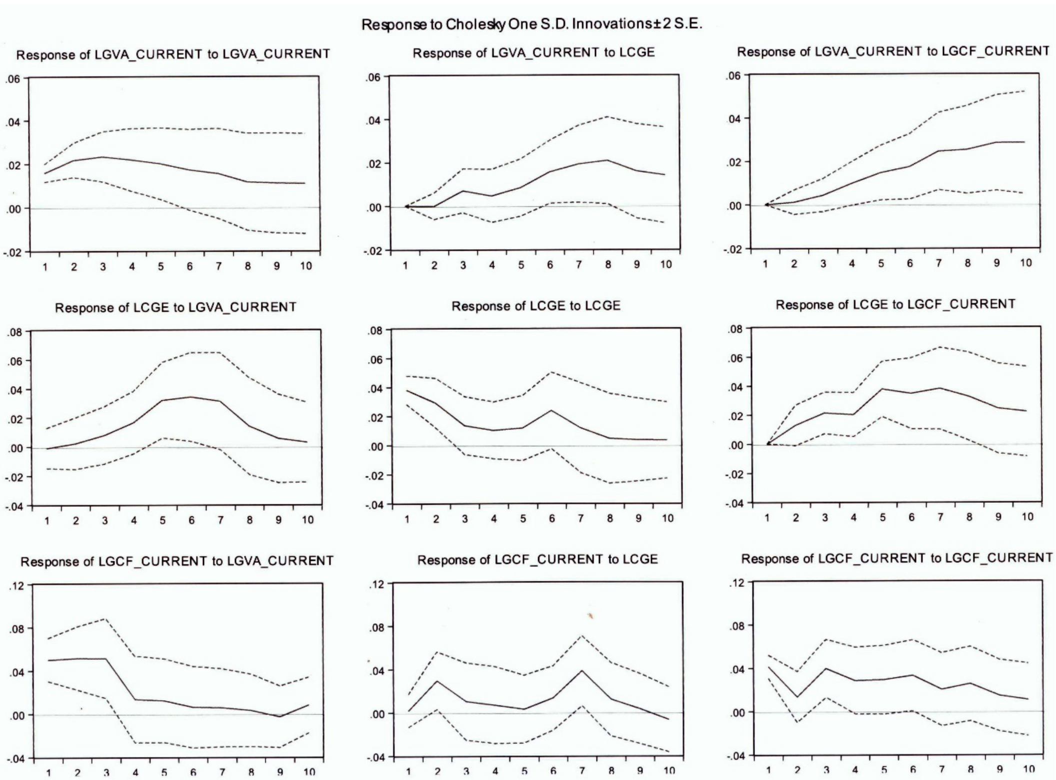

Figure 4: Impulse Response Functions

CONCLUSION

This paper analyses the causal relationship between government size and economic growth in India in order to optimise growth in a mixed developing economy context. More specifically, this study examines whether the size of government spending has any positive or negative effect on economic growth. As government expenditure is sizable and impacts the economy, the marginal return to governance is of crucial importance for the allocation of resources. Over the years, economic growth, along with various other factors, is also determined by government expenditure. In turn, the government also decides public expenditure on the basis of the growth of the economy. Under such a scenario, both government expenditure and economic growth are interdependent, creating an endogenous environment. Hence, this paper estimates the causal relationship between government spending and economic growth in an endogenous system by VAR and SVAR methods. Economic growth is measured by gross value added and the size of government by combined central and state government expenditures.

The estimated results show that the combined government expenditure has no immediate effect on the economic growth in India. The government expenditure has a lagged effect on growth, after three years. Further, government expenditure negatively affects economic growth in the sense that a further increase in government expenditure leads to a decline in economic growth. This suggests the inverted U-shaped Dick Armey Curve in India, a non-linear relationship between governance and economic growth. The same can be seen in the VAR estimates where the coefficients show negative and positive signs alternatively. This shows that India is operating at the negative part of the curve and has already achieved the highest attainable growth for the given level of government. In fact, the estimated relationship reflects the law of diminishing returns. Therefore, the government should cut down its expenditure in order to generate a positive effect of public expenditure on economic growth, keeping in mind that government expenditure will affect the growth only after some years from now.

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