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Money and Sectoral Output Dynamics in the United States, Quarterly 1950/III to 1982/IV

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ABSTRACT

The impact of money growth and money growth surprises is investigated in a framework in which GNP is disaggregated into its major sectoral components. The evidence presented is not fully consistent with a new classical interpretation of the business cycle. In particular light is thrown on the issue of the lag effect of money surprises. It is discovered that, even when sectoral interactions are accounted for, there are effects of lagged money growth. These lags are inconsistent with an equilibrium/rational expectations approach to business cycles. It is also discovered that growth in an 'outside' component of money has significant real effects. The approach adopted offers the possibility that a structural disaggregation of the supply side of the economy may offer advantages not available in either natural rate or Keynesian macroeconomic models.

Debates about the role of money in business cycles have been actively conducted for many years. These debates have generated much heat and even a little light. The past two decades have witnessed two major phases of the discussion. First the work of Friedman and Schwartz (1963) put money back on the agenda as a business cycle causing phenomenon. Second, the analyses of Lucas (1972, 1975) and Sargent and Wallace (1975) and the empirical work of Barro (1977, 1978) provided a case for the argument that unexpected changes in the money stock trigger business cycles even in an 'equilibrium' framework, with rational actors and market clearing prices. More recently a case has been made for viewing equilibrium business cycles as resulting from 'real' disturbances (Long and Plosser, 1983). In such circumstances the money stock may be viewed as responding endogenously to the forces which are associated with the cycles in activity (King and Plosser, 1984).

The present study offers evidence relevant to the debate. First, the impact of money growth on sectoral output is investigated. Second, the impact of unanticipated money growth is investigated in a context where sectoral interactions are allowed for. Third, an attempt is made to isolate effects of the policy determined monetary base. This is taken to be the 'outside' component of money (referred to by King and Plosser). The framework adopted may offer a payoff for macroeconomic analysis well beyond the short term goals of the present paper.

In section I the impact of money on sectoral output is discussed. Section II incorporates intersectoral dynamics. The impact of 'outside' money changes is considered in Section III.

I

The economy is conceived of as consisting of n industries or activities. Each can be thought of as a representative worker/producer operating with a given plant or premises. These operatives are differentiated by the nature of the work they do. Some may work with heavy machinery to produce a product which takes a long time to complete. Others may simply provide a service, say, a haircut, which is quick to produce and requires no fixed capital. For the most part outputs are sold in a competitive market. If information were complete they would simply choose the optimal output each period given the costs they incur and the market price they face. One sector, however, does not produce a marketable output. It produces a public good which we may call 'defense.' The output of defense is decided politically and is financed exactly by lump sum taxes.

The outputs which are marketed are substitutes in demand but it is initially assumed that there is no supply side interaction. This means that outputs of one sector are not inputs into any other sector and that costs of production in each sector are independent of the outputs of other sectors. While this assumption is highly implausible, it will be relaxed below.

Each worker/producer (except in the defense industry) makes an output decision in each period based upon incomplete current information, as in Lucas (1973). The money price in the output market is observed with certainty, but the contemporaneous prices in other markets are only learned about with a one period lag. The worker/producer, therefore, compares his observed output price with his expectation of the general level of prices in order to disentangle relative price changes from general inflation. As in Barro (1977, 1978) the inflation forecast is presumed to be linked directly to a forecast of money growth. If this line of reasoning is correct, as is well known, the unanticipated component of money growth will cause a contemporaneous output rise since this is perceived by each worker/producer to be an increase in demand for his product.

The above conceptual experiment is so familiar that it does not need to be discussed in any greater detail. However, there is one point which needs to be emphasized in the present context where individual sector outputs are being considered. Once the supply curve of the economy is disaggregated, even in a full rational expectations equilibrium model, there is no reason to think that only money growth surprises will have real effects. Any change in any parameter or exogenous variable will have real effects which will vary from sector to sector but may or may not show up in the aggregate (see Chrystal and Chatterji, 1984). Such changes will include government employment, spending and taxation decisions as well as changes in world demand or supply. Indeed, only fully anticipated changes in the money stock will <u>not</u> have real effects. The present study ignores all such possible effects (except the trend in technical progress) since the intention is to highlight the impact of money, though bias may be introduced by this omission.

Another important point is that the innovation to output coming from an unanticipated monetary disturbance should be entirely contemporaneous (McCallum 1979, Pesaran 1982). The autocorrelation in output, associated with business cycles, comes from adjustment costs, lumpiness of investments (Lucas 1975) or perhaps intertemporal substitution in consumption and production (Long and Plosser 1983). Studies which utilize money surprises have, however, found lags in impact. The only convincing explanation of this (apart from non New Classical stories) is that an impulse in one sector which is contemporaneous is transmitted to other sectors with a lag due to a derived and delayed demand for inputs from other sectors.[1/] The presence of such sectoral interactions is tested directly in the present framework. This is discussed in section II. For the present it is assumed that the adjustment dynamics are entirely internal to each sector. The contemporaneous money surprise provides an impulse in each period.

Thus the reduced form New Classical supply curve for the nth sector is of the form

$$(1)\quad y_t^n = \lambda_i^n (L)\, y_{t-i}^n + \alpha_1^n (M_t - E(M_t \mid I_{t-1}) + e_t^n$$

where y_t^n is the deviation of the log of output of sector n from its trend level in period t; L is the lag operator; M_t is the growth of the money stock in period t; and $E(M_t \mid I_{t-1})$ is the expectation of money growth in period t formed on the basis of information available up to the end of period t-1. The λ_i^n, which reflect adjustment speeds, and the a_1^n, which reflect short run supply elasticities, may vary from sector to sector. However, it is presumed that the aggregate information which is available to forecast the growth of the money stock is common to all actors.

An alternative hypothesis to that embodied in (1) would be that both predicted and lagged actual money growth have real effects. Such effects could be justified in a variety of models which may include some or all of sticky wages and prices, adaptive expectations and slow adjustment of actual to desired money balances. In such circumstances information on money growth available prior to period t would be useful in explaining output changes in period t. Such information includes the forecast value of money growth in t and past values of actual money growth. If these variables were important, the sectoral supply curves, (1), would become

$$(2)\quad y_t^n = \lambda_i^n (L)\, y_{t-i}^n + \alpha_i^n (M_t - E(M_t | I_{t-1})) + \beta_o^n \hat{M}_t + \sum_{i=1}^{k} \beta_i^n M_{t-i} + e_t^n$$

where $\hat{M}_t$ is the forecast value of money growth in period t given information available in period t-1 and M_{t-i} is the actual value of money growth in period t-i. According to the above interpretation, the New Classical business cycle theory would be rejected if we could reject the hypothesis that $\beta_o^n = \beta_i^n = 0$ for all i=1....k and all n=1.... ℓ.

In order to generate measures of anticipated and unanticipated money growth it is assumed that the typical worker/producer in each sector has access to the same aggregate information for forecasting purposes. It is also assumed, for the time being, that there is no contemporaneous feed-back from output to money growth. This is an assumption which is common (though often implicit) in the money surprise literature. It will be investigated further in section III below.

A forecasting equation for money growth was arrived at for the period 1949-1982 (M1 quarterly, S.A.) by regressing the first difference in the logarithm of the money stock on its own past values and past values of the Treasury bill rate, unemployment, inflation, and the federal budget deficit. No longer than eight lags were tested and variables were retained on the basis of individual t-tests and joint F-tests. The federal deficit was not found to be significant. Since the purpose of the exercise is to generate a white noise forecast error, all equations were estimated by OLS and by the Cochrane-Orcutt iterative technique with up to fourth order autocorrelation. The resulting equation, which exhibits first, second and fourth order autocorrelation, is as follows.

$$
\begin{aligned}
(3)\quad DM_t = & \underset{(.78)}{-.67} + \underset{(6.6)}{.74}\, DM_{t-1} - \underset{(5.45)}{.67}\, DM_{t-2} + \underset{(5.89)}{.64}\, DM_{t-3} - \underset{(2.99)}{.33}\, DM_{t-4} \\
& + \underset{(4.6)}{.41}\, DM_{t-5} - \underset{(8.1)}{1.95}\, R_{t-1} + \underset{(6.6)}{2.83}\, R_{t-2} - \underset{(4.5)}{2.62}\, R_{t-3} + \underset{(3.5)}{2.07}\, R_{t-4} \\
& - \underset{(1.7)}{.85}\, R_{t-5} + \underset{(1.6)}{.49}\, R_{t-6} - \underset{(1.4)}{.6}\, U_{t-1} + \underset{(2.3)}{.93}\, U_{t-2} + \underset{(2.9)}{.52}\, P_{t-3} \\
& - \underset{(2.7)}{.48}\, P_{t-4}
\end{aligned}
$$

$R^2 = .67 \qquad \rho_1 = \underset{(2.98)}{.35} \qquad \rho_2 = \underset{(6.2)}{-.77} \qquad \rho_3 = \underset{(.61)}{-.07} \qquad \rho_4 = \underset{(3.93)}{.42}$

Data: Quarterly 1949 I - 1982 IV

where DM is the first difference in the log of the money stock; R is the Treasury bill rate; U is the unemployment; and P is the inflation rate; ρ_i is the coefficient of autocorrelation of order i. The residuals from this equation are used as a measure of 'surprise' money growth, DMR. While some researchers have claimed to generate white noise errors by equations of lower order than (3) it was discovered that this was not possible with the inclusion of up to 8 lags on money growth. It certainly was possible to generate acceptable diagnostic tests but, when estimated, autocorrelation proved significant. This may indicate either the low power of the standard diagnostic tests or the necessity of searching for complex error structures.

The generation of a measure of money surprises now permits estimation of the system of equations in (2). The forecast value of contemporaneous money growth, $\hat{M}_t$, is taken as the fitted value of equation (3). Outputs are measured in the log of levels and a time trend is used to account for productivity growth and population growth over time.

Table 1 reports estimates for GNP and private sector output, PRI (PRI = GNP - GOV less net income from overseas assets) as well as eleven sectors the outputs of which add up to PRI. At a disaggregated level, of course, the term 'output' refers in this context to the value added of each sector as it is imputed by national income accountants. Imputation is based upon measures of factor rewards in each sector. This exercise is especially arbitrary when it comes to measuring the contribution of government to GNP as there is not marketed output (for the most part). 'Government' is of the order of a fifth of GNP so this is no small matter. We would not expect government output to respond to money surprises. The present framework offers the advantage of separating the government component from the rest.

The individual sectors are agriculture forestry and fisheries (AG), finance insurance and real estate (FIR), mining (MIN), construction (CON), manufacturing durables (MAND), manufacturing nondurables (MANND), retail trade (RET), wholesale trade (WHST), services (SERV), transport and public utilities (TPU) and government and government enterprises (GOV). The sectoral components of GNP are available only in current price terms for quarterly data (see Chrystal (1984) for a study based on annual 'real' data). These were deflated by the GNP deflator and are all seasonally adjusted.

Two lags of the dependent variables seem to be sufficient. Six lags are reported for money growth. F^1 is a test of the hypothesis that $\sum_{i=o}^{6} \beta_i^n = 0$ (see equation (2)), that is the sum of coefficients on the money variables <u>other than DMR</u> equal zero. F^2 is a test of the hypothesis that $\beta_o^n = \beta_1^n = \ldots = 0$, which is that all coefficients on money variables except DMR equal zero.

The money surprise, DMR, is significant in GNP and PRI and four of the sectors (CON, MAND, MANND, and TPU). It is noticeable, however, that fitted and/or lagged money growth are also significant in the same sectors plus three more (RET, AG and WHST). As expected, GOV is not influenced by any money variable but the same also appears to be true of SERV, MIN and FIR. The contemporaneous value of fitted money growth is significant for GNP, AG, CON, RET and TPU. Thus, while we have found clear evidence that money growth influences activity, there is no support for the view that only 'surprise' money growth has real effects. Innovations do have effects but so also does lagged money growth and, even more surprisingly, 'anticipated' money growth.

II

We now consider more closely the issue of the dynamic response of output to monetary innovations. The evidence above clearly shows that there is more going on than a contemporaneous surprise triggering output cycles which can be represented as an autoregressive process in output itself. The new classical response would be that, while it is true that the innovation comes from contemporaneous money surprises, the dynamic response has to be generalized to allow for sectoral interdependence. An innovation which caused an output increase in sector i in period t may lead to a derived change in demand for inputs bought from sector j in period t+1. Of course, if sector j produces a storable output the rational producer will observe the innovation in period t and anticipate the demand increase in t+1 by increasing output immediately. However, if the output is not storable or the contemporaneous output (as well as price) of other sectors is not observed such anticipation is not possible, and so the output of sector j will appear to respond in period t+1 to the money innovation in period t.

If this interpretation is correct we should be able to modify the supply curves in (2) to incorporate sectoral interdependence. Evidence that lagged (or anticipated) money still had real effects would present a very strong case against the new classical approach to business cycles. With regard to the alternative hypotheses, there will be no attempt to distinguish between approaches which rely upon sticky prices or wages (Fischer 1977) and those which treat money as a buffer stock (Laidler 1984) involving lags from changes in money to changes in spending. Recall the monetarist rule of thumb that there is a mean lag of about a year from changes in money to changes in activity.

With the addition of sectoral interactions equation (2) may be rewritten as

$$(4)\quad y_t^n = \lambda_i^n (L)\, y_{t-i}^n + \sum_{\substack{j=1 \\ j \neq n}}^{P} \gamma_i^{nj} (L)\, y_{t-i}^j + \alpha_1^n (M_t - E(M_t \,|\, I_{t-1}))$$

$$+ \beta_o^n \hat{M}_t + \sum_{i=1}^{k} \beta_i^n M_{t-i} + e_t^n$$

where the new term reflects the impact on the output of sector n of the output of sector j in period t-i. The coefficients on money variables and summary statistics are reported in table 2. Two lags on all sector outputs were included in each sector output equation. These 20 coefficients for each equation are not reported. However a test of their joint impact is reported. F^1 is a test of the hypothesis that the sum of the money coefficients other than DMR is zero. F^2 is a test of the hypothesis that all money coefficients except DMR equal zero. F^3 is a test of the hypothesis that the coefficients on sector outputs at lag 1 are all zero except the lagged dependent variable. F^4 is a test of the hypothesis that the coefficients on sector outputs at lag 2 are all zero except the lagged dependent variable.

The results in table 2 are noticeably more favourable to the new classical business cycle model than were those in table 1. The money surprise is significant in 6 sectors (FIR, CON, MAND, MANND, RET, TPU) and fitted money is not now significant in any. The first order sectoral interaction terms are jointly significant in 6 sectors (MIN, CON, MANND, WHST, SERV, TPU) and the second order terms are significant in only MIN. However, the joint F tests still enable us to reject the hypothesis of no effect of fitted and lagged actual money growth in three sectors (FIR, CON, TPU) and there is, in addition, a significant t-statistic on DM_{t-2} in the MANND equation.

Hence, it must be concluded that the addition of sectoral interaction terms does not salvage the new classical business cycle model. There are still clearly determined effects coming from lagged money growth which are not consistent with the idea of a contemporaneous money surprise providing an impulse to an otherwise autoregressive process.

Essentially the same conclusion is reached if the form of the money variables reported in tables 1 and 2 is replaced with an equation which has both surprises up to lag 6 and fitted money growth up to lag 6 in the same equation, along with two lags on all sector outputs. The results of this alternative formulation are not reported in full but they are easy to summarize. The contemporaneous money surprise were significant in four sectors (FIR, CON, MAND, MANND). Lagged surprises were significant in five sectors (CON lag 1; MAND lag 2; MANND lag 2; WHST lag 1; TPU lag 2 positive lag 5 negative). Fitted money was significant in only 3 sectors (FIR lag 1; MIN negatively lags 1 and 3; GOV contemporaneously).

In summary these results do not sustain a pure new classical interpretation of the role of money in business cycles. Once lagged surprises are admitted the "observational equivalence" problem arises (Sargent 1976, McCallum 1979). Indeed with evidence of lags from changes in money growth to changes in output of up to 2 quarters and evidence of sectoral interactions of up to a further 2 quarters we have rediscovered the old fashioned 'monetarist' rule of thumb that changes in money have cumulative real effects which peak after about a year and thereafter die out.

III

Even if we had discovered above that only contemporaneous surprises had real effects this would not represent watertight 'proof' that money surprises 'cause' cycles in real activity. It is quite plausible, especially where monetary authorities peg interest rates or exchange rates, that money responds endogenously to a variety of shocks which are themselves 'real' in origin (Buiter 1983, King and Plosser 1984). Indeed, in this respect evidence of lags from money to output is helpful to a monetary interpretation of business cycles. The Granger-style notion of causality requires some such lags.

Accordingly tests were performed to discover if there is an identifiable impact on real activity coming from a component of the money stock which is more likely to be exogenous than any other, namely the "adjusted monetary base less borrowed reserves." This is the best measure that could be arrived at of the 'outside' money concept of King and Plosser (op.cit.). Thus, while there is no simple way to disprove arguments that money growth or surprise money growth is endogenous, it is possible to test for influences coming from changes in base which can only be related to behaviour of the authorities. Even this is not conclusive when the authorities are pegging interest rates but this is probably as close as we are likely to come to a measure of the exogenous component of money.

The results of using base growth, contemporaneous and up to 6 lags, are reported in table 3. The aggregate equations for GNP and PRI included a constant, time trend and two lagged dependent variables. The sector equations included a constant, time trend and two lags of all sector outputs. F^1 is a test of the hypothesis that the sum of coefficients on base growth equals zero. F^2 is a test of the hypothesis that all of the coefficients on base growth equal zero. The latter test is rejected strongly in CON as well as in PRI and GNP. The zero sum test is rejected in GNP, PRI, MAND and SERV, though the impact on SERV is negative. Notice, however, that three other sectors are very close to rejection. The hypothesis is rejected in CON, MANND and TPU at the 6 percent level, but not at the 5 percent level. In addition, there is a significant t-statistic in FIR at lag 1.

A comparison of the MSE in table 2 with table 3 shows that base growth does not give as good an overall fit as M1. However, this is not surprising. The important point which is clearly established in table 3 is that there is a significant connection between base growth and changes in real activity. The link between base growth and the construction sector, CON, is particularly well determined with a one quarter lag. The high plausibility of this link must add extra credibility to the strong evidence.

Once the base is viewed as the policy instrument, the new classical approach to business cycles suggests that we should make a distinction between anticipated and unanticipated policy changes. Thus, it is worth investigating the impact of unanticipated base growth. Accordingly a search was conducted for a suitable forecasting equation for base growth. In addition to its own lagged value, lagged values of M1 growth, the budget deficit, the treasury bill rate, GNP, and unemployment were used. Variables were discarded on the basis of both t-tests and joint F-tests. Equations were estimated by OLS and by Cochran-Orcutt ARLS and up to fourth order autocorrelation. The final equation with second order autocorrelation was estimated by maximum likelihood. It is

$$(5)\quad DB_t = \underset{(1.66)}{.35} + \underset{(11.3)}{.9}\ DB_{t-1} + \underset{(.81)}{.087}\ DB_{t-2} - \underset{(3.05)}{.32}\ DB_{t-3} + \underset{(4.3)}{.36}\ DB_{t-4}$$

$$- \underset{(.95)}{.08} DM_{t-1} - \underset{(2.4)}{.23} DM_{t-2} + \underset{(2.7)}{.21} DM_{t-3}$$

$R^2 = .56$ $\rho_1 = \underset{(7.5)}{-.56}$ $\rho_2 = \underset{(7.2)}{-.54}$

D.W. = 2.04

Where DB is the same as DBASE in table 3 and DM is M1 growth also as above. The residuals from (5) were then used in place of DBASE in equations as reported in table 3.

The full results are not reported as there were very few significant effects. Both F-tests in all equations were unable to reject the zero restrictions. Indeed only in the CON equation was there anything at all close to rejection ($F^1 = 3.05$). Even the GNP and PRI equations had nothing close to significant effects (GNP: $F^1 = .69$, $F^2 = .98$; PRI: $F^1 = .36$, $F^2 = 1.0$). There were significant t-statistics in only four equations (AG lag 3 negative (2.05); CON lag 1 positive (2.37) and lag 3 positive (2.1); MANND lag 2 positive (2.05); SERV lag 4 negative (2.08)). Thus there is a noticeable loss of explanatory power resulting from the use of unanticipated as opposed to total base growth.

SUMMARY AND CONCLUSIONS

The impact of money on real output has been investigated in a disaggregated supply model for the U.S. economy. Clear evidence has been found of a link between money growth and output changes in several different sectors. The results add some support to the 'old fashioned' monetarist rule of thumb of a lag of up to about a year for the maximum effect of money on real output. Even when sectoral interactions are allowed for, the pure new classical approach to business cycles is rejected on the grounds that lagged effects of money growth persist.

There is also some evidence that anticipated money growth has real effects.

Results which claim to provide evidence of a link from money to real activity have always been open to the criticism of reverse causation. This possibility can never be entirely disregarded if the authorities are pegging interest rates. However, an attempt was made above to identify the monetary aggregate most likely to be exogenous. Changes in the 'adjusted base less borrowings' were shown to have a significant relationship with real activity. This relationship was especially strong in the construction sector.

There may be advantages to the approach adopted above which are more general than the specific conclusions about the impact of money. Traditionally macro models have considered a single homogeneous production sector. This was a useful tool for comparing equilibrium with disequilibrium states. It is of little use, however, for equilibrium modelling since with one input and one output the solution is unique (or, so called, 'natural'). Once the supply side of the economy is disaggregated, however, the outputs of each sector are not unique even in full equilibrium and, thus, we may fruitfully pursue comparative static analyses of equilibrium states.

The theoretical case for disaggregation is reinforced by the evidence that there is a benefit from so doing. For example, the 'government' component of GNP clearly behaves differently from the rest. At the very least empirical work should distinguish between private sector output and public sector (imputed) output. Even within the private sector, however, we have discovered both a variety of adjustment dynamics and of responses to money growth.

What this argument amounts to is as follows. The Keynesian strategy for building a macro model was to consider a single output but to disaggregate by expenditure categories. This had a payoff but was ultimately discredited because of the almost total neglect of the supply side of the economy (monetarists notwithstanding). A fruitful alternative strategy may be to build a macro model around a structural disaggregation of the output categories of the economy. The behavioral functions would then consist of the system of demand and supply functions for the chosen output categories. Only a great deal of further work will reveal what the best level of disaggregation happens to be.

FOOTNOTES

1/ Notice that decision delays or sticky adjustment which is internal to a sector is not sufficient to require lagged surprises in the supply curve since this adjustment will be picked up by the lagged output terms. Only the lag in transmissions of an impulse from one sector to another is not captured by this.

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Table 1
Money and Sectoral Output

DEP. VAR.	CONST.	DEP. VAR. t-1	DEP. VAR. t-2	DMR_t	$\hat{DM}_t$	DM_{t-1}	DM_{t-2}	DM_{t-3}	DM_{t-4}	DM_{t-5}	DM_{t-6}	TIME	R^2 / $MSEx10^4$	F^1 / F^2
GNP	.58	1.21	-.31	.16	.12	.09	.08	-.01	.04	-.04	-.01	.0006	.9991	8.15**
	(2.5)	(13.5)	(3.6)	(3.3)	(2.4)	(2.3)	(2.1)	(.35)	(1.0)	(1.0)	(.35)	(2.1)	.936	3.9**
PRI	.84	1.17	-.31	.19	.11	.11	.1	.008	.04	-.03	.006	.0009	.9987	11.06**
	(3.2)	(13.0)	(3.6)	(3.5)	(1.86)	(2.4)	(2.3)	(.19)	(.9)	(.7)	(.13)	(2.9)	1.2	3.87**
AG	.42	1.09	-.23	.34	.56	-.26	.26	.35	.04	-.17	.33	-.0002	.8997	6.57*
	(3.5)	(11.8)	(2.5)	(1.2)	(1.98)	(1.2)	(1.3)	(1.7)	(.17)	(.83)	(1.6)	(.88)	29.48	1.93
FIR	.17	1.26	-.31	.06	.05	.08	-.016	-.05	.03	-.04	.04	.0004	.9992	1.26
	(1.8)	(14.1)	(3.4)	(1.10	(.74)	(1.88)	(.39)	(1.2)	(.7)	(1.0)	(.98)	(1.5)	1.24	1.44
MIN	.06	.93	.03	-.02	-.09	.17	-.12	-.048	.31	.09	.25	.00008	.9713	1.91
	(1.35)	(10.5)	(.33)	(.08)	(.31)	(.75)	(.58)	(.22)	(1.4)	(.41)	(1.2)	(.34)	33.89	0.97
CON	.02	1.22	-.22	.26	.25	.17	.07	-.09	.03	-.03	-.08	-.0002	.9973	6.09*
	(.31)	(13.7)	(2.4)	(3.3)	(2.9)	(2.5)	(1.1)	(1.4)	(.39)	(.52)	(1.3)	(1.02)	2.63	4.08**
MAND	.48	1.05	-.15	.45	.22	.3	.22	.05	-.04	-.02	-.16	.0003	.9791	4.33*
	(2.2)	(11.2)	(1.66)	(2.6)	(1.1)	(2.1)	(1.68)	(.33)	(.31)	(.14)	(1.2)	(.87)	12.82	2.3*
MANND	.65	1.05	-.21	.28	.05	.12	.21	-.05	.06	-.12	.02	.0007	.9925	4.02*
	(3.1)	(11.4)	(2.2)	(3.1)	(.55)	(1.6)	(3.0)	(.68)	(.82)	(1.7)	(.32)	(2.7)	3.46	3.05**
RET	.34	.8	.11	.14	.2	.06	.05	.005	.02	-.09	-.04	.0005	.9964	1.68
	(1.95)	(8.5)	(1.2)	(1.78)	(2.3)	(.86)	(.86)	(.09)	(.27)	(1.5)	(.6)	(1.86)	2.59	2.05*
WHST	.44	.89	-.03	.04	-.08	.34	.03	-.007	.01	.12	-.17	.0012	.9973	2.68
	(2.5)	(9.8)	(.3)	(.47)	(.83)	(4.7)	(.48)	(.11)	(.15)	(1.7)	(2.5)	(2.2)	3.45	4.44**
SERV	.13	1.27	-.3	-.02	.04	.01	.05	-.03	.02	-.04	.0003	.0004	.9997	0.71
	(1.5)	(14.4)	(3.5)	(.5)	(.92)	(.3)	(1.6)	(.89)	(.74)	(1.4)	(.01)	(1.3)	0.675	1.02
TPU	.7	.96	-.15	.16	.17	.09	.05	0.0	.13	-.09	.007	.001	.9978	10.52**
	(3.3)	(10.1)	(1.6)	(2.4)	(2.3)	(1.7)	(1.0)	(0)	(2.4)	(1.5)	(.12)	(3.0)	1.9	3.59**
GOV	.086	1.41	-.43	-.008	.09	.002	-.01	.02	-.001	.03	-.06	.0001	.9994	0.65
	(1.7)	(16.9)	(5.1)	(.15)	(1.5)	(.05)	(.29)	(.63)	(.04)	(.6)	(1.5)	(.82)	1.19	0.79

Note: Variables are defined in text. Money variables were expressed as annualized growth rates but coefficients are reported x 10^2. F^2 is a test of the hypothesis that all coefficients on money variables except DMR = zero; degrees of freedom 7 and 118. F^1 is a test of the hypothesis that the sum of the coefficients on money variables except DMR = zero; degrees of freedom 1 and 118. * implies rejection at the 5 percent level, ** implies rejection at the 1 percent level. Data Quarterly 1950 III to 1982 IV. Data Sources: GNP by sector in from Chase Data tapes. These are deflated by the GNP deflator. All other data are from Federal Reserve Bank of St. Louis data files. All data are seasonally adjusted.

Table 2
Money, Output and Sectoral Dynamics

DEP. VAR.	DMR_t	$\hat{DM}_t$	DM_{t-1}	DM_{t-2}	DM_{t-3}	DM_{t-4}	DM_{t-5}	DM_{t-6}	F^1 (1,98)	F^2 (7,98)	F^3 (10,98)	F^4 (10,98)	MSE $\times 10^4$	R^2
AG	.17	.57	-.48	.007	.23	.1	-.17	.31	.69	1.16	.88	1.19	26.28	.9257
	(.56)	(1.68)	(1.77)	(.03)	(1.0)	(.42)	(.72)	(1.3)						
FIR	.13	-.0004	.17	.03	-.04	.001	-.04	.02	1.07	2.65*	1.06	.96	1.02	.9995
	(2.25)	(.007)	(3.24)	(.59)	(.85)	(.03)	(.95)	(.48)						
MIN	.27	-.37	.3	-.38	-.25	.08	.007	.24	.33	1.63	3.02**	2.76**	24.09	.9831
	(.94)	(1.15)	(1.17)	(1.67)	(1.15)	(.35)	(.03)	(1.1)						
CON	.25	.17	.2	.15	-.09	-.04	-.04	.008	3.95*	4.25**	2.88*	1.3	1.92	.9984
	(3.14)	(1.92)	(2.78)	(2.29)	(1.49)	(.61)	(.56)	(.14)						
MAND	.51	.14	.3	.31	.003	-.06	-.07	.02	1.99	1.33	1.8	1.57	11.77	.9841
	(2.56)	(.64)	(1.68)	(1.92)	(.02)	(.4)	(.42)	(.11)						
MANND	.29	-.02	.09	.19	-.06	.02	-.13	.06	.44	1.63	2.07*	1.22	3.14	.9943
	(2.78)	(.19)	(1.0)	(2.32)	(.78)	(.25)	(1.56)	(.79)						
RET	.19	.17	.04	.05	.04	.07	-.05	-.02	2.42	.94	1.63	1.18	2.22	.9974
	(2.15)	(1.7)	(.57)	(.75)	(.66)	(1.0)	(.77)	(.27)						
WHST	.02	.005	.15	-.03	-.1	.01	.1	-.14	.0005	1.3	2.17*	1.06	2.98	.9981
	(.24)	(.05)	(1.7)	(.36)	(1.25)	(.13)	(1.27)	(1.8)						
SERV	.001	.04	.03	.05	-.02	-.01	-.04	-.03	.02	1.32	2.53**	1.82	0.47	.9998
	(.04)	(.82)	(.88)	(1.5)	(.74)	(.45)	(1.3)	(.93)						
TPU	.17	.13	.13	.1	-.03	.09	-.06	.07	6.15*	2.33*	1.98*	1.32	1.7	.9983
	(2.19)	(1.47)	(1.95)	(1.72)	(.51)	(1.5)	(.96)	(1.12)						
GOV	.03	.12	.02	.01	.05	.006	.02	-.03	1.92	.98	.75	.92	.98	.9996
	(.55)	(1.78)	(.32)	(.29)	(1.07)	(.13)	(.37)	(.77)						

Note: These are estimates of equations in the form (4) in the text. Estimated equations included constant, time trend, and two lagged values of all sector outputs in each equation. The individual coefficients on these are not reported.
F^1 is a test of the hypothesis that the sum of money coefficients except DMR = 0.
F^2 is a test of the hypothesis that money variables other than DMR all equal zero.
F^3 is a test of the hypothesis that the coefficients on other sector outputs at t-1 all = 0.
F^3 is a test of the hypothesis that the coefficients on other sector outputs at t-2 all = 0.

* indicates rejection at 5 percent level; ** indicates rejection at 1 percent level. Data quarterly 1952 III to 1982 IV.

Table 3
Sectoral Outputs and Base Money Growth

DEP. VAR.	D $BASE_t$	D $BASE_{t-1}$	D $BASE_{t-2}$	D $BASE_{t-3}$	D $BASE_{t-4}$	D $BASE_{t-5}$	D $BASE_{t-6}$	F^1	F^2	R^2	MSE x 10^4
GNP	.12 (2.2)	.08 (1.47)	.03 (.53)	.08 (1.39)	.05 (.85)	-.04 (.72)	.02 (.38)	11.58**	2.78**	.9989	1.04
PRI	.12 (1.96)	.097 (1.5)	.01 (.22)	.1 (1.52)	.04 (.58)	-.04 (.69)	.03 (.45)	11.52**	2.71*	.9984	1.37
AG	-.16 (.48)	-.25 (.78)	.24 (.68)	.18 (.56)	.53 (1.52)	-.01 (.04)	.05 (.15)	.48	.54	.9196	28.12
FIR	.05 (.8)	.12 (2.04)	-.12 (1.84)	-.04 (.58)	-.04 (.55)	-.05 (.76)	.003 (.04)	.17	1.53	.9994	1.01
MIN	.28 (.92)	.1 (.34)	-.27 (.84)	-.19 (.63)	.15 (.47)	.06 (.21)	.42 (1.44)	.51	.66	.9834	25.16
CON	.18 (2.05)	.32 (3.64)	.15 (1.6)	-.05 (.59)	-.15 (1.57)	-.03 (.39)	.02 (.27)	3.81	3.7**	.998	2.14
MAND	.3 (1.41)	.34 (1.59)	.18 (.77)	.4 (1.85)	.05 (.21)	-.04 (.17)	.13 (.64)	6.22*	1.48	.9816	12.35
MANND	.07 (.66)	.21 (1.89)	.07 (.61)	.17 (1.51)	.01 (.09)	.06 (.58)	-.05 (.49)	3.76	1.1	.9937	3.27
RET	.07 (.82)	.05 (.61)	.04 (.47)	.12 (1.4)	.04 (.49)	.06 (.77)	-.03 (.32)	2.92	.67	.9976	1.9
WHST	.11 (1.05)	-.04 (.35)	-.07 (.64)	-.09 (.84)	.11 (.97)	.04 (.32)	-.12 (1.1)	.05	.74	.9978	3.22
SERV	.02 (.53)	.006 (.15)	-.03 (.71)	-.02 (.45)	-.07 (1.55)	-.08 (1.91)	-.06 (1.52)	4.8*	1.35	.9998	0.42
TPU	.15 (1.84)	.13 (1.55)	-.04 (.43)	.1 (1.2)	-.03 (.3)	-.007 (.08)	.1 (1.22)	3.7	1.59	.9981	1.82
GOV	.007 (.14)	-.04 (.74)	.03 (.56)	-.04 (.7)	.03 (.54)	.05 (.89)	-.04 (.73)	.0008	.47	.9997	0.7

Note: All equations were estimates with intercept and time trend. GNP and PRI equations included 2 lags of the dependent variable. All sectors had 2 lags of all sector outputs included. D BASE is the first difference of the lag of the adjusted monetary base less borrowings seasonally adjusted and expressed as an annualized growth rate. Data period 1952IV-1982/IV.

F^1 is a test of the hypothesis that the sum of coefficients on base growth = 0.
F^2 is a test of the hypothesis that coefficients on base growth jointly = 0.
** indicates rejection at the 1 percent level.
* indicates rejection at the 5 percent level.
Degrees of freedom are F^1: 1 and 112 for GNP and PRI; 1 and 92 for the rest.
F^2: 7 and 112 for GNP and PRI; 7 and 92 for the rest.