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Deficits and Interests Rates: An Empirical Investigation

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I. Introduction

Increasing federal government deficits have revived interest in theoretical discussions of the deficits' impact on an economy. This theoretical interest has recently been transformed into an economic policy issue in the form of the Gramm-Rudman-Hollings balanced budget legislation. ¹ Within the theoretical framework, the question of effects of increasing deficits on interest rates, and thereby on the level of investment and of economic growth is of special interest. Some economists emphasize the negative impact of deficit financing on private investment.² This negative impact is largely due to the "fiscal crowd-out" whereby private investment is crowded-out by public borrowing. According to this theory, the public sector issued debt competes with the private sector demand for savings. As a result, interest rates are bid up and the crowding out of private investment occurs.³ Consequently, the issue of effects of deficits on interest rates is of crucial importance.

Theoretically, it is essential to distinguish clearly between nominal interest rates and real interest rates.⁴ In this sense, the most important issue is what impact if any do deficits have on both nominal and real interest rates. As far as the nominal interest rate determination is concerned, it is possible to assert that it is inflation that predominantly determines this rate. Therefore, deficits have no impact on the nominal interest rate, unless they affect the rate of inflation.⁵ The expected nominal rate of interest can be thought of as the sum of two expected rates of change, namely the expected real rate of interest, and the expected rate of inflation. This relationship can be stated as follows:

\[ i_n = r + p_e. \] (1)
where $i_n$ is the expected nominal rate of interest, $i_r$ is the expected real rate of interest, and $p^e$ is the expected rate of inflation. Within this specification the expected real rate of interest ($i_r$) indicates the expected rate of change in the value of present goods that are converted into future goods, and the expected rate of inflation ($p^e$) measures the expected rate of change in the value of goods in terms of money.\textsuperscript{6}

Theoretically, deficits may affect the expected nominal interest rate through their influence on both components of this rate. First, their effect can be direct through the previously explained fiscal crowd-out. Generally speaking, the financing of deficits requires the sale of U.S. government securities. The most immediate effect of such sales is a drop in bond prices accompanied by an increase in bond rates. Hence, bond rates tend to be affected instantaneously by bond sales. Usually most other interest rates follow this pattern.\textsuperscript{7} When monetized deficits can also affect nominal interest rates through their effect on the expected rate of inflation ($p^e$). Monetization of the federal government debt requires increasing the money supply. Increases in the money supply can lead to inflation.\textsuperscript{8} Hence, nominal interest rates may increase because of an increase in the expected rate of inflation ($p^e$). Finally, deficits can influence expected nominal interest rates through their effects on the expected real rate of interest ($i_r$). One channel through which this influence operates is the effect of inflation on the relative value of future and present consumption. Clearly, inflation reduces the value of savings; i.e., funds for the future consumption. Therefore, it can be expected that inflation reduces the volume of savings in an economy. This outcome directly influences the expected real rate of interest ($i_r$).

The resolution of the above outlined theoretical issues is critical
when assessing the effects of government policies, such as the balanced budget legislation, on the U.S. economy. Here the crucial question has to be answered: what effect, if any, will eliminating deficits have on the U.S. economy in general and on interest rates in particular? In other words, what are the likely effects of deficits and their proposed elimination on interest rates in the U.S. economy? Empirical research can resolve these crucial theoretical issues. In particular, some light can be shed on these questions by empirically testing the causality in the deficit-interest rate relationship.

The purpose of this paper is to use the FPE causality testing method to ascertain the effects of deficits on both nominal and real interest rates in the U.S. economy. The paper is divided into four sections. First, major theoretical and empirical causality test issues are outlined. The bivariate causality test results concerning deficits and nominal interest rates are outlined and critically evaluated thereafter. The following section presents results of a trivariate causality testing analysis. The focus of the trivariate analysis is to ascertain the effects of deficits on the two components of nominal interest rate, the real rate of interest and the rate of inflation. Overall conclusions are presented in the final part of this study.

II. Causality test issues

Numerous empirical causality tests analyzing the U.S. macro-economic data have been conducted in the past. These studies include the pioneering work of Sims (1972). Recent contributions to the causality testing of macro relationships include the works of Geweke, Meese, and Dent (1983), Guilkey and Salemi (1982), and Ram (1984), among others. The common purpose of
these studies is to establish the existence of the Granger (1969) type
causal relationship among the test variables. Most of the causality test
procedures rely on an arbitrary lag selection when deciding on the
appropriate number of lags for the test variables. Hsiao (1981 and 1982)
suggests that in econometric hypothesis testing the order of lags has to be
correctly specified in order to avoid imposing spurious or false
restrictions. His step-wise procedure of determining the minimum final
prediction error (FPE) not only solves the problem of arbitrary lag
selection, but it also provides a powerful causality test method.
Consequently, the FPE procedure is used throughout this study.

III. Optimal lag selection: Bivariate results.

Hsiao’s (1981) procedure combines the minimum final prediction error
criterion (FPE) developed by Akaike (1969a, b) with Granger’s (1969)
definition of causality. Akaike (1969a) defines the estimate of $FPE_{y}[Y(m), X(n)]$ as follows:

$$FPE_{y}(m,n) = \frac{T + m + n + 1}{T - m - n - 1} \cdot Q_{y}(m,n)/T$$

where $m$ and $n$ indicate the number of lags on $Y$ and $X$ respectively, $T$ is the
number of observations, and $Q_{y}$ is the sum of the squares of residuals.
Using the minimum FPE criterion for the optimal-lag selection is
equivalent to applying an approximate $F$ test with varying levels of
significance to each of the test variables. In this way, Hsiao’s optimality
criterion of minimizing the mean-square prediction error avoids the
conventional ad hoc selection of 1 percent or 5 percent levels of
significance in the test procedures. Therefore, an obvious advantage of
using this procedure is its avoidance of the type I and type II errors.
associated with classical hypothesis testing.

According to Hsiao, there are three possible outcomes in causality testing. X is said to cause Y if the predictions of Y using past values of X are more accurate than by not doing so. Feedback occurs if X causes Y, and Y causes X. Finally, it is possible that X and Y are statistically independent or contemporaneously related. This implies that X does not cause Y, and Y does not cause X.12

In this paper, Hsiao's causality testing method is followed. Using the first definition of causality (step 1), Y is treated as a one-dimensional autoregressive process (Y process). The FPE is computed for each regression. The order of lags is varied from 1 to 10; i.e., a total of 10 regressions are computed. The specification yielding the minimum FPE is representative of the optimal lag specification for the Y variable. Once the lag operator of Y is so determined, it is assumed that X is the manipulated variable controlling the outcome of Y. The FPE criterion is then used to determine the lag order of X (step 2), holding the order of the lag operator on Y determined in the previous step constant. Stated alternatively, the optimal univariate model is selected for Y and then the optimal bivariate model is chosen using the order of lags for Y determined in the univariate model. Causality inference are formed on the basis of the comparison of the FPEs from step 1 and step 2. If the FPE obtained from step 1 exceeds the FPE resulting from step 2, than X causes Y, if this FPE is smaller, then Y causes X. This entire procedure is repeated using X as the initial variable (X process). The overall causality inferences are made on the basis of the causality results of both Y and X processes. If in each case Y is found to cause X, then unidirectional causality from Y to X is established. If the opposite is true, then unidirectional causality from X to Y exists. Finally, if Y causes X (in the Y process), and X causes Y (in
the X process), then feedback exists.

In this paper's calculations, Y represents federal government deficits (DEF) with X representing nominal interest rates. The causality tests are undertaken for both short-term nominal interest rates and long-term nominal interest rates. The purpose of this division is to identify the effects of deficits on both the short-term and the long-term nominal interest rates. Nominal short-term interest rates (NSTIR) are approximated by an arithmetic average of three short-term interest rates, namely the federal funds rate, the prime commercial paper rate, and the prime lending rate. Nominal long-term interest rates (NLTIR) are an arithmetic average of the three-year U.S. Treasury notes, ten-year U.S. Treasury securities, and thirty-year FHA mortgages. In further calculations (trivariate analysis), inflation is approximated by the consumer price index (CPI). Monthly seasonally unadjusted data ranging from October 1974 to December 1984 are used throughout all calculations for all relevant variables. The selection of the time period under consideration is most appropriate for the purposes of this paper, because during this period federal government deficits were most prominent. All equations are estimated in the first differences of logarithms form.

The one-dimensional autoregressive estimates of the univariate specifications are reported in Table 1. As reported in this table, the smallest FPEs for the deficits (DEF), nominal short-term interest rates (NSTIR), and nominal long-term interest rates (NLTIR), are with 9, 2, and 9 lags respectively. Choosing the lag structure outlined in Table 1 (step 1), the FPE of the bivariate model is computed by testing the order of lags of the second explanatory variable from 1 to 10 (step 2) while maintaining the original lag order of the first variable. The specifications yielding the
TABLE 1

The FPE of Fitting a One-Dimensional Autoregressive Process for Deficits (DEF), Nominal Short Term Interest Rates (NSTIR), Nominal Long Term Interest Rates (NLTIR), Real Long Term Interest Rates (RLTIR), and Inflation (CPI)

<table>
<thead>
<tr>
<th>The Order of Lags</th>
<th>FPE of DEF x 10^-2</th>
<th>FPE of NSTIR x 10^-2</th>
<th>FPE of NLTIR x 10^-2</th>
<th>FPE of RLTIR x 10^-3</th>
<th>FPE of CPI x 10^-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.5008</td>
<td>0.6621</td>
<td>0.1133</td>
<td>0.8864</td>
<td>0.8553</td>
</tr>
<tr>
<td>2</td>
<td>1.1121</td>
<td>0.6616</td>
<td>0.1086</td>
<td>0.8705</td>
<td>0.8505</td>
</tr>
<tr>
<td>3</td>
<td>1.0757</td>
<td>0.6840</td>
<td>0.1106</td>
<td>0.8553</td>
<td>0.8511</td>
</tr>
<tr>
<td>4</td>
<td>1.0102</td>
<td>0.6992</td>
<td>0.1110</td>
<td>0.8697</td>
<td>0.8672</td>
</tr>
<tr>
<td>5</td>
<td>1.0240</td>
<td>0.7028</td>
<td>0.1127</td>
<td>0.8769</td>
<td>0.8770</td>
</tr>
<tr>
<td>6</td>
<td>1.0505</td>
<td>0.6862</td>
<td>0.1088</td>
<td>0.8730</td>
<td>0.8525</td>
</tr>
<tr>
<td>7</td>
<td>1.0688</td>
<td>0.6995</td>
<td>0.1092</td>
<td>0.8616</td>
<td>0.8222</td>
</tr>
<tr>
<td>8</td>
<td>0.9294</td>
<td>0.7140</td>
<td>0.1087</td>
<td>0.8392</td>
<td>0.7874</td>
</tr>
<tr>
<td>9</td>
<td>0.9004</td>
<td>0.7187</td>
<td>0.1081</td>
<td>0.8334</td>
<td>0.7937</td>
</tr>
<tr>
<td>10</td>
<td>0.9218</td>
<td>0.7321</td>
<td>0.1097</td>
<td>0.8468</td>
<td>0.8078</td>
</tr>
</tbody>
</table>
smallest FPE are reported in Table 2.

The summary of the causality test implications is given in Table 3. The test results indicate that deficits (DEF) and nominal short-term interest rates (NSTIR) are statistically independent. However, when nominal long-term interest rates (NLTIR) are used as test variables, then a unidirectional causal flow is established from deficits (DEF) to nominal long-term interest rates (NLTIR). These results have very important theoretical implications. With respect to nominal short-term interest rates, they indicate that in the short-run the deficits and nominal short-term interest rates are determined independently of each other. This result indicates that there are other variables which determine both deficits and nominal interest rates. With respect to the short-term nominal interest rates, a number of economic variables can explain their determination. Variables such as growth, capital formation, technological change, and exogenous monetary forces can all play an important role in their determination. Similarly, deficits can be determined by many exogenous factors, such as arbitrary government spending decisions. Consequently, the above reported results with respect to the short-term interest rates and deficits can be theoretically justified.

Empirical evidence presented in Table 3 suggests that it is the change in deficits that leads to subsequent changes in nominal long-term interest rates. This result indicates that in the long-run deficits have an important impact on nominal interest rates without any feedback. This result supports the crowd-out theory of deficit financing. It appears that the public sector deficits do have an impact on the long-term interest rates, and consequently on the level of private investment and on the extent of economic growth. These results do not imply that deficits are the only causal variable or even the most important causal variable responsible
### TABLE 2
The Optimum Lags of the Manipulated Variable and the FPE of the Controlled Variable*

<table>
<thead>
<tr>
<th>Controlled Variable</th>
<th>Manipulated Variable</th>
<th>The Optimum Lag of Manipulated Variable</th>
<th>FPE x 10^-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEF (9)</td>
<td>NSTIR</td>
<td>1</td>
<td>0.9144</td>
</tr>
<tr>
<td>NSTIR (2)</td>
<td>DEF</td>
<td>1</td>
<td>0.6780</td>
</tr>
<tr>
<td>DEF (9)</td>
<td>NLTIR</td>
<td>1</td>
<td>0.9100</td>
</tr>
<tr>
<td>NLTIR (9)</td>
<td>DEF</td>
<td>1</td>
<td>0.1063</td>
</tr>
</tbody>
</table>

*Numbers in parentheses are lags for minimum FPEs.
TABLE 3
Causality Implications of the FPE Procedure for Deficits (DEF), Nominal Short Term Interest Rates (NSTIR), and Nominal Long Term Interest Rates (NLTIR)

<table>
<thead>
<tr>
<th>Process</th>
<th>NSTIR</th>
<th>Implications</th>
<th>Process</th>
<th>NLTIR</th>
<th>Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEF Process:</td>
<td></td>
<td></td>
<td>DEF Process:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPE (Step 1)</td>
<td>0.9004</td>
<td>0.9004 &lt; 0.9144</td>
<td>FPE (Step 1)</td>
<td>0.9004</td>
<td>0.9004 &lt; 0.9100</td>
</tr>
<tr>
<td>FPE (Step 1)</td>
<td>0.9144</td>
<td>NSTIR ⇒ DEF</td>
<td>FPE (Step 2)</td>
<td>0.9100</td>
<td>NLTIR ⇒ DEF</td>
</tr>
<tr>
<td>NSTIR Process:</td>
<td></td>
<td></td>
<td>NLTIR Process:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPE (Step 1)</td>
<td>0.6616</td>
<td>0.6616 &lt; 0.6780</td>
<td>FPE (Step 1)</td>
<td>0.1081</td>
<td>0.1081 &gt; 0.1063</td>
</tr>
<tr>
<td>FPE (Step 2)</td>
<td>0.6780</td>
<td>DEF ⇒ NSTIR</td>
<td>FPE (Step 2)</td>
<td>0.1063</td>
<td>DEF ⇒ NLTIR</td>
</tr>
</tbody>
</table>
for changes in the nominal long-term interest rates. However, even though no inferences can be made about the relative importance of deficits as a causal force in the nominal long-term interest rate determination, these test results do imply that deficits have a significant causal effect on the nominal long-term interest rates.

IV. Trivariate Results

The bivariate results reported above provide useful information about the role of deficits as a causal force in determining the nominal interest rates. In case of the long-term nominal interest rates, empirical evidence suggests a unidirectional causal flow from deficits to nominal long-term interest rates. However, these causality test procedures do not indicate to what extent the changes in deficits affect the two components of nominal long-term interest rates: inflation rate and the real rate of interest. The resolution of this issue is crucial. For if deficits affect only the inflation rate leaving the real interest rate unchanged, then their effect on the real capital formation in an economy would be minimal, if any. Theoretically, if deficits effect only the inflation rate leaving real rate of interest unchanged, then no other real variables such as real investment and savings change. Consequently, capital formation and economic growth would not be influenced in this case.16 If, on the other hand, the primary effect of deficits on nominal long-term interest rates operates through the real interest rate component of nominal long-term interest rates, then this result could have, far-reaching impact on capital formation and on economic growth. Consequently, the resolution of this issue is critical for the development of economic theory and for economic policy decision making.

Providing answers to the above questions requires empirically
identifying the existence and strength of the causal flow from deficits to inflation rate and the long-term real rate of interest. This evidence can be obtained by extending Hsiao's causality testing technique to a trivariate format. For this purpose it is necessary to find an appropriate measure of inflation and the real rate of interest. The consumer price index (CPI) can serve as a useful proxy of inflation. Therefore, the monthly data for seasonally unadjusted CPI are used throughout the trivariate analysis. Following equation (1), the real rate of interest is defined as \( i_r = i_n - p_e \).\(^{17}\)

The trivariate analysis is essentially an extension of the FPE bivariate tests to a trivariate format. This format includes an additional test variable. The independent variables in this test are the real long-term interest rate (RLTIR) and the rate of inflation (CPI), respectively. These variables are initially regressed on one another maintaining the optimal lag specification obtained from step one of the FPE procedure. The causality implications can be obtained by including the lagged deficit variable (DEF) to both the inflation and the real interest rate equations (equations 3 and 4), and by comparing the minimum FPEs so obtained.\(^{18}\)

The trivariate results are reported in Table 4. The last two rows of this table enable us to draw inferences about the direction of the causal flow from deficits to the rate of inflation and the long-term real rate of interest. There appears to be evidence of a causal flow from deficits to both components of nominal long-term interest rates. Adding the lagged deficit variable to the real interest rate equation (3) reduces the FPE from 0.0849 to 0.0831. Similarly an inclusion of the lagged deficit variable to the inflation equation (4) also reduces the FPE from 0.0792 to 0.0778. This implies that the impact of deficits on nominal long-term interest rates operates both through the price-level changes and the real
TABLE 4

Trivariate Results. Causality Testing by Computing Final Prediction Error of the Controlled Variable.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Controlled Variable</th>
<th>First Manipulated Variable</th>
<th>Second Manipulated Variable</th>
<th>FPE x 10^{-2}</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3)</td>
<td>RLTIR (9)</td>
<td>CPI (1)</td>
<td>RLTIR (1)</td>
<td>0.0831</td>
</tr>
<tr>
<td>(4)</td>
<td>CPI (8)</td>
<td>RLTIR (1)</td>
<td>DEF (6)</td>
<td>0.0778</td>
</tr>
</tbody>
</table>

* Numbers in Parentheses are Lags for Minimum FPE
interest rate changes. Consequently, in the long run, deficits not only cause inflation, but they also lead to changes in real interest rates.

A rough indication of the magnitude of the effects of deficits on long-term real rates of interest and inflation is illustrated by the values of the lagged coefficients of the deficit variable in equations (3) and (4). These results are reported in Table 5. In the case of the real interest rate equation (3) the coefficients of the lagged deficit variable are all positive and they become quite large from the fifth period onwards. The magnitude of the positive effect of deficits on real interest rates can also be detected by adding these coefficients. The sum of six lagged deficit coefficients is 0.427. Although this number must be interpreted with caution, it indicates that deficits have a substantial positive effects on real interest rates, especially in later periods. This result clearly supports the crowding-out theory of deficit financing.

With respect to the inflation equation (4), it appear that initially deficits have a somewhat negative impact on the price level, as illustrated by the negative values of the first six lagged deficit variable coefficients in equation (4). This negative impact is reversed in later periods (period seven), and thereafter deficits seem to cause an increase in the rate of inflation. Theoretically this result indicates that initially deficits may somewhat reduce inflation, but eventually they lead to increasing rate of inflation. This result may be explained by the fact that initially government borrowing associated with the existence of deficits depresses private consumption expenditures, leading to a somewhat reduced pressure on prices. However, when in later periods deficits become monetized, the rate of inflation increases. Consequently, the results obtained by empirical estimation of equation (4) have a meaningful
## TABLE 5
Autoregressive Estimates of Equations (3) and (4)*

<table>
<thead>
<tr>
<th>Equation 3</th>
<th>Coefficients (t-statistics)</th>
<th>Equation 4</th>
<th>Coefficients (t-statistics)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statistics</strong></td>
<td><strong>Lags</strong></td>
<td><strong>Coefficients (t-statistics)</strong></td>
<td><strong>Statistics</strong></td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.4392</td>
<td>RLTIR (-1)</td>
<td>-0.370</td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.0269</td>
<td>(2)</td>
<td>-0.452</td>
</tr>
<tr>
<td>DW</td>
<td>1.970</td>
<td>(3)</td>
<td>-0.464</td>
</tr>
<tr>
<td>F</td>
<td>4.797</td>
<td>(4)</td>
<td>-0.452</td>
</tr>
</tbody>
</table>

CPI (-1) | 0.345 | (0.514) |
DEF (-1) | 0.046 | (1.657) |

CPI (-2) | 0.075 | (1.637) |
DEF (-2) | 0.063 | (1.142) |

CPI (-3) | 0.060 | (1.079) |
DEF (-4) | 0.106 | (2.224) |

CPI (-5) | 0.077 | (2.597) |
DEF (-6) | 0.077 | (2.597) |

**Note:** Numbers in parentheses are t-statistics.
theoretical explanation.

Comparison of the sum of the lagged deficit variable coefficients from equations (3) and (4) indicates the relative strength of causal flow from deficits to both inflation rate and real rate of interest. Since +0.427 is much greater in absolute value than -0.269, it would seem that the main impact of deficits is on the real rate of interest. Therefore, increasing deficits appear to have a substantial positive effect on real interest rates.

V. Conclusions

This study investigates two closely related theoretical issues. First, it analyzes the question of causality in the deficit-nominal interest rate relationship, and second it investigates the issue concerning the effects of deficits on the two components of nominal interest rates, namely the inflation rate and the real rate of interest. Empirical investigation is conducted for both the short-term and the long-term interest rates. The main purpose of this division of time periods is to ascertain the effects of deficits on an economy both in the short-run and the long-run.

The minimum FPE causality testing technique used throughout this study alleviates some of the inherent difficulties associated with the causality tests relying on the arbitrary lag selection. Using the FPE causality test procedure within the bivariate framework, deficits and nominal short-term interest rates are found to be statistically independent. Consequently, it appear that both deficits and nominal short-term interest rates are determined by other economic variables. Therefore, this study finds no evidence in support of the view that raising deficits lead to subsequent increases in the nominal short-term interest rates.

When investigating the long-run effects of deficits on nominal interest
rates, a unidirectional causal flow is established from deficits to nominal long-term interest rates. This result indicates a significant fiscal crowd-out in the long-run, and a possibility of an important impact of deficits on the economic growth. Economic growth would be affected if deficits lead to substantial changes in the real rates of interest rather than just changes in the rate of inflation.

An important contribution of this study is contained within the trivariate analysis. The results reported in this section indicate that deficits affect both components of the long-term nominal interest rate, the real rate of interest and the inflation rate. However, the deficits' impact on the real interest rate is stronger than their impact on the rate of inflation. It seems that the long-run effect of deficits on the real rate of interest is that of a substantial increase. Consequently, the results indicate not only an existence of fiscal crowd-out associated with deficit financing, but even more important they imply an important negative impact of deficits on economic growth in form of higher real rates of interest. This means, among other factors, that deficits lead to a long-run changes in the real resource allocation in the U.S. economy. Therefore, deficits appear to impede capital formation in the U.S. economy, and through their effect on the capital formation they retard economic growth.

Finally, this study suggests that economic policy changes, such as the Gramm-Rudman-Hollings legislation may have far-reaching effects on the U.S. economy in the long-run. The proposed elimination of the federal government deficits by 1991 may have greater positive impact on the U.S. economy than the mere reduction of the burden of the public debt. The results of this study indicate that eliminating the federal government deficit may result in a substantial long-run growth of the U.S. economy.
Notes

1. The main objective of this legislation is the achievement of the balanced federal budget by fiscal year 1991.

2. For a more detailed representation of this view, see Musgrave (1959, chapter 23).

3. For a further discussion of the fiscal crowd-out, see Blinder and Solow (1973), and many others.

4. The exact definition of both nominal and real interest rates is given in the subsequent section of this paper.

5. According to this view, deficits have no direct impact on nominal interest rates, unless they are monetized by increase in the money supply. It is only the subsequent increases in the money supply that lead to inflation which in turn causes increases in the nominal interest rates.

6. The expected real rate of interest can be defined in several ways. First, it can be thought of as the net rate of increase in wealth which the wealth owners expect to gain from saving and investing their current income. It can also represent the relative cost of current consumption in terms of forgone future consumption. For a further discussion of this point, see Santoni and Stone (1982, p. 11,) and others.

7. Changes in yields of many securities tend to closely follow changes in yields of U.S. government securities.

8. For a further discussion of this view, see Hein (1981) and others.

9. The FPE causality testing method is described in detail in following parts of this paper.

10. The Granger (1969) causality definition states that X2 causes X1, if and only if X1 is better predicted by employing the past history of X2 than by not doing so.

11. For a theoretical explanation of the procedure for correct system identification, see Hsiao (1981, pp. 87 - 93).

12. For a more detailed discussion of causality implications, see Hsiao (1981, pp. 90 - 91).

13. The federal government deficit data are the data for unified budget. These data were obtained from various issues of the Monthly Statement of the Public Data of the United States. The interest rate data were obtained from various publications of the Board of Governors, Federal Reserve System, and from the Housing and Urban Development Department, U.S. Government.
14. Seasonally unadjusted data are selected to avoid the problem associated with different methods of seasonal adjustment.

15. The first differences of logarithms estimation method alleviates problems associated with the nonstationarity of variables often found in the time-series data.

16. For a further discussion of the effects of real interest changes on an economy, see Makinen (1977, pp. 14 - 19).

17. Since the expected real rate of interest and the expected rate of inflation are not observable variables, suitable proxies must be found for these variables. Expected long-term nominal rate of interest is approximated in this study by an arithmetic average of three long-term nominal rates, namely the three and the ten-year U.S. Treasury bond rates and the thirty-year FHA mortgage rate. The expected rate of inflation can approximated by the CPI data. In order to obtain the rate of inflation from the monthly CPI data the following log transformation of this data was undertaken: $P_e = 100 \cdot \frac{\log(CPI_t) - \log(CPI(t - 1))}{\log(CPI_0)}$ where $P_e$ is the rate of inflation, CPI is the monthly consumer price index, and $t$ indicates the time period.

18. For a more detailed description of this method, see Ram (1984, pp. 475 - 6).
Reference


