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Money and Disaggregate Supply in the United States, 1950-1982

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ABSTRACT

The impact of money growth and money growth surprises on real output by sector is investigated. It is shown that money provides a significant contribution to the explanation of the real output cycles in almost all sectors of the U.S. economy. Anticipated money is found to have real effects, though there is some evidence that the real impact of money surprises is larger.

The approach adopted offers the possibility of a new macroeconomics based upon major output categories, in contrast to the traditional Keynesian approach based upon expenditure categories. The way is, thereby, opened up for a genuine 'structural' or supply side macroeconomics, which is aggregative and can be analyzed by means of principles of optimization, and in which individual sector outputs are non-unique even in full equilibrium.

The impact of money on the U.S. economy has long been a controversial subject. Indeed, at one time the economics profession could be divided into "Keynesians" who thought that money did not matter and "Monetarists" who thought it did. Such classifications seem simplistic today, though the range of disagreement is no smaller. The purpose of the present paper is to offer some new evidence on the impact of money on real activity. Novelty arises from the fact that output is disaggregated into major sectors and the impact of money growth on these sectors is investigated.

BACKGROUND

The Keynesian consensus of the 1950s saw GNP as determined by 'effective demand.' Effective demand was broken down into the major expenditure categories such as consumption, investment, government spending, and net exports. By explaining each of these, an explanation was provided for GNP itself. Autonomous shifts in these expenditures caused changes in GNP via the multiplier effect. Such shifts in expenditures could, in principle, be offset by deliberate changes in government spending or taxes which would thereby stabilize the economy.

The Keynesian research strategy was challenged in a series of studies by Milton Friedman and his associates (for example, Friedman, 1959, Friedman and Meiselman, 1963, and Friedman and Schwartz, 1963). These studies were aimed at establishing two points. First, that there was a stable demand for money function, an understanding of which was necessary (and some claimed sufficient) as a guide to aggregate demand policy. Second, exogenous monetary disturbances were the major <u>systematic</u> cause of business fluctuations in the United States. Money, however, should not be used as a countercyclical control instrument because its impact was subject to 'long and variable lags.' A further round of debate about the impact of money on the economy was started by Anderson and Jordan (1968). They showed that money had a significant cumulative impact on nominal GNP whereas the cumulative impact of government spending was not significantly different from zero.

The focus, however, soon shifted away from treating determinants of aggregate demand as the main issue and onto aggregate supply. Initially this was thought of as an expectation augmented Phillips Curve (Friedman, 1968, Phelps, 1967); but later the New Classical aggregate supply curve (Lucas and Rapping 1969, Lucas, 1973, Sargent and Wallace, 1975) became more popular. This has the following form

$$(1) \quad y_t = \lambda_i(L)y_{t-i} + \alpha_1(P_t - E(P_t | I_{t-1})) + e_t$$

where y is the deviation of the log of GDP from its natural rate, L is the lag operator, P_t is the price level or rate of inflation and $E(P_t | I_{t-1})$ is the expectation of the price level or inflation rate conditional on information available up to the end of period t-1, e_t is a white noise error.

The theory behind (1) is that actors have a signal extraction problem. When they observe current prices (Lucas, 1972), they do not know with certainty how much of a price change in <u>their</u> output market is due to inflation and how much due to a relative price change. They, therefore, compare their current output price to a ('rational') forecast of the general price level. The difference is perceived to be a relative price change to which they respond with a supply change. Thus, unexpected price level changes have real effects in the aggregate (relative price changes wash out) but anticipated ones do not.

The principal tests of this story have been conducted not on (1) but rather on a reduced form equation.

$$(2) \quad y_t = \lambda_i(L)y_{t-i} + \beta_1(M_t - E(M_t | I_{t-1})) + u_t$$

where M is the rate of growth of the money stock and E( ) is its expectation given information up to the end of period t-1. Money growth is presumed to cause inflation so unanticipated money growth becomes the source of the surprise which causes an innovation in the real business cycle. Anticipated money growth is fully reflected in prices and (supposedly) has no real effect.

The seminal work on estimation of this reduced form aggregate supply curve is due to Barro (1977, 1978). He claimed his evidence to be supportive of the hypothesis that only unanticipated money growth has real effects. Further evidence has been offered by many studies for several different countries, much of it supportive (though see Mishkin, 1983, and Boschen and Grossman, 1982, for negative results). Virtually all of these studies have been concerned with finding a relationship between money and aggregate income (GNP, GDP, nominal or real). This is a natural focus if the concern is with aggregate demand or the aggregate demand for money. It is not so sensible, however, if one wishes to test a rational optimizing model of real output supply. First, aggregate output measures contain a significant component of public sector output (close to a quarter). Thus, it would be possible to erroneously reject rationality of private sector output simply because of inappropriate aggregation. Second, the dynamics of output adjustment in (1) or (2), which reflects real adjustment costs, production lags, capital rigidities, etc., are likely to vary from industry to industry. An industry with a long production period may behave differently from, say, a service industry. Finally, since the transmission mechanism of monetary policy is of ongoing interest, direct evidence on the differential impact of monetary policy is enlightening in itself.

TEST PROCEDURE

The above discussion suggests that where supply behavior is the central issue it may be fruitful to investigate the supply responses of the economy on a sector by sector basis. The present study investigates the impact of money growth on the output of U.S. economy where the output of the private sector is broken down into 10 categories. The value added of these 10 sectors when combined is equal to the private sector component of GDP.[1/] The addition of the value added of 'government' and 'government enterprises' yields total GDP which differs from real GNP only by net income from overseas assets.

The present study is concerned only with testing for the impact of money on sectoral outputs. Other factors such as terms of trade and the effect of government production are discussed in Chrystal and Chatterji (1984). The omission of other potentially important factors may cause bias. However, no other variables have been found whose omission affects the significance of the money variables. The present study concentrates on the choice between measures of money. In particular it is of interest to compare the impact of money surprises with the impact of actual and anticipated money.

In order to compare anticipated with unanticipated money it is necessary to have a money forecasting equation. The residuals from this equation are viewed as the unanticipated component of money growth. It was intended that the measure of money surprises should be as conventional as possible so that the sectoral output equations could be compared with other work. It would have been possible to use the measure reported in Barro (1981), however, more data had become available. The equation initially used to generate surprises was almost identical to that reported in Evans (1984 equation 5b). It was

$$(3) \quad DM_t = \underset{(2.4)}{.06} + \underset{(7.2)}{.67}\, DM_{t-1} + \underset{(3.6)}{.07}\, FEDV_t + \underset{(4.3)}{.04}\, U_{t-1} - \underset{(2.2)}{.02}\, U_{t-2} + DMR_t$$

$R^2 = .75$ D.W. = 1.97 Data Annual 1948-1982

where DM is the first difference of the log of the money stock, FEDV is abnormal real federal spending as defined by Barro (1977), and U is the log of the percentage unemployed. The marginal differences between this and Evans' results are due to a slightly different data period.

The residuals from (3) were then used in equations of the form (2) (the precise form follows below) for sectoral outputs. However, estimation of these equations produced a curious result. Money surprises were found to have a strong impact (current and lagged one year) on the component of GDP due to 'government and government enterprises.' This was true both for the combined public sector and its two components.[2] Inspection of the data revealed that these series are fairly smooth except for two distinct humps associated with the Korean War and the Vietnam War.

This result raises important questions for the estimation of equations like (2), and raises some doubts about the validity of earlier tests of the money surprises story. Government 'output' is after all a major component of GDP and presumably no one would want to argue that the increase in government activity in these overseas wars was due to monetary surprises! However, the periods were clearly associated with both abnormally high government activity and abnormally rapid money growth. The variable FEDV is supposed to have captured unusual periods of government activity such as this, however, it is clear that it did not do so fully. The major reason is that FEDV relates to government expenditure while the relationship in question is between the imputed value added of government and money growth. These two measures of government activity are remarkably dissimilar.

How to handle this problem in a rational expectations framework is far from clear. It is safe to presume that actors knew when there was a war on. However, there is no statistical basis for forecasting ex ante what the impact on money growth would be. The actual procedure adopted is to add shift dummy variables to (3) corresponding to the major war years 1950-52 and 1968-73.[3] This presumes that the typical actor was able to forecast correctly the average impact of these wars on money growth. Such an assumption is strong. However, it may be equally (or more) incorrect to assume that actors made no allowance at all for the known fact that there was a war on. Proponents of the money surprise story would surely not wish to defend an argument which says that war related booms in measured GDP arise solely because actors underforecast money growth in those periods.[4/]

The addition to (3) of dummies for 1950-52 and 1968-73 yields

$$(4)\quad DM_t = \underset{(3.5)}{.08} + \underset{(7.5)}{.65}\, DM_{t-1} + \underset{(3.2)}{.06}\, FEDV_t + \underset{(5.4)}{.04}\, U_{t-1}$$

$$- \underset{(1.88)}{.02}\, U_{t-2} + \underset{(2.88)}{.019}\, K + \underset{(2.7)}{.015}\, V + DMR_t$$

$R^2 = .84$ D.W. = 2.1 Data Annual 1948-1982

where variables are as in (3) except that K is a shift dummy value unity 1950-52 and zero elsewhere, and V is a shift dummy value unity 1968-73 and zero elsewhere. This simple addition achieves the required effect. The output of government is now unaffected by money surprises (contemporaneous and up to 3 lags). Further discussion of the effect of this change upon the impact of money surprises on the private sector is postponed. A comparison of the residuals from (3) and (4) with those published in Barro (1981) is provided in chart 1.

In order to test for the impact of money and money surprises on sectoral outputs, three alternative formulations are reported.

$$(5)\quad \ln Q_t = \alpha_1 + \alpha_2 \ln Q_{t-1} + \alpha_3 TIME + \sum_{i=0}^{3} \beta_i\, DMR_{t-i} + u_t$$

$$(6)\quad \ln Q_t = \alpha_1 + \alpha_2 \ln Q_{t-1} + \alpha_3 TIME + \sum_{i=0}^{3} \beta_i\, DM_{t-i} + e_t$$

$$(7)\quad \ln Q_t = \alpha_1 + \alpha_2 \ln Q_{t-1} + \alpha_3 TIME + \beta_0\, \hat{DM}_t + \sum_{i=1}^{3} \beta_i DM_{t-i} + \epsilon_t$$

Equation (5) relates the log of output to its own lagged value, to time and to the current and three lagged values of the money surprise. Equation (6) replaces the money surprises in (5) with actual money growth for the same periods. Equation (7) is the same as (6) except that the contemporaneous money growth term is replaced by its fitted (anticipated) value from (4).

If the 'surprises only' matter story is correct, equation (5) should outperform equations (6) and (7). It would be especially troublesome for the approach if (7) were to outperform (5) as (7) contains no contemporaneous information about money growth (except in the sense that $\hat{DM}_t$ is the in sample fitted value rather than a one period ahead forecast).

THE RESULTS

Equations (5),(6) and (7) were estimated for 10 sectors of the U.S. economy--Agriculture, Forestry and Fishery (AG), Finance, Insurance and Real Estate (FIN), Mining (MIN), Construction (CON), Manufacturing Durables (MANDUR), Manufacturing Non-Durables (MANND), Retail Trade (RET), Wholesale Trade (WHST), Services (SERV), and Transport and Public Utilities (TPU). The value added of these sectors is taken as their output. Combined they add up to Private Sector Output (PRI). The addition to PRI of the imputed value added of Government and Government Enterprises and net overseas income gives GNP (Y). No results are reported for the government sector, since as mentioned no monetary effects were found in this sector with the measure of surprises derived from (4). However, results are reported for both PRI and Y.

Table 1 contains the estimates of equation (5). In addition to t-statistics, two F statistics are reported. F^1 is a test of the restriction that $\sum_{i=0}^{3} \beta_i = 0$. F^2 is a test of the restriction that $\beta_0 + \beta_1 = 0$.

The results in table 1 are supportive of the story that surprises have real effects. All sectors but two (AG and MANND) show significant effects of money surprises either in terms of t tests or F tests. In all but one case the effect occurs contemporaneously and/or with a one year lag. The exception is MIN where the effect is lagged up to two years and we can reject the hypothesis of a zero effect over the current and three lagged periods.

These results do not look so impressive, however, when compared to the estimates of equation (6) reported in table 2. In all but two cases (MIN and FIR) equation (6) fits better than (5), when judged by the Mean Squared Error (MSE). The difference is sizable in some cases. Only in the case of MANDUR can the hypothesis of neutrality over the current and three lagged periods be rejected. But only in the cases of AG and SERV is there no significant effect of money growth in the first two years.

The estimates of equation (7) make the 'only surprises matter' story even shakier. These are reported in table 3. In both Y and PRI equations and in six of the ten sectors equation (7) does better than (5) in terms of MSE. Furthermore, the coefficient on fitted money growth is significant in seven of the twelve cases including Y and PRI. Less surprisingly, perhaps, there are no cases in which equation (7) dominates equation (6). Thus, the current innovation <u>does</u> contain additional information useful in the explanation of real activity cycles, however, this information does not consistently dominate that available at the beginning of the period in terms of explanatory power. The ranking of equation (5), (6) and (7) by the MSE criterion is reported in table 4.

SENSITIVITY TO SPECIFICATION

The generality of the above results may be questioned on two grounds. First the lag lengths are arbitrary. Different lag lengths may give different results. Second, the inclusion of war dummies in (4) has arbitrarily improved the performance of fitted money growth and reduced the explanatory power of the money surprises.

The question of lags was investigated by first dropping lag 3 on the money variable and then by additionally dropping lag 2. These changes had no dramatic impact on the ranking of equations. The relative performance of equation (5) improved in terms of ranking in only two cases (AG and SERV). In the case of AG the dropping of lag 3 made no difference but the dropping of lag 2 gave equation (5) the smallest MSE of the three. Despite this the surprises themselves were negative and insignificant. In the case of SERV shortening the lag gave (5) the lowest MSE in both cases. However, in the case of MIN, shortening the lag even by one year moved the surprises from first to last place in MSE ranking. Thus while the lag lengths have some effects in particular cases, they do not influence the tenor of the results.

The same cannot be said for the impact of war dummies. As might be expected, if the residuals from (3) are used in place of those from (4) some explanatory power is shifted from the fitted value of money growth to the money surprise. In all but two cases (AG and MANND) equation (5) now dominates equation (7). However, even then the coefficient on $\hat{DM}_t$ retains significance in four cases (Y, PRI, MANDUR, MANND) and in only one additional case does (5) come to dominate (6)(SERV). Lag length has a marginal impact again in the same sectors as it affected above and in much the same way. Thus money surprises continue to be dominated by actual money growth in terms of explanatory power irrespective of the measure used, though the explanatory power of predicted money growth is noticeably improved by the inclusion of war dummies in the forecasting equation.

It is not clear what weight should be attached to the results which rely upon actors forecasting correctly the average impact of the Korean and Vietnam Wars on money growth. It is equally true, however, that the importance of these events suggests that ignoring them probably involves the greater error. In particular, the correlation of expanded government activity and abnormal money growth in those periods raises serious questions for the whole money surprise approach. As already noted, little credibility could be attached to the argument that the expansion of government activity in times of war was due to a misperception of relative prices.

SURE ESTIMATES

In order to achieve more efficient estimates of the impact of money on sectoral outputs the sectoral equations were estimated as a system along with the aggregate equation. Adding up restrictions were imposed and the contemporaneous error variance/covariance matrix was utilized to give SURE estimates. For economy the system was estimated with surprise and fitted money growth in the same equation. The system of equations is

$$(8) \quad \ln PRI_t = \alpha_1 + \alpha_2 \ln QRI_{t-1} + \alpha_3 TIME + \sum_{i=o}^{2} \beta_i \hat{DM}_{t-i} + \sum_{j=o}^{2} \gamma_j DMR_{t-j} + u_t$$

$$(9) \quad \ln Q_t^k = \alpha_1^k + \alpha_2^k \ln Q_{t-1}^k + \alpha_3^k TIME + \sum_{i=0}^{2} \beta_i^k \hat{DM}_{t-i} + \sum_{j=0}^{2} \gamma_j^k DMR_{t-j} + \varepsilon_t^k$$

Where PRI is private sector output, Q_t^k is the output of k, $\hat{DM}$ is the fitted value of money growth and DMR is the residual from (4). The adding up restrictions come from the fact that PRI = $\sum_{k=1}^{10} Q^k$. These are of the form $\alpha_i = \sum_{k=1}^{10} p^k \alpha_i^k$ where the p^k are weights ($\sum_{k=1}^{10} p^k = 1$) given by $p^k = \frac{\bar{Q}^k}{\overline{PRI}}$; where the bar indicates a sample mean. This means that the slope coefficients in the PRI equation are a weighted average of the coefficients in the individual sectors.

The results of estimating equations (8) and (9) are presented in table 5. It is clear from this that both $\hat{DM}_t$ and DMR_t are significantly related to output in most sectors and in PRI. Only two sectors (AG and SERV) have no significant money effects. It appears (from PRI) that $\hat{DM}$ and DMR have broadly similar effects, though there is some variation between sectors, and the positive impact of DMR seems to be a little longer lasting.

Tests of the restrictions on coefficients are also reported at the bottom of table 5. Neither tests on individual variables restrictions nor the combined restrictions could be rejected at the 5 percent level.

Thus we cannot reject the hypothesis that the slope coefficients in the PRI equation are a weighted average of the individual sector coefficients.

ENDOGENEITY OF MONEY

The evidence above provides strong support for the view that monetary expansions are associated with expansions in real activity or upturns in the business cycle (whether the monetary expansion was anticipated or unanticipated is not central to the present discussion). Similar evidence has been available for some time--whether it be business cycle studies such as those of Friedman and Schwartz, estimates of 'St. Louis' equations, Granger-style causality tests of money on activity (see Thornton and Batten (1984)) or Barro-style money surprise models--though all of it at the aggregate level.

Skeptics have argued that correlation does not prove causation. Even if observed money growth precedes an upturn in activity, this could be due to an endogenous response of money to some unobserved variable such as business optimism or a variety of real disturbances[1] The case for regarding money as endogenous is strong if the monetary authorities are stabilizing interest rates or in a country which has a fixed exchange rate. In such circumstances shocks in the IS curve will simultaneously cause changes in money growth and changes in real activity.

To concede that money may be partially or occasionally endogenous, however, is not to concede the irrelevance of either monetarist or new classical analyses of monetary policy. Indeed from a monetarist perspective if the authorities permit such endogenous variations this is cause to criticize the authorities but not a reason to question dogma.

What matters is only the robustness of the statistical relationship between money and activity (and, of course, prices) over a wide range of circumstances and policy regimes. If this relationship is stable then the monetarist recommendations for stable and slow money growth go through regardless of whether money was endogenous in some particular period.

The results presented above clearly add yet more strong evidence of the link between money and activity. These results survive intact when other potentially important variables are added. Neither government expenditure nor government output weakens the impact of money, and the government variables are not significant in most sectors. Attempts to pick up sectoral linkages by putting lagged WHST and lagged MANND in the output equations of other sectors also provide to be unsuccessful, though a full test for intersectoral dynamics was not possible, due to data limitations. The full significance of sectoral interactions is tested on quarterly data by Chrystal (1984). Thus the relationship between money and real activity appears to be robust. Money growth is linked to real activity in almost all sectors of the economy. The disaggregated evidence reduces the power of the 'output causes money' view (because there is only one money stock but 10 different sectors). However, as has been argued, all that really matters is the policy invariance of the relationship. This can only be established by an accumulation of evidence.

At first sight, the endogeneity of money is more troublesome for the New Classical approach than it is for Monetarism (see Buiter 1983). Certainly equation (5) is misspecified if DMR_t is an endogenous variable (the same can be said of (6) but not of (7) since $\hat{DM}_t$ is independent of ε_t). Statistical problems aside, however, if money surprises are stably related to changes in real activity this is important information regardless of the ultimate source of the shocks. Indeed it is possible that money can usefully be regarded as an indicator of the impact of a wide variety of real or nominal disturbances including those caused by the monetary authorities.

The implications of this for stabilization policy are limited unless the authorities are better informed than actors (a not implausible situation in a fixed exchange rate or pegged interest rate regime where the authorities will know the size of their own interventions before actors do). The implications for the design of monetary institutions, however, are quite general. If perturbations in money growth are systematically related to cycles in real activity, then institutional arrangements which reduce the variance of money growth will reduce the variance of output about its natural growth trend.

SURPRISE OR ACTUAL MONEY?

The evidence presented above would lead us to reject the hypothesis that 'only surprise money growth has real effects.' (Other rejections of this are available in Mishkin 1983, and Boschen and Grossman 1982). However, it is important to notice that what is being rejected is the hypothesis that anticipated money does not have real effects. No one has provided any evidence (including that above) which shows that surprises in money growth do not have real effects. Thus the important remaining question to be addressed is the following--is there any benefit at all from making a distinction between surprise and predicted components of money growth?

The answer to this question may yet be in the affirmative. A sufficient reason for making the distinction would arise if the dynamic adjustment to surprise and anticipated money were significantly different. Evidence of such a difference is available when table 1 is compared to tables 2 and 3. The positive impact of observed money growth is entirely contemporaneous. However, the money surprise continues to yield output gains in the subsequent period (in Y, PRI and MIN, MANDUR, SERV and TPU). Thus it would seem that the rise in activity caused by (or associated with) an unanticipated rise in the money growth rate is both larger and sustained longer (compare $\beta_o + \beta_1$ in table 1 with the same sum in table 2) than the increase that would be caused by a rise in the growth rate of money (as anticipated at t-1) of the same size. Notice, however, that the results in table 5 are only weakly supportive of this argument. Nonetheless, while it must be accepted that anticipated money growth does have real effects, it may also prove to be the case that the identification of the surprise component of money growth contributes significantly to our understanding of business cycles. The dictum which says that 'only surprises matter' will have to be changed to 'surprises matter most!

CONCLUSION

When the central issue in macroeconomics is viewed as the nature of the aggregate supply curve, it makes sense to investigate the determinants of output at a disaggregated level. The public sector component of GDP should behave differently from the rest, and the dynamic adjustment in industries with substantial fixed plant should differ from that in, say, service industries.

The present paper offers estimates of the impact of money and money surprises on the output of major sectors of the U.S. economy. The results demonstrate a very strong relationship between money growth and cycles in real activity. However, the evidence is inconsistent with the view that only surprises in money growth have real effects. Nonetheless it may still be true that surprises do have the largest cumulative real effects.

Novelty in the above estimates also arises from the 'structural' disaggregation. Modelling the economy along these lines may offer a fruitful alternative to the Keynesian disaggregation by expenditure category. Once the model consists of more than one sector, the output of each sector is no longer unique even in full equilibrium. Thus we may pursue an analysis of the economy in an equilibrium framework without being constrained by the natural rate concept which has limited the possibilities for 'real' analysis in a single sector economy.

FOOTNOTES

1/ The term 'value added' here refers to the national income accounting definition which imputes value added to sectors in the basis of factor rewards even where there is no physical output. It is equivalent to the contribution of each sector to GDP.

2/ The result for the total government sector was:

$$GOV_t = \underset{(2.9)}{1.17} + \underset{(7.8)}{.74}\ GOV_{t-1} + \underset{(2.04)}{.74}\ DMR_t + \underset{(3.16)}{1.16}\ DMR_{t-1}$$

$$- \underset{(.02)}{.01}\ DMR_{t-2} + \underset{(2.17)}{.005}\ TIME$$

$R^2 = .9916$ D.W. = 1.59 MSE = .0006

GOV is the log of the government component of GNP and DMR is the residual from (3).

3/ The choice of period for Vietnam is arbitrary owing to a slow build up and rundown of activity. The period 1966-71 was also tried, but, since the results were qualitatively similar, these results are not reported. These results are available on request from the author.

4/ There may be an 'equilibrium' interpretation of war time booms. Intertemporal substitution of supply arises because actors correctly perceive that rewards are higher during war time than they will subsequently be but consume out of permanent income. Here the real disturbance caused by the war is the cause of the cycle and money adjusts partly endogeneously. See King and Plosser, 1984, for an equilibrium business cycle model in which real disturbances 'cause' business cycles and money responds endogeneously.

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Table 1
Sectoral Output and Money Surprises

DEP VAR	CONST	LAG DEP VAR	DMR_t	DMR_{t-1}	DMR_{t-2}	DMR_{t-3}	TIME	R^2 DW	F^1 F^2	MSE x 10^3
Y	2.26	.64	.98	.93	-.24	-.4	.011	.9960	1.79	.522
	(2.4)	(4.3)	(2.4)	(2.1)	(.52)	(.95)	(2.2)	1.57	8.83**	
PRI	2.83	.53	1.0	1.17	-.06	-.59	.016	.9957	2.1	.619
	(2.7)	(3.1)	(2.2)	(2.4)	(.11)	(1.3)	(2.6)	1.69	9.73**	
AG	.92	.72	-.5	-.64	1.02	.49	.003	.9108	0.07	1.33
	(1.7)	(4.5)	(.74)	(.93)	(1.5)	(.74)	(1.8)	2.4	1.27	
FIR	.8	.81	.5	.24	-.22	-.1	.008	.9997	1.91	.069
	(2.6)	(10.3)	(3.3)	(1.6)	(1.5)	(.63)	(2.2)	2.3	11.12**	
MIN	1.3	.44	.09	1.4	1.24	.58	.011	.9828	8.45**	.93
	(4.4)	(3.4)	(.16)	(2.6)	(2.1)	(1.0)	(3.7)	1.72	3.42	
CON	.42	.9	1.93	.24	-1.3	-1.05	-.001	.9551	.01	2.1
	(1.7)	(12.5)	(2.3)	(.27)	(1.5)	(1.2)	(.67)	1.85	3.0	
MANDUR	2.4	.46	2.53	3.5	.12	-1.3	.016	.9670	2.9	4.3
	(3.5)	(2.8)	(2.1)	(2.7)	(.07)	(1.1)	(2.9)	1.8	10.3**	
MANND	.94	.76	1.04	.62	-.42	-1.2	.007	.9909	.002	1.3
	(1.5)	(4.8)	(1.6)	(.92)	(.62)	(1.8)	(1.3)	1.79	2.86	
RET	1.6	.6	.83	.82	-.41	-.8	.012	.9942	.17	.67
	(2.3)	(3.3)	(1.7)	(1.6)	(.78)	(1.7)	(2.1)	1.72	5.0*	
WHST	.28	.93	1.38	.76	-.65	-.48	.002	.9965	.88	.82
	(.64)	(6.6)	(2.6)	(1.4)	(1.2)	(.93)	(.35)	1.64	7.6**	
SERV	1.6	.59	.4	.71	.15	-.06	.016	.9989	4.03	.21
	(3.2)	(4.6)	(1.5)	(2.6)	(.5)	(.2)	(3.2)	1.79	7.94**	
TPU	.68	.82	.84	1.2	-.12	-.68	.007	.9958	1.2	.87
	(1.4)	(5.9)	(1.6)	(2.2)	(.18)	(1.23)	(1.2)	1.86	6.4*	

NOTE: This table presents estimates of equation (5). Data are annual 1950-1982. F^1 is a test of the restriction $\sum_{i=0}^{3} \beta_i = 0$. F^2 is a test of the restriction $\beta_0 + \beta_1 = 0$.

* implies rejection at the 5 percent level.

** implies rejection at the 1 percent level.

Data Sources: Gross National Product by industry and deflators Chase data tapes; moneystock is M1 from Federal Reserve Bank of St. Louis data files. All other variables from the latter.

Table 2
Sectoral Output and Actual Money Growth

DEP VAR	CONST	LAG DEP VAR	DM_t	DM_{t-1}	DM_{t-2}	DM_{t-3}	TIME	R^2 / DW	F^1 / F^2	MSE x 10^3
Y	1.1	.82	1.2	-.09	-.54	-.13	.005	.9977	.82	.297
	(1.2)	(5.2)	(5.1)	(.32)	(1.9)	(.59)	(.97)	1.93	12.23**	
PRI	1.98	.67	1.2	.06	-.46	-.11	.01	.9968	1.56	.452
	(1.76)	(3.5)	(4.1)	(.17)	(1.4)	(.4)	(1.6)	1.84	11.4**	
AG	1.14	.66	-.36	-.05	.69	.6	.003	.9197	1.6	1.2
	(2.2)	(4.2)	(.78)	(.11)	(1.4)	(1.3)	(1.0)	2.32	.61	
FIR	.58	.87	.29	-.06	-.16	-.03	.005	.9996	.03	.08
	(1.4)	(8.6)	(2.2)	(.52)	(1.3)	(.26)	(1.2)	2.23	2.3	
MIN	1.2	.5	.66	.56	-.23	.28	.008	.98	3.3	1.08
	(3.4)	(3.4)	(1.5)	(1.2)	(.48)	(.69)	(2.5)	1.68	5.7*	
CON	.21	.96	1.9	-.95	-1.18	-.09	-.001	.9708	.15	1.35
	(.92)	(14.9)	(3.8)	(1.8)	(2.3)	(.17)	(.62)	1.96	2.8	
MANDUR	2.02	.53	2.94	1.13	-.75	-.31	.009	.9769	4.4*	2.99
	(2.7)	(3.0)	(4.0)	(1.2)	(.82)	(.46)	(1.85)	1.94	19.1**	
MANND	.51	.87	1.47	-.45	-.71	-.21	.004	.9937	.02	.88
	(.82)	(5.3)	(3.7)	(.96)	(1.6)	(.57)	(.66)	1.88	4.0	
RET	1.55	.61	1.02	-.1	-.25	.12	.01	.9947	1.8	.62
	(2.1)	(3.1)	(3.1)	(.25)	(.69)	(.37)	(1.85)	1.66	4.5*	
WHST	.13	.97	1.3	-.7	-.54	.11	.0003	.9974	.08	.61
	(.29)	(6.6)	(3.9)	(1.79)	(1.5)	(.36)	(.05)	1.7	1.92	
SERV	1.53	.61	.37	-.007	-.35	-.13	.016	.9989	.18	.202
	(3.5)	(5.4)	(1.89)	(.03)	(1.8)	(.77)	(3.7)	1.76	2.5	
TPU	1.35	.62	1.26	.43	-.37	-.06	.013	.997	2.3	.61
	(2.1)	(3.3)	(3.6)	(1.1)	(.91)	(.18)	(1.99)	1.65	10.9**	

NOTE: This table presents estimates of equation (6). Data are annual 1950-1982. F^1 is a test of the restriction $\sum_{i=0}^{3} \beta_i = 0$. F^2 is a test of the restriction $\beta_0 + \beta_1 = 0$.

* implies rejection at the 5 percent level.

** implies rejection at the 1 percent level.

Table 3
Sectoral Output, Fitted and Lagged Actual Money

DEP VAR	CONST	LAG DEP VAR	$\hat{DM}_t$	DM_{t-1}	DM_{t-2}	DM_{t-3}	TIME	R^2 / DW	F^1 / F^2	MSE x 10^3
Y	-.24	1.04	1.5	-.79	-.46	-.3	-.002	.9969	.02	.405
	(.19)	(5.3)	(3.5)	(1.65)	(1.4)	(1.2)	(.28)	1.4	4.17	
PRI	1.06	.83	1.31	-.44	-.37	-.26	.005	.9958	.17	.6
	(.75)	(3.5)	(2.56)	(.77)	(.92)	(.82)	(.68)	1.54	4.77*	
AG	1.09	.67	-.26	-.03	.67	.61	.002	.9183	1.93	1.22
	(2.13)	(4.35)	(.39)	(.05)	(1.24)	(1.3)	(.86)	2.35	.32	
FIR	1.04	.75	-.07	.07	-.21	-.06	.011	.9996	1.38	.094
	(2.4)	(6.8)	(.32)	(.4)	(1.4)	(.43)	(2.2)	2.24	.0003	
MIN	1.2	.5	.82	.31	-.06	.17	.008	.9795	3.02	1.11
	(3.4)	(3.3)	(1.3)	(.5)	(.12)	(.39)	(2.5)	1.5	5.03*	
CON	.22	.96	1.86	-1.35	-.86	-.32	-.0004	.9617	.52	1.77
	(.8)	(12.5)	(2.14)	(1.75)	(1.3)	(.56)	(.16)	1.68	.63	
MANDUR	1.04	.76	3.45	-.47	-.77	-.78	.005	.9691	.8	4.0
	(.98)	(3.1)	(2.3)	(.28)	(.72)	(.92)	(.65)	1.71	8.84**	
MANND	.098	.98	1.9	-1.2	-.41	-.45	.0005	.993	.05	.978
	(.14)	(5.6)	(3.1)	(1.93)	(.84)	(1.1)	(.08)	1.7	1.97	
RET	.93	.77	1.21	-.6	-.09	.-05	.006	.994	.62	.699
	(1.1)	(3.6)	(2.3)	(1.1)	(.22)	(.14)	(1.0)	1.38	2.0	
WHST	.18	.96	1.24	-.93	-.34	-.04	.002	.9966	.01	.816
	(.33)	(5.5)	(2.2)	(1.76)	(.75)	(.12)	(.22)	1.46	.37	
SERV	1.45	.63	.25	-.02	-.34	-.16	.016	.9988	.68	.224
	(3.1)	(5.2)	(.82)	(.08)	(1.45)	(.8)	(3.34)	1.65	.88	
TPU	1.1	.69	1.31	.02	-.22	-.26	.011	.9963	.82	.763
	(1.5)	(3.3)	(2.3)	(.04)	(.43)	(.72)	(1.53)	1.37	5.65*	

NOTE: This table presents estimates of equation (7). Data are annual 1950-1982. F^1 is a test of the restriction $\sum_{i=0}^{3} \beta_i = 0$. F^2 is a test of the restriction $\beta_0 + \beta_1 = 0$.

* implies rejection at the 5 percent level.

** implies rejection at the 1 percent level.

Table 4
Ranking of Fit of Equations (5) - (7)

	DMR (5)	DM(6)	$\hat{DM}(7)$
Y	3	1	2
PRI	3	1	2
AG	3	1	2
FIR	1	2	3
MIN	1	2	3
CON	3	1	2
MANDUR	3	1	2
MANND	3	1	2
RET	2	1	3
WHST	3	1	2
SERV	2	1	3
TPU	3	1	2

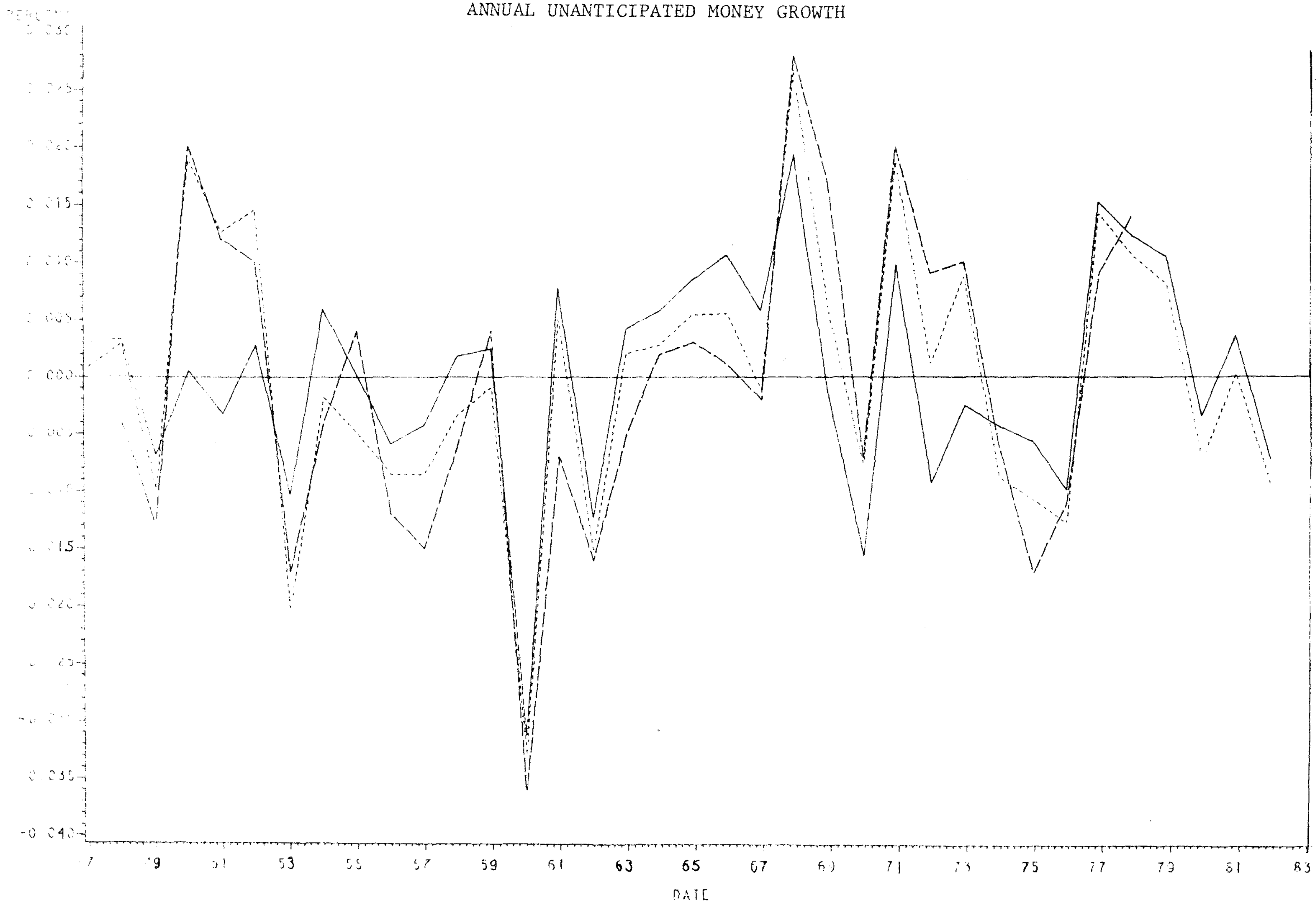
Note: Ranking is on the basis of goodness of fit according to the Mean Square Error as reported in tables 1, 2 and 3.

Table 5
Sure Estimates of Fitted and Surprise Money Effects

	CONST	LAG DEP VAR	$\hat{DM}_t$	$\hat{DM}_{t-1}$	$\hat{DM}_{t-2}$	DMR_t	DMR_{t-1}	DMR_{t-2}	TIME	R^2 (OLS)	MSE x 1 (OLS)
PRI	1.57	.74	1.35	-.22	-.57	1.34	.22	-.11	.0075	.9972	.46
	(9.0)	(25.4)	(3.56)	(.51)	(1.81)	(3.6)	(.53)	(.25)	(6.16)		
AG	.81	.75	.04	-.17	.6	-.69	-.58	.97	.002	.9203	1.35
	(3.3)	(10.2)	(.05)	(.23)	(1.1)	(1.1)	(.82)	(1.3)	(1.5)		
FIR	1.1	.73	-.08	.17	-.27	.54	.25	-.33	0.11	.9997	.006
	(6.1)	(16.1)	(.53)	(.97)	(2.04)	(3.6)	(1.5)	(1.88)	(5.4)		
MIN	.8	.66	1.69	-.29	-.79	.72	.43	.93	.006	.9793	1.35
	(3.9)	(7.5)	(2.5)	(.37)	(1.4)	(1.1)	(.58)	(1.2)	(2.8)		
CON	.41	.9	1.38	-.2	-1.76	1.91	-.97	-1.63	.0004	.9777	1.37
	(2.9)	(22.1)	(1.98)	(.26)	(3.0)	(2.85)	(1.3)	(2.09)	(.22)		
MANDUR	1.51	.65	3.3	.52	-1.32	3.5	1.35	-.52	.006	.9798	3.15
	(7.7)	(14.2)	(3.17)	(.44)	(1.54)	(3.48)	(1.18)	(.45)	(2.44)		
MANND	.35	.92	1.87	-.78	-.89	1.29	-.68	-.03	.002	.9946	.87
	(1.47)	(14.68)	(3.5)	(1.28)	(2.0)	(2.47)	(1.18)	(.05)	(.78)		
RET	1.16	.71	1.32	-.86	.19	.87	.07	.18	.007	.9955	.6
	(3.57)	(8.45)	(2.89)	(1.65)	(.51)	(1.93)	(.14)	(.34)	(2.8)		
WHST	.17	.96	1.54	-1.18	-.33	1.48	-.23	-.07	.001	.9978	.59
	(.85)	(14.55)	(3.45)	(2.33)	(.88)	(3.37)	(.48)	(.13)	(.38)		
SERV	1.57	.6	.39	-.37	-.27	.41	.45	.36	.016	.9992	.16
	(6.98)	(10.3)	(1.65)	(1.39)	(1.39)	(1.81)	(1.82)	(1.25)	(7.2)		
TPU	1.11	.69	1.47	.14	-.67	1.29	.47	.14	.011	.9974	.59
	(4.9)	(10.67)	(3.26)	(.29)	(1.63)	(2.94)	(.99)	(.26)	(4.5)		

NOTE: This table presents estimates of equations (8) and (9). Estimation is by SURE with adding up restrictions discussed in text. F tests were performed on the restrictions both combined and for each coefficient set. None could be rejected at anything close to the 5 percent level. The F values were as follows: joint $F^8_{275} = .85$; LAGDEPVAR $F^1_{275} = 2.25$; $\hat{DM}_t$ $F^1_{275} = .04$; $\hat{DM}_{t-1}$ $F^1_{275} = .06$ $\hat{DM}_{t-2}$ $F^1_{275} = .1$; DMR_t $F^1_{25} = 1.5$; DMR_{t-1} $F^1_{275} = .009$; DMR_{t-2} $F^1_{275} = .37$; TIME $F^1_{275} = 3.1$.

Chart 1
ANNUAL UNANTICIPATED MONEY GROWTH



NOTE: Long dashed line represents the Barro(1981) residuals, short dashed line represents the equation (3) residuals and the solid line represents the equation (4) residuals.