# CAUSALITY BETWEEN PUBLIC EXPENDITURE AND GNP: THE INDIAN CASE REVISITED

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**Abstract.**

Based on relatively comparable and reasonably good data for 1960-61 through 1990-91, and on fairly rigorous econometric techniques, this paper concludes that the direction of causation is from GNP to total government expenditure in the Indian case. Eleven categories of expenditure are also studied for causality with GNP. In respect of the expenditures on defense, industry, water supply and sanitation, and transport, causation runs from GNP. In the case of educational expenditure, causation runs from them to GNP. In the remaining expenditure categories, there is no causation either way.

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## I. Introduction.

The relationship between aggregate public expenditure and the overall level of economic activity (proxied by GNP, for instance) continues to be of significant research and policy interest, as evidenced by a number of cross-country and time-series studies. Two of the recent studies dealing with a large number of countries gave conflicting results. The cross-country study by Landau (1983) has concluded that the growth of government hurts economic growth. In contrast, based on cross-country and time series results, Ram (1986) inferred that government size has a positive impact on economic growth. However, a scrutiny of Ram's time-series results showed that in many countries, causation was not uniquely from government to economic growth [Rao (1989)]. Given these diverse results and the difficulty in generalising the relationships across different countries and cultures, it is perhaps wise to look at the relationship between government expenditure and GNP within

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individual countries as has been done by Singh and Sahni (1984, 1986) and Sahni and Singh (1984). Other recent attempts in this direction include Afxentiou and Serletis (1991).

In their pioneering Indian study based on data from 1950 through 1981, Singh and Sahni (1984) found that while the causal process was rather diverse at the disaggragated level, there was a bidirectional causal relationship at the aggregate level. It is now well known that the fiscal data for the early 1950s did not adequately refer to the total government sector due to the teething difficulties in the consolidation of the central (federal) and state-level financial transactions. Also the decade following 1981 has witnessed significant structural shifts in the overall economic policy, calling for a fresh look at the interaction between government size and economic growth. This paper explores the issue in the light of more recent and relatively more comparable data for 1960-61 through 1990-91 and on the basis of different analytical techniques in addition to the standard Granger causality framework. This inquiry is also quite topical and timely since India is presently going through an economic crisis, necessitating a re-examination of the role of government in the economy.

Section II describes the data and methodology. In Section III, preliminary analysis based on standard Granger causality tests are discussed. Results of stationarity tests are also presented. Section IV provides results based on vector auto regression (VAR) methods. Section V has concluding observations.

## II. Data and Methodology.

### A. The Data

Singh and Sahni (1984) used data for the period 1950-81. The concept of public expenditure was the expenditure charged to the revenue account and the capital account, excluding loans and advances. For the level of economic activity, national income (net national product at factor cost) was used.

This paper mainly utilises the data for 1960-91 obtained from the Ministry of Finance, *Indian Economic Statistics: Public Finance* (various issues). Data on gross national product are from the *National Account Statistics* (various issues) published by the Central Statistical Organisation. In addition to aggregate government expenditure, the following components were also considered: expenditures on defense, police, subsidies, railways, postal services, education, health, agricultural services, industrial services, water and sanitation and transport. Constant price data were used throughout. It may be noted that Sahni and Singh (1984) used current price data and constant price data with a single uniform deflator (national income deflator) to deflate all the expenditures (aggregate as well as by function). In this paper relatively more appropriate, function-specific deflators are used. The deflators are derived from the relevant sectoral GDP estimates at current and constant prices. Also, Singh and Sahni (1984) tried Granger causality analysis on per capita public expenditures and per capita national income. In this paper, total expenditures and GNP are used, partly to eliminate the needless

deflation of both variables by population and partly to avoid the vitiation of results caused by the rough and ready depreciation estimates that are used in converting GNP to NNP.

**B. Methodology.**

*Granger Causality Analysis.* The procedure adopted by the past studies for testing the existence of causality between government expenditure and GNP involved estimation of two linear equations, one each for government expenditure and GNP, expressed as functions of the two variables with appropriate lags. Since the equations involve lagged independent and dependent variables the errors might be serially correlated and the F-test statistic is sensitive to such serial correlation in the errors. Therefore the data series are first passed through alternative filters such as Sims' (1972) and Nerlove's (1964). The approach followed by Singh and Sahni (1984) for example, was to employ Durbin's test II and whenever the test statistic indicated serial correlation in the errors, to pass the data through an *ad hoc* filter devised from autoregressions of the disturbance. The present study also starts with Granger causality tests conducted on unadjusted series, first differenced series and series passed through Sims' filter, to serve as a bench-mark and to approximately be in line with the earlier contribution of Singh and Sahni (1984).

*Stationarity Tests.* It is well-known that testing for Granger causality with unadjusted data series poses problems as the data series need not be stationary and OLS regressions involving nonconvergent polynomials may not be the right method. Further, these regressions are prone to lagged dependence bias. On the other hand, it is not known if first differencing is an

adequate remedy to remove nonstationarity. Also, most economic variables are known to exhibit growth over time and thus de-trending may be required. Without properly diagnosing the source of nonstationarity, first differencing or employing Sims' filter might result in overdifferencing of the series. Moreover, Sims' filter may not be appropriate for transforming a nonstationary series into stationary series, for, the filter polynomial has roots lying outside the unit circle and so, there is no guarantee that it can transform a non-stationary series into stationary series. In addition, it is also advisable to use some scientific criteria to decide on the lag length in the regression equations.

To convert the series to stationarity, the classical devices used for this purpose are the autocorrelation and partial correlation functions. A nondamping autocorrelation function (ACF) and partial correlation function (PCF) would indicate nonstationarity in a series. However, apart from being not very precise, these correlograms cannot suggest the type of methods of conversion to stationarity - whether the series are difference stationary (DS) or trend stationary (TS). Several testing procedures have been suggested in the literature to test not only the existence of unit root in the AR polynomial of the statistical process, but also to test the existence of a regular trend. In this paper, Dickey-Fuller (1979) (DF) test, in particular the version testing for the trend effect given by Nelson and Plosser (1982) is used.

After the series are subjected to standard tests for the existence of unit root as well as time trend effect, depending upon the outcome, the series are converted to stationarity using appropriate processes of transformation, and Granger tests are re-applied.

*Geweke's Canonical Causality Formulation*. The alternative causality testing methods adopted in this study are based on the canonical formulation provided by Geweke (1982, 1984). The advantage of these methods over the others based on F-tests is, that apart from facilitating multivariate causality testing within vector auto regression (VAR) framework, Geweke's method enables quantification of the strength of causality even in the bivariate case, and also provides Wald, likelihood-ratio (LR) as well as Legrange multiplier (LM) versions of the causality tests.

Briefly, the method is as follows. Let a VAR system be

$$[I-A(L)]z_t=e_t \qquad (1),$$

where $z$ is a $k$ - dimensional vector of variables involved, $A$ is a matrix polynomial of order $p$ in the lag / lead operator $L$, where each coefficient matrix has a dimension $(k.k)$, and $I$ being an identity matrix. The error terms of the vector e are serially but not necessarily contemperaneously, uncorrelated. Let $z$ be partitioned into two sub vectors $x$ and $y$ (of dimensions $l$ and $g$, respectively) reflecting an interest to test the Granger causality between the two groups. The partitioned VAR system is of the form

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} A_{xx}(L) & A_{xy}(L) \\ A_{yx}(L) & A_{yy}(L) \end{bmatrix} \cdot \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} u \\ v \end{bmatrix} \qquad (2)$$

where $A_{ij}(L)$ $(i,j=x,y)$ denote the partitioned matrix polynomials.

The linear dependence between the two sub vectors is tested by putting four alternative sets of restrictions on the matrix polynomials. The first set of restrictions implies a system where the sub-vectors x and y are mutually independent, and each is a function of its own lags. The errors are denoted as $u_1$ and $v_1$ and their variances, as $T_1$ and $\tau_1$ respectively. The restrictions also imply that the errors are contemperaneously independent. The second set implies that the matrix polynomials $A_{ij}$ are non-zero for $i \neq j$, but the two sub-vectors of errors are contemperaneously independent. The variances of the two errors are denoted by $T_2$ and $\tau_2$, respectively. The third set implies that the error variance - covariance matrix may contain non-zero off-diagonal elements. Accordingly, this model needs to be estimated by pre-multiplying the system with a factor matrix and so that the transformed errors are uncorrelated with the independent variables in the respective equations and OLS can be applied to estimate them. By virtue of this transformation, the system might contain zero-lagged (current) independent varibles. The variances of the two errors are denoted by $T_3$ and $\tau_3$, respectively. The fourth set relaxes the order of the matrix polynomials to contain non-zero matrix coefficients for lag orders $L=-p$ *to* $1$. The variances of the two errors are denoted by $T_4$ and $\tau_4$, respectively.

Given these four systems, four types of measures of causality or `linear feedbacks' are computed following Geweke. These are:

(a) Feedback from x to y, $F_{x \to y} = ln(|\tau_1|/|\tau_2|)$

(b) Feedback from y to x, $F_{y \to x} = ln(|T_1|/|T_2|)$

(c) Instantaneous feedback between x and y, $F_{x.y} = ln(|T_2|/|T_3|)$,

(d) Total mutual linear dependence $F_{x,y} = ln(|\tau_1|/|\tau_4|)$

Based on these measures, the Granger-causality tests are conducted by computing the likelihood ratio (LR) test statistics. For example, for testing the direction of causality from $x$ to $y$, the LR test statistic is computed as $N.ln(|\tau_1|/|\tau_2|)$. Under the null hypothesis of `no causality', this statistic is compared with the Chi-square table value (with $p$ degrees of freedom). Similar test statistics can be derived for testing the causality from $y$ to $x$, instantaneous causality, as well as total linear dependence. In addition, Geweke also gives the Wald and Legrange multiplier test statistics as $N.(\tau_1/\tau_2 - 1)$ and $N.(1 - \tau_2/\tau_1)$, respectively.

For the present study, the vectors $x$ and $y$ are one-dimensional vectors and refer to government expenditure and gross national product respectively. In cases where disaggregated expenditures are used, total expenditure is replaced by DEF (defense expenditure), POL (expenditure on police), SBS (expenditure subsidies, RLY (expenditure on railways), P&T (expenditure and posts and telegraph), EDN (expenditure on education), HEA (expenditure on health), AGR (expenditure on agriculture), IND (expenditure on industry) WAT (expenditure on water supply and sanitation) and TPT (expenditure on transport).

## III. Results of Granger Causality and Stationarity Testing.

### A. Results of Granger Causality Analysis.

To begin with, the standard F-tests for Granger causality are conducted on three alternative data sets: (a) original series, (b) first differenced series, and (c) series passed through Sims' filter. The results of the analysis are presented in summary Tables 1, and 2. (More detailed results than what are given in the paper are available from the authors on request.)

*Analysis on Total Government Expenditure (GEX).* It is clear from Table 1 that within the Granger-causality framework, GNP causes GEX and not the other way round. This result holds irrespective of whether the series are not transformed, first differenced or Sims' filtered. This result is in slight contrast to the bi-directional type of a relation observed by Singh and Sahni 1984a).

(Table 1 here.)

*Analysis on Expenditure Components.* Results for each expenditure component are summarised in Table 2 indicating only the inferences based on the Granger F tests. These results show that in the case of *Original Series*, GNP causes defense expenditure, expenditure on subsidies, and expenditure on water supply and sanitation. GNP and industrial expenditures have a bi-directional relationship. In the case of *First Differenced series* educational expenditure and industrial expenditure cause GNP. And for *Sims' Filtered Series*, the results show that the

causation runs from GNP to expenditures on defense, subsidies, health and water and sanitation, while expenditures on police, education and agriculture cause GNP.

(Table 2 here.)

**B. Results of Stationarity Testing.**

The results of stationarity testing are as in Table 3. From the first two autocorrelations for the series GNP and GEX, it has been found that their respective ACFs do not damp out quickly, thereby indicating that the series are not stationary, while their first differences appear to be stationary. The obvious conclusion would be to first difference the series. However, the more formal tests go a step further and explore the nature of the stationarity. The DF test statistics are not significant for the level series but significant for the first difference series, thereby indicating the existence and absence of unit root respectively, which is in line with the ACF patterns. However, a notable feature of the testing with the first differences has been the statistical significance of the coefficient of time trend in most cases. It shows that even though the series could be made stationary by first differencing, the trend effect cannot be neutralised.

A solution to this type of problem would be to convert the series into logs. Accordingly log transformations have been made and the tests, repeated. The test results show that the first differences in logs are fairly stationary. Not only the DF test statistics are statistically significant, but the time trend also turns out to be insignificant. Therefore, first differences in logs are used for subsequent empirical exercises.

(Table 3 here.)

**C. Results of Second-Stage Granger Causality Analysis.**

*Total Government Expenditure*. To obtain some indication about optimal lag lengths, two criteria have been tried: AIC and BIC respectively due to Akaike (1974), and Schwarz (1978). While AIC is known to prefer over parameterised models, BIC is found to be less prone to such preferences. In this exercise AIC was in favor of 2 and 3 lags respectively for GEX and GNP, and BIC favored 2 lags for both the series. The causality by F tests is reconducted on first differences of logarithmic series keeping the common lag length alternatively at 2 and 3. These results also show one way causation from GNP to total expenditure (Table 4).

(Table 4 here.)

*Expenditure Components*. Tests conducted on the stationarised series of the expenditure components are broadly (but not completely) in line with the results of Table 2. The causation is from GNP in the case of defence and water supply, while in the case of education the causation is from the expenditure to GNP. (To save space, detailed results are not provided.)

## IV. Results Based on Geweke's Canonical Causality Formulations.

### A. Total expenditure.

The four versions of the bivariate system (2) are estimated keeping the number of lags fixed at 2 and the test statistics are as shown in Table 5. These tests show that the causation flows only from GNP to government activity and not the other way round. Also the evidence for the instantaneous causality is not strong.

(Table 5 here.)

Similar tests are conducted conditionally, given the inter-relation of government expenditure and GNP with three important macro variables, namely, total government revenue, population and urbanisation (proportion of urban population in total). To ascertain the influence of these three factors, bivariate causality tests are conducted between GNP and each of these variables, as well as between expenditure and each of them. The bivariate analysis between GNP and the three variables shows that GNP has a one way causation from revenue (which is rather surprising), a one way causation from population, and a two way causation with urbanisation. Expenditure has a one way causation to revenue, a mild instantaneous causation with population, and a one way causation from urbanisation. These results show that while examining the causation between GNP and government expenditure, the impact of these factors cannot be ignored.

Thus an attempt is made to ascertain the causality conditionally, taking into account the above results. The three variables along with their lags are considered as additional determinants for both GNP and government expenditure equations of the system and the causality tests are re-conducted. The results are as in Table 6. The conditional causality also turns out to be one-way from GNP to expenditure. However, the OLS regression residuals of the equations appear to have a stronger contemporaneous correlation and as a result, there is also an instantaneous causality. Nevertheless, there is no evidence for the reverse causality from expenditure to GNP. An interesting result is that the regression variances for the expenditure equation turn out to be much lower than the unconditional versions of Table 6, thus emphasizing the validity of conditional VAR.

(Table 6 here.)

**B. Expenditure components.**

Only results of the conditional analysis are reported (Table 7). These show that the delayed causation flows from GNP to the expenditure in the case of defence, industrial, water supply and sanitation, and transport, while reverse causality is noticed in the case of only education. Also, changing the number of lags has not changed these inferences.

(Table 7 here.)

## V Concluding Observations.

The overall thrust of the results is in favour of the causation flowing from GNP to government expenditure, which is in slight contrast with the findings of Singh and Sahni (1984). The differences in the results can be explained to some extent, by the shift in the study period. While the deletion of the 1950s from the study period removed the ambiguity in the coverage, the addition of 1980s which witnessed discernible shifts in the economic policy, might have contributed for the change in the results. But, a major source of the differences in the results appears to be the alternative techniques employed in this study. For, results (available from the authors on request) of the analysis carried out with the same methodology, for the period 1950-51 to 1980-81, are also in favour of one-way causation from national income to government expenditure, though the causality measure is not as strong.

As for the disaggregated results, only some expenditure allocations, namely defence, industry, water supply and sanitation, and transport share the causal direction of the aggregate expenditure and follow GNP growth. Educational sector expenditures are found to cause GNP. Other expenditure categories have no relationship eitherway with GNP. Notable among these are expenditures on subsidies and allocations to agriculture. These expenditures perhaps, grew as per the power exercised from time to time by the farm lobby. In the case of police, railway, post and telegraph services, and health, expenditures are probably dependent partly on the needs of the times and partly on the availability of external assistance. Clearly, on the one hand,

aggregate expenditures and expenditure components have different patterns of relations with economic growth, and on the other, individual components of expenditure also differ in their relationships with economic growth.

Table 1. Testing Granger Causality between
Aggregate Government Expenditure and GNP (1980-81 prices).
1960-61 to 1990-91

| Dependent variable | lag length | Durbin's Test II | F value of regression | df | F value Granger test | df | Inference |
|---|---|---|---|---|---|---|---|
| Unadjusted series. | | | | | | | |
| GEX | 2 | -0.16 | 3706.4** | (5 ,22 ) | 8.2** | (2 ,22 ) | GNP CAUSES GEX |
| GEX | 3 | -0.04 | 2943.6** | (7 ,19 ) | 7.3** | (3 ,19 ) | GNP CAUSES GEX |
| GNP | 2 | -0.38 | 5912.3** | (5 ,22 ) | 2.6.. | (2 ,22 ) | ..... |
| GNP | 3 | 0.28 | 3760.5** | (7 ,19 ) | 1.2.. | (3 ,19 ) | ..... |
| First differeces. | | | | | | | |
| GEX | 2 | -0.20 | 10.3** | (5 ,21 ) | 4.8*. | (2 ,21 ) | GNP CAUSES GEX |
| GEX | 3 | -0.17 | 14.1** | (7 ,18 ) | 9.4** | (3 ,18 ) | GNP CAUSES GEX |
| GNP | 2 | -0.23 | 6.5** | (5 ,21 ) | 1.4.. | (2 ,21 ) | ..... |
| GNP | 3 | 0.24 | 5.8** | (7 ,18 ) | 1.6.. | (3 ,18 ) | ..... |
| Sims Filtered series. | | | | | | | |
| GEX | 2 | -0.26 | 294.2** | (5 ,21 ) | 8.9** | (2 ,21 ) | GNP CAU |
| GEX | 3 | -0.03 | 324.7** | (7 ,18 ) | 13.9** | (3 ,18 ) | GNP CAU |
| GNP | 2 | -0.32 | 313.6** | (5 ,21 ) | 2.9.. | (2 ,21 ) | ..... |
| GNP | 3 | -0.03 | 277.6** | (7 ,18 ) | 2.2.. | (3 ,18 ) | ..... |

Notes: ** Significant at 1% level.
* Significant at 5% level.

These inferences are based on the following OLS regressions.

(i) $x_t = a_0 + a_1 x_{t-1} + a_2 x_{t-2} + \ldots + a_s x_{t-s} + b_1 y_{t-1} + b_2 y_{t-2} + \ldots + b_s y_{t-s} + u_t$

(ii) $y_t = c_0 + c_1 y_{t-1} + c_2 y_{t-2} + \ldots + c_s y_{t-s} + d_1 x_{t-1} + d_2 x_{t-2} + \ldots + d_s x_{t-s} + v_t$

where x denotes expenditure component, and y denotes GNP and the lag leng
taken at 2 and 3. The F test result is taken to be true even if the test h
either of the lag length.

**Table 2. Testing Granger Causality between GNP and Government Expenditure by major functions (1980-81 prices). 1960-61 to 1990-91**

| Expenditure component | Unadjusted series | First differenced series | Sims' Filtered series |
|---|---|---|---|
| 1. DEF | + | | + |
| 2. POL | | | |
| 3. SES | + | | + |
| 4. RLY | | | |
| 5. P&T | | | |
| 6. EDN | | - | - |
| 7. HEA | | | + |
| 8. AGR | | | - |
| 9. IND | +/- | - | |
| 10. WAT | + | | + |
| 11. TPT | | | |

Notes: + indicates causality from GNP to the expenditure component.
- indicates causality from the expenditure component to GNP.
+/- indicates bi-directional causality.

**Table 3. Stationarity testing for GNP and Government Expenditure series (1960-61 to 1990-91, constant prices).**

| Series | Non-transformed | | First differenced | | Log transformed | | Log first differenced | |
|---|---|---|---|---|---|---|---|---|
| | unit root | time trend | unit root | time trend | unit root | time trend | unit root | time trend |
| 1. GNP | * | | * | * | * | | | |
| 2. GEX | * | | | * | * | * | | |
| 3. DEF | * | | | | * | | | |
| 4. POL | * | | * | * | * | * | | |
| 5. SBS | * | * | | | * | * | | |
| 6. RLY | * | * | | | * | * | * | |
| 7. P&T | * | | * | | * | | | |
| 8. EDN | * | | * | * | * | * | | * |
| 9. HEA | * | * | * | | * | | * | * |
| 10.AGR | * | * | | * | * | * | | |
| 11.IND | * | | * | | * | | | |
| 12.WAT | * | | * | * | * | * | | |
| 13.TPT | * | | * | | * | | | |

Notes: * indicates existence of unit root or time trend, as the case may be.

Table 4. Testing Granger Causality between
Aggregate Government Expenditure and GNP
Stationarised series (1980-81 prices).
1960-61 to 1990-91

| Dependent variable | lag length | Durbin's Test II | F value of regression | df | F value Granger test | df | Inference |
|---|---|---|---|---|---|---|---|
| GEX | 2 | 0.1 | 6.4** | (4 ,24) | 5.4*. | (2 ,24) | GNP CAUSES GEX |
| GEX | 3 | 0.1 | 4.4** | (6 ,21) | 4.1*. | (3 ,21) | GNP CAUSES GEX |
| GNP | 2 | 0.3 | 4.9** | (4 ,24) | 0.9.. | (2 ,24) | ..... |
| GNP | 3 | 0.1 | 4.1** | (6 ,21) | 0.5.. | (3 ,21) | ..... |

Notes: ** Significant at 1% level.
* Significant at 5% level.

These inferences are based on the following OLS regressions.

(i) $x_t = a_0 + a_1 x_{t-1} + a_2 x_{t-2} + \ldots + a_s x_{t-s} + b_1 y_{t-1} + b_2 y_{t-2} + \ldots + b_s y_{t-s} + u_t$

(ii) $y_t = c_0 + c_1 y_{t-1} + c_2 y_{t-2} + \ldots + c_{t-s} + d_1 x_{t-1} + d_2 x_{t-2} + \ldots + c_{t-s} + v_t$

where x denotes expenditure component, and y denotes GNP and the lag length s is taken at 2 and 3. The F test result is taken to be true even if the test holds for either of the lag length.

**Table 5. Measurement and Testing of Granger Causality between Aggregate Government Expenditure and GNP in a VAR Framework. 1960-61 to 1990-91**

| | Wald Test | LR Test | LM Test |
|---|---|---|---|
| **Granger Type Tests:** | | | |
| Causality from GEX to GNP | -.22 .. | -.22 .. | -.22 .. |
| Causality from GNP to GEX | 10.53 ** | 9.06 *. | 7.86 *. |
| Instant causality.... | 5.17 *. | 4.78 *. | 4.43 *. |
| linear dependence.... | 18.67 ** | 14.61 *. | 11.65 *. |
| **Sims type tests:** | | | |
| Causality from GEX to GNP | 1.57 .. | 1.53 .. | 1.50 .. |
| Causality from GNP to GEX | 11.88 ** | 10.06 ** | 8.59 *. |
| Instant causality.... | 5.17 *. | 4.78 *. | 4.43 *. |
| linear dependence.... | 19.90 ** | 15.37 ** | 12.12 *. |

Notes: ** test statistic is significant at 1% level.
*. test statistic is significant at 5% level.

**Estimated Variances.**

| | System 1 | System 2 | System 3 | System 4 |
|---|---|---|---|---|
| GNP equation. | .0056 | .0041 | .0036 | .0034 |
| GEX equation. | .0019 | .0019 | .0016 | .0012 |

**Table 6. Measurement and Testing (Conditional) of Granger Causality between Aggregate Government Expenditure and GNP in a VAR Framework. 1960-61 to 1990-91**

| | Wald Test | LR Test | LM Test |
|---|---|---|---|
| Granger Type Tests: | | | |
| Causality from GEX to GNP | -1.54 .. | -1.58 .. | -1.62 .. |
| Causality from GNP to GEX | 7.63 *. | 6.82 *. | 6.12 *. |
| Instant causality.... | 17.22 ** | 13.70 ** | 11.07 ** |
| linear dependence.... | 5.39 .. | 4.97 .. | 4.59 .. |
| Sims type tests: | | | |
| Causality from GEX to GNP | -12.23 .. | -15.55 .. | -20.19 .. |
| Causality from GNP to GEX | -14.74 .. | -20.00 .. | -28.09 .. |
| Instant causality.... | 17.22 ** | 13.70 ** | 11.07 ** |
| linear dependence.... | -6.96 .. | -7.88 .. | -8.97 .. |

Notes: ** test statistic is significant at 1% level.
*. test statistic is significant at 5% level.
These results are obtained by keeping the influence of three external variables total revenue, population and proportion of urban population in total.

**Estimated Variances.**

| | System 1 | System 2 | System 3 | System 4 |
|---|---|---|---|---|
| GNP equation. | .0035 | .0028 | .0018 | .0030 |
| GEX equation. | .0007 | .0008 | .0005 | .0009 |

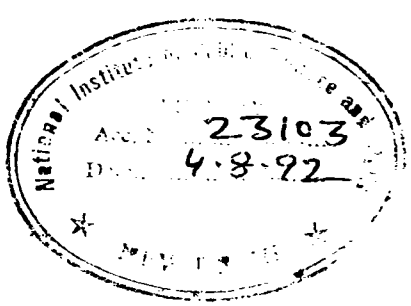

**Table 7. Testing (Conditional) of Granger Causality between Expenditure Components and GNP in a VAR Framework. 1960-61 to 1990-91**

| Item | Wald test | Likelihood ratio test | Legrange multiplier test |
|---|---|---|---|
| 1. DEF | + | + | |
| 2. POL | | | |
| 3. SBS | | | |
| 4. RLY | | | |
| 5. P&T | | | |
| 6. EDN | - | - | - |
| 7. HEA | | | |
| 8. AGR | | | |
| 9. IND | + | + | + |
| 10. WAT | + | + | + |
| 11. TPT | + | + | + |

Note: Although the test statistics in respect of instanataneous causality appear to be significant, it is clear that these results are spurious in view of the negative values of the test statistics for delayed causality, and insignificant test statistics for total linear dependence.

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