THE MONETARY MECHANISM: SOME PARTIAL RELATIONSHIPS*

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The existence of an intimate connection between monetary policy and the commercial banking system is well known. The exact nature of this connection is far from perfectly understood, however. The purpose of this paper is to outline an attempt to specify both the nature and the degree of control that the monetary authorities can exert over commercial banks. Such a specification involves the formulation of the response mechanism of banks to policy. While such a specification is admittedly a small part of the total reaction of the economy to monetary policy, it is an important one; and it represents a logical first step in the determination of this monetary mechanism. The primary goal of this study is the determination of the role of policy; the portfolio analysis which is used is a means to this end. The discussion which follows will be carried out in terms of an individual commercial bank.

The bank is conceived to have a total supply of funds at its disposal comprised of its deposit liabilities (less required reserves) and of its capital account. Given these funds, the bank distributes them among available assets. The total asset portfolio is aggregated into three groups: a transactions balance, a portfolio of relatively long-term bonds, and a group of nonfinancial loans. The transactions balance will be called the portfolio of reserve assets; it provides the bank with a pool of highly liquid assets to be used for transactions purposes. The components of the portfolio are the bank's holdings of cash, Treasury bills, and other highly liquid assets. The portfolio of relatively long-term securities will be called the investment portfolio; it is held for income and diversification purposes and it provides a source of speculation. This portfolio contains such securities as intermediate and long-term government bonds, municipal bonds, and special long-term issues. The nonfinancial loan portfolio is held for income purposes and is composed of all loans other than the extremely short-term loans made to brokers, dealers, and finance companies; these are included in the reserve asset group. The following notation may be used:

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These terms may be arranged in the following balance-sheet identities:

\[ A = R + I + L \]

\[ F = D + T + C \]

\[ F = A. \]

The analysis of portfolio selection is most easily handled by assuming that each asset group is composed of a homogeneous set of assets; i.e., all the assets within any group are perfect substitutes. The reserve, investment, and loan groups will be respectively characterized by cash, long-term bonds, and loans. Each asset has its own return and risk properties. The portfolio problem involves an analysis of how a bank will allocate a given dollar of \( F \) among the three assets in a manner which will maximize its expected utility.

Given the demand nature of many of its liabilities and the small size of the capital account relative to total liabilities, it is safe to assume that the bank is a risk averter investor. Under the further assumption that the bank considers its estimate of the standard deviation of asset return to be the relevant measure of risk, its preferences are approximated by a quadratic utility function.\(^1\)

The bank is not able to completely and reliably schedule its transactions needs; this being the case, \( R \) must also serve as a buffer stock which insulates the other asset groups from unexpected variations in transactions. A clearer isolation of the factors which condition the bank's demand for reserve assets may be achieved by making two initial simplifying assumptions. It is assumed that demand deposits are the bank's only deposit liability and that the level of loan demand is known and constant.

As a means of handling the expected volume of transactions, it is assumed that this volume is a positive function of the bank's deposit size; and it is further assumed for simplicity that the relationship is proportional. The desired reserve asset portfolio will be expressed in terms of the expected value and standard deviation of the future level of deposits where the standard deviation is used by the bank as a measure of the risk that actual deposits will differ from their forecasted or expected value. Assume that the bank has \( N \) depositors, each with a given

\(^1\) Harry Markowitz, *Portfolio Selection* (John Wiley & Sons, 1959), Chap. 10.
size deposit at the beginning of any period. Further assume that the total level of deposits at the end of the period is a random, lognormally distributed variable with expected value \( \alpha \) and variance \( \beta^2 \). The lognormal distribution has several characteristics which make it particularly well suited for the analysis at hand.\(^2\) Consider a random variable, \( x \), defined over the range \( 0 < x < \infty \). If \( y = \log(x) \) is normally distributed with mean \( \mu \) and variance \( \sigma^2 \), then \( x \) is lognormally distributed. The mean of \( x, \alpha \), is given by \( \alpha = e^{\mu + \frac{1}{2} \sigma^2} \), and the variance \( \beta^2 \), by \( \beta^2 = e^{2\mu + \sigma^2} (e^{\sigma^2} - 1) = \sigma^2 \eta^2 \) where \( \eta^2 = (e^{\sigma^2} - 1) \), and \( \eta \) is the coefficient of variation of the distribution. The distribution of \( x \) is completely specified by the parameters \( \mu \) and \( \sigma^2 \).

Abstracting from seasonal and other systematic influences, it is assumed that the bank uses the current level of deposits as a measure of the deposit level which it expects to prevail at the end of the period; i.e., \( E(x_{t+1}) = \alpha + 1 = x_t \) and therefore, \( E(y_{t+1}) = \mu \), where \( x \) denotes the total level of deposits. It is further assumed that the bank considers the parameter \( \sigma^2 \) to be a constant for all \( t \). This assumption implies that given percentage deviations of \( x \) from its expected value are viewed by the bank as having the same likelihood of occurrence no matter what the current level of \( x \) (or of \( \mu \)). It can be seen from the expression above that \( \eta \) depends only on \( \sigma^2 \) and, hence, is a constant under this assumption. It is also seen that the standard deviation of \( x \) is given by \( \beta = \alpha \eta \), so \( \beta_{t+1} = \alpha_{t+1} \eta = \pi \eta \). The bank thus considers the standard deviation of \( x \) in period \( t+1 \) to be proportional to the current level of deposits, \( x_t \).

The proportionality of \( \beta_{t+1} \) to \( x_t \) rests on the assumption that the number of depositors, \( N \), is fixed. In general, however, an increase in current deposit size will at least in part represent an increase in the number of depositors. If these new accounts are not perfectly correlated with the old, or with each other, the standard deviation of deposits will not rise in proportion to the increase in total deposit size. The extent to which the bank considers \( \beta \) to change will depend upon the degree to which the movements in deposits represent a change in the number of depositors and the extent to which it represents an alteration in the size of existing accounts. Only if variations in total deposits arise solely from this latter source will total deposit risk vary proportionally with deposit size; such a phenomenon is indeed unlikely to occur.

Analyses of the transactions demand for money have indicated that the transactions balance should vary positively but less than proportionally with the volume of transactions.\(^3\) For similar reasons, the de-

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sired reserve asset portfolio will also vary positively but less than proportionally with expected deposit size. The portion of $R$ which represents a safety allowance will likewise vary less than proportionally with the level of deposits. Given that the total supply of available funds, $F$, is composed almost exclusively of deposits, the desired reserve asset portfolio will be a positive, less than proportional function of this total supply.

The composition of $F$ should have an important influence on the size of desired $R$. The larger the proportion of highly active and/or erratic deposits in the total supply of funds, the larger should be the desired reserve asset portfolio, given $F$. Such deposits tend to increase both the expected volume of transactions and the variability of this volume.

The entire discussion of the reserve asset portfolio has implicitly assumed the existence of alternative uses of funds. The deposit forecast and the confidence which the bank places in it do not uniquely determine the size of $R$. Given the size and composition of $F$, desired $R$ will vary negatively with the rates of return on investment and loan assets. The desired reserve asset portfolio will vary positively with the transactions costs involved in the purchase and sale of competing assets, and with the risks associated with holding the other two portfolio groups: i.e., risk of default and/or of capital loss. Finally, the $R$ which the bank wishes to hold will vary positively with the penalties involved in being caught with insufficient reserve assets to meet a deposit loss; such penalties include the costs of borrowing and the expenses involved in making frequent short-term adjustments in the investment asset portfolio.

The discussion has so far been conducted under the assumptions that the level of loan demand and the yield on investment assets are known and constant. The characteristics of $I$ and $L$ must now be briefly discussed.

The investment asset portfolio is intermediate with respect to the other two portfolio groups in terms of expected return, liquidity, and risk. The expected return on $I$ is higher than for $R$, but such return can be gained only at the cost of decreased portfolio liquidity and increased asset risk. While investment assets are marketable, they do not provide the high liquidity of short-term assets. The existence of relatively high brokerage fees, of random variations in price, and of possible market "thinness" make them ill-suited for the short-run manipulations required of reserve assets. Rapid and frequent movements into and out of the portfolio in response to unexpected deposit movements would tend to reduce the net yield on these assets below the yield on $R$. Brokerage fees and short-term price fluctuations made the net yield on $I$ in part a function of the length of time these assets are held. The
holding period for investment assets is too long to make them suitable for transactions purposes. If the bank has to sell investment assets to meet a deposit loss, such sale is possible, however; this gives $I$ an important advantage over loan assets which, of course, are not marketable.

The existence of fairly large variations in the prices of investment assets makes such securities subject to risk of capital loss. In deciding how to best allocate a given dollar of funds between $R$ and $I$, the bank must compare expected transactions needs against the expected return and risk on $I$. The actual allocation which is made will depend upon the shape of the bank's utility function. Under the assumption that the function is quadratic in return, the higher the expected return or the lower the risk on $I$, the greater will be the share of investment assets in a dollar of available funds, given expected transactions needs.

The relative shares of the reserve and investment asset portfolios in the total asset portfolio are conditioned by the bank's decision to hold loan assets. Of the three asset groups, loans have the highest expected rate of return, the greatest risk, and the least liquidity. Of the three asset groups, only loans possess significant risk of default. Due to the relatively small capital account of a typical commercial bank, such risk is of crucial importance. The expected return on loans is, of course, conditioned by the interest rate charged by the bank. Such return tends to exceed the expected return on the other two asset groups.

A relatively high rate of return and comparatively large risk provide loans with their two essential characteristics. Under the assumption of the quadratic utility function, the share of total available funds allocated to loans will vary positively with expected return and negatively with loan risk. Unlike the other two asset groups, the return and risk on loans are subject to some control by the bank. The bank will be faced by a demand for its loans which is a decreasing function of the interest charge on loans. Further, if it is assumed that the bank considers such factors as loan size, maturity, and guarantees as important elements in the determination of loan risk, these factors are also subject to bank manipulation. Other things being equal, borrowers prefer relatively large average loan size, long maturity, and no guarantees; banks on the other hand prefer relatively small loan size (per loan), short maturity, and strong guarantees. The work of Hester and of Guttentag indicates that it is useful to combine these return and risk factors into what Hester calls a set of loan terms.4 If stringent loan terms are associated with relatively high interest rates, short maturities, small average loan size, and strong guarantees, the amount of available funds which

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the bank wants to put into loans will be positively related to the stringency of loan terms and the demand for loans will be negatively related to this stringency.

It is likely that the supply of loans function is nonlinear. Given the bank's aversion to risk and the total supply of funds at its disposal, the bank will require ever increasing stringency of loan terms to induce it to supply a constant increment to the loan portfolio. Given $F$, the bank can expand $L$ only at the expense of $R$ and $I$. Such expansion increases the risk associated with unexpected deposit losses and it increases portfolio default risk. The bank's relatively small capital account coupled to ever present transactions needs should be sufficient to produce a less than proportional response of the quantity of loans supplied to a given change in loan terms.

If information on loan terms were generally available, the discussion would now be complete. It could be argued that the supply of loans function is accurately specified by $F$, its composition, the yield on $I$, and the stringency of loan terms. Loan demand, on the other hand, depends upon many factors other than the stringency of loan terms—factors which are often much more important to the borrower (e.g., expected future profits) than the terms on which he can obtain loans from the bank. The demand function is far from being specified. An observed relationship between loan terms and $L$ would be the locus of equilibria between the demand and supply functions. This locus would approximate the bank's supply function if the variance of the stochastic term of the supply function were small compared to that of the demand function. This condition would be more than adequately met in the case at hand. The unexplained variance of the supply function would certainly be much smaller than the unexplained variance of the demand function, which has been taken to be only a function of the stringency of loan terms. This being the case, a more complete specification of the demand for loans function would be unnecessary for identification of the supply schedule. Unfortunately, data on loan terms are not available. A proxy variable must be used to represent the relationship between loan terms and $L$.

In a world in which loan demand is subject to cyclical variation, the bank needs some measure to tell it how its current portfolio position compares to "normal." Normal in this case refers to the cycle average of the proportion of $F$ devoted to loans. The bank compares the present share of $L$ in $F$ to its average share; i.e., the bank uses the variable $(L/F - \bar{L}/F)$, where $\bar{L}/F$ is the cycle average of $L/F$, as an indicator of the desirability of its current portfolio position. It is assumed that in a cyclical setting, the bank expects a movement in loan demand in

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one direction to be followed by another movement in the same direction. With this expectation and given the current value of \((L/F - \bar{L}/F)\), the bank must decide by how much it is willing to alter \(L\) for a given expected change in loan demand. It is argued that the larger \((L/F - \bar{L}/F)\), the less the bank will respond to a given change in loan demand. Thus, \(L\) should vary positively but less than proportionally with \((L/F - \bar{L}/F)\). It should be noted that if the deviations of \(L/F\) from its cycle average were replaced by a measure of the stringency of loan terms, one would expect \(L\) to bear precisely the same sort of relationship to loan terms.

The argument must be altered when discussing the case of cyclical contractions in loan demand. Bond prices, as well as loan demand, experience cyclic variation. The two cyclical patterns should be roughly coincident. At the upper turning point in loan demand, bond prices tend to be low (high interest rates). As loan demand begins to fall, the bank has an incentive, not to greatly reduce loan terms, but rather to let \(L\) decline and to put the liberated funds into a bond market which is expected to rise. As the decline in loan demand continues and as bond prices rise, the incentive to undertake further bond price speculation will be reduced as the bank expects both loan demand and bond prices to reverse their direction of movement in the near future. The bank will begin to realize its gains from the investment portfolio and to build up its reserve asset position for the expected rise in loan demand. Within the context of the short-term cyclical contractions in GNP which have characterized the postwar period, the realization of bank expectations during periods of declining loan demand should be fairly complete.

Holding all other supply determining factors constant, \(L_t\) will depend upon the value of \((L/F - \bar{L}/F)_{t-1}\) and upon the direction in which loan demand is moving. The relationship may be expressed in the following manner: define a variable \(X_t\) which has a value of unity for contractions in loan demand and a value of zero for expansions. Leaving out other factors for the moment, the desired relationship may be expressed by \(L_t = a_1 + (a_2 + a_3X_t)(L/F - \bar{L}/F)_{t-1}\). The coefficient of \((L/F - \bar{L}/F)_{t-1}\) will thus depend upon whether loan demand is rising or falling.

The total model may now be presented. The proportion of available fund devoted to loans is estimated using the following relationship:

\[
\frac{L_t}{F_{t-1}} = a_1 + [a_2 + a_3(X_t)_t] \log \left[ \left( \frac{L}{F} - \frac{\bar{L}}{F} \right)_{t-1} + 5.0\% \right] \\
+ a_4 \log \left( \frac{D_\delta}{F} \right)_{t-1} + a_5 \log F_{t-1} + a_6 \log i_{t-1} + u_t
\]

\(\delta\) All ratio forms are expressed as percentages. The addition of the arbitrary constant to \((L/F - \bar{L}/F)_{t-1}\) renders this variable strictly positive. The coefficients \(a_1\) and \(a_2\) are not unique with respect to choice of the additive constant.
where $D_s$ is government deposits (which are particularly unstable), $i$ is the yield on 3–5 year government bonds, and $u$ is the stochastic term. The structural relationship between $L$ and $F$ is assumed to take the form: $L = F^s$, thus $L/F = F^{(s-1)}$; $L/F$ is conditioned by the size of $F$. The coefficient $a_s$ is an estimate of the structural parameter $\gamma$ less unity. The discussion of the relationship between $R$ and $F$ implies that $\gamma > 1$.

The data used to test the model were obtained from the balance sheets of eighty-five large commercial banks, from all over the country, which are particularly active in the money market. The data are in the form of time series aggregates composed of weekly observation of the banks’ portfolios covering the period from July, 1959, through December, 1962. The results are as follows:

$$\log \frac{L_t}{F_{t-1}} = 1.577 + [0.071 + 0.001(X_{t-1})] \log \left( \frac{L_{t-1}}{F_{t-1}} \right) + 5.0\%$$

$$= 0.010 \log \left( \frac{D_s}{F_{t-1}} \right) - 0.108 \log (F_{t-1}) - 0.063 \log (i_{t-1})$$

$$- 5.7 \quad - 5.3 \quad - 6.09$$

$R^2 = 0.914 \quad D = 1.7$

The corresponding $t$-statistics appear below each parameter estimate.

Given the nature of the data and the simplicity of the model, the fit is surprisingly good. The intensity and the direction of movement of loan demand have an important influence on the loan portfolio. The coefficient for $(L/F - \bar{L}/F)_{t-1}$ strongly implies that $L/F$ responds less than proportionally to the stringency of loan terms. The elasticity of $L/F$ with respect to this proxy for loan terms is significantly less than unity. The coefficient is also significantly larger during contractions in loan demand than during expansions. The bank is more willing to reduce the proportion of $L$ in $F$ for a 1 percent decline in $(L/F - \bar{L}/F)$ than it is to increase it for a 1 percent rise. Such reaction implies that the banks have incentives to channel funds liberated by declining loan demand into the bond market.

The variable $D_s/F$ has been used because government deposits in commercial banks tend to be highly unstable. $D_s$ was the only unstable deposit item which could be isolated from the data. The influence of government deposits on the loan account is relatively important. A 1 percent rise in $D_s/F$ will induce the banks to reduce the proportion of $L$ in total assets by .01 percent. The composition of $F$ is an important element in the portfolio decision.

The coefficient of $F$ needs some explaining. It has been argued that $a_s$ would exceed unity; the discussion of the relationship between $R$ and
$F$ has implied that $\gamma - 1 > 0$. The negative elasticity coefficient for $F$
implies that a 1 percent increase in $F$ will produce a .89 percent increase
in $L$. The original contention that $\gamma$ exceeds unity was based on several
assumptions regarding the relationship between $R$ and $F$. It has been
assumed that banks are willing and able to completely adjust their
desired loan portfolios to variations in $F$ with a one period lag. If, in
fact, the lag is longer than this—perhaps distributed through time—
the coefficient $a_4$ will tend to lie below its “equilibrium” value. The
possibility of such a lag deserves further study. Only if it proves possible
to estimate the lag will it be possible to evaluate the validity of the
assumptions made in deriving the relationship between $L_t$ and $F_{t-1}$,
which lay behind the assertion that $\gamma > 1$. Until this is done, little can
be said concerning the economies or diseconomies of scale exhibited by
the banks in the sample.

Finally the elasticity coefficient for $i$ is quite interesting. This coefficient
indicates that the investment portfolio is an important competitor
for bank funds. Irrespective of the direction of movement of loan demand, a 1 per cent rise in the yield on 3-5 year government securities produces a .66 percent decline in $L/F$. Loan demand movements do not
swamp all other portfolio considerations.

In the introduction to this paper it was stated that the purpose of
the study was to specify the mechanism of response of commercial banks
to monetary policy. On the basis of the sample used in the empirical
work, some conclusions regarding this component of the monetary
mechanism are made. In the interest of brevity, the only policy variable
to be considered is $F$. Through its open market operations and its
control over reserve requirements, the Federal Reserve System can
determine the supply of available funds within tolerably narrow limits
for the banking system as a whole. The manner in which the banks
allocate these funds among alternative asset groups depends upon
the strength and direction of movement of loan demand, the existing com-
position of $F$, and upon the yield on investment assets. The influence
which variations in the total supply of funds exert on the banks’ loan
portfolios is a matter of predictable economic choice. The empirical
evidence strongly suggests that the size of $F$ has had, and will have, an
extremely important influence on the size of $L$. The extent of the influence
will depend upon the factors discussed. Banks do not blindly
meter out a constant proportion of $F$ to the three portfolio groups; and
they do not passively react to variations in loan demand. The link be-
tween policy and loans is a strong one; but $F$ is only one factor among
many. If the quantity of loans is a relevant target variable for policy,
the target can be hit only if these other factors are explicitly and
carefully taken into account in the policy decision.