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Causality Tests and the Relative Effectiveness of Monetary and Fiscal Policies in Pakistan

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INTRODUCTION

A three variable equation, known as the St. Louis equation in the economics literature, was developed by Andersen and Jordan in 1968 with the object of testing the relative effectiveness of monetary and fiscal policies for economic stabilisation in the U. S. This equation had the following linear form:

$$Y = a_0 + a_1 MO + a_2 F + u$$

where a_0 is the intercept, a_1 is the regression coefficient of MO, a general variable representing monetary actions, a_2 is the regression coefficient of F, a general variable representing fiscal actions and U is the unexplained error term. When the relevant variables were expressed in the first differences, this equation assumed the following form:

$$\Delta Y = a_0 + a_1 \Delta MO + a_2 \Delta F + u$$

Keynesian economists are of the view that fiscal policy is more effective than monetary policy in economic stabilisation and they hold that the "full-employment budget surplus"[1] is the crucial and strategic variable in the context of implementation of fiscal policy. Andersen and Jordan used the "full-employment budget surplus" along with full-employment government expenditure and receipts as the specific variables representing fiscal actions in their St. Louis Equation.

On the other hand, the Monetarists believe that monetary policy is more effective than fiscal policy in economic stabilisation and they hold the "monetary base" and the "money stock" as crucial and strategic variables in the context of

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[1]The full employment budget is defined as an estimate of the amount of surplus that would have been realised in any year if there had been full employment, with the tax rates and expenditure programmes then in effect, and with the estimated labour force, productivity, and price level of that year.

implementation of monetary policy. Andersen and Jordan used these variables as specific variables representing monetary actions in the St. Louis Equation.

Andersen and Jordan, using U. S. quarterly data in the first differences for the period from the first quarter of 1952 to the second quarter of 1968 in their estimates of the St. Louis Equation, found that "the response of economic activity to monetary actions compared with that of fiscal actions is larger, more predictable, and faster" [Andersen and Jordan (1968), p. 22]. Their findings won over many economists to the monetarist camp and in recognition to these findings articles like "How Much Does Money Matter? A Look at Some Recent Evidence" [Davis (1969)] were published. But the controversy among the Keynesian and the Monetarist economists over the effectiveness of monetary and fiscal policies could not die out. With a view to countering the monetarist empirical studies establishing the effectiveness of monetary policy and ineffectiveness of fiscal policy, some studies like "Even the St. Louis Model Now Believes in Fiscal Policy" [Friedman (1977)] were also published.

Hafer (1982) has tried to establish the monetarist position on the relative effectiveness of the monetary and fiscal policies by using Granger's Causality test on U. S. data from the first quarter 1960 to fourth quarter, 1980. According to this test if unidirectional causality from money to GNP is detected and a unidirectional causality from GNP to an appropriate indicator of fiscal policy is detected or independence between GNP and the fiscal indicator is found, then it would indicate that monetary variables are exogenous while the fiscal variable is not exogenous with respect to nominal GNP. Consequently we shall be in a position to say that monetary policy is relatively more effective in influencing GNP than fiscal policy. Empirical findings contrary to the above will indicate that fiscal policy is more effective than the monetary policy.

The present writer has already estimated the St. Louis Equation for Pakistan using annual data for the period 1949-50 to 1970-71 and the findings were published in Hussain (1982).

The objective of the present study is to test the relative effectiveness of monetary and fiscal policies in Pakistan by performing Granger's as well as Sims' causality tests using Pakistan data related to GNP and some appropriate indicators of monetary and fiscal policies.

TEST PROCEDURES AND RESULTS

The Granger causality test assumes that the information relevant to prediction of respective variables is contained solely in the time-series data of variables Y and X (where Y may represent GNP and X may represent money

or a fiscal variable). The test procedure involves estimating the following equations:

$$Y_t = \sum_{i=1}^{n} a_i X_{t-i} + \sum_{j=1}^{n} b_j Y_{t-j} + u_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

$$X_t = \sum_{i=1}^{m} c_i X_{t-i} + \sum_{j=1}^{m} d_j Y_{t-j} + e_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

Where u_t and e_t are assumed to be un-correlated error terms. Equation (1) postulates that current Y (say, GNP) is related to past values of itself as well as past values of X (say, money or some appropriate fiscal variable) and Equation (2) postulates current X is related to past values of itself as well as past values of Y. Usually for this test relevant variables are represented by their growth rates and a dot over the variable indicates its growth rate.

The following could be the outcomes of this test procedure:

1. Unidirectional causality running from X to Y (symbolically shown as $X \rightarrow Y$) is detected if the estimated coefficients on the lagged X variable in Equation (1) are statistically significant as a group and the estimated coefficients on the lagged Y in Equation(2) are not statistically significant as a group;
2. Unidirectional causality running from Y to X (symbolically shown as $X \rightarrow Y$) is detected if the set of lagged X coefficients in Equation (1) is statistically insignificant and the set of lagged Y coefficients in Equation (2) is statistically significant;
3. Feedback between X and Y (symbolically shown as $X \leftrightarrow Y$) is suggested when the set of lagged X coefficients in Equation (1) and the set of lagged Y coefficients in Equation (2) are statistically significant; and
4. Independence between X and Y is suggested when the set of lagged X coefficients in Equation (1) and the set of lagged Y coefficients in Equation (2) are statistically insignificant.

With a view to detecting the direction of causality between GNP and monetary variables, Granger's test procedure was applied first using annual growth rates of GNP at current factor cost and monetary base (the commercial banks' deposits with the State Bank of Pakistan plus currency in the tills of the commercial banks plus the currency in circulation among the non-bank public) data from Pakistan for the period 1971-72 to 1989-90. The monetary base was used as the indicator of monetary policy actions because the monetarists believe that it is a strategic monetary variable, which is under direct control of the monetary authorities. [An-

dersen and Jordan (1968), p. 13]. Then the annual growth rate of money stock i.e. narrowly defined money supply, M_1, (which is equivalent to currency in circulation plus demand deposits of the commercial banks) was used as an indicator of monetary policy actions, because it is considered to be a strategic monetary variable by both the Keynesian and the monetarist economists [Andersen and Jordan, p. 13].

For the detection of the direction of causality between GNP and an appropriate measure of fiscal actions, annual growth rates of GNP at current factor cost and total government expenditure (i.e. the sum of all expenditures on both revenue and capital accounts of central and provincial governments of Pakistan net of any transfer payments between them) from Pakistan for the period 1971-72 to 1989-90 were used. It may be pointed out that the total government expenditure is the only available appropriate indicator of fiscal actions in the case of Pakistan. Hence, it was used as an indicator of fiscal actions in the present study.

In all the regressions linear trend as an additional variable was also used. However, wherever the trend variable was found to be statistically insignificant the regression results obtained without this variable were reported. An unconstrained lag of one year was used for lagged variables because Monetarists like [Andersen and Jordan (1968), p. 22] feel that four quarters (i.e. one year) constitute an appropriate response period for both fiscal and monetary actions. The statistical significance of the variables was judged by their F values.

The regression estimates using Granger's test procedure are reported in Table 1.

As indicated earlier the objective of these causality tests was to arrive at some evidence regarding the relative effectiveness of the monetary and fiscal policies in influencing economic activity in Pakistan.

The estimates reported for Equations 1 and 1' in Table 1 suggest that there is unidirectional causality running from monetary base growth to nominal GNP growth in Pakistan.

The estimates reported for Equations 2 and 2' in Table 1 indicate that there is unidirectional causality running from nominal money stock growth to nominal GNP growth in Pakistan.

The estimates reported for Equations 3 and 3' in Table 1 suggest that there is unidirectional causality running from nominal GNP growth to total government expenditure growth in Pakistan.

These findings indicate that there is a causal relationship from monetary variables to nominal GNP in Pakistan, whereas there is a causal relationship from nominal GNP to total government expenditure. These results provide some evidence

Table 1

Granger's Method
(Annual Growth Rate of Variables Data, 1971-72 to 1989-90)

Equation	R^2	*D.W.*	*n*
(1) $\dot{Y}_t = 0.054 + 0.351\ \dot{B}_{t-1}{}^{*} + 0.396\ \dot{Y}_{t-1}$	0.747	2.01	17
(5.616) (2.047)			
(1') $\dot{B}_t = 0.547 - 0.556\ \dot{B}_{t-1}{}^{*} - 0.647\ \dot{Y}_{t-1}$	0.617	2.53	17
(4.488) (1.744)			
Result: $\dot{B} \rightarrow \dot{Y}$			
(2) $\dot{Y}_t = -0.006 + 0.388\dot{M}_{t-1}{}^{**} + 0.659\dot{Y}_{t-1}{}^{*}$	0.553	2.142	17
(3.331) (14.155)			
(2') $\dot{M}_t = 0.167 + 0.007\ \dot{M}_{t-1} - 0.023\ \dot{Y}_{t-1}$	0.0006	2.00	17
(0.001) (0.008)			
Result: $\dot{M} \rightarrow \dot{Y}$			
(3) $\dot{Y}_t = 0.248 + 0.166\ \dot{G}_{t-1} - 0.186\ \dot{Y}_{t-1}$	0.681	1.826	17
(1.742) (0.335)			
(3') $\dot{G}_t = -0.051 + 0.093\ \dot{G}_{t-1} + 1.096\ \dot{Y}^{**}_{t-1}$	0.478	1.872	17
(0.133) (2.829)			
Result: $\dot{Y} \rightarrow \dot{G}$			

Note: *F* values of the estimated coefficients are given in the parentheses. The variables marked with an asterisk(*) are statistically significant at least at 5 percent level of significance and those marked with double asterisk (**) are significant at least at 10 percent level of significance.

that the monetary policy performed better than the fiscal policy in influencing economic activity in Pakistan during the period under study.

According to Sims' test procedure for detecting causality, in the presence of jointly co-variance – stationary pair of stochastic processes *X* and *Y*, if *X* causes *Y*, then a regression of *Y* on past and future values of *X*, after taking account of

serial correlation either by generalised least squares or by prefiltering it, will give statistically significant coefficients for past values of X but statistically insignificant coefficients for future values of X. Again if X causes Y, a regression of X on past and future values of Y will give statistically significant coefficients for future values of Y and it may or may not give statistically significant coefficients for past values of Y. While using Sims' test procedure some writers [Williams and Gowland (1976); Brillembourg and Khan (1979)] have used the current values along with the past values of the independent variables in the above regressions. The current values of independent variables should also exhibit the same behaviour in the test as is mentioned above in connection with the past values of the independent variables.

The test procedure for detecting the direction of causality between money and nominal GNP or total government expenditure and nominal GNP, involves first prefiltering of time-series data on these variables by using an appropriate filter so that they become stationary series. After prefiltering data for the sake of detection of direction of causality between money and GNP, regression of nominal GNP on money's past and future values and regression of money on past and future values of nominal GNP need to be run. In this way if the regression of nominal GNP on money gives statistically significant coefficients for past values of money and gives statistically insignificant coefficients for the future values of money and the regression of money on nominal GNP results in significant coefficients for future values of nominal GNP, and may or may not give statistically significant coefficients for past values of GNP, then a unidirectional causality running from money to nominal GNP is detected. On the other hand, if the regression of money on nominal GNP results in statistically significant coefficients for the past values of nominal GNP and insignificant ones for the future values of nominal GNP and the regression of GNP on money gives statistically significant coefficients for future values of money and may or may not give significant coefficients for past values of money, then a unidirectional causality running from nominal GNP to money is detected. In the test procedure the statistical significance of the variables is judged by their F values.

Sims has also stated that while making these kind of decisions "one should bear in mind that the absolute size of the coefficient is important regardless of the F value" and relatively large coefficients "should not be casually set to zero no matter how statistically insignificant they are" [Sims (1972), p. 545].

According to Sims' test procedure, if in these regressions, the future values of the independent variables either exhibit statistically significant coefficients or give as large or larger coefficients than the estimated coefficients for the past values of these variables, then bi-directional causality or feed back in practice is possible.

If in these regressions the future values of the independent variables exhibit statistically insignificant coefficients, then independence of the variables is detected.

For the detection of direction of the causality between total government expenditure and nominal GNP, the same test procedure can be followed with total government expenditure replacing money.

With a view to detecting direction of causality between money and nominal GNP, Sims' test procedure was applied first using nominal GNP and monetary base annual data from Pakistan for the period 1971-72 to 1989-90. Then the same test was repeated while replacing the monetary base with narrowly defined money supply, M_1.

For the detection of direction of causality between total government expenditure and nominal GNP, Sims' test procedure was applied using annual data from Pakistan on total government expenditure and nominal GNP for the period 1971-72 to 1989-90.

Following the test procedure as adopted by Sims, all variables used in the regressions were measured as natural logarithms and they were prefiltered using the filter $1–1.5B + 0.5625B^2$ i.e. each natural logged variable X_t was replaced by $X_t - 1.5X_{t-1} + 0.5625X_{t-2}$. In other words each X_t is corrected for the first order and the second order autocorrelation coefficients (i.e. 1.5 and 0.5626). Sims has stated that "this filter approximately flattens the spectral density of most economic time series" [Sims (1972), p. 545] and hopefully it may make the regression residuals nearly white noise.

It may also be pointed out that one year's unconstrained lag for past and future values of the independent variables was used in this study because it was considered to be an appropriate lag period for annual data series keeping in view the lag periods determined by the studies using quarterly data [Andersen and Jordan (1968) and Hamburger (1974)]. In all the regression equations linear trend variable was also used as a regressor. Only where the trend variable was adjudged to be statistically insignificant, regression estimates without the trend variable were reported.

Regression estimates based on the Sims test are reported in Table 2.

Regression estimates for Equations 4 and 4' as well as Equations 5 and 5' indicate a unidirectional causality running from the monetary base to nominal GNP in Pakistan. Regression estimates for Equations 6 and 6' and Equations 7 and 7' also show a unidirectional causality running from the money stock to nominal GNP. But regression estimates for Equations 8 and 8' and Equations 9 and 9' suggest that there is unidirectional causality running from nominal GNP to total government expenditure.

Table 2

Sims' Method

(Natural Logged Prefiltered Annual Data 1971-72 to 1989-90)

Equation	R^2	D.W.	n
(4) $Y_t = 0.270 + 0.159B_{t-1}^{**} + 0.158B_{t+1}$ (2.867) (2.541)	0.709	2.695	15
(4') $B_t = -0.263 + 0.393Y_{t-1} + 0.970Y_{t+1}^{*}$ (0.707) (4.592) Result: $B \rightarrow Y$	0.391	2.967	15
(5) $Y_t = 0.357 + 0.173B_t + 0.070B_{t-1} + 0.047B_{t+1}$ (0.978) (0.293) (0.104)	0.735	2.620	15
(5') $B_t = -0.110 - 0.669Y_t + 0.484Y_{t-1} + 1.164Y_{t+1}^{*}$ (2.343) (1.170) (6.760) Result: $B \rightarrow Y$ (as B_t and B_{t-1} have larger coefficients)	0.498	2.997	15
(6) $Y_t = 0.275 + 0.348M_{t-1}^{*} + 0.046M_{t+1}$ (5.821) (0.275)	0.390	2.332	15
(6') $M_t = 0.004 - 0.190Y_{t-1} + 0.968Y_{t+1}^{*}$ (0.213) (5.916) Result: $M \rightarrow Y$	0.339	3.066	15
(7) $Y_t = 0.222 + 0.143M_t + 0.361M_{t-1}^{*} + 0.052M_{t+1}$ (1.023) (6.203) (0.359)	0.442	2.487	15
(7') $M_t = 0.188 - 0.065Y_t - 0.181Y_{t-1} + 0.987Y_{t+1}^{*}$ (0.024) (0.174) (5.198) Result: $M \rightarrow Y$	0.339	3.066	15
(8) $Y_t = 0.276 + 0.049G_{t-1} + 0.350G_{t+1}^{*}$ (0.139) (7.002)	0.396	2.488	15
(8') $G_t = -0.110 + 1.130Y_{t-1}^{*} - 0.060Y_{t+1}$ (6.859) (0.021) Result: $Y \rightarrow G$	0.389	2.698	15
(9) $Y_t = 0.181 + 0.314G_t^{*} + 0.046G_{t-1} + 0.336G_{t+1}^{*}$ (10.991) (0.229) (11.755)	0.698	3.049	15
(9') $G_t = -0.313 + 0.884Y_t^{*} + 1.010Y_{t-1}^{*} - 0.316Y_{t+1}$ (6.192) (7.709) (0.755) Result: $Y \rightarrow G$	0.609	2.935	15

Note: *F* values of the estimated coefficients are given in the parentheses. The variables marked with an asterisk(*) are statistically significant at least at 5 percent level of significance and those marked with double asterisk(**) are significant at least at 10 percent level of significance.

CONCLUSIONS

The Granger and the Sims causality tests as applied to annual data from Pakistan for the period 1971-72 to 1989-90, help us in arriving at identical conclusions even though in the former test growth rates of the relevant variables were used and in the latter natural logged and filtered variables were used. Both tests detected unidirectional causality running from monetary variables (monetary base and money stock) to nominal GNP in Pakistan for the period under study. Both tests also suggest that there is unidirectional causality running from nominal GNP to the total government expenditure in Pakistan for the period under study. The findings of the study suggest that changes in monetary variables do exert their influence on economic activity, represented by the nominal GNP, in Pakistan. The results of the study also provide some evidence that changes in total government expenditure rather than causing changes in the nominal GNP in Pakistan, are rather influenced by the changes in the nominal GNP. Thus, the findings of the study suggest that the monetary policy was relatively more effective than the fiscal policy in influencing the nominal GNP in Pakistan, during the period under study.

These findings are in line with the findings of Hafer (1982), who found that fiscal policy measures are not exogenous with respect to GNP growth in the United States and that fiscal actions are ineffective for stabilisation purposes. He has also concluded that his results add increasing stature to the use of monetary policy as a tool in stabilising fluctuations in economic activity.

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Comments on "Causality Tests and the Relative Effectiveness of Monetary and Fiscal Policies in Pakistan"

The author uses Granger and Sims' tests on the St. Louis Equation to judge the relative effectiveness of monetary and fiscal policy. The main conclusion of the article is that monetary policy is effective and fiscal policy is ineffective. This is too much a sweeping conclusion to believe. Even the debate between the Monetarist and the Keynesian Schools is on the relative effectiveness of monetary and fiscal policy and not on whether one is ineffective or the other. I wish the author had explored this alternative and tried to establish the extent of effectiveness of the two policies.

2. The findings of the article are essentially the result of the unrealistic macroeconometric model and too much massaging of data. The relation between fiscal, monetary and other macro aggregates is non-linear rather than linear as implied by the St. Louis Equation. The St. Louis Equation is really not an economic model but a causal way of looking at the correlation between the three aggregates. So that further manipulation of the Equation seems inappropriate. Further, the derived equations used in the Granger and Sims' tests do not follow logically from the linear St. Louis Equation.

3. As it appears, the data has been chosen and manipulated to prove the conclusion. One, the macro aggregates, GNP, monetary and fiscal, used themselves are not definite; they are defined to suit the author's convenience. Two, the target for economic policy is real GNP rather than nominal GNP as chosen here. Three, the variation in the data has been removed by working with growth rates or by use of arbitrary filters. As a result, relationships were estimated on residuals which mostly contained random grass rather than variation having economic content. Lastly, the assumption of one-year policy lag (adopted from the US economy) is not necessarily correct in the context of Pakistan. Most probably, it is much longer and distributed.

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