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REAL MONEY BALANCES AND THE TIMING OF CONSUMPTION: AN EMPIRICAL INVESTIGATION

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Federal Reserve Bank of Dallas

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ABSTRACT

This paper examines the correlation between changes in consumer spending on non–durables and services, and levels or changes in a variety of other variables which might be expected to enter directly as arguments of the household utility function or to serve as measures of household liquidity. Empirical results strongly suggest that an increase in real money balances raises the marginal utility of consumption. Once the influence of real balances is accounted for, there is little evidence that other variables have a direct impact on the timing of consumption.

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I. INTRODUCTION

The standard version of the permanent income hypothesis—as developed, for example, by Hall [1978]—assumes that the marginal utility of consumption is a function of current consumption alone. Utility maximization and the rational expectations hypothesis then imply that anticipated changes in consumption are uncorrelated with all variables in households' current information sets. In this form the permanent income model has not fared particularly well in empirical tests. Hall himself, for example, found that lagged changes in stock prices help predict changes in consumption, while Mankiw [1981] and Nelson [1987] show that the percentage change in consumption is correlated with lagged growth in disposable income. Flavin [1981, 1985] and Campbell and Mankiw [1987], meanwhile, have argued that consumption is too sensitive to predictable fluctuations in contemporaneous income to be consistent with the permanent income model.[1]

A possible explanation for these negative results is specification error. In particular, it may be that variables other than consumption—typically measured by expenditures on non–durables and/or services—have an impact on its marginal utility. That is, the household utility function may be non–separable between consumption and some other variable. Three candidates for non–separability have already received attention in the literature. Thus Bernanke [1985] has examined the relationship between households' non–durables and services expenditures and their stocks of durable goods; Mankiw, Rotemberg, and Summers [1985] have looked for evidence of non–separability between consumption and leisure; and Aschauer [1985] has looked for non–separability between consumption and government purchases. Only Aschauer finds significant interactions.

Another candidate for non–separability—real money balances—is suggested by recent theoretical and empirical work on the demand for money.[2] The principal contribution of the current paper is to show that once the influence of real balances is taken into account, there is no compelling evidence that changes in consumption are correlated with anticipated or lagged changes in income, stock prices, or government purchases–or, indeed, with any of a wide variety of other variables which might be expected either to serve as measures of liquidity or to directly affect the marginal utility of consumption. Thus the available aggregate time–series evidence is consistent with the permanent income model, provided one is willing to accept a strong influence of real balances on the marginal utility of consumption.

Poterba and Rotemberg [1987] also estimate a model in which money enters the household utility function. They, however, are principally concerned with determining how the composition of asset demands responds to changes in yield–spreads rather than in estimating the strength and direction of the response of consumption to changes in real balances. Further, the parameter estimates which they report imply that increases in liquid assets have a *negative* effect on consumption. Estimates reported here, in contrast, suggest a strong *positive* effect. Possible reasons for this difference in results are discussed below.

Section II reviews the paper's methodology. Section III presents empirical results, and explores some refinements of the basic model. In Section IV the Euler equations for interest–bearing assets and money are estimated jointly. Section V concludes with a brief discussion of policy implications.

II. THE MODEL

A. Formulating the Model

A necessary condition for optimality of a household's consumption plan is that the household be indifferent between one unit of consumption at time t and $1+r(t)$ units of consumption at time $t+1$, where $r(t)$ is the real rate of interest. Formally,

$$V_X(t) = E_t\{\frac{(1+r(t))V_X(t+1)}{(1+\rho)}\}, \tag{1}$$

where $V_X(t)$ is the marginal utility of consumption, ρ is the rate of subjective time–preference, and $E_t(\cdot)$ is the household's expectation as of time t—assumed identical to the mathematical expectation conditional on information available at t.

As Mankiw [1981] has shown, equation (1) implies that, as an approximation,

$$(r(t)-\rho) + \log[V_X(t+1)] - \log[V_X(t)] = \epsilon(t+1) - \epsilon^2(t+1), \tag{1'}$$

where

$$\epsilon(t+1) \equiv [\frac{(1+r(t))}{(1+\rho)}][\frac{V_X(t+1)}{V_X(t)}] - E_t\{[\frac{(1+r(t))}{(1+\rho)}][\frac{V_X(t+1)}{V_X(t)}]\}$$

is white noise from the perspective of time t. If the marginal utility of consumption is log–linear in its arguments, (1′) is easily estimated.[3] Suppose, accordingly, that

$$V_X(t) = \mu(t)[X(t)^{-\alpha}][M(t)^{\beta}], \tag{2}$$

where $X(t)$ and $M(t)$ denote real consumption and real money balances, respectively, $E_t[\log(\mu(t+1))] = \log(\mu(t))+\mu_0$, and α and β are constants. Concavity requires that α be positive. Note that $V_{XM}(t) = \frac{\beta V_X(t)}{M(t)}$, which has the same sign as β. Mankiw and Nelson implicitly assume that utility is additively separable between consumption and other variables, so that, in their models, $\beta = 0$.

Substitute from (2) into equation (1′) to obtain

$$\Delta x(t) = (\mu_0 + \frac{1}{2}\sigma^2)/\alpha + (r(t) - \rho)/\alpha + (\beta/\alpha)\Delta m(t) + e(t+1), \tag{3}$$

where $\Delta x(t) \equiv \log(X(t+1)) - \log(X(t))$, $\Delta m(t) \equiv \log(M(t+1)) - \log(M(t))$,

$$e(t+1) \equiv \frac{1}{\alpha}\{\frac{1}{2}(\epsilon^2(t+1) - \sigma^2) - \epsilon(t+1) + [log(\mu(t+1)) - E_t[log(\mu(t+1))]]\}$$

and σ^2 denotes the variance of ϵ.

If households make full use of available information, then $e(t+1)$ will be white noise from the perspective of time t, and consistent estimation of equation (3) can be accomplished using a linear instrumental variables regression routine. Any variable in the information set of households at time t will be uncorrelated with $e(t+1)$, and hence serve as a legitimate instrument.[4]

B. Testing the Model

As noted in Section I, it has been suggested that the rate at which households purchase non–durables and services—their consumption—is influenced by the level of real money balances per household. According to traditional Keynesian theory, in contrast, it is changes in disposable income which principally determine the timing of consumption expenditures. Alternatively, perhaps households find it costly to vary their rates of consumption, as suggested by Hall. If the Keynesian model is correct, anticipated changes in consumption ought to be correlated with anticipated changes in income. If Hall is correct, lagged changes in income, stock prices, or consumption ought to help predict future changes in consumption. Similarly, if variables such as hours of employment, the stock of consumer durables, or government purchases affect the marginal utility derived from private consumption–spending, anticipated changes in one or more of these variables ought to be correlated with anticipated changes in consumption. To determine whether lagged or anticipated changes in variables other than real money balances have an impact on the timing of consumption, it is necessary only to add these changes to the right–hand–side of equation (3), estimate the modified equation, and conduct the usual significance tests.

Changes in consumption will be correlated with predictable changes in disposable income—as in Keynesian theory—if some constant fraction of the population is "liquidity constrained" in every period, and so finds it consumption limited by current income [Flavin, 1985; Campbell and Mankiw, 1987]. Suppose instead that the fraction of households facing binding liquidity constraints varies over time. Since for liquidity–constrained households equation (1) is replaced by an inequality, with $V_X(t)$ greater than $E_t\{\frac{(1+r(t))V_X(t+1)}{(1+\rho)}\}$, in periods in which a relatively large number of households are constrained, equation (3) will underpredict the rate of change of consumption. Empirically, one would then see variables correlated with the incidence of liquidity constraints—perhaps the delinquency rate on consumer loans, or the household debt/income ratio—enter with significant, positive coefficients when added to the right–hand–side of equation (3).

III. EMPIRICAL RESULTS

In Part A of this section, I examine whether or not, apart from the influence of the real rate of interest, consumption follows a random walk. As in previous studies, both lagged changes in disposable income and lagged changes in stock prices are found to be helpful in predicting changes in consumption. Lagged changes in the stock of consumer durables and in real money balances are also correlated with changes in consumption, as are lagged changes in consumption itself. When current real balances are included in the household utility function however, the influence of each of these lagged variables disappears. That is, each lagged variable is helpful in predicting changes in consumption only insofar as it is correlated with the current change in real balances.

Next I examine whether or not changes in consumption are correlated with predictable, *contemporaneous* change in any variables other than real money balances. Current changes in a number of variables are introduced on the right–hand–side of equation (3), which is then estimated using instrumental variables. None of the coefficients corresponding to the added variables are statistically significant as long as real balances are also included in the equation.

Finally, in Part C, I examine several possible refinements of the model, looking first at alternative measures of liquid assets, then at alternative measures of the real rate of interest. There is found to be little evidence that assets other than cash and checkable deposits offer liquidity services over an interval as short as one quarter. One's choice of a measure of the real interest rate, meanwhile, has little impact on the parameter estimates one obtains.

A. Does Consumption Follow a Random Walk?

Table I reports results obtained when quarter–to–quarter changes in the logarithm of consumption are regressed on a constant, the real rate of interest (here measured by the inflation–adjusted, after–tax return on 3–month Treasury Bills), and lagged quarter–to–quarter changes in the logarithms of each of a number of other variables: consumption, money balances, the stock of consumer durables, government defense purchases, government non–defense purchases, hours of work, disposable income, and stock prices.[5] According to the simplest version of the life cycle–permanent income model, only the ex–ante real interest rate ought to have a significant impact on the timing of consumption. In fact though, consistent with results reported by Hall [1978], the lagged change in stock prices has a highly significant coefficient. Consistent with results reported by Mankiw [1981] and Nelson [1987], the coefficient of the lagged change in disposable income is also significant. The same is true of the coefficients of lagged changes in money balances, consumption, and consumer durables.

The results reported in Table I cast substantial doubt on the ability of the simple life cycle–permanent income model to explain the timing of consumption. As a first test of whether or not these negative results are due to specification error—in particular, the failure to include real money balances as a non-separable argument of the household utility function—equation (3) was estimated in unmodified form, then re–estimated with those variables which were significant in Table I added, one at a time, to its right–hand–side.[6] Results are given in Table II.

The evidence in Table II strongly suggests that consumption–spending is concentrated in periods during which real money balances are high. Further, the influence of lagged changes in other variables, such as stock prices and disposable income, disappears once the impact of real balances is accounted for. Thus each lagged variable has a statistically insignificant coefficient when included on the right–hand–side of equation (3). The coefficient of the current change in real balances is, in contrast, uniformly significant, with an estimated value which changes little from regression to regression.

B. Do Variables Other than Real Balances Have an Impact on the Timing of Consumption?

The results reported in Part A do not rule out the possibility that predictable change in the *current* value of some variable other than real balances might have a significant impact on consumption. It might be, for example, as Aschauer [1985] argues, that the current change in government purchases belongs on the right–hand–side of equation (3) rather than, or in addition to, the current change in real balances. Accordingly, equation (3) was re–estimated with current changes in consumer durables, government defense purchases, government non–defense purchases, hours of work, disposable income, and stock prices added, in turn, as right–hand–side variables.

According to Table III, regardless of which variable is added to the right–hand–side of equation (3), the corresponding estimated coefficient is statistically insignificant. The coefficient of the current change in real money balances is, in contrast, uniformly significant, with a value that varies little from regression to regression.

There is a possibility that time–aggregation is given rise to biased coefficient estimates in Table III. Suppose, for example, that real money balances follow a random walk and that an increase in real balances results in an immediate, permanent increase in the rate of consumption.[7] Then an increase in real balances which occurs in, say, May, will tend to raise third–quarter average consumption by more than it raises second–quarter consumption. Quarter–to–quarter changes in average consumption will thus appear to be serially correlated, as will quarter–to–quarter changes in average real balances. Furthermore, one–quarter lagged increases in average real balances will be correlated with changes in average consumption. So changes in real balances will appear to predict future changes in both real balances and consumption.

Mankiw, Rotemberg, and Summers [1985], and Mankiw [1985], have suggested that the time–aggregation problem be circumvented by using non–adjacent data points. Accordingly Table IV presents results based on regressions using only data from the first month of each quarter.[8]

There is little difference between the parameter estimates reported in Tables III and IV. In Table IV, as in Table III, the coefficient of real balances is largely unaffected when variables are added to the right–hand–side of equation (3). Further, the additional variables invariably fail to have statistically significant coefficients. The coefficient of the change in real balances is sometimes also insignificant, but in each such case its t–statistic is comparatively large.[9]

Time–aggregation bias can also be eliminated by lagging the variables in the set of instruments by two or more periods.[10] This yields the results reported in Table V. In every case the coefficient of the change in real balances is statistically significant, while that of the additional variable is not.[11]

Consider, finally, Table VI, which reports results obtained when variables which might reasonably be expected to be correlated with the incidence of binding, current–period liquidity constraints are added to the right–hand–side of equation (3). According to the table, neither the ratio of consumer installment debt to disposable income, nor the fraction of consumer installment debt more than 30 days delinquent has any significant influence on the timing of consumption. This is true regardless of whether instruments are lagged one period or two.

In summary, once one allows for non–separability between real balances and consumption in the household utility function, there is no compelling evidence that any variable other than real balances has any important effect on the timing of consumption.

C. Refinements of the Basic Model

In the regression results reported thus far, money balances have been measured by total real M1 (currency plus checkable deposits) per adult. It is natural to wonder whether some other measure of real balances might not do a better job of explaining the timing of household consumption expenditures. Table VII reports results obtained when changes in each of several other measures of liquid assets were added, one at a time, to the right–hand–side of equation (3). To avoid time–aggregation bias, all regressions were undertaken using instruments lagged two or more quarters.[12]

According to the table, neither those components of the monetary aggregate M2 which are excluded from M1 (i.e., time, savings, and money market deposits), nor those components of the monetary aggregate L which are excluded from M1 (short–term bonds, plus those components of M2 excluded from M1) provide significant help in explaining quarter–to–quarter movements in consumption expenditures, once the influence of M1 is taken into account. Nor are predictable variations in the Federal Reserve's estimate of the household component of M1 more highly correlated with changes in consumption than are variations in total M1 balances. The latter result is presumably due to the fact that the Federal Reserve's estimate of household money balances contains a large, serially correlated measurement error.[13]

The real rate of interest which appears in equations (1) and (3) ought, in principle, to be the return on that asset with the highest ex–ante one–period yield. Assets with lower ex–ante yields would then be held only insofar as they provide liquidity services—i.e., only insofar as they serve as a within–period buffer between receipts and expenditures. In the real world the appropriate choice of asset yield is far from clear–cut, for the yield on an asset, *net of transaction costs*, may depend both on the amount of the asset purchased and the length of the interval over which the asset is held. Thus an investment in stocks or in real estate might be appropriate in saving for a young child's college education, whereas the money I had planned to spend at a restaurant tonight might, in the event that the dinner must be postponed for a month, quite rationally sit in my checking or savings account.

In practice the real after–tax return on Treasury Bills has been used most often as a measure of r(t). This convention has been followed in the regressions reported thus far. Some studies use stock returns, however, in constructing a measure of the real interest rate, while others suggest use of the time–deposit rate.[14] Table VIII, accordingly, presents a comparison of estimates of equation (3) based on the three different proposed measures of r(t).[15] Results vary little from regression to regression. In every case the estimated value of the coefficient of the change in real balances is about one-third, and statistically significant. The estimated impact of the real interest rate on the timing of consumption is invariably small—indistinguishable from zero at conventional significance levels.[16] The J–statistics, which measure the ability of the instruments to "explain" the residuals from the instrumental variable regressions, are all well below their 95 percent critical values. This indicates that the instruments help predict changes in consumption only through their correlation with real balances and the real interest rate (however measured).

IV. THE DEMAND FOR MONEY AND THE TIMING OF CONSUMPTION

The principal focus of this paper is on the timing of household consumption, and how that timing is influenced by changes in real money balances. Households, however, must decide not only when to consume, but also how they will divide their wealth between money and interest–bearing assets. The two decisions are closely interrelated, so that by looking at the demand for money, some insight is gained into how households allocate consumption across time.

In Part A, a household utility function more general than that underlying equations (2) and (3) of Section II is presented. The money–demand equation implied by this utility function is estimated in Part B. Results suggest a tight linkage between consumption and real money balances. Joint estimation of the money–demand and consumption–timing equations is undertaken in Part C. Here results differ somewhat depending upon the interest rate employed. Using either the rate of return on three–month Treasury Bills or on stocks, the relationship between real balances and consumption appears to be completely rigid: the timing of consumption is uninfluenced by the real interest rate, and the demand for money is uninfluenced by the nominal interest rate. Using the time–deposit rate, the linkage between consumption and money is weaker, but still positive. Finally, Section D contains comments on the differences between the model developed here, and that estimated by Poterba and Rotemberg.

A. The Utility Function

Optimality requires not only that the marginal rate of substitution between current and future consumption equal unity plus the real rate of interest (c.f. eq. (1)), but also that the marginal rate of substitution between real balances and consumption equal the after–tax nominal interest rate:

$$\frac{V_M(t)}{V_X(t)} = R(t). \tag{4}$$

In principle, joint estimation of equations (1) and (4) ought to yield more accurate and complete estimates of the parameters of the household utility function than estimation of either equation alone. This presumes, of course, that the functional form of the utility function is properly specified to begin with. The simplest utility function consistent with equation (3) is:

$$V(X, M) = [\frac{\mu}{(1-\alpha)}][X^{1-\alpha}][M^{\beta}]. \tag{5}$$

This is essentially the utility function adopted by Poterba and Rotemberg [1987], though their measure of liquid assets is broader than that used here. In the present context, serious problems with specification (5) are readily apparent. First, the estimates of equation (3) obtained in Section III often imply values for α and β which are inconsistent with concavity of the function $V(\cdot,\cdot)$ as specified in (5). In Table V, for example, the estimated value of α is usually negative. In Table VIII, the implied value of β is much greater than unity. Further, a log-linear utility function yields a unit-elastic money demand schedule—a result grossly inconsistent with empirical evidence.

Obviously, a log-linear specification of the utility function is too restrictive. Accordingly, suppose that the utility function of the representative household takes the form:

$$V(X,M) = U(C(X,M)) \equiv [\frac{\gamma\theta}{(\gamma-1)}][(C^{\frac{\gamma-1}{\gamma}}) - 1], \tag{6}$$

where

$$\begin{aligned} C(X,M) &\equiv [(1-\theta_m)X^{\frac{-1}{\delta}} + \theta_m(M^{\nu})^{\frac{-1}{\delta}}]^{-\delta} \\ &= \frac{X}{[(1-\theta_m)+\theta_m(\frac{X}{M^{\nu}})^{\frac{1}{\delta}}]^{\delta}}, \end{aligned} \tag{7}$$

where γ, δ, and ν are parameters, and where θ and θ_m are random disturbances, with $\theta > 0$ and $0 < \theta_m < 1$. One may think of C and X as consumption net of and gross of transactions costs, respectively [Feenstra, 1986]. People care directly only about their net consumption, but net consumption is an increasing function of gross consumption expenditures and real money balances.[17] There is a constant elasticity of substitution (γ) between net consumption at different dates. Variation in θ reflects shocks to household tastes between current and future consumption, while variation in θ_m reflects shocks to the transactions technology—shocks which change the utility value of money relative to that of consumption expenditures.

The function $U(\cdot)$ is concave in net consumption if and only if γ is greater than zero. For $V(\cdot,\cdot)$ to be concave it is enough that γ and ν both be greater than zero, with $\nu(\frac{\gamma-1}{\gamma}) < 1$. An increase in real balances will have a positive impact on the marginal utility of consumption spending ($V_{XM} > 0$) if and only if $\nu(\frac{\gamma-1}{\gamma} + \frac{1}{\delta}) > 0$.

B. The Demand for Money

From equations (4), (6), and (7), one can derive a log-linear relationship between consumption, real money balances, and the nominal interest rate. Taking first-differences, one has:

$$\Delta x(t) = (\frac{\delta}{1+\delta})[\Delta\log(R(t)) + (\frac{\delta+\nu}{\delta})\Delta m(t) - \Delta\log(\mu_m(t))], \tag{8}$$

where $\mu_m \equiv \frac{\theta_m}{(1-\theta_m)}$. Table IX presents estimates of equation (8), under the assumption that $\log(\mu_m)$ follows a random walk with drift: $E_t[\log(\mu_m(t+1))] = \log(\mu_m(t)) + \mu_{m0}$.[18] The drift parameter, μ_{m0}, is allowed to jump in the first quarter of 1980, reflecting the rapid financial innovation which began at about that time.

The results are generally encouraging. The Durbin–Watson statistics show little evidence of serial correlation, while the J–statistics are well below their 95 percent critical value.

The estimated values of δ and ν imply an interest–elasticity of the demand for money, $\frac{-\delta}{(\delta+\nu)}$, which is essentially zero when the interest rate is measured by the return available either on stocks or 3–month Treasury Bills, and not significantly different from zero when the interest rate is measured by the return available on time deposits.[19] The estimated consumption–elasticity of the demand for money, $\frac{(1+\delta)}{(1+\nu)}$, is clearly greater than unity, with a point estimate ranging from 2.6 to 2.8.[20] Thus household indifference curves between money and consumption expenditure are found to be nearly L–shaped, with an income–expansion path that becomes flatter as one moves away from the origin. The financial innovations of the early 1980's (perhaps the spread of interest–bearing checking accounts?) appear to have resulted in an increase in the growth rate of the demand for money.

C. Simultaneous Estimation

Using equations (4), (6), and (7), one can show that

$$\begin{aligned}\Delta\log(V_X(t)) &= \Delta\log(\mu(t)) - (\frac{1}{\gamma})\Delta x(t) \\ &\quad - (1+\delta-\frac{\delta}{\gamma})\Delta\log[1+(\frac{1}{\nu})\frac{R(t)M(t)}{X(t)}],\end{aligned} \tag{9}$$

where $\log(\mu) \equiv \log(\theta) - \delta(\frac{\gamma-1}{\gamma})\log(1-\theta_m)$. Substitute into equation (1′) to obtain

$$\begin{aligned}\Delta x(t) &= \gamma r(t) - (\gamma(1+\delta)-\delta)\Delta\log[1+(\frac{1}{\nu})\frac{R(t)M(t)}{X(t)}] \\ &\quad + \gamma(\mu_0 + \frac{\sigma^2}{2} - \rho) + e(t+1),\end{aligned} \tag{10}$$

where μ_0, σ, and $e(t+1)$ are defined as in Section II, with γ taking the place of $\frac{1}{\alpha}$ in the definition of $e(t+1)$.

Simultaneous estimation of equations (8) and (10) yields the parameter estimates reported in Table X.[21] Results differ somewhat depending on the measure of the interest rate employed. In the regressions involving the rate of return either on stocks or on 3–month Treasury Bills, the estimated value of δ is very close to zero, suggesting right–angle indifference curves between money and consumption expenditure. This is consistent with the results reported in Table IX. With $\delta = 0$, the consumption–elasticity of the demand for money is $\frac{1}{\nu}$, which is estimated to be 6.788 (with standard error 2.539) using the 3-month T-Bill rate, and 3.00 (with standard error .670) using the rate of return on stocks. The latter number, at least, is reasonably close to the corresponding estimate in Table IX. The estimated value of γ, the elasticity of intertemporal substitution between net consumption in adjacent quarters, is very small: between .02 and .045.

Using the rate of return on time-deposits, one obtains notably larger point estimates of the parameters γ and δ than with the other interest rate measures. The implied interest and consumption elasticities of demand for money are -.353 (s.e., .134) and 3.871 (s.e., 1.018) respectively, somewhat higher than the estimates reported in Table IX. The relationship between consumption expenditure and real balances is thus not completely rigid. It is, nevertheless, positive: the value of $\nu(\frac{\gamma-1}{\gamma} + \frac{1}{\delta})$, which determines the sign of V_{XM}, is 1.340 (s.e., .957).

In each of the regressions in Table X, the sufficient conditions for concavity of the utility function are satisfied: γ, ν, and $1-\nu+\frac{\nu}{\gamma}$ are invariably positive. The J-statistics for those regressions based on the rates of return on time-deposits and on stocks fall well below their 95 percent critical values. The J-statistics for the regressions based on the 3-month T-Bill rate lie between their 95 and 99 percent critical values. On the whole then, the data are not inconsistent with the model. This is surprising, given the level of aggregation.

D. Relationship to Poterba and Rotemberg's Work

Recall that Poterba and Rotemberg [1987] have also estimated a model in which a measure of liquid assets is assumed to enter the household utility function, and that their estimates imply a *negative* relationship between consumption and liquid assets. The model developed here differs from that of Poterba and Rotemberg in two obvious respects: in the measure of liquid assets employed, and in exact manner in which that measure is assumed to enter the household utility function. On the first point, Poterba and Rotemberg measure liquidity as a CES function of cash and checkable deposits, time and savings account balances, and holdings of short-term government debt. Here preliminary estimates using a log-linear approximation to the marginal utility of consumption suggested no significant liquidity role for the latter two assets (c.f. the results in Table VII), and so they were excluded from subsequent analysis.[22] On the second point, Poterba and Rotemberg assume a Cobb-Douglas relationship between consumption expenditures and liquidity. Here a modified CES form was adopted, including the Cobb-Douglas relationship of Poterba and Rotemberg as a limiting case. Estimates of the critical parameter, δ, of this CES relationship were found to be much closer to their fixed-coefficients value, zero, than to their limiting Cobb-Douglas value, plus infinity, suggesting that the Poterba and Rotemberg utility function is misspecified.

A third difference between the models may also help explain the contrasting results obtained. The model developed here, unlike that estimated by Poterba and Rotemberg, allows for two types of "drift" in household preferences: a tendency for consumption to become more or less valued through time (depending upon the sign of $\mu_0 = E_t[\Delta \log(\mu(t))]$), and a tendency for valuation placed on money relative to consumption to rise or fall through time (depending upon the sign of $\mu_{m0} = E_t[\Delta \log(\mu_m(t))]$). Their failure to allow for the first type of drift probably accounts for the negative estimate of the rate of household time preference which Poterba and Rotemberg obtain [Poterba and Rotemberg, 1987, pp. 230–1]. More importantly, since the consumption–velocity of money and the nominal interest rate exhibit a common upward trend over the sample period, Poterba and Rotemberg's failure to make provision for drift in the valuation of liquid assets relative to consumption may lead them to assign a larger role to the interest rate in determining the demand for liquid assets than is, in fact, warranted.

V. CONCLUSION

The empirical results presented here support the notion that households tend to concentrate their consumption–spending in intervals during which holdings of liquid assets are large. As a practical matter, this liquidity effect can be adequately modeled by including real money balances as a non–separable argument of the household utility function. In this context, increases in real balances raise the marginal utility of consumption.

The effect of changes in real balances on consumption is quite strong: a ten percent increase in real balances results in about a three percent increase in spending on non–durables and services. Further, there is no compelling evidence that, apart from the real interest rate, any variables other than real balances have an impact on the timing of consumption. There is, in particular, no compelling evidence that predictable changes in either income or government purchases are correlated with changes in consumption, once the influence of real balances and the real interest rate are taken into account.

The importance assigned to interest rates in mediating the linkage between consumption and money varies depending upon the measure of the interest rate employed. Using the rate of return on 3–month Treasury Bills or on stocks, changes in nominal rates have a negligible impact on the demand for money, and changes in the real interest rate have little effect on the timing of consumption, given the path of real balances. When the interest rate is measured by the rate of return on time–deposits, however, significant elasticities of money–demand and intertemporal substitution are discernable.

An important implication of these empirical results is that anticipated changes in monetary policy can be expected to have real effects even in the absence of Keynesian wage–price stickiness. A high nominal interest rate, for example, will tend to act as a tax on consumption, and so reduce the supply of labor

[Wilson, 1979]. Similarly, investment will tend to be greatest in periods during which the nominal interest rate is thought to be high in relation to its own moving average [Koenig, 1987a, 1988].

APPENDIX: THE DATA

Unless otherwise noted, all raw data were seasonally adjusted versions of series in the Citibase economic data bank. Transformations were as follows:

Consumption: .25*(GCS82+GCN82)*1000000/P016, where GCS82 and GCN82 are constant–dollar household expenditures on services and non–durables, respectively, and where P016 is the Citibase series for the population age 16+.

Real Money Balances: FM1*1000000/(P016*P), where FM1 is nominal M1 and P = (GCN + GCS)/(GCN82 + GCS82) is a price index for non–durables and services, obtained by dividing nominal expenditures on non–durables and services by constant–dollar expenditures on non–durables and services. Series for real M2, real L and real household M1 were constructed similarly, with FM2, FML, and unpublished Federal Reserve Flow of Funds estimates of household currency and checkable deposits taking the place of FM1. The series FMS was used in place of FM1 over that period (prior to 1959) when FM1 is unavailable. (FMS was multiplied by a constant to eliminate any discontinuity in 1959:I.)

Durable Goods: Average of beginning and end–of–quarter values, except in Table IV, where only beginning–of–quarter figures were used. Constructed from a beginning–of–sample benchmark for the stock of consumer durables, a series for real, gross investment in consumer durables, and an assumed depreciation rate of .0506 per quarter. The benchmark was obtained by dividing beginning–of–sample aggregate durables [Musgrave, 1979] by beginning–of–sample population age 16+. The gross investment series was GCD82*1000000/P016, where GCD82 is constant–dollar spending on consumer durables. The depreciation rate is from Bernanke [1985].

Government Defense Purchases: Constant–dollar defense purchases, GGFEN8. Not divided by population on the grounds that national defense is, as a first approximation, a public good.

Government Non–Defense Purchases: (GGE82–GGFEN8)*1000000/P016, where GGE82 is constant–dollar government purchases, and GGFEN8 is defined as above.

Hours of Work: LHOURS*1000/P016, where LHOURS measures man–hours worked by the employed labor force.

Disposable Income: GYD82*1000000/P016, where GYD82 is constant–dollar disposable income.

Stock Prices: FSPCOM*1000000/(P016*P), where FSPCOM is the Citibase series for the Standard and Poors Common stock price index.

Debt/Income Ratio: CCBPY, ratio of consumer installment credit to disposable income.

Delinquency Rate: CCI30M, delinquency rate on consumer installment loans.

Nominal Interest Rate: The basic measure of the quarterly, after–tax nominal interest rate was FYGN3* .01* (1–Tax)/4, where FYGN3 is the rate of return on 3–month Treasury Bills, and where Tax is the average marginal income tax rate from Barro and Sahasakul [1985]. (The Barro and Sahasakul series ends in 1982. I assume that the tax rate in subsequent years remained constant at its 1982 value.) Similarly the return on stocks was defined as (1-Tax)*(FSDXP*.01/4 + (FSPCOM (t+1)-FSPCOM(t))/FSPCOM(t)), where FSDXP is the annual dividend yield on the Standard and Poors 500 common stocks. The return on time–deposits was defined as RMS& L*.01*(1-Tax)/4 from 1956:I through 1970:IV, where RMS&L is the annual rate of return on time–deposits (of all maturities) at savings institutions, obtained from the DRI data bank. After 1970:IV, RMS&L was replaced by the ceiling rate on 90–day notice accounts at savings institutions, as published in various issues of the *Savings and Loan Fact Book* [U.S. League of Savings Associations].

Real Interest Rate: $(1 + R)/(1 + \pi) - 1$ where R is one of the measures of the after–tax nominal interest rate defined above, and where $\pi = ((P(t + 1)/P(t)) - 1$ is the quarterly rate of inflation.

Dummy: Zero prior to 1980:I, unity thereafter. The precise date of the jump within 1980 is unimportant in estimating equation (3). An additional dummy variable, taking the value of unity at the start of 1983—corresponding to the abandonment, by the Federal Reserve, of its new operating procedures—was insignificant. Interest–bearing checking accounts were made legal in Massachusetts and New Hampshire in January, 1974; over all New England in February, 1976; in New York in November, 1978; New Jersey, in December, 1979; and in the rest of the United States in December, 1980.

The starting date of the basic sample period (1951:II) was dictated by a desire to avoid the beginning of the Korean War, when fear that rationing would be imposed led to an unusual spurt in consumption [U.S. President, 1951, p. 37]. Estimations were performed using TSP for the PC, version 4.0.

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NOTES

1. See also Hayashi [1982] and Hall and Mishkin [1982]. Nelson [1987] criticizes Falvin's econometric methodology.

2. The standard theoretical reference is Sidrauski [1967]. See also Feenstra [1986] and, for empirical evidence, Mankiw and Summers [1986].

3. The empirical results obtained from estimation of a linear model are very similar, qualitatively, to those obtained from estimation of the log–linear model developed here [Koenig, 1987b]. Nelson [1987] argues that linear models of the marginal utility of consumption are probably misspecified. In Section IV, below, the log–linearity assumption is relaxed.

4. However, as Campbell and Mankiw [1987] emphasize, one must be careful not to over–instrument. Unfortunately, there is no well–established rule governing the maximum acceptable number of instruments. In the regressions reported below, in Section III, I generally use about two instruments per right–hand–side variable. Thus the number of right–hand–side variables ranges from two to four, while the number of instruments (excluding constant) always lies between five and eight. The number of observations in the standard sample period (1951:II - 1986:I), is 140.

5. See the appendix for a detailed description of the data.

6. A dummy variable, taking the value of unity beginning in the first quarter of 1980, was also included on the right–hand–side of equation (3). This dummy is meant to capture, in an admittedly crude way, the increased pace of financial innovation which began at about this time. Evidence for such a shift is reported in Rasche [1987] and Friedman [1988]. As Feenstra's analysis demonstrates [Feenstra, 1986], any change in the transactions technology is equivalent to a shift in the indirect utility function relating consumption expenditures and real balances.

7. The latter supposition might make sense even if money and consumption are additively separable in the utility function. One would expect consumption to respond to contemporaneous changes in money if, for example, households perceive real money balances (or, at least, their outside–money component) to be wealth.

8. Monthly data for government defense and non–defense purchases was unavailable.

9. When the expected real interest rate is treated as a constant, rather than allowed to vary, the coefficient of the change in real balances is statistically significant in every case but one: that being when the change in stock prices is included as a right–hand–side variable. Even in this case, the t–statistic attached to the coefficient of the change in real balances is much larger than that attached to the corresponding coefficient for the change in stock prices (1.20 for real balances as against .441 for stock prices).

10. The use of twice–lagged instruments is also appropriate in estimating equation (3) if $\log(\mu(t))$ is a constant plus white noise rather than a random walk with drift. Measurement error provides another justification [Mankiw, Rotemberg, and Summers, 1985; Hall, 1988].

11. In many of the regressions reported in Table V, the estimated elasticity of intertemporal substitution ($\hat{d}$) is negative (though not significantly so). Similar results are reported by Hall [1988]. Setting the elasticity of intertemporal substitution equal to zero in these regressions has almost no effect on the estimated value ($\hat{e}$) of the coefficient of the change in real balances. The t–statistic for the change in real balances invariably rises (sometimes markedly). In the constrained regressions it remains true that no variable other than real balances has a significant impact on the timing of consumption.

12. Sample periods vary, depending upon the availability of data.

13. Household money balances are obtained as a residual, after the balances of businesses, the government, and foreigners are deducted from M1. The problem is that the cash holdings of foreigners are not known with any accuracy.

14. Poterba and Rotemberg [1987], for example, use the rate of return on stocks to measure the real rate of interest. Mankiw, Rotemberg, and Summers [1985, p. 236] suggest using the time–deposit rate.

15. The sample period, which is somewhat shorter than that employed heretofore, is dictated by the limited availability of data on time–deposit yields.

16. First-stage $\bar{R}^2$ and F coefficients—reported on the penultimate and final rows of Table VIII—indicate that this result is *not* due to an inability to forecast the real interest rate.

17. Net consumption approaches gross consumption as $\frac{X}{M^{\nu}}$ goes to zero, and approaches zero as real balances go to zero. In fact, net consumption is bounded above by $M^{\nu}\mu_m^{-\delta}$.

18. Since the ex-post rate of return on stocks is often negative, it was necessary to replace the expression $\Delta\log(R(t))$ on the right-hand-side of equation (8) by $\frac{\Delta R(t)}{R(t)}$ in those regressions in which stock returns were used as a measure of the interest rate.

19. In comparison, Mankiw and Summers [1986] obtain an estimate of -.054 (s.e., .013) for the interest elasticity of the demand for money. Instrumental variables were apparently not used in the Mankiw and Summers regressions.

20. The corresponding Mankiw and Summers [1986] estimate is 1.61 (s.e., .28). Again, the Mankiw and Summers estimates are not based on instrumental variables regressions.

21. In those regressions where the interest rate was measured by the rate of return on stocks, the expression

$$\Delta\log[1 + (\frac{1}{\nu})\frac{R(t)M(t)}{X(t)}]$$

in equation (10) was replaced by

$$\Delta(\frac{R(t)M(t)}{X(t)})/(\nu + \frac{R(t)M(t)}{X(t)}).$$

See Note 18.

22. Even without reference to formal statistical tests, I find it implausible that, over the sample period in question, stocks or Treasury Bills were used to any significant extent as a within-quarter buffer between household receipts and expenditures. While passbook savings accounts might well have played such a buffer-stock role, the share of such accounts in total time and savings account balances had fallen to less than one-third by 1978 [U.S. League of Savings Associations, 1979]. In any case, the interest rate penalty which one incurred, over this time period, by putting money into a passbook savings account as opposed to, say, a 90-day time deposit account was quite small (typically half a percentage point)—suggesting that the within-quarter liquidity services offered by passbook savings accounts were also small.

TABLE I

DOES CONSUMPTION FOLLOW A RANDOM WALK?

Estimated Equation: $\Delta x(t)=a+dr(t)+f\Delta z(t-1)$.
Instruments: const., dummy, after-tax T-Bill rate, two lagged inflation rates, $\Delta z(t-1)$.
Sample Period: 1951:II - 1986:I.

Z	*a* (s.e.)	*d* (s.e.)	*f* (s.e.)	$\bar{R}^2$ S.E.*100	F D.W.
1. None	0.0045** (0.0004)	0.2663** (0.1056)	———	0.1040 0.5162	17.130 1.508
2. Consumption	0.0035* (0.0006)	0.1970 (0.1036)	0.2115** (0.0794)	0.1288 0.5090	11.278 1.961
3. Real Balances	0.0047** (0.0004)	0.0709 (0.1095)	0.1808** (0.0492)	0.1289 0.5090	11.288 1.850
4. Durable Goods	0.0025** (0.0008)	0.3124** (0.1043)	0.2474** (0.0890)	0.1516 0.5023	13.419 1.613
5. Gov't Defense	0.0044** (0.0005)	0.2632** (0.1057)	0.0122 (0.0124)	0.1034 0.5164	9.011 1.523
6. Gov't Non-Defense	0.0044** (0.0005)	0.2603** (0.1057)	0.0234 (0.0249)	0.1024 0.5167	8.926 1.499
7. Hours of Work	0.0045** (0.0004)	0.2560** (0.1054)	0.0613 (0.0488)	0.1061 0.5156	9.251 1.558
8. Income	0.0039** (0.0005)	0.2224** (0.1032)	0.1061** (0.0462)	0.1233 0.5106	10.770 1.725
9. Stock Prices	0.0043** (0.0004)	0.1529 (0.1045)	0.0292** (0.0073)	0.1701 0.4968	15.242 1.722

** Significant at five percent level.

TABLE II

DO LAGGED VARIABLES HAVE ANY INDEPENDENT INFLUENCE?

Estimated Equation: $\Delta x(t)=a+b$ dummy $+\ dr(t) + e\Delta m(t) + f\Delta z(t-1)$.
Instruments: const., dummy, two lagged after-tax T-Bill rates, lagged inflation, $\Delta m(t-1)$,$\Delta m(t-2)$,$\Delta z(t-1)$.
Sample Period: 1951:II - 1986:I.

	Z					
	None	Consumption	Real Balances	Durable Goods	Income	Stock Prices
a	0.0058**	0.0056**	0.0058**	0.0048**	0.0056**	0.0056**
(s.e.)	(0.0005)	(0.0006)	(0.0005)	(0.0009)	(0.0005)	(0.0005)
b	-0.0048**	-0.0047**	-0.0047**	-0.0044**	-0.0046**	-0.0046**
(s.e.)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
d	0.1948	0.1949	0.2059	0.2052	0.1827	0.2087
(s.e.)	(0.1247)	(0.1235)	(0.1254)	(0.1239)	(0.1205)	(0.1246)
e	0.2851**	0.2738**	0.2188**	0.2717**	0.2767**	0.2251**
(s.e.)	(0.0588)	(0.0624)	(0.0788)	(0.0597)	(0.0596)	(0.0708)
f	———	0.0307	0.0711	0.1124	0.0319	0.0131
(s.e.)		(0.0754)	(0.0559)	(0.0797)	(0.0412)	(0.0078)
$\bar{R}^2$	0.3749	0.3706	0.3707	0.3796	0.3721	0.3794
S.E.*100	0.4311	0.4327	0.4326	0.4295	0.4321	0.4296
F	28.792	21.457	21.472	22.261	21.590	22.248
D.W.	1.935	1.991	1.947	1.959	1.987	1.947

** Significant at five percent level.

TABLE III

DO VARIABLES OTHER THAN REAL BALANCES AFFECT CONSUMPTION?

Estimated Equation: $\Delta x(t)=a + b\ \text{dummy} + dr(t) + e\Delta m(t) + f\Delta z(t)$.
Basic Instruments: const., dummy, two lagged after-tax T-Bill rates, lagged inflation, $\Delta m(t-1)$,$\Delta m(t-2)$.
Sample Period: 1951:II - 1986:I.

	Z					
	Durable Goods	Gov't Defense	Gov't Non-Def.	Hrs. of Work	Income	Stock Prices
a	0.0045**	0.0058**	0.0056**	0.0058**	0.0044**	0.0056**
(s.e.)	(0.0010)	(0.0005)	(0.0008)	(0.0005)	(0.0012)	(0.0006)
b	-0.0042**	-0.0052**	-0.0044**	-0.0049**	-0.0035**	-0.0045**
(s.e.)	(0.0012)	(0.0012)	(0.0015)	(0.0012)	(0.0015)	(0.0013)
d	0.2047	0.2008	0.1618	0.2535	0.1172	0.1874
(s.e.)	(0.1233)	(0.1248)	(0.1473)	(0.1295)	(0.1286)	(0.1253)
e	0.2592**	0.2818**	0.2875**	0.2353**	0.2117**	0.2170**
(s.e.)	(0.0615)	(0.0589)	(0.0608)	(0.0687)	(0.0771)	(0.1091)
f	0.1378	0.0222	0.0316	0.1358	0.2186	0.0188
(s.e.)	(0.0909)	(0.0208)	(0.0753)	(0.1033)	(0.1733)	(0.0226)
$\bar{R}^2$	0.3841	0.3754	0.3333	0.4052	0.4898	0.3664
S.E.*100	0.4280	0.4310	0.4453	0.4206	0.3895	0.4341
F	22.673	21.882	18.370	24.677	34.360	21.091
D.W.	1.969	1.959	1.933	2.049	2.170	1.931
1st Stage$^+$ $\bar{R}^2$	0.8902	0.3400	0.0778	0.1797	0.1181	0.2989
1st Stage$^+$F	161.97	11.23	2.68	6.08	3.66	9.46
Additional Instruments	$\Delta z(t-1)$	$\Delta z(t-1)$	$\Delta z(t-1)$	None	$\Delta z(t-1)$	$\Delta z(t-1)$

** Significant at five percent level.

$^+$ Results from regressions of Δz on the instruments.

TABLE IV

DO VARIABLES OTHER THAN REAL BALANCES AFFECT CONSUMPTION?
(First Month of Quarter Data)

Estimated Equation: $\Delta x(t) = a + b$ dummy $+ dr(t) + e\Delta m(t) + f\Delta z(t)$.
Basic Instruments: const., dummy, two lagged after-tax T-Bill rates, two lagged inflation rates.
Sample Period: 1959:III - 1986:II.

	Z				
	None	Durables	Hours of Work	Income	Stock Prices
a	0.0052 (0.0009)	0.0048** (0.0018)	0.0052** (0.0009)	0.0075** (0.0023)	0.0051** (0.0009)
b	-0.0038 (0.0021)	-0.0038 (0.0021)	-0.0040 (0.0020)	-0.0059 (0.0032)	-0.0037 (0.0021)
d	0.1355 (0.2507)	0.1754 (0.2514)	0.2298 (0.2515)	0.2494 (0.3077)	0.1405 (0.2257)
e	0.2744** (0.1327)	0.2518 (0.1367)	0.2169 (0.1384)	0.3634** (0.1719)	0.2144 (0.1812)
f	------	0.0506 (0.2035)	0.1185 (0.1364)	-0.3606 (0.3069)	0.0185 (0.0569)
$\bar{R}^2$	0.2820	0.2841	0.3418	-0.0662	0.2930
S.E.*100	0.6956	0.6946	0.6660	0.8477	0.6903
F	15.005	11.615	14.894	-------	12.008
D.W.	2.380	2.389	2.414	2.092	2.357
1st Stage$^+\bar{R}^2$	0.366	0.742	0.110	0.096	0.081
1st Stage$^+$F	11.276	44.914	2.894	2.619	2.179
Additional Instruments	$\Delta m(t-1)$	$\Delta m(t-1)$, $\Delta z(t-1)$	$\Delta m(t-1)$, $\Delta z(t-1)$	$\Delta x(t-1)$, $\Delta z(t-1)$	$\Delta m(t-1)$, $\Delta z(t-1)$,$\Delta z(t-2)$

** Significant at five percent level.

$^+$ Column 1 gives results from a regression of Δm on the instruments. All other columns give results from regressions of Δz on the instruments.

TABLE V

DO VARIABLES OTHER THAN REAL BALANCES AFFECT CONSUMPTION?
(Twice-Lagged Instruments)

Estimated Equation: $\Delta x(t)=a + b$ dummy $+ dr(t) + e\Delta m(t) + f\Delta z(t)$.
Basic Instruments: const., dummy, twice-lagged change in after-tax T-Bill rate, twice-lagged inflation rate, $\Delta m(t-2)$, $\Delta m(t-3)$.
Sample Period: 1951:II - 1986:I.

	Z						
	None	Durable Goods	Gov't Defense	Gov't Non-Defense	Hours of Work	Income	Stock Prices
a	0.0058**	0.0048**	0.0058**	0.0064**	0.0057**	0.0043**	0.0062**
(s.e.)	(0.0005)	(0.0013)	(0.0005)	(0.0008)	(0.0005)	(0.0011)	(0.0007)
b	-0.0043**	-0.0039**	-0.0044**	-0.0054**	-0.0043**	-0.0031**	-0.0047**
(s.e.)	(0.0014)	(0.0014)	(0.0015)	(0.0018)	(0.0013)	(0.0015)	(0.0016)
d	-0.0998	-0.0050	-0.0916	0.0748	-0.0236	-0.0828	-0.1204
(s.e.)	(0.2477)	(0.2373)	(0.2546)	(0.3047)	(0.2266)	(0.1913)	(0.2492)
e	0.4675**	0.3874**	0.4663**	0.4123**	0.3958**	0.3347**	0.5907**
(s.e.)	(0.1330)	(0.1440)	(0.1330)	(0.1402)	(0.1326)	(0.1185)	(0.1718)
f	—	0.1117	0.0052	-0.0709	0.0810	0.2314	-0.0277
(s.e.)		(0.1227)	(0.0236)	(0.0777)	(0.1118)	(0.1564)	(0.0337)
$\bar{R}^2$	0.2664	0.3313	0.2661	0.3293	0.3359	0.4440	0.1268
S.E.*100	0.4671	0.4459	0.4672	0.4466	0.4444	0.4066	0.5096
F	17.824	18.217	13.599	18.065	18.576	28.746	6.047
D.W.	1.928	1.970	1.935	1.967	1.995	2.150	1.874
1st Stage[+] $\bar{R}^2$	0.4580	0.7472	0.3373	0.1121	0.1760	0.1233	0.1482
1st Stage[+] F	24.49	69.47	12.79	3.93	5.24	3.79	4.46
Additional Instruments	None	$\Delta z(t-2)$	$\Delta z(t-2)$	$\Delta z(t-2)$	$\Delta m(t-4)$, $\Delta x(t-2)$	$\Delta m(t-4)$, $\Delta z(t-2)$	Lagged After-Tax T-Bill Rate, $\Delta m(t-4)$

** Significant at five percent level.

[+] Column 1 gives results from a regression of Δm on the instruments. Other columns give results from regressions of Δz on the instruments.

TABLE VI

IS THERE EVIDENCE OF TIME-VARYING LIQUIDITY CONSTRAINTS?

Estimated Equation: $\Delta x(t)=a + b$ dummy $+ dr(t) + e\Delta m(t) + fZ(t)$.
Instruments: Columns 1 and 3: const., dummy, two lagged after-tax T-Bill rates, lagged inflation rate, $\Delta m(t-1)$, $\Delta m(t-2)$, $Z(t)$.
Columns 2 and 4: const., dummy, twice-lagged change in after-tax T-Bill rate, twice-lagged inflation rate, $\Delta m(t-2)$, $Z(t-1)$, $Z(t-2)$ (Col. 2 only).
Sample Period: 1951:II - 1986:I.

	Z			
	Debt/Income Ratio	Debt/Income Ratio	Delinquency Rate	Delinquency Rate
a	0.0081**	0.0091**	0.0039	0.0081
(s.e.)	(0.0023)	(0.0027)	(0.0035)	(0.0075)
b	-0.0041**	-0.0031	-0.0056**	-0.0031
(s.e.)	(0.0014)	(0.0018)	(0.0021)	(0.0046)
d	0.1487	-0.2108	0.2504	-0.2358
(s.e.)	(0.1329)	(0.2859)	(0.2044)	(0.6151)
e	0.2860**	0.4908**	0.2944**	0.4839**
(s.e.)	(0.0580)	(0.1406)	(0.0579)	(0.1640)
f	-0.0002	-0.0003	0.0011	-0.0013
(s.e.)	(0.0002)	(0.0002)	(0.0020)	(0.0044)
$\bar{R}^2$	0.3720	0.2187	0.3740	0.2103
S.E.*100	0.4321	0.4820	0.4315	0.4846
F	21.588	10.726	21.760	10.254
D.W.	1.955	1.919	1.938	1.905
1st Stage+ $\bar{R}^2$	------	.9968	------	.9476
1st Stage+ F	------	6178.73	------	419.81

** Significant at five percent level.

+ From regression of Z(t) on the instruments.

TABLE VII

ALTERNATIVE MEASURES OF REAL MONEY BALANCES

Estimated Equation: $\Delta x(t)=a + b$ dummy $+ dr(t) + e\Delta m(t) + f\Delta z(t)$.
Basic Instruments: const., dummy, twice-lagged change in after-tax T-Bill rate, twice-lagged inflation rate, $\Delta m(t-2)$, $\Delta m(t-3)$, $\Delta z(t-2)$.
Sample Period: 1959:IV - 1986:II (Columns 1 and 2).
1953:I - 1983:IV (Columns 3 and 4).

	Z			
	M2-M1	L-M1	Household M1 (Flow of Funds)	Non-Household M1 (Flow of Funds)
a	0.0046**	0.0052**	0.0058**	0.0057**
(s.e.)	(0.0013)	(0.0007)	(0.0005)	(0.0005)
b	-0.0030	-0.0042**	-0.0034**	-0.0036**
(s.e.)	(0.0020)	(0.0015)	(0.0016)	(0.0015)
d	-0.3166	-0.0416	-0.1357	-0.0369
(s.e.)	(0.3260)	(0.2920)	(0.2704)	(0.2306)
e	0.4725**	0.3801**	0.5324**	0.3383**
(s.e.)	(0.1668)	(0.1455)	(0.1643)	(0.1118)
f	0.0318	0.0068	-0.0520	0.0478
(s.e.)	(0.0902)	(0.0623)	(0.0359)	(0.0455)
$\bar{R}^2$	0.0495	0.2794	0.2670	0.3260
S.E.*100	0.5254	0.4575	0.4713	0.4519
F	2.380	11.274	12.201	15.871
D.W.	1.750	1.870	2.028	2.065
1st Stage$^+\bar{R}^2$	0.4185	0.1587	0.2084	0.1366
1st Stage$^+$F	11.90	4.33	5.05	3.43
Additional Instruments	$\Delta z(t-3)$	None	$\Delta z(t-3)$, $\Delta z(t-4)$	$\Delta z(t-3)$

** Significant at five percent level.

$^+$ Results from a regression of Δz on the instruments.

TABLE VIII

ALTERNATIVE MEASURES OF THE INTEREST RATE

Estimated Equation: $\Delta x(t) = a + b\ \text{dummy} + d\ r(t) + e\ \Delta m(t)$.

Instruments: const., dummy, twice-lagged inflation, lagged stock dividend yield, $\Delta m(t-2)$, two lagged logarithms of the after-tax time-deposit and T-Bill rates.

Sample Period: 1956:III - 1982:II.

	Interest Rate Measure		
	Time-Deposit Rate	T-Bill Rate	Return on Stocks
a	0.0054**	0.0055**	0.0054**
(s.e.)	(0.0006)	(0.0006)	(0.0007)
b	-0.0033**	-0.0038**	-0.0036**
(s.e.)	(0.0015)	(0.0018)	(0.0015)
d	0.0678	0.0371	0.0039
(s.e.)	(0.1304)	(0.1583)	(0.0278)
e	0.3039**	0.3448**	0.3479**
(s.e.)	(0.1364)	(0.1070)	(0.1256)
$\bar{R}^2$	0.3984	0.3889	0.3799
S.E.*100	0.4304	0.4338	0.4370
F	23.735	22.852	22.033
D.W.	2.055	2.068	2.059
J^{++}	8.094	8.188	8.105
1st Stage$^{+}\bar{R}^2$	0.643	0.441	0.215
1st Stage^{+}F	24.24	11.18	4.52

** Significant at five percent level.

\+ Results from a regression of the real interest rate on the instruments.

++ Distributed as $\chi^2(5)$, with a .95 critical value of 11.070.

TABLE IX

ESTIMATES OF THE MONEY DEMAND EQUATION

Estimated Equation: $\Delta x(t) = g + h\,\text{dummy} + \delta/(1+\delta)\,\Delta\log(R(t)) + (\nu+\delta)/(1+\delta)\,\Delta m(t)$.
Instruments: const., dummy, twice-lagged inflation, lagged stock dividend yield, $\Delta m(t-2)$, two lagged logarithms of the after-tax time-deposit and T-Bill rates.
Sample Period: 1956:III - 1982:II.

	Interest Rate Measure		
	Time-Deposit Rate	T-Bill Rate	Return on Stocks
g	0.0052**	0.0054**	0.0054**
(s.e.)	(0.0007)	(0.0006)	(0.0006)
h	-0.0035**	-0.0035**	-0.0051**
(s.e.)	(0.0015)	(0.0015)	(0.0019)
δ	0.0451	0.0021	-0.0001
(s.e.)	(0.0684)	(0.0051)	(0.0001)
ν	0.3364**	0.3560**	0.3824**
(s.e.)	(0.0934)	(0.0825)	(0.0901)
$\delta/(\delta+\nu)$	0.1183	0.0058	-0.0003
(s.e.)	(0.1718)	(0.0145)	(0.0002)
$(1+\delta)/(\nu+\delta)$	2.7391**	2.7981**	2.6155**
(s.e.)	(0.6157)	(0.6412)	(0.6166)
$\bar{R}^2$	0.3787	0.3862	0.2652
S.E.*100	0.4374	0.4348	0.4757
F	21.927	22.605	13.392
D.W.	2.041	2.088	2.201
J^{++}	7.615	8.037	4.499
1st Stage$^{+}\bar{R}^2$	0.146	0.238	0.108
1st Stage^{+}F	3.20	5.03	2.57

** Significant at five percent level.

\+ From a regression of $\Delta\log(R)$ on the instruments.

++ Distributed as $\chi^2(5)$ with a .95 critical value of 11.070.

TABLE X

JOINT ESTIMATION OF THE OPTIMALITY CONDITIONS

Estimated Equations: $\Delta x(t) = g + h$ dummy $+ \delta/(1+\delta)\ \Delta\log(R(t)) + (\nu+\delta)/(1+\delta)\ \Delta m(t)$.
$\Delta x(t) = a+b$ dummy $+ \gamma r(t) - (\gamma(1+\delta)-\delta)\ \Delta\log\ (1+ (1/\nu)\ R(t)\ M(t)/X(t))$.
Instruments: const., dummy, twice-lagged inflation, lagged stock dividend yield, $\Delta m(t-2)$, two lagged logarithms of the after-tax time-deposit and T-Bill rates.
Sample Period: 1956:III - 1982:II.

	Interest Rate Measure				
	Time-Deposit Rate	T-Bill Rate	T-Bill Rate	Return on Stocks	Return on Stocks
g	0.0045**	0.0047**	0.0046**	0.0053**	0.0053**
(s.e.)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0005)
h	-0.0039**	-0.0044**	-0.0044**	-0.0051**	-0.0037**
(s.e.)	(0.0014)	(0.0014)	(0.0014)	(0.0018)	(0.0015)
a	0.0047**	0.0041**	0.0041**	0.0047**	0.0047**
(s.e.)	(0.0005)	(0.0006)	(0.0006)	(0.0009)	(0.0009)
b	-0.0030	-0.0053**	-0.0052**	-0.0041	-0.0043
(s.e.)	(0.0016)	(0.0019)	(0.0018)	(0.0028)	(0.0028)
γ	0.2732**	0.0434	0.0253	0.0248	0.0214
(s.e.)	(0.0767)	(0.0723)	(0.0484)	(0.0156)	(0.0145)
δ	0.1005**	-0.0011	----	-0.0001	-----
(s.e.)	(0.0496)	(0.0045)		(0.0001)	
ν	0.1838**	0.1641**	0.1473**	0.3481**	0.3332**
(s.e.)	(0.0634)	(0.0605)	(0.0551)	(0.0802)	(0.0744)
$[1-\nu+\nu/\gamma]$	1.4890**	4.6208	6.6811	14.703**	16.221
(s.e.)	(0.1709)	(5.8011)	(10.705)	(6.948)	(8.636)
J++	14.138	21.486	21.420	6.729	10.381

** Significant at five percent level.

++ Distributed as $\chi^2(11)$ in columns 1, 2, and 4, with .95 and .99 critical values of 19.675 and 24.725 respectively. Distributed as $\chi^2(12)$ in columns 3 and 5, with .95 and .99 critical values of 21.026 and 26.217 respectively.

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