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THE ROLE OF MONEY SUPPLY SHOCKS IN THE SHORT-RUN DEMAND FOR MONEY

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ABSTRACT

Previous models of the demand for money are either inconsistent with contemporaneous adjustment of the price level to expected changes in the nominal money supply or imply implausible fluctuations in interest rates in response to unexpected changes in the nominal money supply. This paper proposes a shock-absorber model of money demand in which money supply shocks affect the synchronization of purchases and sales of assets and so engender a temporary desire to hold more or less money than would otherwise be the case. Expected changes in nominal money do not cause fluctuations in real money inventories. The model is simultaneously estimated for the United States, United Kingdom, Canada, France, Germany, Italy, Japan, and the Netherlands using the postwar quarterly data set and instruments used in the Mark III International Transmission Model. The shock-absorber variables significantly improve the estimated short-run money demand functions in every case.

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THE ROLE OF MONEY SUPPLY SHOCKS IN THE SHORT-RUN DEMAND FOR MONEY

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Existing models of the demand for money are either inconsistent with contemporaneous adjustment of the price level to expected changes in the nominal money supply or imply implausible fluctuations in interest rates in response to unexpected changes in the nominal money supply. This paper proposes and tests a shock-absorber model of money demand which has neither of these defects. The shock-absorber model proved superior empirically for the eight industrial countries used in our tests.

A critical review of the main alternative models is presented in Section I. Our shock-absorber model is outlined in Section II. Section III discusses the empirical results.

I. Alternative Adjustment Models

Partial adjustment models are almost universally adopted in analysis of money demand applied to quarterly data. This is so because the effect of changes in real income and interest rates appear to be much smaller in the first quarter than in the long-run.[1]

The usual approach was proposed by Chow (1966) who argued that a change in the determinants of the long-run demand for money would lead to a change in real money balances in the current quarter which is a fraction of the difference real long-run money demand and lagged real money balances. In logarithmic form this is:

$$m_t - m_{t-1} = \lambda(m_t^d - m_{t-1}) \tag{1}$$

where m_t is the logarithm of real money balances in period t and m_t^d is the logarithm of the long-run desired quantity in period t.[2] The short-run demand for money is therefore

$$m_t = \lambda m_t^d + (1-\lambda)m_{t-1} \tag{2}$$

That is, short-run money demand is a (geometric) average of the long-run desired quantity and lagged real money.

Although conceived for analysis of changes in the long-run desired quantity of real money, the model also works well for expected changes in the nominal money supply. A number of recent articles[3] have demonstrated that expected changes in the nominal money supply are neutral in the sense that the price level and other nominal variables move proportionately while real variables are unaffected.[4] Thus neither m_t^d nor m_{t-1} will change due to an expected change in the nominal money supply, and real money will be unchanged since

$$m_t \equiv M_t - P_t \tag{3}$$

where M_t and P_t are the logarithms of the nominal money supply and price level, respectively, and M_t and P_t increase equally. Thus the Chow model is consistent with contemporaneous changes in expected nominal money and the price level.

The Chow model does not seem to work so well in the case of nominal money supply shocks.[5] If M_t^* is the expected logarithm of the nominal money supply, the money supply shock or innovation is defined as

$$\hat{M}_t \equiv M_t - M^*_t \tag{4}$$

Money supply shocks do not have the neutral properties of expected changes. Recent empirical research can be summarized as showing that a money supply shock will have relatively little contemporaneous effect on the price level, but will instead increase real income and reduce interest rates via the liquidity effect. But if the impact effect on P_t of $\hat{M}_t$ is no more than say 0.1, then the impact effect on m_t must be at least 0.9.[6] That is an unexpected increase (decrease) in the nominal money supply of 1 percent would be associated with an increase (decrease) in real money of at least 0.9 percent. To stay on the short-run money demand function (2), long-run desired balances must increase by $0.9/\lambda$ percent, and estimated values of λ rarely exceed 0.1 for quarterly data. To achieve even a 9 percent change in m_t^d requires implausible changes in real income and interest rates.

We can illustrate this by reference to a simple Cagan (1956) long-run money demand function:

$$m_t^d = \alpha_0 + \alpha_1 y_t + \alpha_2 R_t \tag{5}$$

where y_t is the logarithm of real income, and R_t the nominal interest rate. Differentiating (5) we obtain

$$\frac{dm_t^d}{d\hat{M}_t} = \alpha_1 \frac{dy_t}{d\hat{M}_t} + \alpha_2 R_t \cdot \frac{1}{R_t} \frac{dR_t}{d\hat{M}_t} \tag{6}$$

Using a short-term interest rate for R_t, estimates of α_1 and $\alpha_2 R_t$ (the income and interest elasticities of m_t^d) are typically about 1 and -0.1 respectively.[7] Finally, assuming that the first-quarter income effect is no more than 1,[8] we can solve for the interest rate impact necessary to achieve a $\frac{dm_t^d}{d\hat{M}_t}$ of 9. This is

$$\frac{1}{R_t} \frac{dR_t}{d\hat{M}_t} \approx -80$$

An 80 percent decrease in the interest rate in response to a 1 percent unexpected increase in money strikes us as an implausibly large first quarter liquidity effect.[9]

In summary, the Chow model works well with respect to changes in the determinants of long-run money demand or expected changes in the nominal money supply. It is unsatisfactory as an explanation of short-run money demand in quarters in which money supply shocks occur.

In two influential papers, Goldfeld has proposed that the partial adjustment model be applied to nominal money balances instead of real money balances:[10]

$$M_t - M_{t-1} = \lambda(M_t^d - M_{t-1}) \tag{7}$$

This formulation is less satisfactory than the Chow formulation in the case of money supply shocks since it can be shown[11] that it requires

$$\frac{dm_t^d}{d\hat{M}_t} = \frac{1}{\lambda}(1 - \lambda \frac{dP_t}{d\hat{M}_t}) \tag{8}$$

which is larger than the corresponding value $\frac{1}{\lambda}(1 - \frac{dP_t}{d\hat{M}_t})$ for the Chow form.

Further the Goldfeld form has a peculiar nonneutrality with respect to expected changes in the nominal money supply: Equation (7) can be solved as

$$m_t = \lambda m_t^d + (1-\lambda)m_{t-1} - (1-\lambda)(P_t - P_{t-1}) \tag{9}$$

Thus the Goldfeld model is identical to the Chow formulation except for the addition of the term $-(1-\lambda)(P_t-P_{t-1})$. This deduction of $-(1-\lambda)$ times the quarterly inflation rate is in addition to any effects operating via the interest rate and implies that people will never catch on to an expected inflation when it comes to adjusting their cash holdings. Thus the Goldfeld approach seems less satisfactory than the Chow approach on two counts.

II. The Shock-Absorber Model

One of the authors (Darby, 1972) has previously proposed that money balances serve as a shock absorber or buffer stock which temporarily absorbs unexpected variations in income (transitory income) until the portfolio of securities and consumers' durable goods can be conveniently adjusted. A similar response would seem reasonable for the portfolio shock engendered by unexpected changes in the nominal money supply. If the Fed increases the nominal money supply by an open market operation, the initial impact on the price of Treasury bills will quickly spread to the prices of other securities. In the process, individual investors will find that they cannot obtain their expected yield from their planned portfolio and will take some time to choose an alternative portfolio, incidentally holding larger average balances. Others will find that they sell assets -- stocks, houses, cars -- quicker than expected at their reservation price and have larger average balances. Credit availability will be greater also, and loans will be approved more quickly and more frequently with temporary increases in money balances. Of course for each individual the temporary increases may be brief, but as the changes are quite general the aggregate effect can be large. The process can be reversed for unexpected decreases in the nominal money supply, with unexpectedly low asset prices, slow sales, and restricted credit availability causing individuals to temporarily dip into their cash reserves.

In summary, money supply shocks will affect the synchronization of purchases and sales of assets and so engender a temporary desire to hold more or less money than would otherwise be the case.[12] This indeed is one of the basic functions of money, much discussed in undergraduate classes, but not previously included in aggregate demand functions. Whether this effect is important is an empirical question to be examined in Section III.

Our discussion suggests two modifications to the basic Chow mechanism: (1) addition of a transitory income term and (2) addition of a money supply shock term. The shock-absorber version of the Chow mechanism is thus:

$$m_t=\lambda m_t^d+(1-\lambda)m_{t-1}+\beta y_t^T+\phi\hat{M}_t \qquad (10)$$

where y_t^T is logarithmic transitory income ($y_t^T \equiv y_t - y_t^P$ where y_t^P is the logarithm of real permanent income).[13] Our preferred long-run money demand function is

$$m_t^d=\gamma_0+\gamma_1 y_t^P+\gamma_2 R_t \qquad (11)$$

Combining (10) and (11) we get the estimating equation

$$m_t=\lambda\gamma_0+\lambda\gamma_1 y_t^P+\lambda\gamma_2 R_t+(1-\lambda)m_{t-1}+\beta y_t^T+\phi\hat{M}_t \qquad (12)$$

The reduced form differs from that of equations (2) and (5) only in allowing for different effects of the permanent and transitory components of real income and in the addition of the money supply shock term.

Under the Chow model, $\phi=0$ while under our alternative hypothesis $\phi>0$. If equation (11) is the true long-run money demand function, then $\beta=0$ under the Chow hypothesis and $\beta>0$ under the shock absorber model. But in fact the true long-run money demand function might weight transitory income anywhere between 0 [equation (11)] and the weight of permanent income [equation (5)]. So the Chow hypothesis is $0\leq\beta\leq\lambda\gamma_1$ and the shock absorber hypothesis is $0<\beta$. A β which falls in the overlapping region $0<\beta<\lambda\gamma_1$ does not distinguish between the two hypotheses.

Before going on to the empirical estimates, we should note another, possibly complementary reason why money supply shocks might enter the short-run money demand function. Suppose, following Barro and Santomero (1972) and

Klein (1974), that the long-run money demand function should include both the short-term interest rate R_t and the implicit yield on the bank deposit portion of money, R_t^M. Because banks pay interest on deposits in hidden ways for legal reasons, R_t^M is not observable. However there is anecdotal evidence that the implicit rate is sticky in the sense of being slow to adjust to changes in R_t.[14] If we consider R_t^M as an omitted variable and apply standard specification analysis,[15] the coefficient of $\hat{M}_t$ would have an expected value equal to its own value plus the product of the coefficient of R_t^M and the coefficient of $\hat{M}_t$ in the auxiliary regression of R_t^M on the variables included in the estimated money demand function. Now if a positive money shock causes R_t to drop relative to R_t^M, the auxiliary-regression coefficient will be positive as is the coefficient of R_t^M. So positive weight may be given to $\hat{M}_t$ as a proxy for R_t^M in addition to any effect due to a pure shock-absorber effect.

III. Empirical Tests

In this section we estimate the shock-absorber money demand equation (12) and test (a) whether the coefficient of transitory income differs significantly from both 0 and the coefficient of permanent income and especially (b) whether the coefficient of the money supply shock is significantly greater than zero. This raises two major econometric difficulties: simultaneity bias and estimation of the money supply shock $\hat{M}_t$.

Simultaneity bias arises because y_t^P, R_t, y_t^T, and $\hat{M}_t$ are all determined simultaneously with m_t and so are likely correlated with the stochastic disturbance in (12). In particular, to the extent that the monetary authority is passive in its monetary policy a positive value of the real money demand disturbance will induce an unexpected increase in the nominal money supply. This would induce a positive bias in the coefficient of $\hat{M}_t$ if equation (12) were estimated by ordinary least squares. Similarly transitory income may be affected by the stochastic disturbance in (12) as well as by the money shock which could result in additional bias to both coefficients. To avoid this sort of bias, we must use a simultaneous equation method in the context of a model in which the simultaneously determined variables are endogenous. The Mark III International Transmission Model developed as part of the NBER-NSF Project on the International Transmission of Inflation fits the bill nicely and permits us to test the equation for eight major countries.[16]

In the Mark III model, the expected logarithm of the nominal money supply (that is, M_t^*) is based on a univariate ARIMA process. This definition was found to work better (in terms of fit, coefficients, and autocorrelation of residuals) in the behavioral equations of the model than alternative formulations based on transfer functions including all lagged variables in the central bank's money supply reaction function. A rationalization of this apparent limitation on the information set would involve costs of acquiring and processing information.[17] We did check that the results do not change substantially from those reported below when the transfer function definition of M_t^* is used.[18] David Laidler (1979) used Barro's definition of M_t^* in a new comparative study of money demand functions also with similar results.[19]

Table 1 presents instrumental variable estimates of equation (12) for the eight countries in the Mark III model (the United States, United Kingdom, Canada, France, Germany, Italy, Japan, and the Netherlands). All estimates are for the entire period 1957I-1976IV for which all required variables are available in the NBER International Transmission Data Bank. Permanent income is estimated using the method in Darby (1974) with a current quarter weight of 0.025.[20] The instruments used are the (approximately 25) principal components for each country which span the predetermined domestic variables and fitted foreign variables in the country's submodel. For comparison, Table 2 presents OLS estimates of the equations which are virtually identical except that the estimated coefficients of $\hat{M}_t$ do appear to be biased upward to an extent in the OLS estimates.

Examining the results in Table 1, we see that the money shock variable enters consistently as predicted by the shock absorber model with a coefficient between 0.6 and 1.2. The coefficient of transitory income is not very precisely estimated and exceeds that of permanent income in only three cases -- significantly so only for the United States. Perhaps this reflects the greater movements in U.S. transitory income in the sample period. Alternatively, the Darby (1972) estimates of a very strong transitory income effect on money demand may have been due to spurious correlation with the there-omitted money supply shock. As a whole these results are consistent with the shock-absorber model of equation (12), particularly as to the importance of including the money-supply shock term. Figure 1 compares the actual values of m_t with the fitted values based on the Table 1 regressions for benefit of eyeball econometricians.

A problem with these results, as with most if not all applications of the Chow model, is that positive autocorrelation in the residuals biases the estimated value of λ toward zero. Using Durbin's h to test for such autocorrelation in the presence of a lagged dependent variable, we find significant and positive autocorrelation for all countries except the United States, the United Kingdom, and Canada (which is nearly significantly negative). We would like to correct for this autocorrelation to confirm that this does not affect the results. In principle, a generalization of Fair's (1970) method for first-order autocorrelation in simultaneous equation systems could be used. But the TROLL system uses an inconsistent method of combining instrumental variables and generalized least squares (GLS) methods which apparently heightens the bias of λ toward 0 without any appreciable effect on the estimates or t-values of the $\hat{M}_t$ coefficient. Table 3 reports instead straight GLS estimates for which there is some upward bias on the $\hat{M}_t$ coefficients. The estimated coefficients of $\hat{M}_t$ are little changed. Apparently the near-orthogonality of the money-shock variable to the other explanatory variables makes it little affected by bias due to autocorrelation of the residuals.

We note that we have only an imperfect measure of the division of nominal money into its anticipated and unanticipated components. Thus, our $\hat{M}_t$ variable is measured with error and this would generally[21] bias <u>downward</u> its estimated coefficient. Whether this bias is greater or less than the upward simultaneous-equation bias which we detected is impossible to say.

IV. Summary and Conclusions

We have argued that money supply shocks cause unexpected variations in yields, asset prices, and credit availability which induce a temporary sympathetic movement in the short-run demand for money. Failure to allow for such movement requires very large movement in prices, real income, and interest rates as compared to typical reduced form estimates. We find that a simple amendment to the popular Chow short-run money demand function produces a shock absorber model which works well in explaining short-run money demand for eight industrial countries. We believe that inclusion of such a variable in the money demand equation of a modern macroeconometric model is necessary to obtain reasonable price level behavior.[22]

A policy implication of our shock-absorber model is that money-supply shocks will induce smaller interest rate fluctuations than implied by the Fed's model so that policymakers need have less concern over interest rate implications of a monetary policy couched in terms of monetary aggregates.

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TABLE 1

Instrumental Variables Estimates of Shock-Absorber Demand for Money

COUNTRY	Coefficient of: Const.	y_t^P	R_t	m_{t-1}	y_t^T	$\hat{M}_t$	S.E.E.	$\bar{R}^2$	Durbin's h
United	-0.1572	0.0233	-0.4260	1.0036	0.1007	0.6330			
States	(0.1175)	(0.0066)	(0.0738)	(0.0274)	(0.0220)	(0.1559)	0.0042	0.9945	0.936
	-1.339	3.552	-5.774	36.668	4.578	4.060			
United	0.1668	0.0364	-0.5705	0.8828	0.2623	0.6903			
Kingdom	(0.1253)	(0.0236)	(0.1464)	(0.0552)	(0.1426)	(0.1647)	0.0152	0.9475	0.287
	1.331	1.544	-3.896	15.994	1.840	4.192			
Canada	-0.1297	0.1464	-0.4730	0.7826	0.0870	0.9133			
	(0.0493)	(0.0415)	(0.1483)	(0.0631)	(0.0805)	(0.1764)	0.0142	0.9932	-1.942
	-2.629	3.529	-3.191	12.413	1.081	5.178			
France	-0.1132	0.0413	-0.5511	0.9807	0.0360	0.7076			
	(0.0509)	(0.0239)	(0.0741)	(0.0199)	(0.0541)	(0.1733)	0.0106	0.9991	3.184
	-2.225	1.730	-7.438	49.260	0.665	4.083			
Germany	0.0233	0.0284	0.0466	0.9604	0.0027	1.1248			
	(0.0684)	(0.0305)	(0.0590)	(0.0269)	(0.0346)	(0.0963)	0.0086	0.9992	3.882
	0.340	0.932	0.790	35.751	0.079	11.678			
Italy	-0.0919	0.0384	-0.0954	0.9699	0.0469	1.1848			
	(0.2855)	(0.0509)	(0.1890)	(0.0269)	(0.0704)	(0.1351)	0.0130	0.9994	3.308
	-0.322	0.755	-0.505	36.068	0.665	8.770			
Japan	-0.2461	0.1583	-1.8704	0.8633	0.0275	0.9070			
	(0.1320)	(0.0428)	(0.4976)	(0.0348)	(0.0513)	(0.1407)	0.0148	0.9995	3.668
	-1.864	3.697	-3.759	24.844	0.536	6.452			
Netherlands	-0.0559	0.0625	0.0459	0.9349	-0.0772	0.7219			
	(0.0571)	(0.0457)	(0.1267)	(0.0472)	(0.0726)	(0.1664)	0.0153	0.9964	2.266
	-0.978	1.368	0.362	19.812	-1.064	4.339			

Note: Standard errors are given in parentheses below the estimated coefficients; t-values are below the standard errors. Estimates are for 1957I-1976II.

TABLE 2

OLS Estimates of Shock-Absorber Demand for Money

COUNTRY	Coefficient of								
	Const.	y^P_t	R_t	m_{t-1}	y^T_t	$\hat{M}_t$	S.E.E.	$\bar{R}^2$	Durbin's h
United States	-0.0629	0.0198	-0.3148	0.9894	0.0900	0.8028			
	(0.1052)	(0.0060)	(0.0565)	(0.0251)	(0.0200)	(0.0997)	0.0040	0.9948	0.199
	-0.598	3.325	-5.571	39.467	4.506	8.052			
United Kingdom	0.0353	0.0148	-0.4232	0.9713	0.0929	0.8541			
	(0.1184)	(0.0202)	(0.1258)	(0.0503)	(0.1245)	(0.1088)	0.0148	0.9502	0.280
	0.298	0.730	-3.363	19.316	0.746	7.848			
Canada	-0.1067	0.1240	-0.4245	0.8154	0.0818	0.9411			
	(0.0455)	(0.0385)	(0.1372)	(0.0595)	(0.0745)	(0.1282)	0.0141	0.9932	-2.296
	-2.346	3.219	-3.094	13.716	1.097	7.342			
France	-0.0945	0.0335	-0.5159	0.9861	0.0358	0.8392			
	(0.0478)	(0.0224)	(0.0677)	(0.0187)	(0.0480)	(0.1076)	0.0105	0.9992	3.014
	-1.976	1.496	-7.622	52.714	0.744	7.802			
Germany	0.0796	-0.0026	-0.0022	0.9896	-0.0029	1.0690			
	(0.0671)	(0.0302)	(0.0530)	(0.0266)	(0.0323)	(0.0716)	0.0085	0.9992	4.000
	1.185	-0.085	0.041	37.177	-0.090	14.939			
Italy	-0.1931	0.0556	-0.1162	0.9616	0.0534	1.0914			
	(0.2760)	(0.0494)	(0.1733)	(0.0262)	(0.0634)	(0.0950)	0.0129	0.9994	3.768
	-0.700	1.125	-0.670	36.680	0.843	11.485			
Japan	-0.0766	0.1017	-1.7576	0.9091	-0.0121	0.9233			
	(0.1303)	(0.0425)	(0.4836)	(0.0345)	(0.0494)	(0.1029)	0.0146	0.9995	3.448
	-0.588	2.395	-3.635	26.378	-0.244	8.971			
Netherlands	-0.0150	0.0303	0.0312	0.9664	-0.0409	0.9262			
	(0.0529)	(0.0430)	(0.1177)	(0.0448)	(0.0660)	(0.1162)	0.0150	0.9966	1.744
	-0.283	0.704	0.265	21.580	-0.619	7.974			

Note: Standard errors are given in parentheses below the estimated coefficients; t-values are below the standard errors. Estimates are for 1957I-1976II.

TABLE 3

GLS Estimates of Shock-Absorber Demand for Money

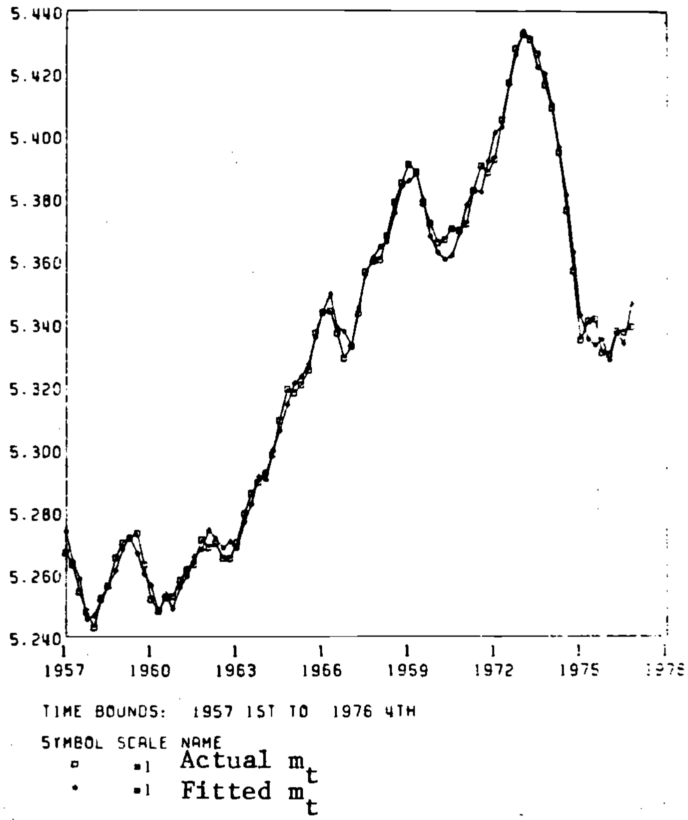
	Coefficient of											
	Const.	y_t^P	R_t	m_{t-1}	y_t^T	$\hat{M}_t$	Noise Model[2]	$\hat{\rho}_1$	$\hat{\rho}_2$	S.E.E.	$\bar{R}^2$	Durbin's h
United States	-0.0629	0.0198	-0.3148	0.9894	0.0900	0.8028						
	(0.1052)	(0.0060)	(0.0565)	(0.0251)	(0.0200)	(0.0997)	None	-	-	0.0040	0.9948	0.199
	-0.598	3.325	-5.571	39.467	4.506	8.052						
United Kingdom	0.0442	-0.0052	-0.2887	0.9959	0.0005	0.9306						
	(0.1160)	(0.0207)	(0.1153)	(0.0458)	(0.0959)	(0.0762)	MA(2)	0.0412	-0.6569	0.0121	0.9305	0.737
	0.381	-0.253	-2.504	21.761	0.005	12.212						
Canada	-0.0753	0.0785	-0.3996	0.8907	0.0182	0.9221						
	(0.0312)	(0.0264)	(0.0967)	(0.0405)	(0.0503)	(0.1205)	AR(2)	-0.3569	-0.1735	0.0135	0.9973	0.003
	-2.416	2.978	-4.133	21.977	0.361	7.653						
France	-0.0858	0.0316	-0.4896	0.9864	0.0175	0.7693						
	(0.0607)	(0.0281)	(0.0852)	(0.0236)	(0.0560)	(0.0873)	AR(2)	0.3910	-0.0773	0.0098	0.9985	-0.034
	-1.413	1.124	-5.746	48.823	0.312	8.809						
Germany	-0.0291	0.0540	0.0261	0.9381	0.0272	0.9564						
	(0.1125)	(0.0489)	(0.0720)	(0.0423)	(0.0518)	(0.0589)	AR(2)	0.4931	0.0791	0.0074	0.9971	-0.007
	-0.259	1.105	0.363	22.160	0.525	16.233						
Italy	-0.9615	0.1940	-0.0694	0.8880	0.1379	0.9456						
	(0.4937)	(0.0885)	(0.2181)	(0.0475)	(0.0690)	(0.0738)	AR(2)	0.4395	0.2529	0.0110	0.9961	-0.048
	-1.948	2.192	-0.318	18.688	1.998	12.808						
Japan	-0.2051	0.1534	-2.1340	0.8668	-0.0068	0.7585						
	(0.1844)	(0.0606)	(0.6857)	(0.0494)	(0.0683)	(0.0847)	MA(2)	-0.4147	-0.3555	0.0130	0.9989	0.321
	-1.112	2.533	-3.112	17.556	-0.101	8.955						
Netherlands	-0.0356	0.0523	0.0344	0.9428	-0.0470	0.9034						
	(0.0590)	(0.0481)	(0.1308)	(0.0501)	(0.0733)	(0.1086)	AR(2)	0.2164	-0.0812	0.0147	0.9956	0.014
	-0.603	1.087	0.263	18.815	-0.641	8.319						

Notes:

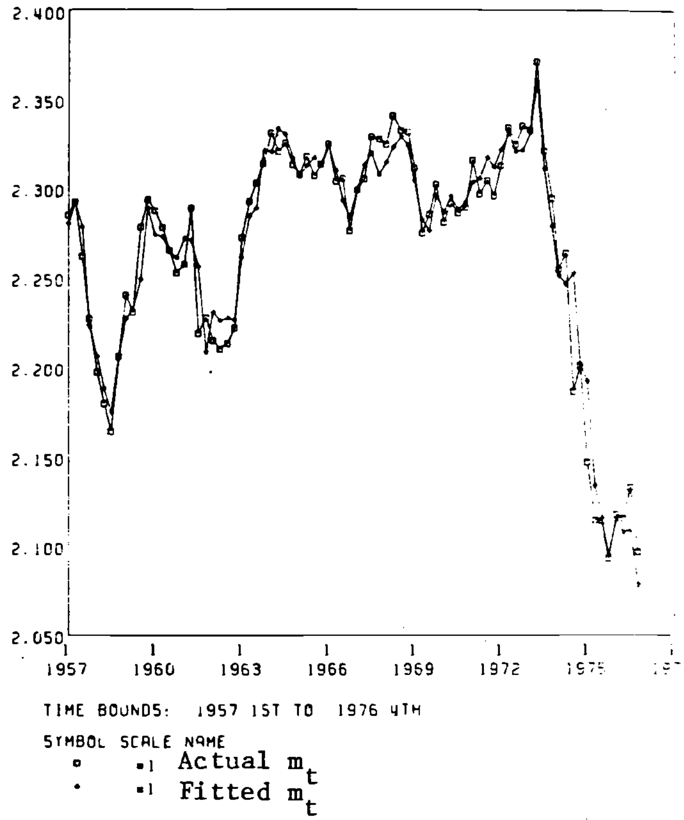
1. Standard errors are given in parentheses below the estimated coefficients; t-values are below the standard errors. Estimates are for 1957I-1976II.
2. This is the noise model which minimized the S.E.E. among the choices available in the TROLL system which are first and second order autoregressive, AR(1) and AR(2) respectively, and first and second order moving average, MA(1) and MA(2) respectively. Using e_t as the residual and ε_t as a white noise, an AR(2) is $e_t = \rho_1 e_{t-1} + \rho_2 e_{t-2} + \varepsilon_t$ and a MA(2) is $e_t = \varepsilon_t - \rho_1 \varepsilon_{t-1} - \rho_2 \varepsilon_{t-2}$.

FIGURE 1

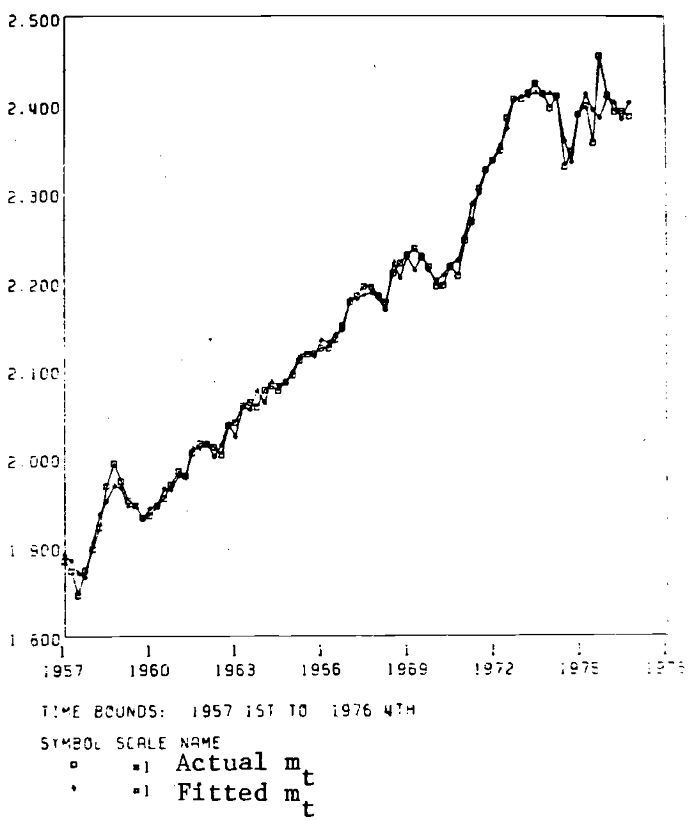
Comparison of Actual m_t with Fitted Values from Table 1 Regression



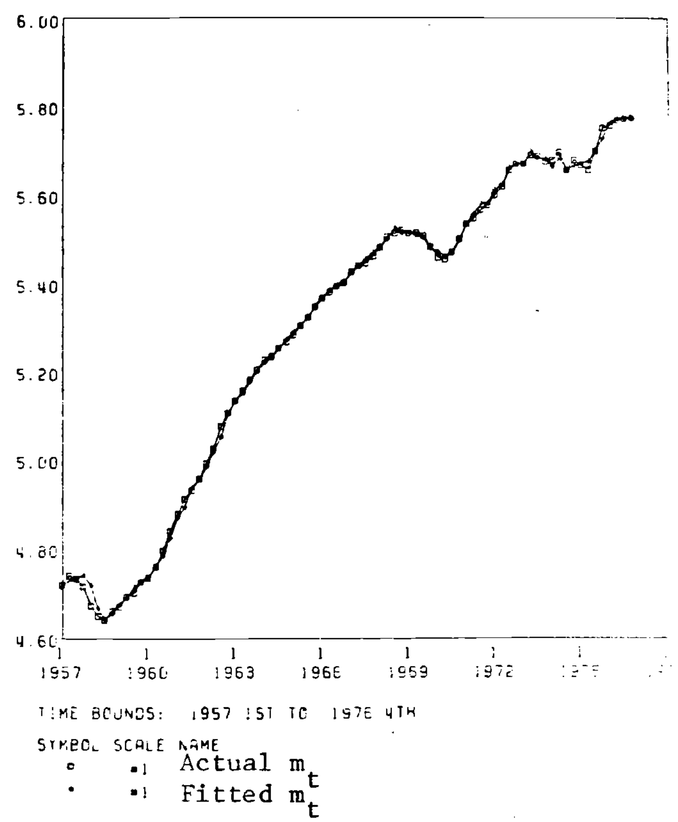
(a) United States



(b) United Kingdom

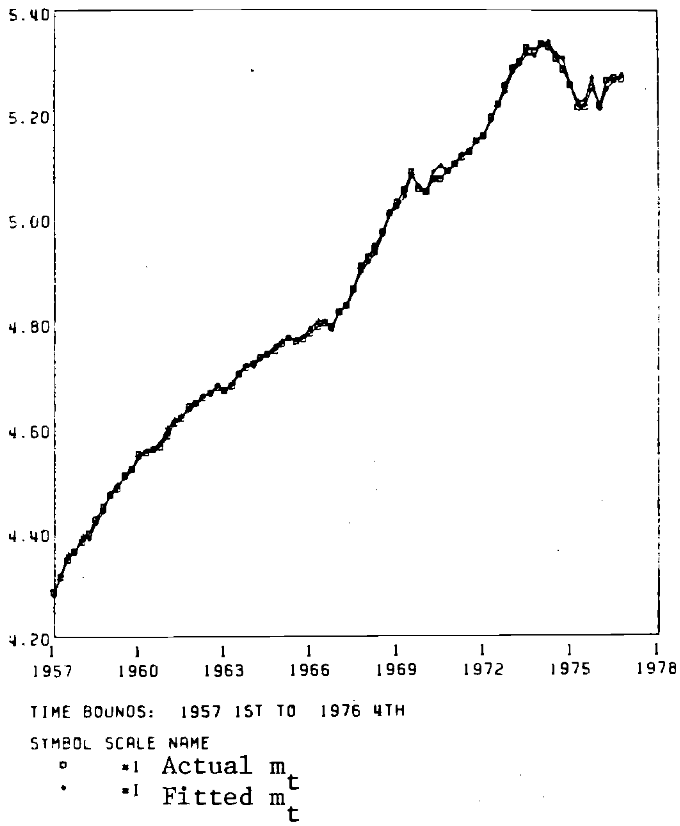


(c) Canada

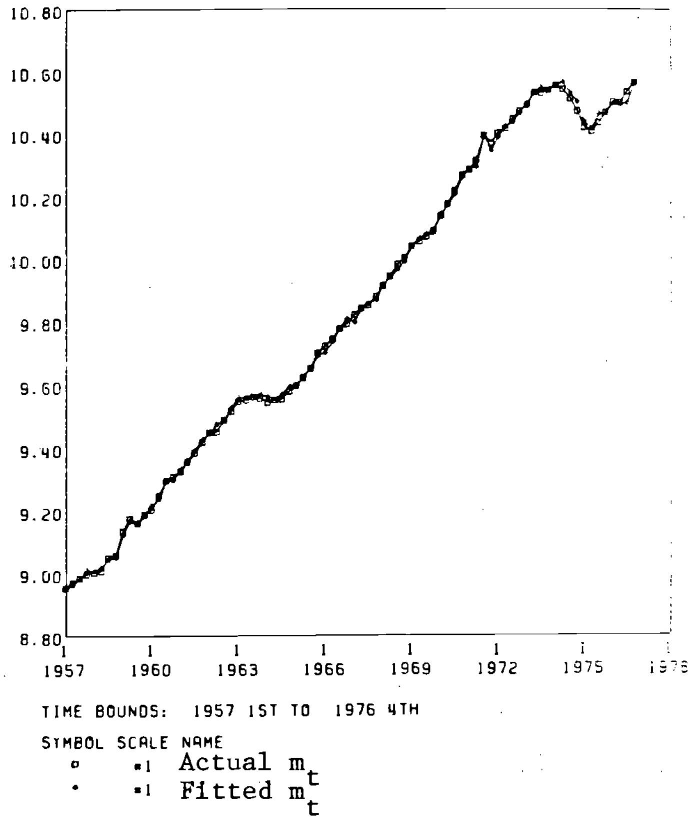


(d) France

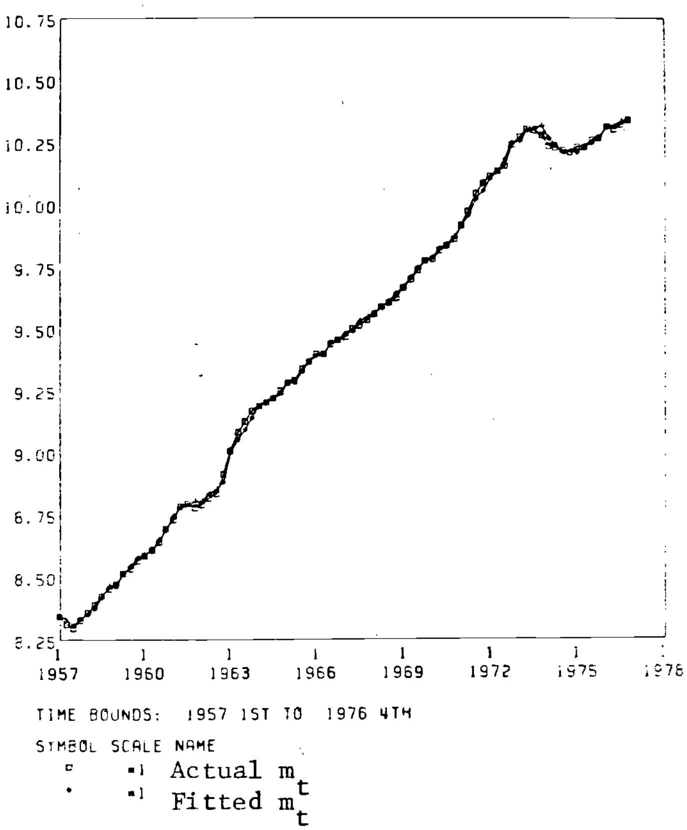
FIGURE 1 (Continued)



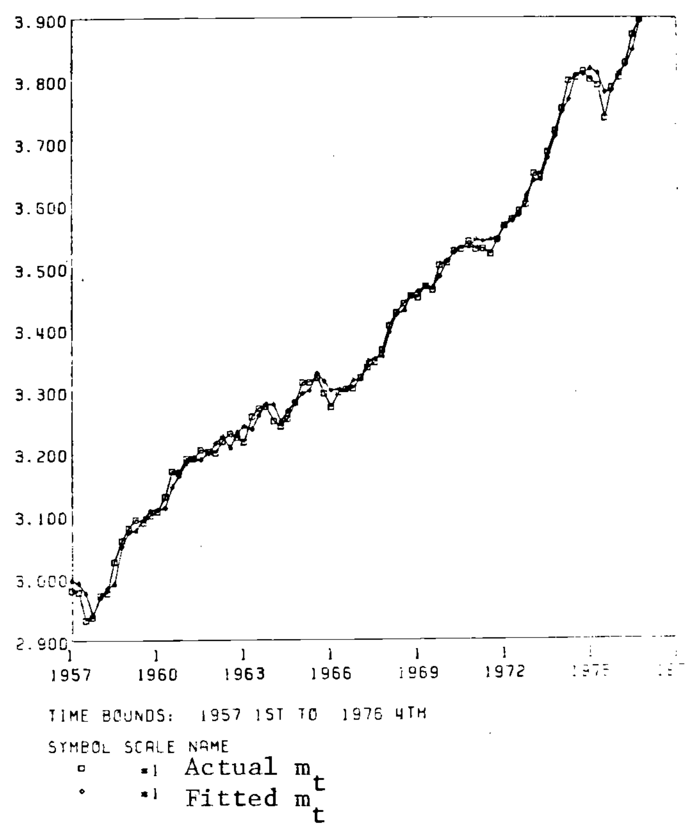
(e) Germany



(f) Italy



(g) Japan



(h) Netherlands

FOOTNOTES

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[1]An alternative explanation would attribute this phenomenon to money demand being a function of permanent income and permanent interest rates; see Feige (1967) and Laidler (1977, pp. 142-48). However lagged adjustment still appears to be present when permanent income is used as an income variable.

[2]There should also be a term for normal planned growth, but this is de facto captured in empirical estimates by the constant in the function explaining m_t^d.

[3]Most notably Lucas (1973), Sargent and Wallace (1975), and Barro (1977, 1978).

[4]We are abstracting here from possible effects on interest rates from changes in the expected growth rate of the nominal money supply. See Darby (1979, pp. 134-138, 207-213) for a discussion of real effects in the non-superneutral case.

[5]As early as 1967, Alan Walters observed that the aggregate nominal money supply was fixed by the central bank and that the Chow model could be interpreted as a model of price adjustment to nominal money supply changes.

Artis and Lewis (1976), Lewis (1978), and Jonson (1976) also considered money demand functions in the context of adjustment to changes in the aggregate nominal money supply. Quite understandably, these authors did not see the importance of distinguishing between expected money supply changes and money supply shocks.

[6]Barro's (1978) equation (9) indicates an impact effect of $\hat{M}_t$ on p_t of 0.26, but this is for annual data. Estimates of the first-quarter effect are much smaller.

[7]The estimated values of λ, α_1, and $\alpha_2 R_t$ do vary somewhat in the literature, but this is much less true for $\lambda\alpha_1$ and $\lambda\alpha_2 R_t$ on which the liquidity effect calculated below depends. For example, a high estimate of λ will be offset empirically by a low estimated $\alpha_2 R_t$.

[8]For the 8 countries in our sample (see Section III), the largest current quarter value of $\frac{dy_t}{d\hat{M}_t}$ was 0.33. Barro's value of 1.04 (1978, equation 3) was obtained for annual data which thus includes lagged as well as impact effects.

[9]See Cagan and Gandolfi (1969) and Gibson (1970) for estimates of the liquidity effect.

[10]Goldfeld (1973, p. 611) and (1976, pp. 691-692).

[11]Substitute $M_t^d \equiv m_t^d + P_t$ in (7) and differentiate to obtain

$$\frac{dM_t}{d\hat{M}_t} = \lambda\frac{dm_t^d}{d\hat{M}_t} + \lambda\frac{dP_t}{d\hat{M}_t}$$

Note that $\frac{dM_t}{d\hat{M}_t} = 1$ and equation (8) follows.

[12]Offsetting changes in the very short-run demand for non-money assets are implied.

[13]In Darby (1972), transitory income was measured as real dollars per annum rather than as a fraction of permanent income as here. The earlier measure was more natural for the shock-absorber effect but required a linear money demand function and iterative estimation techniques. The present version should serve nearly as well but the coefficients should be divided by the mean income velocity for comparison with the 1972 estimates.

[14]See for example Barro and Santomero's discussion (1972, p. 399) of the infrequency of change in service charge remission rates.

[15]See Theil (1971, pp. 549-550).

[16]See Darby and Stockman (1979).

[17]See Darby (1976) and Feige and Pearce (1976).

[18]These results are available from the authors on request.

[19]We may perhaps be forgiven for noting that our formulation won Laidler's race hands down.

[20]This amounts to a real interest rate of 10 percent per annum, compounded quarterly.

[21]But not necessarily in a multiple regression context.

[22]Barro (1978, pp. 568-571) relied instead on the transitory income aspect of the shock-absorber model to obtain consistent price level behavior. But we saw that this is relatively unimportant compared to the money shock effect.