Expectations, Commercial Bank Adjustment, and the Short-run Performance of Monetary Aggregates

by

John M. Mason*
Richard J. Rogalski*
Joseph D. Vinso*

Working Paper No. 6-77a

John M. Mason*
The Wharton School
University of Pennsylvania

Richard J. Rogalski*
The Amos Tuck School
Dartmouth College

and

Joseph D. Vinso*
The Wharton School
University of Pennsylvania

February, 1978

EXPECTATIONS, COMMERCIAL BANK ADJUSTMENT, AND THE SHORT-RUN PERFORMANCE OF THE MONETARY AGGREGATES

"A bank must, therefore, first of all decide what amount of reserves it will be prudent to aim at ...." J.M. Keynes, A Treatise on Money, Vol. 1, The Pure Theory of Money, the collected writing of John Maynard Keynes, p. 25

I. INTRODUCTION

It has been shown by Rogalski and Vinso (1977) that the rate of growth of the money supply is incorporated into stock returns as argued by monetary portfolio theorists. Subsequent analysis (Rogalski and Vinso (1978)) has shown that security markets incorporate changes in monetary policy instigated by the Federal Reserve System. In general, this work suggests that the monetary sector does not adjust instantaneously to changes in reserves provided by the Federal Reserve. That is, monetary aggregates respond to changes in Federal Reserve behavior with a delay. This delay is subsequently reflected in the short-run relationships observed between the security markets, money supply variables and monetary aggregates which measure Federal Reserve actions. A description of the institutional characteristics which generate these results is not presently available.

Judging the performance of monetary aggregates, money supply variables, and reserve aggregates is crucial for policy makers and interpreters of monetary policy. Much of the current analysis of these variables is based upon *ad hoc* reasoning or static models of the money supply. This type of analysis may be reasonably adequate in an economy experiencing secular growth, because steady state money multipliers imply constant relative growth rates for the different money and reserve aggregates. In those periods of transition when the course of monetary policy is being altered, complicated lags and adjustment patterns may distort analysis and lead to misinterpretation of the situation resulting in either a policy that is too extreme or business behavior that is inappropriate.

The Federal Reserve System is charged with the administration of monetary policy in the U.S., and fulfills this responsibility by using its combination of operating tools to bring about results desirable for the health of the economy and the banking system. In the longer run, as expectations regarding Federal Reserve behavior and economic performance homogonize and contracts can be renegotiated, the Fed can achieve its desired path by controlling the reserve base available to the economy.

In the short-run, the actual monetary aggregates achieved are a result of a combination of Federal Reserve actions, bank reserve positions, expectations, bank loan commitments, and economic activity. To better understand the performance of the monetary aggregates in the short-run, we must seek a better understanding of the factors impacting upon the banking system as a whole.

The purpose of the research presented in this paper is to fill a void in the current literature by obtaining a better understanding of how the banking system adjusts to changes in Federal Reserve behavior and the consequent affects this response has on the monetary aggregates. Since the securities markets are subsequently affected by this adjustment of the banking system, we can likewise expect to have some better understanding of the results previously obtained.

In section II the model will be presented and its empirical specification will be developed. Section III develops the particular formation of expectations. Empirical results are discussed in section IV. Section V describes the economic implications of this work followed by a short summary of the conclusions reached at this stage of our research.

II. A MODEL OF THE BANKING SECTOR

To examine the adjustment process, a model of the banking sector is developed which is a simplified version of that presented by Brunner and Meltzer (1967, 1972). However, the approach is consistent with Tobin's (1969) general equilibrium model as well as several other models of the banking sector.

A. Sectoral Equations

In their model, Brunner and Meltzer (B-M) (1972, p. 955-956) define the monetary sector in terms of assets supplied by the economy, assets demanded by the banking system, and the equilibrium conditions present in the market for these assets. B-M define the following set of equations:

$$E_t^d = a\,B: \quad a = a(i, i_t, P, W_m, W_h, e);\ a_1, a_2, a_3, a_4, a_5 > 0,\ a_6 < 0 \qquad (1)$$

where:
- E_t^d = demand for earning assets
- B = monetary base
- i = market rate of interest
- i_t = interest rates paid on time deposits
- P = price of existing capital
- W_n = market value of nonhuman wealth
- W_h = nominal human wealth
- e = expected real net yield on real capital per unit of real capital
- a = asset multiplier

and:

$$E_t^s = \sigma\text{:}\ \sigma(i-\Pi,P,p,W_n,W_h,e,S);\sigma_1,\sigma_2<0;\ \sigma_3,\sigma_4,\sigma_5,\sigma_6>0 \qquad (2)$$

where: E_t^s = supply of earning assets

σ = stock of bank credit

Π = anticipated rate of price change

p = price level of new production

S = nominal stock of government debt outside the Federal Reserve System

P, W_m, W_h, e as defined in (1)

In equilibrium, the supply of and demand for earning assets must be equal which allows Brunner ad Meltzer (1972, p. 956) to obtain:

$$aB = \sigma \text{ or}$$

$$E_t^s = E_t^d \qquad (3)$$

It should be observed that the subscripted multipliers are the partial derivatives of the function with respect to the argument as it appears in the parenthesis.

Turning now to the liabilities side of the balance sheet of the commercial banking industry, B-M (1972, p. 956) define the demand and supply of nongovernment deposits and the required equilibrium condition for the market. The supply of demand deposits is:

$$D_t^s = mB\text{:}\quad m=m(i,i_t,P,W_m,W_h,e);\ m_1,m_2>0;\ m_3,\ldots,m_6<0 \qquad (4)$$

where: D_t^s = supply of nongovernment demand deposits

m = money multiplier

i,i_t,P,W_m,W_h,e as defined in (1)

and the demand for deposits in:

$$D_t^d = L: \quad L=f(i,P,p,W_n,W_h,e); \; L_1,L_2<0; \; L_3,L_4,L_5,L_6>0 \tag{5}$$

where: D_t^d = demand for nongovernment deposits

L = stock of money

i,P,p,W_n,W_h,e as defined in (1)

Again, in equilibrium, supply must equal demand and Brunner and Meltzer (1972, p. 956) obtain:

$$mB = L \quad \text{or}$$

$$D_t^s = D_t^d \tag{6}$$

This model is somewhat cumbersome to use for empirical investigations. Since our focus is only on the short-run adjustment of the banking system, we assume that there will be no change in the expected real net yield on real capital so the argument e will disappear from the specification. Likewise, separating the specification of interest rate paid on time deposits, i_t, from the market rate of interest, i, was necessitated by the concern of B-M with Regulation Q which specifies maximum allowable rates of interest on time deposits. Since we will be concerned with short run changes in the narrow definition of money, we are not concerned explicitly with time deposits, any interest rate effects will be observed in the argument i. Furthermore, the anticipated rate of price changes is not expected to vary in the short-run so that change in nominal rates and real rates of interest will be the same. In the short run one can ignore differential inflationary impact in the supply of earning assets. Finally, a proxy for wealth and prices is needed. Brunner and Meltzer (1967, p.

207) demonstrate that national income, Y_t, is a function of wealth (W_n and W_h) and the price of existing capital, P. Since national income is a function of total wealth and the price of capital, it can be used as a proxy for the wealth and pricing arguments in the sectoral equations.

Federal Reserve Policy and the Commercial Banks

Before proceeding further the use of the monetary base, B, as suggested by Brunner and Meltzer must be investigated. In the short-run some factors must be taken as given to the monetary authorities and to the banking system, whereas within a longer time horizon these same factors would be assumed to be endogenous.

For example, the Federal Reserve System seems to react differently to the separate components of the money supply (the narrow measure, M1) in the short-run.[1] Whereas currency is pretty well supplied on demand, the Fed is quite concerned with the reserves that go into the banking system.[2] The central bank offsets currency flows to and from the banking system, leaving the currency component of the money supply demand determined in the short-run. This type of behavior on the part of the Federal Reserve suggests that the monetary base is an inappropriate choice as the reserve aggregate for short-run monetary analysis.[3]

We also feel that, in the short-run, member bank borrowings must be considered endogenous to the system; i.e., total reserves are an inappropriate measure of Federal Reserve activity. These borrowings from the Federal Reserve are looked on as a temporary source of funds available for transitional adjustments due to reserve misallocations, seasonal needs, or periods of change in monetary policy. Since we are primarily interested in the transitional states of monetary policy we shall only be interested in the latter use of borrowings. Thus, if the Federal Reserve is tightening up on monetary growth, commercial banks will be encouraged to use the discount window to make reserve adjustments because the Federal Reserve allows the spread between the Federal Funds rate and the discount rate to widen because changes in the discount rate lag changes in the market rate. When the central bank is attempting to speed up monetary growth, member bank borrowing will be discouraged because this spread will narrow, or even become negative as again the discount rate lags the market.

We expect that in the longer-run the banking system would eventually adjust to the level of nonborrowed reserves, R_t, available to it.[4] Even if the Federal Reserve were to maintain a much slower growth in the money supply than they had achieved previously we would assume that the banking system would completely adjust to the equilibrium level of deposits implied by the unborrowed reserves available to it and loan demand would be reduced through the raising of interest rates and tightening of credit terms, as well as the restricting or non-renewal of credit lines.
Thus, we assume that the banking system adjusts to the level of nonborrowed reserves provided it by the Federal Reserve System.[5]

Role of Expectations

As previously shown, the level of nonborrowed reserves, R_t, is preferred in the reserve multiplier equations rather than the nonborrowed monetary base. However, bankers may not wish to adjust their portfolios immediately for reasons such as outstanding lines of credit and/or their existing maturity structure of assets and liabilities. These reasons will cause them to borrow from the Federal Reserve or pay back previous borrowings as they adjust to the new equilibrium. It is the borrowing privilege that breaks the strict balance sheet relationship between bank earning assets and deposits. In a sense, member bank borrowings serve as a residual during times of transition that reduces the costs of adjustment placed by the central bank upon the commercial banking system. The banking system, therefore, tries to "guess" what amount of reserves the Federal Reserve is aiming at and then tries to adjust deposits and earning assets to levels that are optimally consistent with the expected amount of reserves. As a result, it is suggested that the levels of assets and liabilities will be adjusted based on the expected level of nonborrowed reserves, R_t^*.

It is now argued that other expectations enter the sectoral equations. For example, it is proposed that the expected stock of earnings assets, E_t^*, be included in the asset multiplier for two reasons. First, banks are faced with demands for funds that they do not wish to turn away due to the relationship that exists between the bank and their customers. In conducting their business they must make some estimate of what these demands will be. Second, the bank's portfolio will generally contain securities with maturities greater than one calendar period and we expect that transactions costs exist so as to prevent costless adjustments; thus the complete portfolio will not be turned over within one period. Similarly, it is argued that the supply of demand deposits would be a function of the expected level of deposits, D_t^*, due to the existence of compensating balances (among other things) that may be related to the expected demand for earning assets, or deposits arising from factors not related in any way to the asset side of the balance sheet.

The expected level of deposits and earning assets play an important role in determining the level of earning assets and demand deposits because they pick up the effects of things that banks place a high value on (whether explicitly or implicitly) due to the high perceived (at least to the banks) costs associated with the times. For example, in the case of not lending to a "customer" the major cost is the future loan demand of the customer that would be lost.[6] In other cases, banks may feel "locked-in" to portions of their securities portfolios or may want to avoid showing capital losses. Treatment of capital losses and/or transactions costs may cause banks to retain investments even in the face of rising loan demand.

B. Sectoral Reduced Form Equations

Introducing the simplifications outlined above, equations (1) and (2) describing the demand, E_t^d, and supply, E_t^s, of earning assets in the economy have the following form (see Appendix A for a glossery of Terms):

$$E_t^d = aR_t^*; \; a=a(i,Y_t,E_t^*); \; a_1,a_2,a_3>0 \tag{7}$$

$$E_t^s = \sigma; \; \sigma=\sigma(i,Y_t,S_t); \; \sigma_1<0; \; \sigma_2,\sigma_3>0 \tag{8}$$

Assuming a multiplicative model, these equations can now be solved for the sectoral reduced form of the earning asset market (see Appendix B for the derivation):

$$E_t = a_0 + a_1Y_t + a_2R_t^* + a_3E_t^* + a_4S_t + u_{1t} \tag{9}$$

where E, Y, R^*, E^*, and S are expressed as natural logarithms, asteriks denote expectations, and all $a_i>0$.

Equation (9) has two endogenous variables, the level of earning assets in the economy, E_t, national income, Y_t, and three predetermined variables,

R_t^*, expected level of non-borrowed reserves, S_t, the level of government debt and outside the Federal Reserve System, E_t^*, expected level of earning assets in the economy. The random disturbance term, u_{1t}, has mean zero, constant variance, σ^2, uncorrelated.

Turning now to the liabilities side of the balance sheet of the commercial banking industry, equations (3) and (4) describing are the nongovernment demand for deposits, D_t^d, and the supply of demand deposits, D_t^s, reduces to:

$$D_t^s = mR_t^*; \; m = f(i,D_t^*); \; m_1, M_2 > 0 \qquad (10)$$

$$D_t^d = L; \quad L = f(i,Y_t); \; L_1 < 0; \; L_2 > 0 \qquad (11)$$

Again, the sectoral reduced form for this set of equations can be obtained (this derivation is also shown in Appendix B):

$$D_t = b_0 + b_1Y_t + b_2R_t^* + b_3D_t^* + u_{2t} \qquad (12)$$

where: D_t^* (the expected level of deposits), Y_t and R_t^* are all expressed as natural logarithms, asteriks denote expectations, all $b_i > 0$, and u_2 is a random error term.

Finally, we must determine Y_t. The reason for this is that we expect that E_t and D_t will, at least partially, influence economic activity. If this is true, equations (9) and (12) are not truly reduced form equations. They are, as described, sectoral reduced form equations. Within the full model of the economy, they contain endogenous components and therefore are subject to simultaneous equation bias. In order to eliminate this bias we must introduce an equation showing how Y_t is determined. Brunner and Meltzer (1967, p. 207) argue that Y_t can be determined as follows:

$$Y_t = v\ M + G \tag{13}$$

where: M = currency and demand deposits
v = circuit velocity of private expenditures
G = Government expenditures

We have previously argued, though, that the relationship of the Federal Reserve differs between cash and demand deposits. Likewise, other exogenous influences besides government expenditures may be included. As a result, equation (13) should be respecified as

$$Y_t = vC_t + vD_t + wZ_t + u_{3t} \tag{14}$$

where: C_t = Currency

Z_t = vector of exogenous influences such as government expenditures

v,w > 0 and u_3 is a random error term and all variables are in terms of natural logarithms.

It should be noted that for purposes of empirical testing Government Expenditures are used as a proxy for this vector of external influences. Since we have argued that currency can be assumed to be demand determined in the short-run, the currency component can be specified as $C_t = cY_t$, so that Y_t is determined as follows:

$$Y_t = v/(1\text{-}cv)\ D_t + w/(1\text{-}cv)\ Z_t + 1/(1\text{-}cv)\ u_{3t}. \tag{15}$$

Substituting (15) into the reduced form equations (9) and (12) for earning assets and deposits we obtain the following equations after simplification:

$$E_t = c_0 + c_1R_t^* + c_2E_t^* + c_3D_t^* + c_4S_t + c_5Z_t + \varepsilon_{1t} \tag{16}$$

and

$$D_t = e_0 + e_1R_t^* + e_2D_t^* + e_3Z_t + \varepsilon_{2t} \tag{17}$$

where: the coefficients are defined in footnote 7 with all c_i and $e_i > 0$. All variables are in the form of natural logarithms as before.

Using these equations, the role of expectations in the adjustment of the banking sector to changes in Federal Reserve policy can be analyzed.[8] If the banking system adjusts rapidly to changes in Federal Reserve policy so that observed changes in the forecast of nonborrowed reserves are not significant, the Federal Reserve has effective control over economic activity in the short-run through its control of deposit and earning asset levels. If expectations do play a role in determining the levels of earning assets and demand deposits, it would suggest that the Federal Reserve can influence the direction which bank portfolios and the stock of money may take but cannot quickly or accurately attain some predetermined level of the money supply. Such a result would explain the lagged relationships demonstrated by Rogalski and Vinso (1978). Likewise, finding equations (16) and (17) appropriate for determining the levels of deposits and earning assets would question the assertion by Feige and McGee (1977) that the Fed's use of traditional reserve-multiplier mechanism to control the money supply is not useful and that money supply equations predicated on the assumption of reserve exogeneity are not appropriate.

Before proceeding to the estimation of equations (16) and (17), it is necessary to review the method of expectation formation.

III. EXPECTATION FORMATION

The model developed in the previous section contains the expectations of several variables such as earning assets, demand deposits, and non-borrowed reserves. Before investigating the full model, we must specify how these expectations are formed.

Basically, there are three types of information upon which these expectations can be formed: 1) noneconomic events such as local events, political actions and the like, 2) economic events such as changes in fiscal or monetary variables, and 3) the previous history of each series.

Generally the process by which economic agents utilize information of the first type is not understood. As a result, it is generally assumed that such information does not provide any systematic variation into the observations of a given series.

Utilizing information of the second type is equivalent to generating expectations based on the "true" model of the adjustment process with all the information available to the bankers at the end of period t. Thus, all endogenous and exogenous variables, including current and past values, enter into the determination of these expectations. This process is generally referred to as restricted rational expectations.

An example of such expectation formation is provided by looking at R_t^*. Assume that the "true" model for R_t is set by a linear feedback rule as a function of government expenditures, debt, and unemployment where the w_i's are parameters and X_{t+1} is a normally distributed random variable with mean zero and constant variance, such that:

$$R_{t+1} = \sum_{i=0}^{\infty} w_{1i} R_{t-i} + \sum_{i=0}^{\infty} w_{2i} u_{1t-i} + \sum_{i=0}^{\infty} w_{3i} u_{2t-i} + \sum_{i=0}^{\infty} w_{4i} u_{3t-i}$$

$$+ \sum_{i=0}^{\infty} w_{5i} Z_{t-i} + \sum_{i=0}^{\infty} w_{6i} S_{t-i} + \sum_{i=0}^{\infty} w_{7i} y_{t-i} + X_{t+1} \quad (18)$$

where: y_t = real income and u_1, u_2, and u_3 come from equations (2), (4), and (5).

X_{t+1} represents the random part of reserve growth that may result from policy but cannot be predicted on the basis of information about the state of the economy (type 1 information). Real income, y, enters into equation (18) as a proxy for capacity output because policy attempts to set a level of non-borrowed reserves that is consistent with full employment without inflation. A linear model such as this with known coefficients and a quadratic loss function in the exogenous variables is an optimal feedback rule if $E(X_{t+1}) = 0$. For purposes of illustration, the exogenous variables Z and S in (18) are assumed to be governed by an autoregressive process similar to that for y; i.e.,

$$y_{t+1} = \rho_y y_t + \lambda_{yt+1}$$

where the λ's are mutually and serially uncorrelated, normally distributed with zero means.

Summarizing this approach, the expected level of reserves would be mathematically equal to:

$$R_t^* = E(R_{t+1}\ \theta_t),$$

the expectation of R_{t+1} conditional on all observations of R,Z,S and y dated t or earlier as denoted by θ. It was explained earlier that the u_j were serially uncorrelated and possessed zero mean. In taking the expectation of equation (18) these random disturbances drop out.

One problem with the rational expectations formulation is that it assumes that all information is instantly available and costless to obtain. Since information is not costless, bankers will probably opt for a more restrictive information set with which to formulate expectations. One such method of formulating these expectations is by using past history of the series, i.e., the type 3 information set. The usual way to determine the expectations is using an autoregressive model similar to that of Cagan (1956). This model would be represented as:

$$R_t^* = \sum_{i=0}^{n} q_i R_{t-i} \tag{19}$$

where the q_i's are fixed numbers. Such a formulation assumes, however, that all type 2 information is contained in the error terms and disappears upon taking expectations. Since it is assumed that the error terms are independent, it means that economic information external to the series itself has no systematic impact on expectation formation. Furthermore, models such as (19) are a subset of the general class of multivariate time series models.

An expectation model which incorporates all the predictive information in the time series of an economic series is that developed by Box and Jenkins (1970). This approach assumes that information on the role of external economic agents is utilized in the forecasting process through the adjustment of the forecast for the error between the actual observation of a series and the forecasted value. Forecasts are based not only on past values of the series as in (19) but also information contained in the differences between actual and forecast values. Using the notation of Box and Jenkins (1970), the general form of the model is:

$$\phi_p(B)(1-B)^d Y_t = \theta_q(B)\varepsilon_t + c \tag{20}$$

where: ϕ_p = coefficients on the autoregressive parameters up to lag p

θ_q = coefficients on the moving average parameters up to lag q

$(1-B)^d$ = d^{th} difference of the series

ε_t = error term

Y_t = series to be estimated

c = constant terms.

Continuing the example of R_t^*, an appropriate Box-Jenkins model takes the form:

$$R_t^* = \sum_{q=0}^{n} \theta_q \ (B)\varepsilon_t - \sum_{p=1}^{n} \phi_p \ (B)(1-B)\ ^dR_t + c \qquad (21)$$

The appropriate values for ϕ_p and θ_q to generate a stationary series are estimated according to the methodology developed by Box and Jenkins (1970). The values for R_t^* now contain all of the information on the systematic influences of the economic agents available to the banker and are known as the one-step ahead forecasts. It is this method of expectation generation which will be utilized in the empirical investigation. The expectations of demand deposits, D_t^*, and earning assets, E_t^*, will also be formed in a similar fashion. After estimating the appropriate forms of expectation generating model for the economic agents using equation (21), equations (16) and (17) will be used to estimate the role each has in the management of the asset and liability accounts of the bank portfolio. The results of this testing will also carry implications for the inter-relationship of the various monetary aggregates.

IV. EMPIRICAL RESULTS

Before equations (16) and (17) can be investigated, it is necessary to obtain expectation models for the non-borrowed reserves, earning assets, and demand deposit series so as to generate one-step ahead forecasts. For each series, month end data are obtained from January, 1963, to December, 1974. These data were chosen as the data were readily available and several episodes of the business cycle occurred over that period.[9] There is no reason to expect the introduction of any bias due to specific dates.

It then is necessary to produce a stationary series for each by filtering to a white noise series.[10] Table 1 provides a summary of the fitted models for the various series.[11]

After filtering the series, the one-step ahead forecasts for each series, R^*, E^*, D^*, were generated. Various forms of equations (16) and (17) were then estimated using ordinary least squares with the results summarized in Table 2.

Regression A obtains the estimates of parameters in equation (16). As can be noted, the coefficients of the three expectational variables, R^*, E^*, D^*, are significantly different from zero and have the correct sign. The constant term, the amount of Government Securities outstanding and Government Expenditures are not significantly different from zero. In the case of the latter, either an increasing Government deficit or the conduct of open market operations do not appear to affect the level of earning assets unless expected reserves are affected or expected earning assets are affected. It should be noted that S and Z often enter the regression equations with a negative sign whereas it was expected that the sign should be positive. It may be that the influence of these variables is being picked up in the expectational variables.

It would be of interest to determine whether omitting one or the other non-significant variable results in the remaining variable being significant. Re-estimating equation (16) without the Z_t variable (see regression B) then without the S_t variable (see regression C) shows that

Table 1

SUMMARY OF FITTED MODELS

Series (144 obs.)	Models Fitted to Each Series	Residual Variance	Q_{24}
Earnings Assets	$(1-B)\,E_t = (1-\underset{(.080)}{.440}B^4)\,\varepsilon(E_t) + \underset{(.001)}{.008}$	.3767E-03 (141 d.of f.)	15.1 (33.9)
Non-borrowed Reserves	$(1+\underset{(.080)}{.464}B + \underset{(.080)}{.380}B^2)(1-B)\,R_t = (1-.322B^4)\,\varepsilon(R_t) + \underset{(.002)}{.007}$	.1141E-02 (140 d. of f.)	27.7 (31.4)
Demand Deposits	$(1+\underset{(.081)}{.715}B + \underset{(.082)}{.385}B^2)(1-B^{12})(1-B)\,D_t = (1-\underset{(.046)}{.785}B^{12})\,\varepsilon(D_t) + \underset{(.001)}{.008}$	.1150E-03 (129 d. of f.)	32.7 (33.9)

NOTES:

1. All variables E_t, R_t, D_t were expressed as natural logarithms.
2. The notation $\varepsilon(*_t)$ refers to the residuals of the model for the appropriate series with * equal to E_t, R_t, or D_t.
3. Standard errors are shown in parentheses below parameter estimates.
4. Residual variances are reported in exponential form, i.e. .1101E-02 = .001101 with degrees of freedom given in parentheses on the line below.
5. The Q statistic as discussed in Box and Jenkins (1970) is approximately chi-square distributed with (N-n) degrees of freedom where N is the number of residual autocorrelations and n is the number of parameters estimated. In parentheses below the Q value is the χ^2 value for the appropriate degrees of freedom (24) at the 5% level of significance under the null hypothesis of zero serial correlation in the residuals of the model. The reported values support the notion that the original series has been successfully reduced to white noise series.

Table 2

SUMMARY OF REGRESSION MODELS

Identifier	Regression Model	R_A^2	SEE	DW
A	$E_t = \underset{(.254)}{.001} + \underset{(3.597)}{.338} R^*_t + \underset{(5.699)}{1.115} E^*_t + \underset{(3.482)}{.263} D^*_t - \underset{(.431)}{.010} S_t + \underset{(.223)}{.004} Z_t + \varepsilon_t$	.321	.01922	1.995
B	$E_t = \underset{(.281)}{.001} + \underset{(3.834)}{.344} R^*_t + \underset{(5.791)}{1.121} E^*_t + \underset{(3.512)}{.260} D^*_t - \underset{(.436)}{.010} S_t + \varepsilon_t$	.326	.01914	1.993
C	$E_t = \underset{(.229)}{.001} + \underset{(3.602)}{.337} R^*_t + \underset{(5.717)}{1.118} E^*_t + \underset{(3.475)}{.261} D^*_t + \underset{(.230)}{.004} Z_t + \varepsilon_t$	.325	.01915	1.991
D	$E_t = \underset{(.257)}{.001} + \underset{(3.841)}{.343} R^*_t + \underset{(5.831)}{1.124} E^*_t + \underset{(3.503)}{.258} D^*_t + \varepsilon_t$	.331	.01907	1.988
E	$D_t = \underset{(.974)}{.001} + \underset{(1.192)}{.063} R^*_t + \underset{(24.772)}{1.049} D^*_t - \underset{(.105)}{.001} Z_t + \varepsilon_t$	.840	.01082	1.869
F	$D_t = \underset{(.984)}{.001} + \underset{(1.219)}{.061} R^*_t + \underset{(25.317)}{1.050} D^*_t + \varepsilon_t$	.841	.01077	1.870
G	$D_t = \underset{(-.404)}{-.001} + \underset{(1.116)}{.056} R^*_t + \underset{(25.589)}{1.053} D^*_t + \underset{(1.745)}{.188} E^*_t$	.844	.01068	1.849

All variables are represented as natural log differences. Numbers in parentheses are t statistics for the coefficients. Asterisks indicate expectation variables. R_A^2, SEE, DW denote the adjusted R squared, standard error of the estimate, and Durbin-Watson statistic, respectively.

neither of these variables, representing the fiscal and debt management sides of governmental activity, seems to be significant for our sample period. Finally, dropping the S_t and Z_t variables (see regression D) and re-estimating we obtain the final equation for earning assets.

Two things should be noted about regressions A, B, C, and D. First, analyzing the correlation matrix shows that there is no observed multicollinearity in the estimated equations. Secondly, if the term E_t^* is dropped, the constant term becomes significant. It appears that a correct specification of the earnings asset equation must contain the banks' expectations about what those earning assets are to be as well as expected deposit levels. More importantly, the earning asset levels appear to be influenced by the banks' expectation of the course of future Federal Reserve policy as reflected through expectations of future levels of non-borrowed reserves.

Next, we estimated equation (17), the reduced form for deposits. Regression E suggests that neither the expected level of non-borrowed reserves nor Government expenditures contribute a significant amount of explanation to the movements in demand deposits. The level of bank deposits is apparently related only to the expected level of deposits because re-estimating equation (17) without Z_t (see regression F) shows the expected level of non-borrowed reserves does not contribute significant explanatory power.

In developing the model, it was discussed in footnote 9 that since all coefficients are assumed to be greater than zero and a_i and b_i are all positive, the following constraint is implied: $cv<1$ and $v(c+b_1)<1$. In reviewing the results obtained for c and v over the time period used in estimation show that the first constraint seems to holds; approximately

$0.18 < cv < 0.28$. The question then concerns the value of vb_1. As shown in the appendix, the magnitude of b_1 is determined in this model by $-(m_1L_2/L_1-m_1)$. The coefficients L_1 and m_1 have dropped out in solving for the reduced form equations; thus we canot obtain empirical evidence as to their magnitude. Many estimates of these coefficients are quite low (see Goldfield (1973)). Estimation of equation 12 shows that $L_2 = 0$. Since L_2 is zero, b_1 must also be zero. Thus the second constraint also appears to hold.

We can also determine whether $d\ell nE_t = d\ell nD_t$ during an expansion (or contraction) of non-borrowed reserves. As stated in footnote 10, to achieve this result $c_1e_1 = 1$, since c_4, the coefficient attached to government securities held outside the Federal Reserve, is not significantly different from zero. In this case $c_1 = 0.343$ and $e_1 = 0.06$ so that the condition does not hold which means that $d\ell nE_t \neq d\ell nD_t$ in the short-run.

While these results suggest that the management of demand deposits is dependent on the expected level of demand deposits, it would be instructive to inquire whether an interrelationship exists between earning assets and demand deposits due to customer relationships as previously shown. To test this relationship, equation (17) was estimated using E_t^* as an independent variable. Regression G suggests that the estimate of future asset levels does not appear to significantly affect the demand deposit component of liability management.[12]

Finally, we investigated whether a simple extrapolative model for expectation formation instead of the model used here could be utilized. In equations (16) and (17) all expectations, R_t^*, E_t^*, and D_t^*, were replaced by lagged terms R_{t-1}, E_{t-1}, and D_{t-1}, respectively. Re-estimating the equations showed the constant was the only coefficient to be significantly different from zero and the explanatory power of the regression was extremely small.[13] Thus, the method of developing expectations described in Section III may be valid in specifying the actions of the components of the monetary sector because a simple extrapolative model of expectation formation appears to be inappropriate.

V. ECONOMIC IMPLICATIONS

The results of this study lead to several interesting implications. First, current levels of demand deposits appear to depend on only expectations of future deposit levels. Expectations of future Federal Reserve actions do not appear to directly influence the money supply because the role of non-borrowed reserves is not significant in determining the level of demand deposits. This result is consistant with the findings of Feige and McGee (1977) and Rogalski and Vinso (1978) because neither study could observe a direct relationship between future reserve changes and money supply. Such a result does not imply that demand deposit levels are independent of reserve changes. Changes in reserves may be used in the formation of demand deposit forecasts which then influences current deposit levels.

Second, these results suggest that the adjustment to Federal Reserve actions are primarily observed through the asset account. Since deposit expectations (which may implicitly include estimates of changes in reserve positions) and reserve level expectations (which may lead to future changes in deposit levels) are significant in determining current levels of earning assets, it suggests that the adjustment of asset levels does not occur instantaneously with changes in Federal Reserve policies. Bankers do not adjust asset levels merely on what reserves the Federal Reserve are currently providing but also on what policies the Fed are expected to pursue in the near future and how these policies will influence the level of deposits available for investment. These results suggest that banks cannot quickly adjust asset portfolios but rather such adjustments lag changes in Federal Reserve policies. Such a result would be consistent with the findings of Rogalski and Vinso (1977,1978) that portfolios of other assets such as the security markets anticipate these adjustments based on changes in reserve position but that these adjustments take several months to be completed.

Third, the results obtained here provide some insight into the management practices of the banking sector. The feedback process between asset and liabilities appears to be unidirectional. While bankers utilize forecasts of demand deposits when deciding on asset levels, they apparently do not manage deposit levels with a view to future demand for loans. Since the Federal Reserve cannot manage asset levels and thereby economic activity, but only current reserve levels, such a result suggests that these management practices will dilute attempts by the Fed to regulate economic activity through monetary policy because of the indirect route that such effects must take. It also suggests that the impact on economic activity might be increased and the delay experienced in the adjustment of earning assets to changes in monetary policy can be reduced if the Federal Reserve were more explicit in defining its policy with respect to providing reserves to the banking system so that the accuracy of forecasts of reserve levels can be improved.

Finally, it appears that such exogenous factors as fiscal policy and debt management policies of the Federal Government do not directly influence bank assets and liabilities in the short-run. To the extent that such activities cause changes in the levels of reserves provided by the Federal Reserve, changes in these variables may ultimately influence the banking system but only to the extent that as bankers do not explicitly consider these variables in making short-run portfolio adjustments.

VI. SUMMARY AND CONCLUSIONS

This paper has explored the adjustment process of the banking system to changes in monetary policy. An adapted version of the Brunner-Meltzer (1969,1972) model for the monetary sector is utilized to analyze this adjustment process. Specifically, a model of the asset and deposit levels of the banking system is developed and the role of expectations in the determination of these levels is explored.

It is found that deposit levels are independent of expected changes in reserves provided by the Federal Reserve to the banking system. Asset levels not only depend on forecasts of reserve changes but also forecasts of future deposit levels. It is also found that management of balance sheet accounts goes undirectionally from deposit levels to earning assets which suggests that attempts to influence economic activity through changes in monetary policy will be effective only with a considerable lag. It appears that changes in other types of economic variables such as fiscal actions do not influence portfolio adjustments of banks except insofar as they influence the forecast of future reserve levels.

These results are consistent with previous work which described relationships among various monetary aggregates and now provides one possible description of the institutional characteristics which generate those relationships. The results obtained here also attempt to explain the observed relationship between the securities market and monetary aggregates previously shown by Rogalski and Vinso (1978).

Finally, the results obtained here suggest that Federal Reserve might find it fruitful to examine the policy of explicitly specifying the thrust of current monetary policy rather than waiting for the publication of the minutes of board meetings ninety days hence. Since forecasts of the future course of Fed policy affects adjustments of loan levels, it can be expected that the more accurately these forecasts can be made, the more quickly and efficiently changes in monetary policy can be conveyed to the economy.

FOOTNOTES

*The authors are Assistant Professor of Finance, The Wharton School, University of Pennsylvania; Assistant Professor of Finance, The Amos Tuck School, Darmouth College; and Assistant Professor of Finance, The Wharton School, University of Pennsylvania, respectively. We wish to thank Anthony Santomero, Jeremy Seigel, and Mark Flannery for helpful comments on earlier drafts.

[1]We have only focused on the narrow measure of the money supply (M1), composed of currency and demand deposits, in this paper. There are two reasons for this. First, we feel that M1 is the most homogenous definition of the money supply available, since people generally demand it for transactions purposes whereas broader measures involve portfolio decisions that are more closely related to the income-saving process. Secondly, there is empirical evidence that greater aggregation of the money supply provides little additional information in estimating the demand for money equation. On the latter point see Goldfeld (1973) for a detailed analysis.

[2]This behavior pattern on the part of the Federal Reserve has been documented by past and present members of the Federal Reserve System (see for example, DeLeeuw and Kalchbrenner (1969), Keran and Babb (1969), and Robinson (1964)). The implied assumption for such a response is a concern for the health of the banking industry. If currency drains from the banks were ot offset, banks would find the level of their raw materials, i.e., reserves, subject to greater uncertainty; banks would tend to make shorter, more liquid loans thus reducing possibilities for economic development. Also, it is probably true that the drain of reserves due to currency flows would occur just at the times banks really needed the reserves, possibly inducing liquidity problems into the money markets.

[3]An attempt has been made to empirically justify this conclusion with the same sample period used in the susequent tests reported in this paper. We found that for the period 1963 to 1974, that there was a strong contemporaneous relationship between another reserve aggregate, nonborrowed reserves, and the monetary base indicating one can gain all the information about the monetary base by looking at nonborrowed reserves. Furthermore, since monetary base and nonborrowed reserves show only a strong contemporary relationship, it can be expected that the currency component would be independent of specific Federal Reserve actions. These results do indicate that watching the monetary base alone is not sufficient. Details are available from the authors on request.

[4]DeLeeuw and Kalchbrenner (1969) and Keran and Babb (1969) provide some empirical support to justify this.

[5]An obvious question is the relationship among the total reserves, borrowed reserves and non-borrowed reserves series. For the period 1963 to 1974, we found that member bank borrowings are independent of both total reserves and nonborrowed reserves while total and nonborrowed reserves show a strong contemporaneous relationship. These results suggest that not only is

all the information obtained from total reserves contained in nonborrowed reserves but also nonborrowed reserves is the variable most generally under the control of the Federal Reserve system. They also suggest that nonborrowed reserves should be the preferred indicator of Federal Reserve policy. Details are available from the authors on request.

Such results are not surprising. To finance an expansion, banks must use reserves more efficiently, if they can, or borrow at the Federal Reserves' discount window. Another alternative is that the level of nonborrowed reserves may not stay constant. It will be seen that an increase (decrease) in the demand for money and/or the supply of earning assets will put upward (downward) pressure on interest rates. To moderate this increase (decrease) the Federal Reserve might increase (decrease) reserves available to the system which would lead then to an increase (decrease) in deposits and loans. Since excess reserves have been kept at a minimum in recent years, particularly over the sample period we use in our empirical work, we will abstract from their existence and assume them to be zero. Thus, deposits may be assumed to be close to the maximum allowed by reserve requirements. The relationship at any one time, therefore, between reserves and demand deposits, given the level of time deposits is the relationship between demand deposits and nonborrowed reserves, i.e., $TR_t^{max} = r_d D_t + r_p T_t$, where r_d and r_p are the reserve requirements for demand and time accounts respectively. T_t, is the exogenous level of time accounts. Borrowings (B_t) will then be represented as the difference between this total reserve figure and the actual level of non-borrowed reserves (R) supplied by the Federal Reserve. In this sense, the total reserve series is an endogenous variable.

Note that, ignoring bank capital, the balance sheet of the banking system is $TR + E_t = D_t + T_t + B_t$. Since B_t is determined endogenously a strict relationship between E_t, D_t and non-borrowed reserves doesn't exist and this allows for E_t and D_t to follow their own paths of adjustment.

[6] See Wood (1974) for a description of how the customer relationship may be included in model specification.

[7] The coefficients in equations (16) and (17) after the substitution of (15) take the form:

$$c_0 = a_0 + \frac{va_1b_0}{1-v(c+b_1)}; \quad c_1 = a_2 + \frac{a_1b_2v}{1-v(c+b_1)};$$

$$c_2 = a_3 \quad ; \quad c_3 = \frac{a_1vb_3}{1-v(c+b_1)}; \quad c_4 = a_4;$$

$$c_5 = \frac{a_1vb_1w}{1-v(c+b_1)} + \frac{a_1w}{1-cv};$$

$$e_0 = \frac{b_0(1-cv)}{1-v(c+b_1)}; \quad e_1 = \frac{b_2(1-cv)}{1-v(c+b_1)}; \quad e_2 = \frac{b_3(1-cv)}{1-v(c+b_1)}$$

$$e_3 = \frac{b_1(1-cv)}{1-v(c+b_1)}; \quad \varepsilon_{1t} = u_{1t} + \frac{a_1v}{1-v(c+b_1)}u_{2t} + \frac{a_1vb_1}{(1-cv)(1-v(c+b_1)}u_{3t} + \frac{a_1}{1-cv}u_{3t}$$

$$\varepsilon_{2t} = \frac{(1-cv)}{1-v(c+b_1)}u_{2t} + \frac{b_2}{1-v(c+b_1)}u_{3t}$$

It is assumed that the error terms, ε_{1t} and ε_{2t}, have the usual properties. In developing this model, the coefficients are all assumed to be greater than zero. Since the a_i and b_i are all positive, the following constraints are implied: $cv<1$ and $v(c+b_1) <1$; the validity of which are investigated in Section IV of the text.

[8]Our model allows for the divergent movement of deposits and earning assets. Specifically, an open market operation that affects expected reserves and the amount of government securities outstanding will only cause deposits and earning assets to change by the same percentage amount under very special conditions. For example, an open market operation will affect both reserves and currency outstanding (assuming that member bank borrowings are not affected). Thus by taking derivatives, dS = - d(R+C), but since C = cY and dC = cdY we have dS = - dR - cdY. Assuming Z to be constant, i.e., we have a pure monetary policy, e obtain dY = (v/1-cv) dD from equation (6) and thus dS = - dR - (cv/1-cv) dD.

Therefore, for given values of Z_t, E_t^* and D_t^* if dE_t is to equal dD_t, we must have the following condition hold:

$$\frac{c_1}{e_1} = 1 + c_4\left(\frac{1}{x} + \frac{cv}{1-cv}\right)$$

where x is the amount R_t^* is affected by a change in R_t, i.e., $dR_t^* = xdR_t$. Since c_1 and e_1 are combinations of a_i's and b_i's, it is highly unlikely that dE_t will equal dD_t and then only in the event of $dR_t^* = dR_t$ which would more generally approximate the secular situation.

[9]It should be noted that the results reported are based upon preliminary data. Data revision often exceeded the time of adjustment found in estimation so that one must assume that portfolio adjustments were usually made on the basis of the preliminary data.

[10]A white noise series is a random sequence which is independent, normally distributed with zero mean and constant variance.

[11]The reader is referred to Box and Jenkins (1970) for a complete discussion.

[12]It was previously argued that there maybe high perceived future costs in failing to lend to a customer or may fail locked-into portions of their portfolios due to capital losses. If this argument is carried to an extreme, earning assets and deposits would be outside the control of the banking system. For example, as the economy expands and other sources of funds to companies become less available at any price, the companies possessing lines of credit will begin to draw upon them. Banks may seek to use member bank borrowings to support these loan demands. Thus, loans and deposits may tend to increase irregardless of the level of nonborrowed reserves. If banks, as they have in recent years, possess minimal levels of Government securities, earning assets should increase. The converse of this is also true.

To test this we also investigated the following equations, assuming that the deposits and earning assets of banks are demand determined:

$$D_t = g_0 + g_1 Y_t + u_{4t} \qquad (13.1)$$

where: $g_0, g_1 > 0$ and u_4 is a random error term, and all variables are in terms of natural logarithms.

$$E_t = h_0 + h_1 Y_t + h_2 S_t + u_{5t} \qquad (13.2)$$

where: $h_0, h_1, h_2 > 0$ and u_5 is a random error term, and all variables are in terms of natural logarithms.

Estimation of both equations leave something to be desired with coefficients of determination of 0.10 and 0.004 respectively. Furthermore, even though only Y_t is significantly different from zero only in equation (A1), all coefficients are of the wrong sign leaving us to question the viability of the argument that dependence runs from economic activity to bank assets and liabilities. Details of these tests are available from the authors on request.

[13] Results of these tests available from authors on request.

REFERENCES

1. Box, George E. P. and Gwelyn M. Jenkins, Time Series Analysis. (Holden-Day Inc., San Francisco) 1970.

2. Brunner, K. and Meltzer A.H., "The Meaning of Monetary Indicators," in Monetary Process and Policy: A Symposium, ed., by George Horwich (Richard D. Irwin, Inc., Homewood, Ill). 1967

3. ______________: "Money, Debt, and Economic Activity" Journal of Political Economy, (Sept./Oct. 1972), pp. 951-977.

4. Burger, A.E., The Money Supply Process, (Belmont, Cal: Wadsworth Publishing Co., 1971).

5. Cagan, P., "The Monetary Dynamics of Hyperinflation" In Studies in the Quantity Theory of Money, edited by M. Friedman. Chicago: Univ. of Chicago Press, 1956.

6. DeLeeuw, F. and Kalchbrenner, J. "Monetary and Fiscal Actions: A Test of Their Relative Importance in Economic Stabilization--A Comment" Review, Federal Reserve Bank of St. Louis (April, 1969), pp. 6-11.

7. Feige, E. L. and R. McGee, "Money Supply Control and Lagged Reserve Accounting," Journal of Money, Credit, and Banking, November, 1977, pp. 536-551.

8. Goldfeld, S.M. "The Demand for Money Revisited", Brookigs Papers on Economic Activity (1973:3), pp. 577-646.

9. Keran, M.W. and Babb, C.T. "An Explanation of Federal Reserve Actions (1933-68)" Review, Federal Reserve Bank of St. Louis (July, 1969), p. 7-20.

10. Robinson, R.I., Money and Capital Markets, (McGraw-Hill Book Co., New York, 1964).

11. Rogalski, R. and J. Vinso," Stock Returns, Money Supply and the Direction of Causality," Journal of Finance, Vol. XXXII, No. 4, September, 1977, pp. 1017-1030.

12. ______________, "An Analysis of Monetary Aggregates," Journal of Money, Credit and Banking, forthcoming, 1978.

13. Tobin, J., "A General Equilibrium Approach to Monetary Theory" Journal of Money, Credit and Banking, (February, 1969), pp. 15-29.

14. Wood, J., "A Model of Commercial Bank Loan and Investment Behavior," in H.G. Johnson and A.R. Nobay, ed., Issues in Monetary Economics, Oxford University Press, 1974.

APPENDIX A

LIST OF SYMBOLS

B^t = monetary base

C = currency

D_t^s = supply of nongovernment demand deposits

D_t^d = demand for nongovernment deposits

D_t = level of demand deposits

D_t^* = expected level of demand deposits

E_t^d = demand for earning assets

E_t^s = supply of earning assets

E_t = level of earning assets

E_t^* = expected level of earning assets

e = expected real net yield on real capital per unit of real capital

G = Government expenditures

i = market rate of interest

i_t = interest rate paid on time deposits

L = stock of money

M = currency and demand deposits

P = price of existing capital

ρ = price level of new production

R_t = level of nonborrowed reserves

R_t^* = expected level of nonborrowed reserves

S = nominal stock of government debt outside the Federal Reserve System

t = time

v = circuit velocity of private expenditures

W_n = market value of nonhuman wealth

W_h = nominal human wealth

Y_t = national income

y = Real Income

Z_t = Vector of exogenous influences

Π = anticipated rate of price change

σ = stock of bank credit