

# GOVERNMENT DEFICITS AND MONEY GROWTH

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*Abstract*—Additional empirical evidence is provided concerning the impact of government financing decisions on monetary expansion in the United States for the post-World War II period. The budget position of the fiscal authority and the rate of money growth set by the Fed are specified as endogenous variables within a system of equations. The empirical analysis generates evidence of a policy shift in the 1980s with budget deficits exerting no independent influence on high-powered money growth prior to 1981 while after 1981 such a linkage is found to exist.

THE relationship between monetary expansion and the government's budget position has been empirically examined in a number of studies for the United States. This empirical literature can be broadly classified into three categories: (1) studies that estimate a central bank reaction function within a single equation framework (Hamburger and Zwick, 1981; Allen and Smith, 1983; King and Plosser, 1985; Joines, 1985; Grier and Neiman, 1987), (2) studies in which the central bank's reaction function is imbedded within a system of equations describing the macroeconomy (Levy, 1981; Turnovsky and Wohar, 1987), and (3) causality studies examining the linkages between money growth and a variety of macro variables (Dwyer, 1982; McMillin, 1986). The conclusions resulting from this research agenda have been mixed. For example, in three recently appearing investigations, Joines (1985) concludes that money growth does not appear to be determined by "non-war" government financing requirements, Turnovsky and Wohar (1987) find that deficits influenced money growth prior to 1961 but not afterward, and McMillin (1986) concludes that deficits Granger-caused the monetary base during the 1961 to 1979 period.

The following analysis provides additional empirical evidence concerning the impact of government financing decisions on monetary expansion in the United States. The analysis departs from previous studies in two important respects. First, the rate of money growth and the borrowing requirements of the fiscal authority are specified

as endogenous variables within a system of equations describing the monetary and fiscal authorities' policy rules as well as the determination of two important macroeconomic variables. This results in the Federal Reserve's policy reaction function being estimated simultaneously with an equation determining the government's fiscal position. Second, the data set used in this empirical study extends to the end of 1987 and allows an examination of whether monetary and/or deficit policy has been changed during the "Reagan" years of the 1980s.

Section I describes the basic model and the data employed in the estimation process. Section II presents empirical estimates of the basic model and details the conclusions that can be obtained from those estimates concerning the relationship between money growth and deficit financing. The final section provides some brief concluding comments.

## I. The Model and Data Description

The most common method of examining the potential relationship between government deficits and money growth has been to utilize a single-equation framework in which the change in the money supply over time has been regressed against a set of explanatory variables that includes some measure of the government's budget position (see, for example, Niskanen, 1978; Hamburger and Zwick, 1981; Allen and Smith, 1983; Joines, 1985; and Grier and Neiman, 1987). However, such a single-equation approach is inappropriate and can lead to biased parameter estimates in cases where the rate of monetary expansion and the government's budget position are set simultaneously. For example, a change in the rate of monetary expansion may alter the current level of output or the rate of money price change which may, in turn, impact on the government's budget position causing the monetary authority to alter the money growth rate.

To allow for possible simultaneity in the monetary and fiscal policy reaction functions, a system of equations is specified which describes the be-

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havior of the monetary and fiscal authorities:

$$\begin{aligned} \Delta M_t = & \alpha_0 + \alpha_1 \Delta M_{t-1} + \alpha_2 \Delta M_{t-2} + \alpha_3 \Delta M_{t-3} \\ & + \alpha_4 \Delta M_{t-4} + \alpha_5 DEF_t + \alpha_6 WAR_t \\ & + \alpha_7 R_{t-1} + \alpha_8 (R_{t-1} - R_{t-2}) \\ & + \alpha_9 \Delta P_t^e + \alpha_{10} Y_{t-1} + \epsilon_{1t} \end{aligned} \quad (1)$$

$$\begin{aligned} DEF_t = & \beta_0 + \beta_1 DEF_{t-1} + \beta_2 DEF_{t-2} \\ & + \beta_3 DEF_{t-3} + \beta_4 DEF_{t-4} + \beta_5 WAR_t \\ & + \beta_6 G_t + \beta_7 Y_t + \beta_8 R_{t-1} \\ & + \beta_9 \Delta P_t^e + \epsilon_{2t} \end{aligned} \quad (2)$$

$$\begin{aligned} Y_t = & \gamma_0 + \gamma_1 Y_{t-1} + \gamma_2 Y_{t-2} + \gamma_3 Y_{t-3} + \gamma_4 Y_{t-4} \\ & + \gamma_5 WAR_t + \gamma_6 DEF_{t-1} + \gamma_7 DEF_{t-2} \\ & + \gamma_8 DEF_{t-3} + \gamma_9 DEF_{t-4} + \gamma_{10} \Delta M_{t-1} \\ & + \gamma_{11} \Delta M_{t-2} + \gamma_{12} \Delta M_{t-3} + \gamma_{13} \Delta M_{t-4} \\ & + \gamma_{14} G_t + \gamma_{15} G_{t-1} + \gamma_{16} G_{t-2} + \gamma_{17} G_{t-3} \\ & + \gamma_{18} G_{t-4} + \epsilon_{3t} \end{aligned} \quad (3)$$

$$\begin{aligned} \Delta P_t = & \mu_0 + \mu_1 \Delta P_{t-1} + \mu_2 \Delta P_{t-2} + \mu_3 \Delta P_{t-3} \\ & + \mu_4 \Delta P_{t-4} + \mu_5 WAR_t + \mu_6 \Delta M_{t-1} \\ & + \mu_7 \Delta M_{t-2} + \mu_8 \Delta M_{t-3} + \mu_9 \Delta M_{t-4} \\ & + \mu_{10} DEF_{t-1} + \mu_{11} DEF_{t-2} \\ & + \mu_{12} DEF_{t-3} + \mu_{13} DEF_{t-4} + \mu_{14} Y_{t-1} \\ & + \mu_{15} Y_{t-2} + \mu_{16} Y_{t-3} + \mu_{17} Y_{t-4} \\ & + \mu_{18} G_{t-1} + \mu_{19} G_{t-2} + \mu_{20} G_{t-3} \\ & + \mu_{21} G_{t-4} + \mu_{22} R_{t-1} + \mu_{23} R_{t-2} \\ & + \mu_{24} R_{t-3} + \mu_{25} R_{t-4} + \epsilon_{4t} \end{aligned} \quad (4)$$

where the  $t$  subscripts refer to time periods measured at quarterly frequency and the  $\epsilon_{it}$  are random disturbance terms. All variables, except  $R$ , are measured as natural logarithms to reduce the problem of heteroskedasticity that often arises when estimating equations with time series data that trend upwards.<sup>1</sup> A complete description of each variable, except  $\Delta P_t^e$ , and the manner in which it is measured is provided in the data appendix. The variable  $\Delta P_t^e$  is the expected rate of price change to prevail in period  $t$  based upon information available at the end of period  $t - 1$ .

<sup>1</sup> Rather than specifying variables in natural logarithmic form, the problem of heteroskedasticity could be addressed in a variety of other ways. For example, Joines (1985) chose to "deflate" all variables in his estimating equation by trend nominal GNP. The problem with such a procedure is that it assumes the "amount" of heteroskedasticity is proportional to the square of the variable used for deflation purposes. To determine whether the choice of log or deflation specification matters, the equations were also estimated using data that had been deflated by trend nominal GNP. The results of this estimation were similar to those reported here.

Equation (1) of the model describes the policy rule of the monetary authority and allows for several possible factors in the determination of money growth. The model of Fed behavior used in this paper is basically a linear reaction function. This is consistent with the existing literature but, more importantly, is consistent with Fed optimizing behavior as linear decision rules are obtained from a framework in which the decision-maker attempts to minimize a quadratic loss function. Thus, the empirical analysis contained within this paper is an attempt to determine what elements are contained within the Fed's objective function. The policy rule specified above is, with the exception of the contemporaneous deficit flow and the war dummy, essentially a feedback rule in which lagged or past values of the explanatory variables determine the current rate of money growth.<sup>2</sup> The adoption of a feedback specification does not seem to be an unreasonable approximation to monetary authority behavior given that in the empirical analysis all variables will be measured at quarterly frequency.

The dependent variable of the monetary policy rule is measured as the rate of change in nominal high-powered money which is the monetary aggregate under the direct control of the Fed. Equation (1) relates this nominal variable to the rate of nominal debt issue,  $DEF$ , which represents the fiscal authority's nominal revenue requirements beyond that revenue generated from non-borrowed sources. If the Fed decides to monetize all or some portion of the fiscal authority's deficit, then the growth of nominal high-powered money would be, at least partially, determined by the growth of nominal government debt and the  $DEF$  variable would have a significant positive impact on monetary expansion.

The use of high-powered money in the monetary policy rule is also the appropriate monetary aggregate regardless of whether the Fed is monetary aggregate targeting or interest rate targeting.

<sup>2</sup> Lag effects of up to four quarters are contained implicitly through the lagged dependent variables appearing in both equations (1) and (2). The acceptability of excluding lags on other explanatory variables was examined. For example, for the money growth equation, a likelihood ratio test for excluding versus including four lagged values of the  $DEF$  variable yielded a calculated test statistic of 0.92 which does not exceed the critical  $\chi^2$  value at any standard levels of confidence. Thus, the data do not reject the exclusionary restrictions.

Whether the Fed targets on an aggregate like M1 or on interest rates, control of either of these variables is obtained through transactions that alter the stock of high-powered money.

In addition to federal government financing requirements, equation (1) recognizes the possible effects of other variables on money growth. Joines (1985) found it was necessary to distinguish between "normal" and "wartime" financing requirements so a war dummy variable,<sup>3</sup> *WAR*, has been included in equation (1). If the Fed adjusts the rate of growth in high-powered money supply for stabilization purposes then output, price and interest rate behavior could influence Fed policy decisions. The inclusion of an output gap variable,  $Y_{t-1}$ , is designed to capture adjustments in the money growth rate for countercyclical purposes. The level and change in nominal interest rates are present to reflect possible Fed concern with credit conditions<sup>4</sup> and the expected rate of price change is included to account for any desire to achieve price stability.

Equation (2) describes the fiscal authority's policy rule. It contains the impact of automatic stabilizers on the government's budget position through the  $Y_t$  variable. It includes the impact of government output demand through  $G$ , war periods through the *WAR* dummy and interest payments on the outstanding stock of government debt through the lagged interest rate variable.<sup>5</sup>

<sup>3</sup> A war dummy, rather than Joines' war expenditure variable, is used in this analysis because the period of analysis is post-World War II and, thus, includes the relatively small expenditure wars of Korea and Viet Nam. The use of a single war dummy does constrain these two war periods to have the same impact. The validity of this restriction was tested by estimating the equations in the model with separate dummy variables for the Korean and Viet Nam wars. An asymptotic  $t$ -test could not reject the hypothesis that the dummy variable coefficients were the same for the two war periods and so, accordingly, a single war-period dummy is used in the reported equations.

<sup>4</sup> The use of lagged interest rates may introduce a misspecification of Fed behavior as the monetary authority receives interest rate data almost continuously throughout the quarter and not at discrete intervals, thus allowing it to respond to interest rate changes more frequently than with quarterly lags. An attempt was made to reduce the possibility of this misspecification by measuring interest rates as the average daily rate for the last month of the quarter so that the lagged interest rate appearing in the Fed's reaction function is not a one-quarter lag but a one-month lag.

<sup>5</sup> The lagged interest rate is used because the previous period's market yields determine the previous period's coupon payments on newly issued debt and, hence, the current period's interest payments on the outstanding national debt.

Finally, the deficit equation reflects Barro's (1979) arguments concerning the determination of debt financing. In an inflationary environment, the nominal stock of government debt must grow by the expected rate of inflation to maintain the purchasing power of the outstanding stock of debt. If the fiscal authority had, as a policy objective, a desire to maintain this purchasing power, then the expected rate of price inflation would affect the flow of government debt to the private sector.

Equations (3) and (4) are included to close the model. They provide the instruments needed to estimate the system and, in the case of the price inflation equation, provide the cross-equation restrictions associated with the expected inflation variable appearing in the money growth and deficit equations. Equations (3) and (4) are simply reduced form equations of a vector autoregressive form.

## II. Empirical Estimates of the Model

The central bank's and fiscal authority's policy functions were estimated using quarterly U.S. data for the 1948:2 to 1987:4 period (159 observations).<sup>6</sup> Two estimation methodologies were employed. Where a sufficient number of observations to achieve convergence were available, the entire system of four equations was estimated using Full Information Maximum Likelihood (FIML) methods. For comparison purposes and in cases where there were insufficient observations the two policy equations were estimated using Two-Stage Least Squares (2SLS) methods in which all of the exogenous and predetermined variables contained in the four-equation system were used as the set of instrumental variables.<sup>7</sup>

The FIML and 2SLS estimates of the money growth and deficit financing equations are re-

<sup>6</sup> The total sample space of 1947:1 to 1987:4 was reduced by the need to difference stocks to obtain flows and the use of four lags in the empirical analysis.

<sup>7</sup> The robustness of the empirical results to alternative specification was examined by expressing equations (3) and (4) as pure autoregressive equations in which only lagged dependent variables appeared as regressors. The results obtained from doing this are qualitatively the same as the empirical estimates reported here.

ported in table 1.<sup>8</sup> The first and third columns of the table present the estimated values of coefficients when the entire sample is used to estimate the equations while the other columns provide estimated coefficients for subperiods of the sample space. Comparing the results contained in columns (1) and (3) for the 1948:2 to 1987:4 period and those in columns (2) and (4) for the 1948:2 to 1980:4 period reveals the FIML and 2SLS estimates are qualitatively similar. The parameter estimates obtained under either estimation method are of the same sign and those estimated parameters found to be significantly different from zero under FIML are also found to be so under 2SLS.

The estimated Fed policy equation for the 1948:2 to 1987:4 period reveals that the significant determinants of high-powered money growth are lagged money growth, the lagged nominal interest rate, expected inflation, output behavior and the fiscal authority's budget position. The positive estimated coefficients on the expected inflation and output variables ( $\alpha_9$  and  $\alpha_{10}$ , respectively) indicate a somewhat accommodative policy with the Fed meeting, at least partially, the increased demand for nominal cash balances that would arise from increases in either of these two variables.<sup>9</sup> The positive and significantly different from zero estimate of  $\alpha_5$  indicates that deficit financing leads to increased rates of monetary expansion. While these deficit effects are significant, they are not exceptionally "large." Using the parameter estimates obtained from the FIML estimation, a permanent 10% increase in the rate

of growth in federal debt above that existing in the fourth quarter of 1987 would lead to an immediate increase in the quarterly rate of money growth of 0.2 percentage points and a long-run increase, once the deficit increase works through all the lags and interrelationships in the model, of 0.7 percentage points.<sup>10</sup>

Examination of the estimated deficit equation for the 1948:2 to 1987:4 period reveals that lagged deficits, the Korean and Vietnam wars, government purchases of goods and services, output fluctuations around trend and possibly expected inflation exerted a statistically significant impact on deficit financing decisions. The negative coefficient associated with the output variable ( $\beta_7$ ) indicates the impact of automatic stabilizers in the fiscal authority's expenditure and revenue functions. The positive coefficient of the expected inflation variable ( $\beta_9$ ) generates some support for Barro's (1979) optimal debt provision in an inflationary environment argument although the parameter estimate is substantially smaller than Barro's predicted value of one.

The "appropriateness" of the estimated equations summarized in the first and third columns of table 1 was assessed in two ways. First, the autocorrelation functions of the residuals were examined and Box-Leung  $Q$ -statistics calculated to ascertain whether these residuals were white noise or exhibited serial correlation. None of the  $\chi^2$  tests based on the Box-Leung  $Q$ -statistics rejected the hypothesis of white noise residuals in any of the estimated equations.<sup>11</sup>

Second, the estimated equations were subjected to tests of structural stability over the sample period. These tests were prompted by the view that the 1980s, the Reagan years, may have

<sup>8</sup> While table 1 does not report the estimated parameter values for the output and inflation equations of the model, the results obtained from the full sample estimation can be summarized as follows. For the output equation  $Y_{t-1}$ ,  $WAR_t$ ,  $\Delta M_{t-1}$ ,  $G_t$ , and  $G_{t-2}$  had estimated coefficients that were positive and significantly different from zero, while  $Y_{t-2}$ ,  $Y_{t-3}$  and  $G_{t-1}$  had significant and negative coefficients. For the inflation equation  $\Delta P_{t-1}$ ,  $\Delta P_{t-3}$ ,  $\Delta M_{t-1}$ ,  $\Delta M_{t-3}$ ,  $DEF_{t-2}$ ,  $Y_{t-1}$ ,  $R_{t-1}$  and the constant had estimated coefficients that were positive and significantly different from zero while  $\Delta P_{t-4}$ ,  $Y_{t-2}$  and  $R_{t-2}$  had significant and negative coefficients. These two equations were also tested for structural stability over the sample space. These tests found no evidence of structural instability for the 1980s, unlike the money growth and deficit equations.

<sup>9</sup> To determine whether the Fed's policy is truly accommodative or non-accommodative it is necessary to know the impact of changes in price inflation and output on the nominal demand for high-powered money.

<sup>10</sup> The simulation experiment that is being performed here corresponds to a permanent 10% increase in the rate of growth of the gross federal debt above the rate actually experienced in the fourth quarter of 1987. The "immediate" effect is the impact that would occur on money growth without accounting for the impact of the lag structure in the model, while the "long-run" effect explicitly allows the policy change to work itself through the model's lag structure.

<sup>11</sup> Box-Leung  $Q$ -statistics were calculated at lags of one, four, eight and twelve periods. For example, using eight period lags and residuals from the FIML estimation the calculated statistics were 13.9 for the money growth equation, 4.2 for the deficit equation, 4.0 for the price inflation equation and 2.1 for the output equation. The critical  $\chi^2$  values for eight degrees of freedom at the 1% and 5% levels are, respectively, 20.1 and 15.5

TABLE 1.—ESTIMATED PARAMETER VALUES  
(ASYMPTOTIC *t*-VALUES IN PARENTHESES)

Parameter	Full Information Maximum Likelihood		Two Stage Least Squares		
	1948:2–1987:4	1948:2–1980:4	1948:2–1987:4	1948:2–1980:4	1981:1–1987:4
Money Equation:					
$\alpha_0$	0.002 (0.49)	-0.000 (0.07)	0.002 (0.46)	-0.001 (0.09)	0.097 <sup>b</sup> (2.71)
$\alpha_1$	-0.235 <sup>a</sup> (2.00)	-0.220 <sup>b</sup> (1.50)	-0.229 <sup>a</sup> (3.04)	-0.248 <sup>a</sup> (3.09)	-0.603 <sup>a</sup> (2.98)
$\alpha_2$	-0.122 (1.04)	-0.117 (0.64)	-0.104 <sup>b</sup> (1.34)	-0.114 <sup>b</sup> (1.42)	-0.864 <sup>a</sup> (4.22)
$\alpha_3$	-0.158 (1.19)	-0.119 (0.66)	-0.152 <sup>a</sup> (1.94)	-0.156 <sup>a</sup> (1.90)	-0.576 <sup>a</sup> (2.17)
$\alpha_4$	0.437 <sup>a</sup> (3.76)	0.483 <sup>a</sup> (3.41)	0.434 <sup>a</sup> (5.64)	0.456 <sup>a</sup> (5.61)	-0.104 (0.43)
$\alpha_5$	0.800 <sup>a</sup> (3.15)	0.079 (0.31)	0.557 <sup>a</sup> (2.24)	0.186 (0.65)	0.774 <sup>a</sup> (2.41)
$\alpha_6$	-0.001 (0.14)	0.004 (0.53)	0.000 (0.01)	0.002 (0.51)	—
$\alpha_7$	-0.210 <sup>a</sup> (1.66)	-0.286 <sup>b</sup> (1.45)	-0.123 <sup>b</sup> (1.41)	-0.144 <sup>b</sup> (1.33)	-0.585 <sup>a</sup> (2.30)
$\alpha_8$	0.014 (0.12)	0.164 (0.50)	-0.008 (0.06)	0.094 (0.58)	-0.102 (0.41)
$\alpha_9$	1.092 <sup>a</sup> (1.93)	2.194 <sup>a</sup> (3.12)	0.946 <sup>a</sup> (2.37)	1.510 <sup>a</sup> (3.52)	0.047 (0.03)
$\alpha_{10}$	0.136 <sup>b</sup> (1.32)	0.062 (0.53)	0.106 <sup>b</sup> (1.33)	0.085 (1.02)	0.311 <sup>b</sup> (2.17)
Deficit Equation:					
$\beta_0$	-0.057 <sup>b</sup> (1.48)	-0.052 (1.10)	-0.053 <sup>a</sup> (2.29)	-0.049 <sup>a</sup> (2.01)	-0.723 <sup>a</sup> (3.35)
$\beta_1$	0.116 <sup>b</sup> (1.30)	0.238 <sup>a</sup> (2.40)	0.126 <sup>a</sup> (1.66)	0.253 <sup>a</sup> (2.99)	-0.134 (0.80)
$\beta_2$	0.109 (1.09)	0.061 (0.45)	0.144 <sup>a</sup> (1.86)	0.069 (0.78)	0.424 <sup>a</sup> (2.46)
$\beta_3$	0.063 (0.59)	0.054 (0.33)	0.059 (0.78)	0.067 (0.76)	0.453 <sup>a</sup> (2.58)
$\beta_4$	0.275 <sup>a</sup> (3.01)	0.279 <sup>a</sup> (2.17)	0.274 <sup>a</sup> (3.71)	0.289 <sup>a</sup> (3.42)	0.380 <sup>a</sup> (2.29)
$\beta_5$	0.006 <sup>a</sup> (1.70)	0.006 <sup>b</sup> (1.37)	0.006 <sup>a</sup> (2.54)	0.005 <sup>a</sup> (2.36)	—
$\beta_6$	0.012 <sup>b</sup> (1.42)	0.011 (1.04)	0.011 <sup>a</sup> (2.19)	0.010 <sup>a</sup> (1.91)	0.134 <sup>a</sup> (3.40)
$\beta_7$	-0.171 <sup>a</sup> (3.03)	-0.166 <sup>a</sup> (2.50)	-0.164 <sup>a</sup> (4.23)	-0.153 <sup>a</sup> (3.63)	-0.231 <sup>a</sup> (4.01)
$\beta_8$	0.028 (0.36)	0.011 (0.09)	0.010 (0.20)	0.012 (0.22)	0.413 <sup>a</sup> (2.29)
$\beta_9$	0.500 (1.21)	0.534 (1.04)	0.474 <sup>a</sup> (1.85)	0.424 <sup>a</sup> (1.68)	0.866 (0.87)

<sup>a</sup> Significantly different from zero at the 95% level of confidence.

<sup>b</sup> Significantly different from zero at the 90% level of confidence.

represented structural shifts in monetary policy or fiscal policy or the behavior of other elements in the economy or all three.<sup>12</sup> The Fed's successfully achieved intention to reduce the rate of price inflation from what prevailed in the 1970s, the large and growing deficits incurred by the fiscal authority and the sustained period of economic expansion following the deep recession of 1980–81 provide some evidence to indicate that structural changes may have occurred during this period.

To examine this issue, the system of four equations was re-estimated by FIML methods using a sample space of 1948:2 to 1980:4. The results of this appear as the second column of table 1. Comparing these estimated coefficients to those obtained from using the full sample period reported in the first column reveals substantial differences. For example, in the money growth equation the estimated parameter associated with the deficit is positive and significantly different from zero for the full sample yet it is not significantly different from zero for a sample of 1948:2 to 1980:4. These parameter differences are a sign of structural change. Unfortunately, formal tests for the existence of structural change could not be conducted using the FIML estimates because the "Reagan period" of 1981:1 to 1987:4 does not contain a sufficient number of observations to estimate all of the parameters of the four-equation model.

To circumvent this problem the money growth and deficit financing equations were estimated for the sample periods of 1948:2 to 1980:4 and 1981:1 to 1987:4 using 2SLS methods. The results of this estimation are reported in the fourth and fifth columns of table 1. Chow tests for a structural break in 1981 in these two equations were conducted and calculated *F*-statistics of 2.46 for the money growth equation and 2.57 for the deficit equation were obtained. These are distributed as

$F(10, 159)$  and  $F(9, 159)$ , respectively, with critical values of 1.83 and 1.88 at the 95% level of confidence. Thus, the hypothesis of structural stability is rejected by the data for both of the estimated policy equations.

The differences between the estimated coefficients for the 1948:2 to 1980:4 and the 1981:1 to 1987:4 periods can be seen by comparing the last two columns of table 1. For the deficit financing equation of the fiscal authority the most significant differences are with respect to the parameters associated with the lagged interest rate ( $\beta_8$ ) and expected price inflation ( $\beta_9$ ). Prior to 1981 the lagged interest rate has no significant impact on the size of the deficit, yet after 1981 the estimated value of  $\beta_8$  is positive and significantly different from zero, likely reflecting the impact of relatively high interest rates combined with large accumulated budget deficits in the government's budget position during the 1980s. In addition to this, Barro's argument about debt determination in an inflationary environment is supported somewhat by the data prior to 1981 for which a positive estimate of  $\beta_9$  is obtained, but is not supported at all after 1981 as the estimated value of  $\beta_9$  is not significantly different from zero for the "Reagan era." This effect is likely caused by the continuing large and growing budget deficits during a period of relatively low and stable inflation rates.

As with the deficit equation, the Fed's money growth equation exhibits two significant differences between the two subperiods examined. First, the coefficient associated with the expected price inflation variable is significantly positive prior to 1981 but not significantly different from zero after 1981. This finding is consistent with a Fed policy focussed on controlling the rate of price inflation such that high-powered money growth does not accommodate expected price level changes during the 1980s. Second, and more important for the focus of this study, the budget position of the fiscal authority only possesses a significantly different from zero, positive influence on high-powered money growth for the 1981:1 to 1987:4 subperiod, and not for the period prior to that. Thus, there appears to have been a change in monetary authority behavior during the large budget deficit period towards financing a portion of those deficits. Again, while

<sup>12</sup> In addition to the pre-Reagan years and Reagan years split in the sample space, the equations were also examined for structural change occurring in 1961. This analysis was prompted by the work of Turnovsky and Wohar (1987) who discovered a significant link between money growth and deficits prior to 1961, but not afterward. No evidence was generated to support that a change in the relationship between money growth and deficit financing occurred at this time for the sample and model specification appearing in this analysis.

this is a significant effect, it is not an exceptionally large effect. Applying the 2SLS estimated parameters obtained from the 1981:1 to 1987:4 sample period to a permanent 10% increase in the rate of growth of federal debt above that existing in the fourth quarter of 1987 yields a 0.2 percentage point increase in the short-run (impact period) rate of money growth and a 0.1 percentage point increase in the long run when the effect of all lagged variables has been included.

It could be argued that the structural shift in the money growth equation may not be due to a "Reagan years" phenomenon but rather may be due to the change in operating procedure adopted by the Fed in the third quarter of 1979. The validity of this argument is difficult to assess empirically given the small sample of observations lying between 1979:3 and 1981:1, the beginning of the Reagan presidency. However, to shed some light on this issue, both the money growth and deficit equations were estimated by 2SLS using samples of 1948:2 to 1979:3 and 1948:2 to 1980:4. For neither equation did an asymptotic  $F$ -test support the hypothesis that a structural shift had occurred in 1979:3.

It could also be argued that the appearance of a "Reagan years" policy change may, in fact, not represent a shift in money growth or deficit policy. Such would be the case if the monetary and/or the fiscal authority were to behave differentially over the business cycle by setting money growth and deficits differently in economic downturns than in upturns. Since the 1980s have been a period of sustained economic expansion after the 1980–81 recession, the finding of structural change for this period may be illusory.

To examine the validity of this argument, the sample period of 1948:2 to 1987:4 was partitioned into "upturn" and "downturn" quarters and the money growth and deficit equations were estimated by 2SLS over the two partitioned subsamples. Two definitions of the business cycle were used in this exercise. First, the cycle was defined simply in terms of whether output was above or below its trend value. Second, the cycle was defined in NBER terms as movements from a trough to a peak or movements from a peak to a trough. Chow tests were conducted to determine whether the estimated money growth and deficit equations were homogeneous over the two subsample peri-

ods. In both cases of alternative business cycle definition, the hypothesis of homogeneity was not rejected by the data. Thus, it appears as though the differential estimates obtained for the 1980s are not just the result of a sustained cyclical upturn but rather truly reflect changes in money growth and deficit policies.

### III. Conclusions

This paper has provided a reexamination of the relationship between the federal government's budgetary position and the rate of high-powered money expansion chosen by the Federal Reserve Board in the U.S. over the 1948 to 1987 period. This empirical analysis was characterized by two important elements. First, the budget position of the fiscal authority and the rate of money growth set by the monetary authority are both specified as endogenous variables within a system of equations. Second, the data set extends well into the 1980s and allows the analysis to address the question of whether money growth and/or deficit policy has changed during the "Reagan years."

The empirical evidence reported in this paper supports the position that policy has changed during the 1980s. Prior to 1981 there is no evidence that budget deficits exerted an independent influence on high-powered money growth while after 1981 a linkage is found to exist. During the Reagan administration, increases in the federal budget deficit have led to an acceleration in the high-powered money growth rate.

### DATA APPENDIX

#### Description and Sources

$\Delta M$  = The first difference of the natural log of high powered money. High powered money is defined as notes in circulation plus Federal Reserve member banks' reserves (end of period). Sources: 1946–54, 1963–64, 1971–72, 1985–87, *Survey of Current Business*, U.S. Department of Commerce, various issues; 1955–62, 1965–70, 1973–84, *Business Statistics*, U.S. Department of Commerce, various issues.

$DEF$  = The first difference of the natural log of U.S. federal government gross debt (end of period). Sources: 1947–54, 1963–67, 1971–72, 1985–87, *Survey of Current Business*, U.S. Department of Commerce, various issues; 1955–62, 1968–70, 1973–84, *Business Statistics*, U.S. Department of Commerce, various issues. This deficit measure is consistent with that used by Barro (1979).

$WAR$  = A dummy variable for U.S. participation in the Korean and Vietnam wars. It equals one in 1951:1 to 1954:1 and 1966:3 to 1973:1, zero at other times.

$R$  = The nominal interest rate. This is proxied by the average of daily data for the last month of each quarter of the 6-month commercial paper rate. Sources: 1947-54, 1963-64, 1971-72, 1985-87, *Survey of Current Business*, U.S. Department of Commerce, various issues; 1955-62, 1965-70, 1973-84, *Business Statistics*, U.S. Department of Commerce, various issues.

$Y$  = The difference between the natural log of real output and the log of trend real output. Trend real output is the predicted value from the regression of the log of real GNP on a constant and trend. Sources for real GNP: 1947-52, *The National Income and Product Accounts of the United States, 1929-76*, U.S. Department of Commerce, Washington, D.C., 1981; 1953-84 *Business Statistics 1984*, U.S. Department of Commerce, Washington, D.C., 1985; 1985-87, *Survey of Current Business*, U.S. Department of Commerce, various issues. The validity of using a single estimated trend equation over the entire sample of 1947 to 1987 was tested by examining the residuals obtained from such an equation. After adjusting these residuals for fourth-order autocorrelation they were subjected to a Brown-Durbin-Evans Cusum testing procedure and no evidence of structural instability was found. Additionally, the adjusted residuals were subjected to tests for heteroskedasticity and no problems were indicated by such tests.

$G$  = The natural log of Federal government expenditure on goods and services in constant dollars. Sources: 1946-52, *The National Income and Product Accounts of the United States, 1929-76*, U.S. Department of Commerce, Washington, D.C., 1981; 1953-84, *Business Statistics 1984*, U.S. Department of Commerce, Washington, D.C., 1985; 1985-87, *Survey of Current Business*, U.S. Department of Commerce, various issues.

$\Delta P$  = The first difference of the log of the GNP price index (1972 = 100). Sources: 1946-52, *The National Income and Product Accounts of the United States, 1929-76*, U.S. Department of Commerce, Washington, D.C., 1981; 1953-1984, *Business Statistics 1984*, U.S. Department of Commerce, Washington, D.C.,

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Note: All data are quarterly for the period 1947:1 to 1987:4 and are seasonally adjusted.

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