GOVERNMENT BORROWING AND MONETARY ACCOMMODATION

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Abstract:
This paper re-examines the relationship between Treasury borrowing and monetary growth examined previously with annual data by Barro, Niskanen and Hamburger and Zwick. Our analysis, based on quarterly data, produces evidence of a positive and significant impact of total Treasury borrowing upon the growth of the monetary base for the 1954/I-1961/II and 1961/III-1974/IV periods but an insignificant coefficient for the Barro expenditure variable. When the coefficient instability during the 1961/III-1980/IV period is corrected by a dummy variable technique thy debt coefficient is positive and significant and remains stable for this two decade period.

Article:

1. Introduction

Recently, Hamburger and Zwick (1981, hereafter HZ) have employed Barro's (1977, 1978a, b) model of money supply determination and have shown that both Barro and Niskanen (1978) err in their investigation of the budget deficit-money supply relationship by not recognizing two different policy regimes in the postwar period. HZ argue that the pre-1961 data used by Barro and Niskanen represent a different policy regime and show that budget deficits had a positive and significant effect on money supply growth for the 1961-1974 period but not for the 1954-1976 period.[1] Using coefficient estimates for the 1961-1974 period, HZ's equation overpredicts monetary growth for 1975-1976 but accurately predicts monetary growth for 19771978.[2] From this evidence, HZ conclude that the 1975-1976 period represents only a brief deviation from the Keynesian macroeconomic regime of 1961-1974 because the predictive accuracy for 1977-1978 reflects a return by the Federal Reserve Board to their 'interest rate smoothing policy' and monetization of the debt through open-market operations. This conclusion is reinforced by Hamburger and Zwick (1982) where they report evidence of a positive and significant coefficient on the budget deficit for the 1961-1981 period in a money supply equation which includes a dummy variable for 1975-1976.

This evidence of a significant budget deficit coefficient and their assertion of different policy regimes in the post-war period suggests that the residuals employed by Barro as a measure of unanticipated monetary growth are obtained from a money supply equation which is misspecified and subject to structural instability.[3] HZ, however, are limited in their ability to test for a change in the deficit to monetary growth relationship prior to 1961 and after 1974 or to test for the structural stability of their model around these dates because they employ annual data. A quarterly version of the Barro (1977, 1978a) money supply model has been published by Barro and Rush (1980, hereafter BR) for the 1941/I-1978/I period, but they do not test for the significance of a deficit variable or for the structural instability of the equation. Therefore, the purpose of this paper is twofold: (1) to test for the significance of fiscal variables such as real government expenditures and the real deficit, and (2) to test for the structural stability of the coefficient estimates over 1954/I-1980/IV.

In section 2 we introduce and respecify the Barro, BR and HZ money supply models. The substantial growth in off-line budget items in the past decade suggests that the total change in the government's debt rather than the deficit is the more appropriate variable to test for the total impact of government borrowing upon Federal

Reserve policy.[4] Accordingly, we substitute the total change in the debt for the deficit and the monetary base for the money supply, because it is the monetary base which is directly affected by the Federal Reserve's purchase of government bonds. In section 3 we use quarterly data to test for the stability of the monetary base equations in both the early 1960s and 1970s and find that Quandt and Chow tests fail to accept the null hypothesis of structural stability. Therefore, we test for coefficient instability in section 4 for the 1961/III-1980/IV period. Conclusions appear in section 5.

2. The models

Barro (1977, 1978a) estimates the following money supply equation with annual data for the 1941-1976 and 1946-1976 period:

$$DM_t = a_0 + a_1 DM_{t-1} + a_2 DM_{t-2} + a_3 UN_{t-1} + a_4 FEDV + a_5 DEF, \quad (1)$$

while BR estimate a quarterly version of eq. (1) for 1941/I-1978/I:

$$DM_t = \alpha_0 + \sum_{i=1}^{6} \beta_i DM_{t-i} + \sum_{i=1}^{3} \delta_i UN_{t-i} + \gamma_1 FEDV, \quad (2)$$

where $DM_t = \log(M_t/M_{t-1})$ and M_t is the average stock of M_1 money; $UN_{t-1} = \log [U/(1-U)]_{t-1}$ and U is the unemployment rate of the total labor force; *FEDV* is an exponentially declining distributed lag of the log of real federal expenditures; and $DEF=[deficit/(P_t \bullet y_t^*)1)]$, where P_t is the GNP deflator and y_t^* is the trend value of real GNP.[5] To maintain a consistent definition between fiscal variables, HZ redefine *FEDV* to be *FED*, where $FED = (G_t/P_t \bullet y_t^*)$ and G_t is current federal government expenditures. While HZ estimate eq. (1) and variations of this equation for the 1954-1976 period, they estimate only the following equation for the 1961-1974 period to conserve degrees of freedom:[6]

$$DM_t = b_0 + b_1 DM_{t-1} + b_2 FED + b_3 DEF. \quad (3)$$

We estimate eq. (3) using quarterly data with the *DEBT* substituted for *DEF* and with the monetary base substituted for the money stock such that:

$$DB_t = c_0 + \sum_{i=1}^{5} c_i DB_{t-i} + d_1 FED + d_2 DEBT, \quad (4)$$

where $DEBT = \Delta NFD/(P_t \bullet y_t^*)$, ΔNFD is the change in net federal debt in period *t*, and $DB_t = \log(B_t/B_{t-1})$ with B_t equal to the quarterly average of the base.[7] The Barro and Rush money supply model with the *DEBT* variable included also is estimated with either *DM* or *DB* as the dependent variable:

$$DM_t = \alpha_0 + \sum_{i=1}^{5} \beta_i DM_{t-i} + \sum_{i=1}^{3} \delta_i UN_{t-i} + \gamma_1 FEDV + \gamma_2 DEBT. \quad (5)$$

The appropriate lag length for the dependent variable in eqs. (4) and (5) is determined by searching over an eight period lag for the 1961/III-1974/IV period. In each case the coefficients for six, seven and eight period lags are individually and collectively insignificant for both equations.[8]

3. The results

Eq. (4) is first estimated for the 1954/I-1974/IV period and for the appropriate subperiods in order to conduct the Quandt likelihood ratio test and the Chow test for a structural shift in the equation between 1959/I-1961/IV. The results are presented in table 1 as eqs. (1.1)-(1.3). The breakpoint of 1961/II maximizes the test statistics for both the Quandt and Chow tests and results in the rejection of the null hypothesis of structural stability of the equation during the 1954/I-1974/IV period. [9] The structural instability of the equation is a result of the instability of the individual lagged base coefficients whose cumulative sums (t-statistics) for the two subperiods are -1.27 (2.35) and 0.66 (5.96) respectively. The debt coefficient is significant and similar in magnitude in *both* periods while the expenditure coefficient is insignificant in both periods. The R^2 of 0.70 for the 1954/I-1974/IV period and the significance of the debt and three lagged base coefficients camouflages the instability of the lagged base coefficients across the two subperiods and the poor fit of the equation for the 1954/I-1961/II period.[10]

Eq. (4) is then estimated for the 1961/III-1980/IV period and for the appropriate subperiods in order to test for a structural shift between 1969/I- 1975/IV. These results are presented in table 1 as eqs. (1.4) -(1.6) given the breakpoint at 1969/III which maximizes the test statistics for both the Quandt likelihood ratio and the Chow test and leads to the rejection of the null hypothesis of structural stability over 1961/III-1980/IV.[11] There is evidence of coefficient instability because the debt coefficient is positive and significant for the 1961/III-1969/III period while the expenditure coefficient is positive and significant for the 1969/IV-1980/IV period. The lagged base coefficients also display instability across the two periods as their sum (t-statistic) declines from 0.67 (3.75) to 0.34 (2.03). The R^2 of 0.51 and the significance of two lagged base coefficients for the 1961/III-1980/IV period camouflages the instability of the lagged base, debt, and expenditure coefficients across the two periods and the poor fit of the equation for the 1969/IV-1980/IV period.

Table 1

Estimates of eq. (4).[a]

Eq.	Period	c_0	c_1	c_2	c_3	c_4	c_5	d_1	d_2	$\bar{R}^2$	SE	DW
(1.1)	1954 I-1961 II	−0.00	−0.23	−0.55	−0.24	−0.18	−0.07	0.03	0.53	0.20	0.0041	2.18
		(0.00)	(0.127)	(2.98)	(1.17)	(0.93)	(0.39)	(0.38)	(2.30)			
(1.2)	1961 III-1974 IV	−0.01	0.41	−0.04	0.10	−0.14	0.32	0.07	0.56	0.52	0.0032	1.87
		(0.78)	(3.28)	(0.30)	(0.73)	(0.99)	(2.55)	(1.10)	(2.78)			
(1.3)	1954 I-1974 IV	−0.01	0.37	−0.09	0.22	0.08	0.23	0.08	0.43	0.70	0.0040	1.97
		(1.33)	(3.52)	(0.80)	(2.06)	(0.68)	(2.18)	(1.41)	(2.71)			
(1.4)	1961 III 1969 III	0.01	0.41	−0.33	0.19	−0.12	0.52	−0.02	0.81	0.37	0.0030	2.22
		(0.59)	(2.48)	(1.83)	(1.07)	(0.69)	(3.02)	(0.28)	(3.14)			
(1.5)	1969 IV-1980 IV	−0.02	0.13	0.26	0.15	−0.15	−0.05	0.14	−0.27	0.18	0.0031	2.19
		(1.00)	(0.91)	(1.86)	(0.97)	(1.01)	(0.34)	(1.74)	(1.27)			
(1.6)	1961 III 1980 IV	−0.01	0.36	0.06	0.08	−0.12	0.20	0.06	0.13	0.51	0.0033	1.94
		(0.54)	(3.26)	(0.47)	(0.70)	(0.98)	(1.86)	(1.08)	(0.87)			
(1.7)	1954 I 1980 IV	−0.01	0.35	−0.02	0.22	0.06	0.19	0.05	0.20	0.73	0.0040	1.98
		(0.85)	(3.68)	(0.24)	(2.21)	(0.57)	(1.99)	(1.00)	(1.47)			

[a] T-scores are shown in parentheses. All regressions were run on the 3.5c version of TSP.

The equation estimates for both the 1961/III-1980/IV and 1954/I-1980/IV periods reveal insignificant debt and expenditure coefficients for these longer time intervals. The previously reported results, however, confirm the existence of three distinct regimes where the debt coefficient is positive and significant in the first two regimes and the expenditure coefficient is positive and significant in the third regime.

We now consider our version of the *BR* equation with either the money supply *(DM)* or the monetary base *(DB)* as the dependent variable. The results of estimating eq. (5) given the break points determined for eq. (4) appear in table 2. Coefficient instability and insignificance across subperiods is once again apparent. First, the expenditure variable *(FEDV)* is never significant.[12] Second, the unemployment coefficients e only significant for the *DM* equation estimated for the 1961/III-1969/III period. Third, the debt coefficient is significant for both dependent variables for only the 1961/III-1969/III period. A structural shift in eq. (5) at 1969/III is confirmed by the Quandt test for both dependent variables and by the Chow test for the *DB* equation at the five percent level of significance.[13] The Chow and Quandt tests also fail to accept the null hypothesis of structural stability at 1961/II for the *DB* equation at the one percent level, but the two tests fail to reject the null hypothesis at the five percent level for the *DM* equation.[14] Despite the failure to reject the hypothesis of structural stability for the *DM* equation at 1961/II, a comparison of eq. (2.1) which has no significant coefficients, and eq. (2.2) which has five significant coefficients reveals considerable difference in coefficient size and significance. Therefore, there is also evidence of three distinct regimes for the Barro and Rush money supply or monetary base equations.[15]

4. Analysis of coefficient instability

The Quandt and Chow tests are incapable of pinpointing the source of structural instability. Therefore, a dummy variable test developed by Gujarati (1970) is employed to test the coefficient instability in eq. (4) by including a dummy variable for the intercept, a dummy variable times the debt variable *(DDEBT)* and a dummy variable times the expenditure coefficient *(DFED).*

Table 2

Estimates of eq. (5).[a]

Eq.		α_0	β_1	β_2	β_3	β_4	β_5	δ_1	δ_2	δ_3	γ_1	γ_2	$\bar{R}^2$	*SE*	*DW*
1954/I–1961/II															
(2.1)	*DW*	0.02	0.07	−0.05	−0.05	0.14	0.10	0.00	0.02	−0.01	−0.01	0.30	−0.15	0.0059	2.00
		(0.75)	(0.31)	(0.20)	(0.20)	(0.55)	(0.40)	(0.03)	(0.82)	(1.04)	(0.15)	(0.67)			
(2.2)	*DB*	0.02	−0.28	−0.66	−0.29	−0.21	−0.04	0.01	−0.03	0.02	0.03	0.38	0.36	0.0037	2.01
		(1.11)	(1.60)	(3.80)	(1.57)	(1.20)	(0.26)	(1.20)	(2.17)	(2.79)	(1.06)	(1.44)			
1961/III–1969/III															
(2.3)	*DM*	−0.03	0.53	−0.21	−0.27	−0.01	0.38	−0.07	0.11	−0.05	−0.02	0.92	0.60	0.0038	1.94
		(1.72)	(3.09)	(0.99)	(1.15)	(0.03)	(2.09)	(2.56)	(2.70)	(2.33)	(0.71)	(2.53)			
(2.4)	*DB*	−0.00	0.39	−0.35	0.15	−0.05	0.45	−0.02	0.02	−0.00	−0.01	0.83	0.31	0.0031	2.17
		(0.05)	(2.09)	(1.69)	(0.65)	(0.26)	(1.96)	(0.82)	(0.64)	(0.21)	(0.24)	(2.83)			
1969/IV–1978/IV															
(2.5)	*DM*	0.03	0.46	0.18	0.47	0.22	0.26	0.00	0.03	−0.02	0.02	−0.37	0.21	0.0045	1.97
		(1.39)	(2.42)	(0.85)	(2.38)	(1.04)	(1.31)	(0.19)	(0.95)	(1.18)	(0.48)	(1.10)			
(2.6)	*DB*	0.02	0.06	0.34	0.18	−0.26	−0.03	−0.01	0.01	−0.01	0.01	−0.07	0.12	0.0033	2.08
		(0.89)	(0.31)	(1.87)	(1.04)	(1.39)	(0.15)	(0.72)	(0.82)	(0.51)	(0.19)	(0.27)			
1961/III–1978/IV															
(2.7)	*DM*	0.00	0.60	−0.26	0.25	−0.23	0.37	−0.01	0.03	−0.02	0.02	0.18	0.43	0.0046	2.01
		(0.43)	(4.90)	(1.73)	(1.81)	(1.66)	(3.30)	(0.90)	(1.46)	(1.50)	(0.85)	(0.70)			
(2.8)	*DB*	0.01	0.37	0.10	0.10	−0.13	0.22	−0.00	0.01	−0.01	−0.00	0.16	0.47	0.0035	1.96
		(1.12)	(3.07)	(0.71)	(0.82)	(0.98)	(1.95)	(0.13)	(0.59)	(0.79)	(0.03)	(0.84)			

[a] *T*-scores are shown in parentheses.

Three shift periods are tested for the 1961/III -1980/IV period such that *DI* represents a dummy variable equal to zero from 1961/III-1969/III and one thereafter, *D2* represents a second dummy variable equal to zero from 1961/III-1973/IV and one thereafter, and *D3* represents a third dummy variable equal to zero from 1961/III-1976/III and one thereafter. *D1* is specified as a result of the structural break in eq. (4). *D2* is specified to test for any coefficient shift at the beginning of the 1974-1975 recession. *D3* is specified on the basis of the HZ argument that the debt to monetary growth linkage reappeared in 1977 and 1978. The exact specification of *D3* is determined by searching over the 1975/II to 1977/IV period for the dummy variable which minimizes the standard error of the regression in eq. (6):

$$DB_t = a_0 + a_1 D1 + a_2 D2 + a_3 D3 + \sum_{i=1}^{5} b_i DB_{t-i} + c_0 FED + c_1 D1FED + c_2 D2FED + c_3 D3FED + d_0 DEBT + d_1 D1DEBT + d_2 D2DEBT + d_3 D3DEBT. \qquad (6)$$

The results are reported in table 3 for eq. (6) and for an equation which constrains $d_1 = d_2 = d_3 = 0$ because these coefficients are insignificant in the results reported as eq. (3.1).[16] This evidence confirms shifts for the intercept and the expenditure coefficient for each of the three breakpoints. The expenditure coefficient is not significantly different from zero for the 1961/III-1969/III period and is close to zero after the third shift because the sum (t-statistic) of c_i equals 0.10 (0.18) and 0.04 (0.45) in eqs. (3.1) and (3.2). The debt coefficient is significant and similar in magnitude (0.57 and 0.49) in both equations." The insignificance of the debt shift parameters and the significance of the debt coefficient suggests that a positive and significant linkage between the change in the stock of government debt and the growth of the monetary base existed during the 1961/III-1980/IV period. Furthermore, the significant debt coefficient estimate of 0.53 for the 1954/I-1961/II period provides evidence of monetary accommodation of Treasury borrowing by the Federal Reserve Board for the entire post-Accord period.

5. Summary

The positive and significant impact of the real trend value of the change in the stock of government debt upon the growth of the monetary base is the most important finding of this paper. Yet, the Barro-type money supply and monetary base models which have been the focus of this paper differ from the standard reaction function models which may include income, interest rates, the rate of inflation, the grip between actual and potential output and a balance-of-payments measure as explanatory variables.

Table 3

Estimates of eq. (6).[a]

1961/III–1980/IV					
(3.1) DB_t	$a_0 =$ 0.00 (0.38)	$b_1 =$ 0.31 (2.96)	$c_0 =$ 0.00 (0.07)	$d_0 =$ 0.57 (2.42)	$\bar{R}^2 = 0.60$
	$a_1 = -0.07$ (1.75)	$b_2 =$ 0.00 (0.01)	$c_1 =$ 0.33 (1.79)	$d_1 = -0.25$ (0.63)	$SE = 0.0030$
	$a_2 =$ 0.22 (2.52)	$b_3 =$ 0.07 (0.65)	$c_2 = -1.08$ (2.49)	$d_2 =$ 1.00 (1.13)	$DW = 2.00$
	$a_3 = -0.18$ (2.03)	$b_4 = -0.12$ (1.02)	$c_3 =$ 0.85 (1.99)	$d_3 = -1.26$ (1.25)	
		$b_5 =$ 0.26 (2.37)			
(3.2) DB_t	$a_0 =$ 0.00 (0.30)	$b_1 =$ 0.29 (2.81)	$c_0 =$ 0.01 (0.19)	$d_0 =$ 0.49 (2.66)	$\bar{R}^2 = 0.61$
	$a_1 = -0.06$ (1.75)	$b_2 = -0.01$ (0.06)	$c_1 =$ 0.30 (1.79)		$SE = 0.0030$
	$a_2 =$ 0.14 (3.65)	$b_3 =$ 0.05 (0.44)	$c_2 = -0.65$ (3.63)		$DW = 1.97$
	$a_3 = -0.08$ (2.78)	$b_4 = -0.10$ (0.87)	$c_3 =$ 0.39 (2.83)		
		$b_5 =$ 0.26 (2.41)			

[a]*T*-scores are shown in parentheses.

Previous studies using reaction functions usually have not included a debt variable.[18] Our results of a significant debt coefficient are consistent with the evidence reported by Levy (1981) who tests a reaction function derived from a structural IS-LM model.[19] Further, the evidence of structural shifts and coefficient instability in eqs. (4) and (5) suggest a fundamental difficulty in obtaining estimates of anticipated versus unanticipated monetary growth. Barro (1977,1978a), and Barro and Rush have implicitly assumed structural stability of the money supply equation to obtain their unanticipated monetary growth series.[20] The problem of economic agents identifying structural shifts and forming expectations during transition periods of systematic and unsystematic components of a variable must be addressed in the future.

Appendix

M_t = the stock of M_{1B} money. Published in *Macroeconomics,* 2nd edition, by Robert J. Gordon. Revised quarterly data, 1947/I-1980/IV.
B_t = the adjusted monetary base. Calculated from a monthly series provided by the Federal Reserve Bank of St. Louis, January 1950--December 1980.
U = the unemployment rate of the total civilian labor force. Published in Gordon's *Macroeconomics,* 2nd edition, 1947/I-1980/IV.
FEDV= Barro's exponentially declining distributed lag of the log of real federal expenditures, 1947/I-1978/IV. See Barro (1977, 1978a, b), and Barro and Rush (1980).
P_t = the GNP deflator. Published in Gordon's *Macroeconomics,* 2nd edition, 1947/I-1980/IV.
y_t^* = the trend value of real GNP. Calculated over the 1948/II-1980/IV period as a linear time trend corrected for serial correlation.
G_t =nominal federal government expenditures (NIPA bass). Published in Business Statistics 1977 and the Survey of Current Business, various issues, 1947/I-1980/IV.
NFD = the stock of net federal debt. Published by the Federal Reserve Bank of St. Louis. Revised quarterly data, 1948/I-1980/IV.

Notes:

[1] Hamburger and Zwick chose 1961 as the breakpoint on the basis of the Buchanan and Wagner (1978) argument that macroeconomic pokey underwent a change in the early 1960's. Buchanan and Wagner (pp. 114-116) label 1961-1976 as the Keynesian period and provide casual evidence in a table that the 1961-19·4 period reinforces the thesis that budget deficits are positively related to changes in the stock of money'.

[2] HZ report predicted values of monetary growth of 8.0%, 7.7%, 7.4% and 8.2% for 1975-1978 while actual rates were 4.4%, 5.3%, 7.3% and 7.8%. Therefore, their simulation errors were -3.6% and -2.4% for 1975-1976 and -0.1% and -0.4% for 1977 and 1978.

[3] The work by Barro, and Barro and Rush (1980) came under initial criticism by Small (1979) and by Blinder (1980), Gordon (1980) and Weintraub (1980) in their response to the Barro and Rush paper which was presented at a 1978 NBE R conference. Other responses to Barro's work are cited by Mishkin (1982).
[4] HZ did note that a variable defined as the funds raised in the credit market by the U.S. government in the Flow of Funds Account strengthened their results (see p. 146, fn. 5). While the deficit has averaged $38.2 billion from 1977-1980, the total change in the debt which includes the deficit and off-line budget items has averaged $54.8 billion in the same period.
[5] See Barro (1977, p 103 and 1978b, p. 577), and Barro and Rush (1980, p. 33) for more information about the data.
[6] HZ also estimate eq. (3) with either b_2 or b_3 constrained to zero. The Barro unemployment rate variable lagged one period was not included because it was insignificant.
[7] See the appendix for the definitions and sources of the raw data.
[8] Eqs. (4) and (5) which include an eight-period quarterly lag on *DB* are also estimated for each of the regressions reported in tables 1 and 2. The individual coefficients for c_0, c_1, and $c_?$ are never positive and significant.
[9] The calculated χ^2 statistic for the likelihood ratio test is 33.68 with a critical value of 23.2 at the one percent level of significance, The calculated F-statistic for the Chow test is $F_{,,,,m}$ —4,05 with a critical value of 2.80 at the one percent level,
[10] The results of estimating eqs. (1.1)-(1.3) with either d_1 or d_3 constrained to zero results in significant d_1 coefficients of 0.13, 0.14 and 0.15 and significant d_2 coefficients of 0.58, 0.66, and 0.54. The results of estimating eq. (4) with DM substituted for DB reveal R^2 values of -0.11, 0.44 and 0.51 for eq. (1.1)-(1.3). There are no positive and significant coefficients in eq. (1.1) whereas c_1, c_2, and d_2 are positive and significant in eq. (1.2) and c_1, c_2, and d_1 are positive and significant in eq (1.3). Results are available from the authors as appendices A and B.
[11] The calculated χ^2 statistic for the likelihood ratio test is 24.96 with a critical value of 23.2 at the one percent level of significance. The calculated F-statistic for the Chow test is $F_{?,?}$ = 2.89with a critical value of 2.82 at the one percent level.
[12] The results of estimating eq. (5) with y_2 constrained to zero shows an insignificant *FEDV* coefficient in every equation reported in table 2. R^2 values for the eight equations are —0.11, 0.32, 0.51, 0.10, 0.20, 0.15, 0.43 and 0.47 respectively. Results are available from the authors as appendix C.
[13] For the 1969/III-1969/IV breakpoint the calculated F-statistic for the Chow test is 2.02 for the *DB* and 1.88 for the *DM* equation where the critical value for $F_{11,48}$ is 2.00 at the five percent level. The calculated X^2 statistic for the Quandt test is 26.84 for the *DB* and 26.32 for the *DM* equation where the critical values are 22.36 and 27.69 for the five and one percent levels of significance.
[14] For the 1961/II-1961/III breakpoint the calculated F-statistic is 3.92 for the *DB* and 1.11 for the *DM* equation where the critical values for $F_{11,62}$ are 1.95 and 2.56 for the five and one percent levels of significance. The calculated χ^2 statistic is 44.34 for the *DB* and 19.06 for the DM equation where the critical values are 22.36 and 27.69 for the five and one percent levels of significance.
[15] The structural instability of these equations may be a result of the variations in central bank behavior resulting from the change in administrations in 1961 and 1969 and in the Federal Reserve Board Chairman in 1970, or from the change in the response by the Federal Reserve to certain economic variables. The exact reason the structural shifts of the equations lies beyond the scope of this paper, though the next section tests for the stability of each coefficient estimate.
[16] An anonymous referee suggested that we test for the output effect of unanticipated monetary growth with the residuals obtained' from eqs. (3.1) and (3.2). The following output equation, which is similar to the one reported by BR in their Table 2.1, is estimated for 1961/III-1980/1V

$$\ln y_t = \alpha_0 + \sum_{i=0}^{8} \theta_i e_{t-i} + \xi_1 T + \xi_2 \ln(G/P), \qquad (16.1)$$

where y_t is real GNP, e_1 are the residuals obtained from either eq. (3.1) or (3.2) estimated for 1961/III-1980/IV, T is a time trend and *G/P is* real government expenditures. Regardless of whether the residuals of eqs. (3.1) or (3.2) are obtained from either the monetary base version (reported in table 3) or the money supply version (not reported), the current and at least the first three lagged residuals are positive and significant for eq. (16.1) and the $\bar{R}^2$ = 0.99. The $\bar{R}^2$ of the money supply versions of eqs. (3.1) and (3.2), however, are only 0.30 and 0.32. Furthermore, the residuals (unanticipated monetary growth) are more highly correlated with the growth rate of the actual money supply (0.75) than is anticipated monetary growth (0.66). The high correlations between unanticipated and actual monetary growth must call into questions the interpretation of significant 'residuals' in output equations like (16.1).

[17] Eq. (6) is also employed to test separately for shifts in the lagged base coefficients for each of the three breakpoints. The shift coefficients are insignificant except for DB_{t-2} times the *D1* dummy shift variable and for DB_{t-1} times the *D2* dummy shift variable. When these two shift variables are included in eq. (6), their coefficients are insignificant and the results are similar to those reported in table 3.

[18] Of the twelve reaction function studies summaried by Barth, Sickles and Wiest 11982) only Froyen (1974) includes a debt variable.

[19] Levy's reaction function includes income, inflationary expectations, the unemployment rate, the interest rate and a debt measure which is the outstanding publicly-held debt (not seasonally adjusted). Levy's debt variable is not deflated by either a price index or a trend value of real GNP. If the change in nominal debt or the change in real debt is substituted in eq. (4) for the *DEBT* variable, the significance of the debt coefficient is maintained for the results reported in table 1. These results are available from the authors as appendices D and E.

[20] Froyen (1979) uses quarterly data and tests a monetary equation for three separate periods to obtain anticipated and unanticipated money supply data. His study provides empirical evidence that real output is affected by anticipated monetary growth in the short run.

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