Patterns of Causality Between Public Expenditure and Growth of Money and National Income in India

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Abstract

We use the argument of Lutkepohl (1982), and Ahsan, Kwan, and Sahni (1992) to model causal relation between public expenditure and national income growth in India during the period 1951-1989. The "omitted" variable considered is the rate of growth of M1. It is revealed that the pattern of causality is affected by the inclusion of the "omitted" variable. Several empirical hypotheses of significance with regard to these macro/fiscal variables are tested. Implications for policy are also drawn.

I. Introduction

Conventional investigations into the relationship between growth of public expenditure and economic growth have been based on analyzing the time pattern of covariance between some measure of government sector growth and the rate of economic growth. Since the advent of causality analysis the focus has shifted to discerning the patterns of causal links between these two aggregates. Usually the analysis is based on Granger type tests which analyze bivariate causality.

The empirical results of such causality analyses for various countries are mixed, sometimes even contradictory. For the U.S., for example, Conte and Darrat (1988) reported no causality, whereas Ahsan, Kwan, and Sahni (1989) reported unidirectional causality from growth of public expenditure to growth of national income, Ram (1986) also reported unidirectional causality *albeit* in the opposite direction, and Singh and Sahni (1986) reported bivariate causality.

The focus of causality studies has, by no means, been confined to developed countries alone. Starting from Landau (1983, 1986) a number of works have analyzed causality between these two variables in several LDCs. Landau (1986), and Ram (1986, 1988) provide useful summary statements. However, in these studies as well, there seems to be a wide array of results on the pattern of causality between the growth of public expenditure and the growth of national income.

Several explanations have been offered for this variance of results. Perhaps the most promising of these explanations has been that of Lutkepohl (1982). In this seminal work he argues that the pattern of bivariate causality between two variables may be influenced by other variable(s). The omission of these variables from the analysis of bivariate causality may bias the results in one direction or the other. This theme was picked up by Ahsan, Kwan, and Sahni (1992) who, in their analysis of causality for the U.S., discovered that monetary or debt policy changes influenced the pattern of causality between growth of public expenditure and growth of national income.[1]

The purpose of this paper is to examine this possibility for the case of India. The planner's view has always been that growth of public expenditure has stimulated economic activity and growth. In recent times, this outlook has been questioned. Growth of public expenditure, it is felt, crowds out private investment and stifles productive activity. An examination of the causal relationship between public expenditure and economic growth in the case of a large developing country like India would shed considerable light on this debate. In this paper we attempt such an exercise. We cover the period 1951-1989. The plan of this paper is as follows. In section II we describe the methodology for the Granger test and detail the data sources. In section III we present our results. Section IV offers some concluding comments.

II.The Granger Test for Causality

Granger's causality theorem states that a time series *Y* is said to be caused by a time series *X*, if current values of *Y* can be better predicted by past values of *X* and *Y* than by past values of *Y* alone. Clearly, this theorem is based on the improvement of the predictive efficiency of the model with the introduction of the past values of *X*.

To test for causality the following models may be used.

$$Y_t = \alpha + \sum_{l=1}^{s} \beta_l Y_{t-l} + \sum_{i=1}^{r} \gamma_i X_{t-i} + v_{1t} \qquad (1)$$

$$X_t = \alpha' + \sum_{l=1}^{n} \beta'_l Y_{t-l} + \sum_{i=1}^{m} \gamma'_i X_{t-i} + v_{2t} \qquad (2)$$

where s,r,n, and m (the order of the lags) are to be determined and v_{1t} and v_{2t} are white noise.

These equations can be written as (using L as the one period lag operator):

$$[1 - (\beta_1 L + \beta_2 L^2 + \ldots + \beta_s L^s)]Y_t - [\gamma_1 L + \gamma_2 L^2 + \ldots + \gamma_r L^r]X_t$$
$$= \alpha + v_{1t}$$
$$-[\beta'_1 L + \beta'_2 L^2 + \ldots + \beta'_n L^n]Y_t + [1 - (\gamma'_1 L + \gamma'_2 L^2 + \ldots + \gamma'_m L^m]X_t$$
$$= \alpha' + v_{2t}.$$

Or, as

$$\begin{bmatrix} \Phi_{11} & \Phi_{12} \\ \Phi_{21} & \Phi_{22} \end{bmatrix} \begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} \alpha \\ \alpha' \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \end{bmatrix} \qquad (3)$$

where Φ_{ab} (a,b =1,2) are as defined above.

Granger's bivariate causality can be deduced as follows:

(i) $X_t \rightarrow Y_t$ (X_t causes Y_t if $\Phi_{12} \neq 0$ (statistically),

(ii) $Y_t \rightarrow X_t$ (Y_t causes X_t if $\Phi_{21} \neq 0$),

(iii) $X_t \leftrightarrow Y_t$ (X_t causes Y_t and Y_t causes X_t if neither Φ_{12} nor Φ_{21} is zero).

(iv) X_t and Y_t are independent if $\Phi_{12} = \Phi_{21} = 0$.

With trivariate causality (between X_t, Y_t, and Z_t) we would write equations (4),(5), and (6) below instead of (1) and (2).

$$Y_t = \alpha + \sum_{l=1}^{s} \beta_l Y_{t-l} + \sum_{i=1}^{r} \gamma_i X_{t-i} + \sum_{k=1}^{q} \delta_k Z_{t-k} + v_{1t} \qquad (4)$$

$$X_t = \alpha' + \sum_{l=1}^{m} \beta'_l Y_{t-l} + \sum_{i=1}^{n} \gamma'_i X_{t-i} + \sum_{k=1}^{p} \delta'_k Z_{t-k} + v_{2t} \tag{5}$$

$$Z_t = \alpha'' + \sum_{l=1}^{d} \beta''_l Y_{t-l} + \sum_{i=1}^{e} \gamma''_i X_{t-i} + \sum_{k=1}^{g} \delta''_k Z_{t-k} + v_{3t} \tag{6}$$

which can be written as:

$$\begin{bmatrix} \phi_{11} & \phi_{12} & \phi_{13} \\ \phi_{21} & \phi_{22} & \phi_{23} \\ \phi_{31} & \phi_{32} & \phi_{33} \end{bmatrix} \begin{bmatrix} Y_t \\ X_t \\ Z_t \end{bmatrix} = \begin{bmatrix} \alpha \\ \alpha' \\ \alpha'' \end{bmatrix} + \begin{bmatrix} v_{1t} \\ v_{2t} \\ v_{3t} \end{bmatrix} \tag{7}$$

where α, α', α'' are constants and v_{1t}, v_{2t}, v_{3t} are white noise, and ϕ_{ab}, a,b = 1,2,3 are appropriately defined parameters.

It is clear that non-causality in a bivariate system ($\Phi_{12} = \Phi_{21} = 0$) does not necessarily imply the lack of causal relation between Y_t, and X_t. This is because indirect causality between these two variables is possible so long as (i) ϕ_{13} and ϕ_{32} or (ii) ϕ_{31} and ϕ_{23} are significantly different from zero. It is also possible that Granger causality in a bivariate system ($\Phi_{12} \neq 0$, and $\Phi_{21} \neq 0$) may cease to hold as. the presence of Z_t removes any spurious causality between them. Thus it will be necessary to examine the causal direction between the variables considered and the omitted variable (Z_t).

Data Requirements

The data used in this paper have been collected from <u>International Financial Statistics Yearbooks</u> (1973, 1987, 1991) and pertain to India and <u>Indian Economic Survey</u> of various years. The data on government expenditure (Y_t) and gross national product (X_t) in nominal terms are obtained from this source and rates of growth calculated. The "omitted" variable considered is nominal growth of M_1. To consider an alternative specification, government expenditure was proxied by government deficit. In this case also the omitted variable was growth of M_1.

The rationale for using growth of M_1 comes from the structuralist argument that growth in less developed countries is often constrained by the existing supply of money which, in the presence of imperfectly developed capital markets, is often to be viewed as a producer's good[2]. In a growth context the analysis of the causal relation between grow h rates of money supply and output would also shed light on the propert y of superneutrality (or otherwise) of money.

The causal relationship between government expenditure and economic growth can be analyzed in terms of (i) absolute values of aggregates, (ii) per capita values of aggregates, and (iii) the growth rates of aggregates. For an analysis of the causal relations between government expenditure and rates of growth of money and national income a study of all these is overly exhaustive. We attempt an analysis of causality with respect to each of these three categories.

The data are collected for the period 1951-89 (39 observations). The maximum length of lags for determining the autoregressive process was ascertained by minimizing Akaike Criterion Values (ACV). This is another major innovation of this paper. The lag structure in the only other paper to have followed the Lutkepohl approach[3] is essentially exogenous.

We began by assuming that an aggregate may be affected by its past values for ten years. Then we selected the length of the lags to determine the optimum order of the autoregressive process. First, ten data points were considered as pre-sample values for determining the order of autoregressive process. The variables used were: GDPR = log (Gross Domestic Product at 1980-81 prices), GOVTEXP = log (Government Expenditure at 1980-81 prices), GM11 = growth rate of M_1 , GGDPR = Growth rate of gross domestic product (1980-81 prices), GGVTDEF = growth rate of government deficit (1980-81 prices), GGVTEXP = growth rate of real government expenditure (1980-81 prices), GDPRPC = real gross domestic product per capita, and GOVTEXPC = real government expenditure per capita.

Once the order of autoregressive process was determined the pre-sample values were reduced from ten to five because for none of the series did the order of autoregressive process involve lags of more than five periods. The ACVs obtained in this case are given in Table 1.

Table 1 here.

The procedure for analyzing causality in both the bivariate and trivariate regime is similar to those of Lutkepohl (1982). All the variables were transformed to stationary time series employing Box-Jenkins (1970) methods. Thereafter Akaike (1973, 1974) information criterion[4] was employed to determine the lag structure of the variables involved in the system. Finally zero restrictions were imposed on certain coefficients in order to examine causal direction between government expenditure and GNP.

III. Estimation of the Models

First of all we tested the two way causality by estimating the model (3) and examined whether any of these minimize ACV previously achieved by the autoregressive process of dependent variable. After minimizing the ACV we examined whether zero restrictions could be imposed on the selected equations. The results are reported below; first for bivariate and then for trivariate causality tests.

Estimated Equations for Bivariate Causal Direction

(A) Causal Direction between Real Gross Domestic Product and Real Government Expenditure.

(i) GROSS ABSOLUTE VALUES OF THE VARIABLES

$$\begin{bmatrix} GDPR \\ GOVTEXP \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & 0 \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} GDPR \\ GOVTEXP \end{bmatrix}$$

where

$$\alpha_1 = \underset{(-0.779)}{-0.0209}, \qquad \alpha_2 = \underset{(-3.4695)}{-4.504},$$

$$\phi_{11}(L) = \underset{(0.893)}{0.00991\,L} + \underset{(91.002)}{1.010\,L^2},$$

$$\phi_{12}(L) = 0,$$

$$\phi_{21}(L) = \underset{(3.521)}{2.190\,L} + \underset{(3.518)}{2.189L^2}, \quad \phi_{22}(L) = \underset{(3.298)}{0.473\,L}$$

Thus there is evidence of causality running from GDPR to GOVTEXP.

(ii) GROWTH RATES OF THE VARIABLES

Causal Direction between the growth rate of real gross domestic product and growth rate of real government expenditure.

The estimated equations are

$$\begin{bmatrix} GGDPR \\ GGVTEXP \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & 0 \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} GGDPR \\ GGVTEXP \end{bmatrix}$$

where $\alpha_1 = \underset{(4.127)}{0.275}$ $\qquad \alpha_2 = \underset{(0.5117)}{0.00430}$,

$$\phi_{11}(L) = \underset{(-1.226)}{0.218\,L} - \underset{(-1.425)}{0.274\,L^2} \underset{(-0.73)}{-0.140\,L^3} \underset{(1.895)}{-0.351\,L^4}$$

$$\phi_{12}(L) = 0,$$

$$\phi_{21}(L) = \underset{(-0.219)}{-0.791\ L} + \underset{(1.309)}{4.954\ L^2}$$

$$\phi_{22}(L) = \underset{(-12.314)}{-0.906\ L} \ .$$

Our analysis (Table 2) indicates that there is no causality.

(iii) PER CAPITA VARIABLES

Causality between growth rate and per capita real expenditure.

$$\begin{bmatrix} GDPRPC \\ GOVTEXPC \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & \phi_{12}(L) \\ \phi_{21}(L) & \phi_{22}(L) \end{bmatrix} \begin{bmatrix} GDPRPC \\ GOVTEXPC \end{bmatrix}$$

$$\alpha_1 = \underset{(2.685)}{4.891} \qquad \alpha_2 = \underset{(1.219)}{2.605}$$

$$\phi_{11}(L) = \underset{(1.285)}{0.3275\ L}$$

$$\phi_{12}(L) = \underset{(-0.666)}{-0.129\ L} + \underset{(2.533)}{0.329\ L^2}$$

$$\phi_{21}(L) = \underset{(-1.154)}{-0.350\ L}$$

$$\phi_{22}(L) = \underset{(2.588)}{0.587\ L} + \underset{(3.050)}{0.464\ L^2}$$

Our analysis in Table 2 indicates that GOVTEXPC causes GDPRPC.

(B) When Growth Rate of Government Deficit is used as a proxy for government expenditure the following regressions were obtained:

(i) Causal Direction between growth of real GDP per capita and growth rate of government deficit.

$$\begin{bmatrix} GDPRPC \\ GGVTDEF \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{bmatrix} \begin{bmatrix} GDPRPC \\ GGVTDEF \end{bmatrix}$$

$$\alpha_1 = \underset{(3.315)}{3.663}, \quad \alpha_2 = \underset{(0.597)}{0.058}, \qquad \phi_{11} = \underset{(3.459)}{0.512}$$

$$\phi_{12} = -\underset{(-1.531)}{0.228\ L} - \underset{(-1.633)}{0.248\ L^2}, \qquad \phi_{21} = 0,$$

$$\phi_{22} = \underset{(-6.500)}{-0.754\ L} \underset{(-0.412)}{-0.062\ L^2} \underset{(-2.889)}{-0.411\ L^3} - \underset{(-4.395)}{0.218\ L^4}$$

No bivariate relationship in respect of the causality between growth rate of real gross domestic product and growth of government budget deficit could further reduce the ACVs previously achieved through autoregressive process.

In Table 2 below we test for zero restrictions for the bivariate causality tests. From this table it is observed that (a) in case of levels of variables $\phi_{12}=0$ but $\phi_{21} \neq 0$ indicating causal direction from GDPR -> GOVTEXP. This may be reflecting the budgetary relationship from GDPR to Revenue to GOVTEXP. (b) In the case of growth rates of variables $\phi_{12} = 0$ and $\phi_{21} = 0$ at 5 % level of confidence. Although the equation testing direction GGDPR -> GGVTEXP could better predict GGVTEXP in terms of ACVs, but the null hypothesis could not be accepted. Thus the zero restrictions were not applicable.

(c) In the case of per capita variables we find that $\phi_{12} \neq 0$, i.e. H_o is rejected at the 5 % level of significance. Therefore in this case GOVTEXPC is causing GDPRPC.

(d) When government deficit was used as a proxy for government expenditure,no significant direction of causality was found indicating that there is no significant relationship between growth government deficit and GDP growth.

We report results on our tests for zero restrictions in Table 2.

Table 2 here.

Estimated Equations for Trivariate Causality Directions

(i) GROSS ABSOLUTE REAL VALUES

Causal Direction between Gross Real Domestic Product and Real Government Expenditure including the Omitted Variable GM11

The estimated equations are:

$$\begin{bmatrix} GDPR \\ GOVTEXP \\ GM11 \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} \phi_{11}(L) & 0 & 0 \\ \phi_{21}(L) & \phi_{22}(L) & 0 \\ 0 & 0 & \phi_{33}(L) \end{bmatrix} \begin{bmatrix} GDPR \\ GOVTEXP \\ GM11 \end{bmatrix}$$

$\alpha_1 = -0.0209$ (−0.279) $\alpha_2 = -4.504$ (−3.4695) $\alpha_3 = 0.032$ (5.443)

$\phi_{11}(L) = 0.00991\,L + 1.010\,L^2$, (0.893) (91.002) $\phi_{12}(L) = 0$, $\phi_{13}(L) = 0$

$\phi_{21}(L) = 2.190L + 2.189\,L^2$ (3.521) (3.518), $\phi_{22} = 0.473\,L$ (3.298), $\phi_{33}(L) = -0.0166\,L - 0.344\,L^2$ (−0.10067) (−2.083)

The above regression equations show that the introduction of omitted variables does not change the causal direction obtained in the bivariate case. But Table 3 indicates that thid pattern of causality cannot be sustained when zero restrictions are applied.

(ii) GROWTH RATES OF VARIABLES

The estimated equations are:

$$\begin{bmatrix} GGDPR \\ GGVTEXP \\ GM11 \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} 0 & \phi_{12}(L) & \phi_{13}(L) \\ 0 & \phi_{22}(L) & \phi_{23}(L) \\ 0 & 0 & \phi_{33}(L) \end{bmatrix} \begin{bmatrix} GGDPR \\ GGVTEXP \\ GM11 \end{bmatrix}$$

$\alpha_1 = 0.00100$ (2.257) $\alpha_2 = 0.0115$ (3.772) $\alpha_3 = 0.032$ (5.443

$\phi_{12}(L) = -0.293\,L$, (−0.882) $\phi_{13}(L) = 0.0295\,L - 0.0165\,L^2$, (2.375) (−1.882)

$\phi_{21}(L) = 0$, $\phi_{22}(L) = -0.778\,L$ (−6.930) $\phi_{23}(L) = -0.01939\,L$ (−1.668)

$\phi_{31}(L) = 0$, $\phi_{32}(L) = 0$, $\phi_{33}(L) = \underset{(-0.1006)}{-0.0166\,L} - \underset{(-2.083)}{0.344\,L^2}$

From Table 3 we now have GM11 -> GGDPR and that GGVT does not cause GGDPR. This is at variance with the results in the bivariate case.

(iii) PER CAPITA VALUES OF THE VARIABLES

The estimated equations are:

$$\begin{bmatrix} GDPRPC \\ GOVTEXPC \\ GM11 \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{bmatrix} + \begin{bmatrix} 0 & \phi_{12}(L) & \phi_{13}(L) \\ 0 & \phi_{22}(L) & 0 \\ 0 & 0 & \phi_{33}(L) \end{bmatrix} \begin{bmatrix} GDPRPC \\ GOVTEXPC \\ GM11 \end{bmatrix}$$

$\alpha_1 = \underset{(95.34)}{7.278}$ $\alpha_2 = \underset{(2.339)}{0.139}$ $\alpha_3 = \underset{(5.443)}{0.032}$

$\phi_{11}(L) = 0$, $\phi_{12}(L) = \underset{(0.501)}{0.0632\,L} + \underset{(2.167)}{0.261\,L^2}$; $\phi_{13}(L) = \underset{(-0.817)}{-2.0037\,L}$

$\phi_{21}(L) = 0$, $\phi_{22}(L) = \underset{(2.638)}{0.387\,L} + \underset{(3.827)}{0.535\,L^2}$, $\phi_{23}(L) = 0$,

$\phi_{31}(L) = 0$ $\phi_{32}(L) = 0$, $\phi_{33}(L) = \underset{(-0.1006)}{-0.0166\,L} \underset{(-2.083)}{-0.344\,L^2}$

Here we get (from Table 3) the result that GOVTEXPC ->GDPRPC.

When Government Deficit was used as a proxy for Government Expenditure in the trivariate case with GGVTDEF and GM11 as other explanatory variables, no regression equation could minimize ACVs. In Table 3 we test for zero restrictions in the trivariate causality case.

Table 3 here.

IV. Conclusions

Our bivariate causality analysis indicates that there is a causal relation running from real gross domestic product to real government expenditure. This points to the budgetary relationship between expected tax revenue and government expenditure. We also examined the causal link between growth rates of real gross domestic product and real gross government expenditure. Although it was revealed that the testing equation for GGDPR to GGVTEXP could minimize ACV, but this pattern of causality could not be sustained when zero restrictions were applied. Hence we came to the conclusion that so far as growth rates are concerned there is no significant pattern of causality.

It was also revealed that there is a causal link from per capita real government expenditure to per capita real gross domestic product. It thus appears that in the Indian economy a reduction in per capita government expenditure may retard growth. When growth rates of government deficit was used as a proxy for real government expenditure no significant pattern of causality could be detected.

To further study our results we introduced a third variable- growth rate of M_1. The introduction of this previously "omitted" variable further strengthened our conclusions. No significant pattern of causality between the levels of the variables could be detected. However we did detect causality running from growth of M_1 to growth of real GDP but no causal relation between GGVTEXP and GGDPR. When per capita values of the variables were taken into account the direction of causality was from GOVTEXPC to GDPRPC. However GM11 and GDPRPC were not causally linked. When government deficit was used as a proxy for government expenditure no significant pattern of causality could be detected.

It would therefore appear that the generalization of the causality tests from the bivariate to the trivariate case has helped us better understand the pattern of dependence existing among key macro/fiscal variables in the Indian economy. The analysis in this paper also attests to the fact that bivariate causality can be misleading - both by rejecting causality when a pattern exists and by inferring causality when no such pattern exists. At a policy level we learned that money supply growth does positively affect real growth; so money is not superneutral. It is also discovered that per capita government expenditure has a positive effect on output growth. Growth in the Indian economy thus seems to be demand led. Increases in growth rates of money supply raise output growth and increase in per capita government expenditure raise growth rate of per capita output. However, government deficit does not affect output growth.

FOOTNOTES

1. A major shortcoming of the Ahsan, Kwan, Sahni analysis is that their lag structures are essentially exogenous. The lag structure used in the present paper is based on the robust criterion of minimizing Akaike critical values.
2. See Taylor (1983), for instance.
3. See Ahsan, Kwan and Sahni (1992).
4. In choosing lag structures for a regression equation one is faced with the problem of deciding upon a criterion for such choice. The Akaike criterion value is one such measure. The intuition behind the use of this criterion is as follows. As we add more and more explanatory variables (lagged endogenous and/or exogenous) to a regression equation its performance in predicting the endogenous variable is likely to increase. If it does not, then these additional variable are superfluous and may be removed from the regression equation. The Akaike criterion value is a measure of the performance of the regression equation as we conduct precisely the above-mentioned exercise. As the value of this index drops the predictive power of the regression equation improves. The optimal lag structure for any equation is reached when the ACV is minimized. At an operational level, then, we can use the ACVs of an equation to decide upon optimal lag structures as well as whether addition of exogenous variables is worthwhile. For technical details see Akaike (1973).

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TABLE 1

TABLE OF AKAIKE CRITERION VALUES (ACV) OF VARIOUS SERIES USED

LAGS	GDPR	GOVTEXP	GGVT DEF	GOVTEXPC	GDPRPC	GM11	GGDPR	GGVTEXP
1.	-6.7724	-7.362	-4.857	-3.03	-3.420	-8.97	-14.08	-8.042*
2.	-12.302*	-7.345	-4.83	-3.376*	-3.445*	-9.07*	-14.08	-8.021
3.	-12.2984	-7.371*	-4.811	-3.375	-3.433	-9.043	-14.052	-7.994
4.	-12.3013	-7.341	-4.788	-3.343	-3.427	-9.011	-14.13*	-7.99
5.	-12.270	-7.310	-5.727*	-3.337	-3.422	-8.977	-14.115	-7.96

N.B. An asterisk (*) signifies minimum ACV. The autoregressions corresponding to minimum ACVs can be obtained from the first author

TABLE 2 : TESTING ZERO RESTRICTIONS FOR BIVARIATE CAUSALITY

Variables	Hypothesis Tested	χ^2 = nobs(Log RSS_R - Log RSS_U)	$\chi^2_{p,0.05}$
(a) TESTS FOR ABSOLUTE VALUES OF VARIABLES			
Causality Between Real Gross Domestic Product and Real Government Expenditure			
GDPR	$H_o:\phi_{12}=0;H_1:\phi_{12}\neq 0,$	$\chi^2_1 \leq 0$	$\chi^2_{1.0.05}$ =3.841 (H$_o$ is accepted)
GOVTEXP	$H_o:\phi_{21}=0;H_1:\phi_{21}\neq 0,$	χ^2_2 =128.364	$\chi^2_{2,0.05}$=5.991 (H$_o$ is rejected)
(b) TESTS FOR GROWTH RATES OF VARIABLES			
Causality between Growth Rate of Real Gross Domestic Product and Growth Rate of Real Government Expenditure.			
GGDPR	$H_o:\phi_{12}=0;H_1:\phi_{12}\neq 0$	$\chi^2_1 \leq 0$	$\chi^2_{1,0.05}$ =3.841 (H$_o$ is accepted)
GGVTEXP	$H_o:\phi_{21}=0;H_1:\phi_{21}\neq 0$	χ^2_1 = 1.398	$\chi^2_{1,0.05}$ = 3.841 (H$_o$ is accepted)
(c) TESTS FOR PER CAPITA VARIABLES			
Causality between Growth Rate and Per Capita Real Expenditure			
GDPRPC	$H_o:\phi_{12}=0;H_1:\phi_{12}\neq 0$	χ^2_1 = 19.877	$\chi^2_{1,0.05}$ =3.841 (H$_o$ is rejected)
GOVTEXPC	$H_o:\phi_{21}=0;H_1:\phi_{21}\neq 0$	$\chi^2_1 \leq 0$	$\chi^2_{1,0.05}$ =3.841 (H$_o$ is accepted)

(d) TESTS FOR PER CAPITA VARIABLES WITH GOVERNMENT DEFICIT AS PROXY

Causality between Growth and Growth Rate of Government Deficit

GDPRPC	$H_o:\phi_{12} = 0$;	$H_1:\phi_{12} \neq 0$,	$\chi^2 = 3.967$,	$\chi^2_{2,0.05} = 5.99$
				(H_o is accepted)
GGVTEXP	$H_o:\phi_{21} = 0$;	$H_1:\phi_{21} \neq 0$,	$\chi^2 \leq 0$	$\chi_{1,0.05} = 3.841$
				(H_o is accepted)

N.B. (i) p indicates degrees of freedom.

(ii) F tests, also used in the literature, gave the same results.

TABLE 3: TESTING ZERO RESTRICTIONS FOR CAUSALITY IN TRIVARIATE REGIME

Variable	Hypothesis Tested	χ^2 =nobs(Log RSS_R $-RSS_U$)	$\chi^2_{p,0.05}$

(A) (i) In the case of omitted variables with GDPR and GOVTEXP as the principal variables, the introduction of omitted variables did not reduce the value of the ACVs any further from that obtained in the bivariate case. Hence no hypotheses were tested for this case.

(ii) Test of hypothesis in respect of growth rates of variables.

GGDPR	$H_o:\phi_{13}=0;H_1:\phi_{13}\neq 0$	$\chi^2_{2,0.05}$ =7.628	$\chi^2_{2,0.05}$ =5.991

H_o is rejected, i.e. GM11 -> GGDPR

GGVTEXP	$H_o:\phi_{12}=0;H_1:\phi_{12}\neq 0$	$\chi^2_{1,0.05}$ =0.867	$\chi^2_{1,0.05}$ = 3.841

H_o is accepted,i.e., GGVTEXP does not cause GGDPR.

(iii) Test of hypothesis in respect of per capita real gross domestic product and per capita gross real expenditure.

GDPRPC	$H_o:\phi_{13}=0;H_1:\phi_{13}\neq 0$	$\chi^2_{1,0.05}$ =0.746	$\chi^2_{1,0.05}$ =3.841

H_o is accepted, GM11 does not cause GDPRPC.

	$H_o:\phi_{12}=0;H_1:\phi_{12}\neq 0$	$\chi^2_{1,0.05}$ =24.0135	$\chi^2_{1,0.05}$ =3.841

H_o is rejected. This indicates that GOVTEXPC ->GDPRPC.

(B) When growth rate of government deficit was used as a proxy for government expenditure no regression equation could further reduce the ACVs previously achieved.

N.B.(i)Various functional forms, ACVs, $\bar{R}$, and RSS can be obtained from the first author.

(ii) p indicates degrees of freedom.

(iii) F tests also revealed the same results.