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FINANCIAL INNOVATION AND MONETARY POLICY EFFECTIVENESS

Cara S. Lown*
Economist
Research Department
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*The views expressed in this article are solely those of the author, and should not be attributed to either the Federal Reserve Bank of Dallas or to the Federal Reserve System.

ABSTRACT

How financial innovation and financial intermediaries affect the Federal Reserve's ability to target the monetary aggregates and/or interest rates has been a long standing debate in macroeconomics. With the recent development of new money market instruments and the growth of money market funds this issue is again being discussed. This article develops a model of the financial sector to examine how the growth in money market funds has altered the effectiveness of monetary policy. The work presented in this paper differs from previous work in that the important actors in the model are specified from first principles. The major conclusion reached is that, when an explicit role for the intermediary is specified, the asset choice of the money market fund is the key variable in determining the effectiveness of monetary policy.

1. Introduction

How financial innovation and financial intermediaries affect the Federal Reserve's ability to target the monetary aggregates and/or interest rates has been a long standing debate in macroeconomics beginning with Gurley and Shaw (1955) and Tobin and Brainard (1963). With the recent development of new money market instruments and the growth of money market funds this issue is again being discussed. The concern centers around three specific points: how the development of new instruments which are components of M1 (NOW Accounts) as well as those which are components of M2 (Money Market Funds) have altered the demand for M1; how deregulation of deposit interest rates has altered M1 demand; and finally whether or not the growth of money market funds has diminished the effectiveness of monetary policy in the sense that a given action by the Federal Reserve would have less impact on the variables being targeted. Although these three issues are closely related, the purpose of this paper is to focus narrowly on how the growth in money market funds has impacted the effectiveness of monetary policy.

The idea that money market funds lead to less effective monetary control has caused some to argue that reserve requirements should be placed on them (see Discussion after Hester 1981). These arguments are not unlike those given in the late 1950's and early 1960's when economists were concerned about how institutions such as Savings and Loans and Mutual Savings Banks altered monetary policy. Brainard (1964) included nonbank financial intermediaries in a model of the financial sector and examined the size of the interest rate change for a given open market operation with and without nonbank institutions. He concluded that a given open market operation has a smaller effect on interest rates in the presence of financial intermediaries than without them. More recently, Wood (1981) argued that Brainard's model was incorrect because it misspecified nonbank financial intermediaries: since the development of intermediaries improves market efficiency (decreases market segmentation), a model that incorporates that improved efficiency has to be specified. Wood constructed a model in which there were two sets of individuals and two types of securities. Each set of individuals had access to only one bond market. The inclusion of financial intermediaries then allowed the individuals access to both security markets through the intermediary. In this example the model with the intermediary produced open market operations with larger effects on interest rates, thus contradicting Brainard's result. Wood concluded that the Federal Reserve's concern over the development and growth of nonbank intermediaries was therefore unwarranted.

Wood's idea that financial intermediaries should be specified to represent a decrease in market segmentation is an important one, but there are three potential problems with this approach. First, it is not obvious what particular institution his intermediary represents (or, in fact, that such an institution presently exists). Second, the intermediary is not specified as exhibiting optimizing behavior. Finally, bank behavior, in addition to the intermediary, is not included in the model.

To examine the effect on Wood's results of taking these criticisms into account, the model developed in this paper consists of a banking sector, a household sector, a business sector and a government securities market. The household sector consists of two subsectors--i and j. Sector i consists of individuals only able to hold demand deposits while sector j consists of individuals who hold demand deposits and government securities. A nonbank financial intermediary is then added to represent Money Market Funds (hereafter MMF) and individuals in sector i may hold government securities indirectly through the MMF. The major conclusion reached is that, when an explicit role for the intermediary is specified, the asset choice by the MMF is the key variable in determining the effectiveness of monetary policy. Specifically, when the money market fund holds a nontrivial amount of assets in investments which have a higher risk and yield a higher return than government securities, the effectiveness of monetary policy increases.[1/]

2. Model Without a Nonbank Financial Intermediary

This section specifies the behavior of the household sector, the firm sector, the government securities market and the banking sector. The comparative statics of an open market operation is then calculated and will be compared, in Section 3, to the results of the same experiment when the model is extended to include a money market fund.

Households

For tractability, the analysis assumes a separability in household behavior such that the decision regarding the allocation of current income to consumption and saving is made prior to the decision to allocate the sum of initial wealth and current saving among various financial assets. The primary household decision represented here is the allocation of financial wealth among demand deposits, government securities and holdings of the net worth of the banking system.

Household subsector i possesses a fraction, k, $(0 \leq k \leq 1)$, of the wealth and income in the economy, and is only able to hold demand deposits. This is because the minimum denomination of a Treasury security is 10,000 dollars and it is assumed that no individual in sector i possesses enough financial wealth to invest in these large denomination securities. Therefore, in the absence of a money market fund, sector i is limited to holding demand deposits. Households in sector j possess the remainder of the wealth and income, $(1 - k)W$ and $(1 - k)y$ respectively, and divide it between demand deposits, government securities and holdings of the bank's net worth. In other words, sector j may be viewed as the wealthy sector which has access to the government securities market.

By assumption the demand for government securities is positively related to its own rate of return, inversely related to the rate of return on demand deposits, and positively related to wealth and income. Specifically, the demand function for government securities (on the part of subsector j) is given by

$$\frac{S_h}{R_S} = K(R_S, R_D, (1-k)W, (1-k)\delta y) \tag{1}$$

where

W = initial stock of financial wealth, exogenously given

S_h = household holdings of government securities (number of consols paying \$1/yr. in perpetuity)

R_S = rate of return on government securities

R_D = interest rate paid on demand deposits, exogenously set at the binding constraint

y = nominal aggregate income, assumed to be exogenously given

δ = proportion of nominal income held as financial wealth (current savings).

Subsector j's demand function for deposits, D_{hj}, is then equal to the remainder of this sector's wealth:

$$D_{hj} = (1-k)W + (1-k)\delta y - N - \frac{S_h}{R_S}$$

where

N = the initial net worth of the banking system, exogenously given.

Also $K_1 \equiv \partial K/\partial R_S > 0$, $K_2 \equiv \partial K/\partial R_D < 0$, $K_3 \equiv \partial K/\partial(1-k)W > 0$, $K_4 \equiv \partial K/\partial(1-k)\delta y > 0$. Finally it is assumed that household subsector j holds positive amounts of both demand deposits and government securities.[2/]

With regard to household subsector i, its holdings of demand deposits are equal to its entire financial wealth,

$$D_{hi} = kW + k\delta y.$$

Therefore total household demand deposits, D_h, are the sum of demand deposits held by subsector i and subsector j:

$$D_h = D_{hi} + D_{hj}$$

$$= kW + k\delta y + (1-k)W + (1-k)\delta y - N - \frac{S_h}{R_S}.$$

$$= W + \delta y - N - \frac{S_h}{R_S}.$$

Non-financial Firms

Turning to the specification of the firm sector, firms demand loans and deposit the proceeds in the bank. Loan demand is assumed to depend on the interest rate on loans and on aggregate income:

$$L^d = L^d(R_L, y) \tag{3}$$

$$D_f = L^d \tag{4}$$

where

L^d = firms' loan demand

R_L = the interest rate on business loans

D_f = firm's holdings of demand deposits

and

$$L_1^d \equiv \partial L^d / \partial R_L < 0 \quad L_2^d \equiv \partial L^d / \partial y > 0.$$ [3/]

Government Securities Market

The stock of government securities is determined by the size of the government debt and is assumed to be exogenously given. This stock of securities is held by households in the amount S_h and by the banking system in the amount S_B. Further, although the Central Bank is not explicitly modeled, presumably it affects the supply of government securities available for purchase. When the Treasury issues securities, the Central Bank purchases its desired amount, leaving the remaining securities for the public and the banking system. S as used in the model is this net stock of government securities.

<u>The Banking Sector</u>

The last sector to be specified is the banking sector. This model of the banking firm is viewed as representing the banking system. A bank is assumed to maximize its profits and to operate in perfectly competitive loan and security markets. In the deposit market it is assumed that banks must pay a fixed rate on demand deposits. With the household sector choosing to hold a portion of its wealth as demand deposits, the bank can then choose to supply loans, earning a rate of return R_L, or it can choose to hold government securities, earning a rate of return R_S.

Loans issued to firms are assumed to remain within the banking system so that the balance sheet identity in a T-account framework is

A		L	
Reserves	R	D	Total demand deposits
Securities	$\frac{S_B}{R_S}$		
Loans	L	N	Net Worth

or in equation form,

$$R + \frac{S_B}{R_S} + L = D + N \tag{5}$$

where

R = bank reserves

S_B = number of government securities held by the bank (number of consols paying $1/yr. in perpetuity)

L = loans to the business sector

N = net worth of banking system, assumed constant.

Total demand deposits, D, can be written as

$$D = D_h + D_f. \tag{6}$$

Finally, there is an exogenous reserve requirement, ρ, on the bank's holdings of demand deposits which requires that

$$\rho D \leq R \tag{7}$$

where

$$0 < \rho \leq 1.$$

The Bank's Objective Function. The bank determines its loan supply function and its securities demand function by maximizing profits with respect to its choice variables, L and S_B. The objective function is defined as

$$\Pi = R_S\left(\frac{S_B}{R_S}\right) + \lambda(L)(1+R_L)L - L - C(L) - R_D D_h. \tag{8}$$

The function $\lambda(L)$ reflects the fact that a certain portion of the bank's loans, $(1 - \lambda)$, will default. The non-default rate, λ, is assumed to be a non-increasing function of loans such that

$$\lambda'(L) \leq 0, \qquad \text{and} \qquad 0 \leq \lambda(L) \leq 1.$$

$C(L)$ is the cost of issuing and servicing loans and it is assumed that this cost increases as the amount of loans increases and at a nondecreasing rate so that $C' \geq 0$ and $C'' \geq 0$.

Note that in fact (7) can be rewritten as an equality: suppose $\rho D < R$, given D, N and L. Then, from (5)

$$R = D + N - L - \frac{S_B}{R_S}$$

and the bank can continue to satisfy its balance sheet constraint and reserve requirement by using its excess reserves to purchase government securities. With $R_S > 0$ this would increase bank profits. Hence the bank (i.e. the banking system)[4/] will always have an incentive to satisfy the reserve requirement as an equality. Equation (7) can then be written

$$\rho D = R. \tag{7'}$$

Moreover, in this model, there would be no reason for anyone--either households or banks--to hold government securities if R_D were greater than R_S.[5/] Thus $R_S \geq R_D$ must characterize the equilibrium.

Further, from the bank's point of view (6) can always be written as

$$D = D_h + L. \tag{6'}$$

Then (7') and (6') imply that (5) can be written as

$$\rho(D_h+L) + \frac{S_B}{R_S} + L = (D_h+L) + N$$

or

$$\frac{S_B}{R_S} + \rho L = (1-\rho)D_h + N. \tag{5'}$$

Substituting (6') and (5') into the profit function for D and $\frac{S_B}{R_S}$, respectively, the objective function contains explicitly the single decision variable, L. It is assumed that the optimal loan supply curve is determined from the first order condition

$$\frac{d\Pi}{dL} = -R_S\rho + (1+R_L)(\lambda(L)+L\lambda'(L)) - 1 - C' = 0.$$

or

$$(1+R_L) = \frac{1+\rho R_S+C'}{(\lambda(L)+L\lambda')}. \tag{9}$$

That is, the first order condition is satisfied for some value of L in the open interval

$$(0, (\frac{1}{\rho}(1-\rho)D_h + N)).$$

Further, to guarantee a maximum solution, it is assumed that

$$\frac{d^2\Pi}{dL^2} = (1+R_L)(2\lambda'+L\lambda'') - C'' < 0.$$

Finally, from (9), the loan supply function can be written

$$L^s = L^s(R_S,R_L) \tag{9'}$$

where

$$L_1^s \equiv \partial L^s/\partial R_S < 0 \qquad L_2^s \equiv \partial L^s/\partial R_L > 0.$$ [6/]

The bank's demand curve for government securities is then

$$\frac{S_B}{R_S} = (1-\rho)D_h - \rho L^s + N.$$

It is useful, at this point, to examine the relationship among R_L, R_S and R_D. Since the economics of the problem requires $R_L > 0$, it must be that $1+R_L > 0$. Equation (9) then implies that

$$\frac{1+\rho R_S+C'}{(\lambda(L)+L\lambda')} > 0$$

and since the numerator of the fraction above is clearly positive, it must be that

$$\lambda(L) + L\lambda'(L) > 0.$$

But even this is not sufficient to characterize the equilibrium. Consider, for example, the special case $C' = \lambda' = 0$, $\lambda = 1$. Then, at the optimal L, (9) implies that $R_L = \rho R_S$. This result cannot be taken seriously, however, because it implies $R_L < R_S$ in equilibrium. If $R_L < R_S$ the last dollar a bank has invested in loans could be shifted to the government securities market with a resulting increase in bank profits. With loans being subject to direct costs and a default risk, the representative bank would close its loan department unless $R_L > R_S$. The equality $R_L = \rho R_S$ can be understood from the perspective of the banking system since, from (5'), a fully loaned up system can acquire only ρ in government securities for each \$1 of loans not made. But no individual bank will loan out \$1 unless $R_L > R_S$. The economics of the problem thus requires that R_L exceed R_S, so that the three rates involved in this analysis must satisfy the relation

$$R_L > R_S \geq R_D.$$

As a more realistic example, suppose that $\lambda = \bar{\lambda}$, where $\bar{\lambda}$ is a constant and $0 < \bar{\lambda} < 1$. Then with $C' = 0$ and $\lambda' = 0$ equation (9) implies that the optimal L satisfies

$$1 + R_L = \frac{1+\rho R_S}{\lambda}.$$

For $R_S = .05$, $\rho = .1$ and $\bar{\lambda} = .9$,

$$1 + R_L = 1.12$$

$$R_L = .12$$

so that indeed R_L is greater than R_S. Further for $C' > 0$ and $\lambda' L < 0$ the case becomes even stronger that $R_L > R_S$. Henceforth, we assume that the internal optimum satisfies the economic requirement $R_L > R_S \geq R_D$.

Equilibrium Conditions

Note that the bank determines its demand for government securities, S_B, and the public determines its demand for securities, S_h. In the loan market, firms have a desired demand for loans, L^d, and banks have an optimal loan supply function, L^s. These two markets, the securities market and the loan market, adjust simultaneously to determine the equilibrium interest rates, R_S and R_L. Explicitly, the equilibrium conditions are

$$\frac{S_h}{R_S} + \frac{S_B}{R_S} = \frac{S}{R_S} \tag{10}$$

$$L^d = L^s. \tag{11}$$

Before turning to the examination of an open market operation, it is worthwhile to summarize the economics of the entire model: individuals are endowed with an initial financial wealth, which is divided between demand deposits, government securities and bank net worth. Banks are endowed with an initial net worth and, given household demand deposits, banks choose to hold some quantity of government securities, earning a rate of return R_S, and to supply loans to firms, earning a rate of return R_L. A certain percentage of loans is not repaid and that percentage increases with the amount of loans extended. (Hence, λ, which is defined as the percentage of loans which <u>are</u> repaid, is a decreasing function of loans). Banks choose their optimum loan supply curve and security demand curve by maximizing profits subject to a balance sheet identity and subject to being fully loaned up. In other words, in this model, banks earn maximum profits by holding only enough reserves to cover their reserve requirements. Thus, a bank technically only chooses its loan supply curve. Its demand for securities is residually determined.

With individuals and banks having a demand for securities and with a fixed supply of securities, the interest rate on securities (R_S) adjusts to equilibrate the demand for and supply of securities (simultaneously determining the equilibrium interest rate R_S). Similarly in the loan market, the demand for and supply of loans equilibrate, determining the market clearing interest rate R_L.

The Comparative Statics of an Open Market Operation

The final step in this analysis is to consider an increase in the supply of government securities with initial wealth held fixed. In other words, suppose there is an open market sale of securities. What is the effect on the equilibrium interest rates, R_S and R_L? This result will then be compared to the same experiment when the model is extended to include a money market fund.

In equilibrium the 11 equations which make up the system reduce, via a series of substitutions, to the two market clearing conditions, (10) and (11), defined explicitly as

$$R_S K(R_S,R_D,(1-k)W,(1-k)\delta y) + R_S((1-\rho)D_h - \rho L^S(R_S,R_L) + N) = S \qquad (10')$$

$$L^d(R_L,y) = L^s(R_S,R_L). \tag{11'}$$

Totally differentiating the two equilibrium conditions results in,

$$\frac{dR_S}{dS} > 0 \tag{12}$$

$$\frac{dR_L}{dS} > 0.\underline{7/} \tag{13}$$

Further in this model M1 is defined as

$$\begin{aligned} M1 &= D = D_h + D_f \\ &= W + \delta y - N - K + L^d \end{aligned}$$

so that

$$\frac{dM1}{dS} = -K_1 \frac{dR_S}{dS} + L_1^d \frac{dR_L}{dS} < 0.$$

That is, an increase in the supply of government securities results in an increase in the equilibrium interest rates and a decline in the money stock, as one would expect.

A useful characterization of this open market experiment is the following. When there is an increase in the supply of government securities individuals initially buy them at the existing price. Individuals then realize they are not at an optimal position with the resulting demand deposit-security combination. As a result, the excess supply of securities is sold causing the price of securities to fall and interest rates to rise until the economy reaches a new equilibrium. Also, given that bank reserves are determined by the amount of household demand deposits, a decline in deposits means an initial decline in reserves of the same amount.

3. Model with a Nonbank Financial Intermediary

In this section a financial intermediary is added to the model and the comparative statics of an open market operation is compared with the result of Section 2. The role of the intermediary is to allow sector i access to the government securities market. Since household sector j can already hold government securities, it is assumed that sector j continues to purchase securities directly. The budget constraint for household sector i becomes

$$kW + k\delta y = D_{hi} + M_h$$

where

M_h = deposits in the money market fund.

The households demand for these deposits is assumed to be determined by

$$M_h = M_h(R_D, R_m, kW, k\delta y) \tag{14}$$

where

R_m = the interest rate paid on deposits held at money market funds

and $M_{h1} \equiv \partial M_h/\partial R_D < 0$, $M_{h2} \equiv \partial M_h/\partial R_m > 0$, $M_{h3} \equiv \partial M_h/\partial kW > 0$, $M_{h4} \equiv \partial M_h/\partial k\delta y > 0$.

Thus

$$D_{hi} = kW + k\delta y - M_h$$

and household demand deposits held in banks are defined as

$$D_h = D_{hi} + D_{hj}$$

$$= (kW+k\delta y-M_h) + (1-k)W + (1-k)\delta y - N - \frac{S_h}{R_S}$$

$$= W + \delta y - N - M_h - \frac{S_h}{R_S}. \qquad (2')$$

Firm behavior and Bank behavior do not change from the specification of Section 2 so it remains to specify the behavior of the money market fund.

Money Market Fund

A money market fund is a financial intermediary which accepts deposits from individuals (and businesses) and earns income by managing a bond portfolio. The fund also provides its depositors access to their deposits through some form of check-writing privilege and is therefore, in many ways, similar to a bank. The growing popularity of the MMF is the source of recent interest in the central question of this paper--the effectiveness of monetary policy. In actuality, a money market fund is a special case of a mutual fund and the mutual fund industry has a much longer history. In fact, it is more accurate to think of the model being developed here as representing the behavior of the mutual fund industry, including MMFs, since the greater degree of liquidity characteristic of an MMF is rarely the issue of critical importance. As will be seen, a major distinction between an MMF and a bank is that an MMF is not required to hold reserves against its deposits. And this is the case for non-MMF mutual funds as well.

The modeling of the representative MMF proceeds as follows. Household sector i determines its holdings of deposits in the MMF. The fund, in turn, can choose between holding government securities, earning a rate of return R_S, and other investments expected to earn a rate of return greater than R_S. These other investments can be thought of as foreign securities whose higher return is accompanied by a non-negligible risk of default, or as a portfolio of corporate bonds and other assets sufficiently diversified as to minimize risk but still yielding a rate of return generally above R_S. In other words, another distinction between an MMF and a bank is the former's ability to diversify its investment portfolio more widely than is the case of a bank, since a bank generally operates under greater geographic and regulatory constraints. Notationally, the model uses F_m to refer to the MMF's holdings of these other investments and R_F to refer to their yield, thus suggesting their identity as foreign securities. But the reader should keep a broader interpretation in mind.

In a T-account framework the balance sheet identity for the money market fund is

	A	L	
Government Securities	$\frac{S_m}{R_S}$	M_h	Deposits
"Foreign" Securities	F_m		

or in equation form

$$\frac{S_m}{R_S} + F_m = M_h.$$

It is assumed that the MMF is willing to supply all the deposits demanded, M_h, at the interest rate R_m. The fund pays at least the demand deposit interest rate, R_D, plus some function of the differential between the government security's rate and the demand deposit interest rate. Specifically R_m is specified as

$$R_m = R_D + \gamma(R_S - R_D), \tag{15}$$

where γ is a decision variable for the MMF.[8/] With the fund dividing its assets between government and foreign securities, the fund also chooses p, the amount of deposits held in foreign securities so that

$$F_m = pM_h. \tag{16}$$

and

$$\frac{S_m}{R_S} = (1-p)M_h. \tag{17}$$

The MMF's Objective Function. The MMF determines the interest rate paid on its deposits and the fraction of its assets held in foreign securities by maximizing profits with respect to its choice variables, γ and p. The objective function is similar to the bank's objective function and is defined as

$$\Pi_m = R_S\left(\frac{S_m}{R_S}\right) + \lambda_2(F_m)(1+R_F)F_m - F_m - R_m M_h \tag{18}$$

$\lambda_2(F_m)$ reflects the fact that a certain portion of the foreign securities will default. λ_2 is assumed to be a decreasing function of these securities so that

$$\lambda_2'(F_m) < 0 \quad \text{and} \quad 0 \leq \lambda_2(F_m) \leq 1.$$

The MMF's profits are maximized subject to the constraints (14), (15), (16), and (17). Substituting these constraints into the profit function, obtaining the first order conditions and solving the two first order conditions for the optimal values of γ and p results in

$$\gamma = \gamma(R_D, R_S, R_F) \tag{19}$$

$$p = p(R_D, R_F) \tag{20}$$

where

$$\gamma_1 \equiv \frac{\partial \gamma}{\partial R_D} < 0 \quad \gamma_2 \equiv \frac{\partial \gamma}{\partial R_S} < 0 \quad \gamma_3 \equiv \frac{\partial \gamma}{\partial R_F} > 0$$

$$p_1 \equiv \frac{\partial p}{\partial R_D} > 0 \quad p_2 \equiv \frac{\partial p}{\partial R_F} < 0.$$

Finally, since R_m is defined as

$$R_m = R_D + \gamma(R_S - R_D)$$

we have

$$\frac{dR_m}{dR_D} = (1-\gamma) + \gamma_1(R_S - R_D) > 0$$

$$\frac{dR_m}{dR_S} = \gamma + \gamma_2(R_S - R_D) > 0$$

$$\frac{dR_m}{dR_F} = \gamma_3(R_S - R_D) > 0.$$

That is, an increase in R_D leads the MMF to raise R_m in order to remain competitive with banks, while an increase in either R_S or R_F leads the fund to increase R_m in order to attract more deposits with which it can invest.

Equilibrium Conditions

In this version of the model, with the money market fund holding government securities, there is an additional demand for securities. Thus the equilibrium condition (10) becomes

$$\frac{S_h}{R_S} + \frac{S_B}{R_S} + \frac{S_m}{R_S} = \frac{S}{R_S} \tag{21}$$

and the loan market equilibrium condition (11) does not change. Substituting the explicit expressions for each of the functions in (21) and (11) the equilibrium conditions are:

$$R_S K(R_S, R_D, (1-k)W, (1-k)\delta y) + R_S((1-\rho)D_h - \rho L^S + N) + R_S(1-\rho)M_h = S \tag{21'}$$

$$L^d(R_L, y) = L^S(R_S, R_L) \ . \tag{11'}$$

The Comparative Statics of an Open Market Operation

The model now consists of the 11 equations from section 2 with (2') replacing (2) and (21) replacing (10). In addition the model includes equations (14) thru (20), with the additional exogenous variable, R_F, and the additional endogenous variables, $M_h, R_m, F_m, S_m, p,$ and γ.

Differentiating the equilibrium conditions (21') and (11') with respect to an increase in government securities results in:

$$\left.\frac{dR_S}{dS}\right|_2 \gtreqless \frac{dR_S}{dS}$$

$$\left.\frac{dR_L}{dL}\right|_2 \gtreqless \frac{dR_L}{dL} \text{ as } (\rho - p) \lesseqgtr 0.$$ 9/

The explanation for this result is as follows: the initial increase in the supply of government securities raises the interest paid on these securities. This leads to a higher interest rate paid on MMF deposits. With R_D fixed, household sector i lowers its demand deposit accounts, D_{hi}, and increases its holdings of MMF's, M_h. Hence the bank is forced to decrease its holdings of government securities S_B while the MMF can increase its holdings, S_m.

Now, due to the expansionary power of the banking system, the bank need only lower S_B by $(1-\rho)$ times the amount of decline in D_h. Since the MMF holds foreign securities in the amount p, S_m only rises by $(1-p)$ times the amount of increase in M_h. $(\rho-p) > 0$ implies that the amount of decline in S_B is less than the increased demand S_m. Overall the demand for government securities rises due to this reallocation. Hence the price of government securities falls and the interest rate rises by a smaller degree than in the case when MMF's don't exist. $(\rho-p) < 0$ results in the opposite story. Given that today (since 1980) the reserve requirement on demand deposits is 3% for the first $25 million in deposits and 12% above that amount, p need only be greater than .12 for the scenario with $(\rho-p) < 0$ to apply. That is, as long as the percentage of the MMF's assets held in foreign (or "other") bonds is not negligible, the presence of nonbank financial intermediaries leads to larger interest rate effects for a given open market operation.

Finally in this version of the model

$$M1 = D = W + \delta y - N - K - M_h + L^d$$

so that

$$\frac{dM1}{dS} = -K_1 \frac{dR_S}{dS} + L_1^d \frac{dR_L}{dS} - M_{h2} \frac{dR_m}{dS} < 0.$$

For equal interest rate changes, demand deposits fall by a larger amount than in the model without the MMF. This is because the increase in R_S leads the MMF to raise its deposit rate, R_m. The individuals in sector i take a portion of their demands deposits out of the bank and put them into the fund so that bank deposits fall by a larger amount than in the case without the fund. For interest rate changes that are larger than in the first model M1 falls by more, whereas for interest rate changes that are smaller, whether M1 falls by more or less depends on the size of the interest rate partial M_{h2}. Note also that in this model M2 is defined as

$$M2 = D + M_h = W + \delta y - N - K + L^d$$

which is exactly equal to M1 in the first model. Thus the condition under which M2 falls by more (or less) than the original M1 is analogous to whether the interest rates rise by more (or less) than in the original model.

Explanation of Results

The result of this section can be understood as a result of a change in the slope of the bond demand curve in R_S-S space. With an exogenous supply of securities, a less interest elastic demand curve implies a larger interest rate effect for a given increase in securities. This is the case if $(\rho - p) < 0$.

Further in this fixed price model an "LM curve" in R_S-R_L-y space can be derived where

$$\left.\frac{dR_S}{dy}\right|_2 \gtreqless \frac{dR_S}{dy}$$

$$\left.\frac{dR_L}{dy}\right|_2 \gtreqless \frac{dR_L}{dy} \text{ as } (\rho - p) \lesseqgtr 0.$$ [10]

When $(\rho - p) < 0$ the bond demand curve is steeper than in the case without the MMF and the LM curve is also steeper. This is because a less interest elastic bond demand curve implies that for a given increase in income a larger increase in the interest rate is needed to reequilibrate the bond market. This in turn implies less potent effects from fiscal policy and more potent effects from monetary policy.[11] Further as Roth (1985) discussed in his recent article, a steeper LM curve implies more interest rate volatility for a given monetary policy. This results again from the fact that for a given change in the money supply a larger interest rate change is needed to reequilibrate the bond market. Finally a steeper LM curve implies a flatter aggregate demand curve in P-y space. The flatter the aggregate demand curve the more a disturbance in aggregate supply will result in a change in income and the less it will result in a change in the price level. Perhaps the analysis of a steeper LM curve could be an explanation for the volatile interest rates experienced during the early 1980's, which to date have been inclusively studied (see Antoncic (1986)).

4. Conclusion

Using a more complete model of the financial sector and focusing on a particular type of financial intermediary-mutual funds, this paper supports Wood's conclusion that the existence of nonbank financial intermediaries leads to open market operations with larger effects on interest rates than in the case when these intermediaries do not exist. This conclusion suggests that the Federal Reserve should not be concerned with the development of this particular nonbank intermediary, in the sense that the presence of this institution does not result in less effective monetary policy. Finally, this analysis offers a possible explanation for the volatile interest rates experienced during the early 1980's.

FOOTNOTES

1. It is important to keep in mind that this paper is concerned only with modeling the financial sector. Hence the results here admittedly represent the partial equilibrium effect of changes in the financial sector. How these resulting changes affect the real sector, which in turn may have feedback effects on the financial sector, is an interesting avenue for further research.
2. A careful discussion of the derivation of the functions representing household sector behavior appears in Lown (1986).
3. Note that equation (4) is a simplification of a more complete firm sector specification. Accounting for the firm sector's capital stock and allowing firms to issue securities their budget constraint is $K + D_f = L^d + S_f^s$. If it is assumed that the securities issued by the firms exactly support the capital stock ($K = S_f^s$) we are left with equation (4).
4. The existence of a Federal Funds Market permits banks to eliminate excess reserves without the risk of violating the reserve requirement. Since borrowing and lending on the Federal Funds Market nets to zero (by definition) in the banking system, the Federal Funds Market does not appear in this model.
5. Households would still choose to hold demand deposits when $R_S < R_D$ if demand deposits provided required liquidity and/or some households simply had too little wealth to purchase even a single government bond. These issues are discussed more fully in Lown (1986).

6. Note that the L^s function could be augmented to include shift parameters from the cost and non-default rate functions. Additional comparative statics can be examined by including these shift parameters.

7. See Appendix A for a proof of this result.

8. In this version of the model it is assumed that the MMF sets the rate it pays on its liabilities. Another equally plausible assumption would be that R_m is market determined. This latter case is discussed in Lown (1986).

9. The notation $\left.\frac{dR_S}{dS}\right|_2$ refers to the derivative $\frac{dR_S}{dS}$ in case (2) (the model with an MMF) to distinguish it from the $\frac{dR_S}{dS}$ already derived for the model without an MMF and similarly for $\left.\frac{dR_L}{dS}\right|_2$. The proof of this result appears in Appendix A.

10. See Appendix B for a proof of this result.

11. A more detailed examination of the policy issue would involve a discussion of anticipated and unanticipated effects which is beyond the intent of this analysis.

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Appendix A

To sign the derivatives, (12) and (13), the equilibrium conditions are differentiated with respect to S:

$$\begin{bmatrix} R_S\rho K_1+\rho K+\rho N+(1-\rho)(W+\delta y)-\rho L^s-\rho R_S L_1^s & -\rho R_S L_2^s \\ -L_1^s & L_1^d - L_2^s \end{bmatrix} \begin{bmatrix} \frac{dR_S}{dS} \\ \frac{dR_L}{dS} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \quad \text{(A.1)}$$

so that

$$\frac{dR_S}{dS} = \frac{(L_1^d-L_2^s)}{DN} \quad \text{(A.2)}$$

$$\frac{dR_L}{dS} = \frac{L_1^s}{DN}. \quad \text{(A.3)}$$

DN is the determinant of the matrix on the left hand side of (A.1):

$$\begin{aligned} DN &= (R_S\rho K_1+\rho K+\rho N+(1-\rho)(W+\delta y)-\rho L^s-\rho R_S L_1^s)(L_1^d-L_2^s)-\rho L_1^s R_S L_2^s \\ &= (R_S\rho K_1+\rho K+\rho N+(1-\rho)(W+\delta y)-\rho L^s)(L_1^d-L_2^s)-\rho R_S L_1^s L_1^d. \end{aligned}$$

The numerators of (A.2) and (A.3) are negative and to sign the denominator, DN, note that

$$\rho K+\rho N+(1-\rho)(W+\delta y)-\rho L^s = \frac{S_B}{R_S} + \frac{S_h}{R_S} > 0$$

so that with $R_S\rho K_1 > 0$, we have

$$R_S\rho K_1 + \rho K + \rho N + (1-\rho)(W+\delta y) - \rho L^S > 0.$$

Also since

$$L_1^d - L_2^s < 0 \qquad\qquad \rho R_S L_1^d L_1^s > 0,$$

DN is negative so that (A.2) and (A.3) are positive.

To obtain the derivatives (22) and (23), (21') and (11') are differentiated with respect to S:

$$\begin{bmatrix} (\rho-p)[R_S M_{h2}(\gamma+\gamma_2(R_S-R_D))+M_h]+ & -R_S\rho L_2^s \\ R_S\rho K_1+\rho K+\rho N+(1-\rho)(W+\delta y)-\rho L^S-R_S\rho L_1^s & \\ -L_1^s & L_1^d - L_2^s \end{bmatrix} \begin{bmatrix} \frac{dR_S}{dS} \\ \\ \frac{dR_L}{dS} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \tag{A.4}$$

so that

$$\frac{dR_S}{dS} = \frac{L_1^d - L_2^s}{DN_2} \tag{A.5}$$

$$\frac{dR_L}{dS} = \frac{L_1^s}{DN_2} \tag{A.6}$$

where

$$DN_2 = DN+(\rho-p)[R_S M_{h2}(\gamma+\gamma_2(R_S-R_D))+M_h](L_1^d-L_2^s).$$

DN_2 denotes the determinant of equation system (A.4) while DN is the determinant of equation system (A.1).

Note that

$$DN_2 \gtreqless DN \text{ as } (\rho - p) \lesseqgtr 0$$

so that

$$\left.\frac{dR_S}{dS}\right|_2 \gtreqless \frac{dR_S}{dS}$$

$$\left.\frac{dR_L}{dL}\right|_2 \gtreqless \frac{dR_L}{dL} \text{ as } (\rho - p) \lesseqgtr 0.$$

APPENDIX B

PROOF OF THE RELATIONSHIP BETWEEN THE LM CURVES

To show

$$\left.\frac{dR_S}{dy}\right|_2 \gtreqless \frac{dR_S}{dy}$$

$$\left.\frac{dR_L}{dy}\right|_2 \gtreqless \frac{dR_L}{dy} \text{ as } (\rho-p) \lesseqgtr 0.$$

Note that

$$\begin{bmatrix} (1-\rho)(W+\delta y-K)+N-\rho L^S-R_S\rho L_1^S+\rho K_1 & -R_S\rho L_2^S \\ +(\rho-p)(R_S M_{h2}R_{m2}+M_h) & \\ -L_1^S & L_1^d-L_2^S \end{bmatrix} \begin{bmatrix} \left.\frac{dR_S}{dy}\right|_2 \\ \left.\frac{dR_L}{dy}\right|_2 \end{bmatrix}$$

$$= \begin{bmatrix} -(\rho R_S K_4+R_S(1-\rho)\delta+R_S(\rho-p)M_{h4}) \\ -L_2^d \end{bmatrix}$$

so that

$$\left.\frac{dR_S}{dy}\right|_2 = \frac{-(\rho R_S K_4+R_S(1-\rho)\delta+R_S(\rho-p)M_{h4})(L_1^d-L_2^S)-R_S\rho L_2^S L_2^d}{DN+(\rho-p)(R_S M_{h2}R_{m2}+M_h)(L_1^d-L_2^S)}$$

$$\left.\frac{dR_L}{dy}\right|_2 = \frac{AL_2^d-(\rho R_S K_4+R_S(1-\rho)\delta+R_S(\rho-p)M_{h4})L_1^s}{DN+(\rho-p)(R_S M_{h2}R_{m2}+M_h)(L_1^d-L_2^s)}$$

where

$$A = -[(1-\rho)(W+\delta y-K)+N-\rho L^s-R_S\rho L_1^s+\rho K_1+(\rho-p)(R_S M_{h2}R_{m2}+M_h)]$$

$$K_4 = \frac{\partial K}{\partial\delta y} > 0$$

$$M_{h4} = \frac{\partial M_h}{\partial\delta y} > 0$$

$$M_{h2} = \frac{\partial M_h}{\partial R_m} > 0$$

$$R_{m2} = \frac{dR_m}{dR_S} > 0$$

and

$$\left.\frac{dR_S}{dy}\right|_2 = \frac{dR_S}{dy}$$

$$\left.\frac{dR_L}{dy}\right|_2 = \frac{dR_L}{dy} \text{ for } \rho=p.$$

This proof proceeds for $(\rho-p)>0$ and shows that in this case $\left.\frac{dR_S}{dy}\right|_2 < \frac{dR_S}{dy}$. (The opposite case, $(\rho-p)<0$, is analagous, as is the proof for $\frac{dR_L}{dy}$.)

To show $\left.\frac{dR_S}{dy}\right|_2 < \frac{dR_S}{dy}$

or

$$\frac{-[\rho R_S K_4 + R_S(1-\rho)\delta + R_S(\rho-p)M_{h4}](L_1^d - L_2^s) - R_S\rho L_2^s L_2^d}{DN + (\rho-p)[R_S M_{h2} R_{m2} + M_h](L_1^d - L_2^s)}$$

$$< \frac{-(\rho R_S K_4 + R_S(1-\rho)\delta)(L_1^d - L_2^s) - R_S\rho L_2^s L_2^d}{DN} \tag{B.1}$$

note that (B.1) can be rewritten as

$$-DN\{[\rho R_S K_4 + R_S(1-\rho)\delta + R_S(\rho-p)M_{h4}](L_1^d - L_2^s) + R_S\rho L_2^s L_2^d\}$$

$$< -DN[(\rho R_S K_4 + R_S(1-\rho)\delta)(L_1^d - L_2^s) + R_S\rho L_2^s L_2^d] \tag{B.2}$$

$$+(\rho-p)[R_S M_{h2} R_{m2} + M_h](L_1^d - L_2^s)[-(\rho R_S K_4 + R_S(1-\rho)\delta)(L_1^d - L_2^s) + R_S\rho L_2^s L_2^d)].$$

Simplifying (B.2):

$$-DNR_S(\rho-p)M_{h4}(L_1^d-L_2^s) < (\rho-p)[R_SM_{h2}R_{m2}+M_h](L_1^d-L_2^s)$$

$$\cdot(-\rho R_SK_4-R_S(1-\rho)\delta(L_1^d-L_2^s) -R_S\rho L_2^sL_2^d)$$

or

$$DNM_{h4} < [R_SM_{h2}R_{m2}+M_h]((\rho K_4+(1-\rho)\delta)(L_1^d-L_2^s)+\rho L_2^sL_2^d) \tag{B.3}$$

since $-(\rho-p)(L_1^d-L_2^s)>0$.

Recall from Section 2 that

$$DN = [(R_S\rho K_1 + \frac{S_h}{R_S} + \frac{S_B}{R_S})(L_1^d-L_2^s)-\rho R_SL_1^sL_1^d]$$

so that (B.3) can be written

$$\begin{aligned}(R_S\rho K_1 + \frac{S_h}{R_S} + \frac{S_B}{R_S})(L_1^d-L_2^s)M_{h4} - \rho R_SL_1^dL_1^sM_{h4}& \\ < ((\rho K_4+(1-\rho)\delta)(L_1^d-L_2^s)+\rho L_2^sL_2^d)(R_SM_{h2}R_{m2}+M_h).&\end{aligned} \tag{B.4}$$

Thus it remains to be shown that the inequality (B.4) is true.

It is clear that

$$(R_S\rho K_1 + \frac{S_h}{R_S} + \frac{S_B}{R_S})M_{h4} > (\rho K_4+(1-\rho)\delta)(R_SM_{h2}R_{m2}+M_h) \tag{B.5}$$

since $\frac{S_h}{R_S} + \frac{S_B}{R_S} > M_h$ and $M_{h4} > \rho K_4+(1-\rho)\delta$.

It could be the case that $\rho K_1 < M_{h2}R_{m2}$ so that $R_S\rho K_1 < R_S M_{h2}R_{m2}$. Yet these latter values are small compared with $\frac{S_h}{R_S} + \frac{S_B}{R_S}$ and M_h so that the inequality (B.5) holds. Multiplying (B.5) by $(L_1^d - L_2^s) < 0$ results in

$$(R_S\rho K_1 + \frac{S_h}{R_S} + \frac{S_B}{R_S})(L_1^d - L_2^s)M_{h4} < (\rho K_4 + (1-\delta)\rho)(L_1^d - L_2^s)(R_S M_{h2}R_{m2} + M_h). \tag{B.6}$$

Finally, it is true that

$$-\rho R_S L_1^d L_1^s M_{h4} < \rho L_2^s L_2^d (R_S M_{h2} R_{m2} + M_h) \tag{B.7}$$

since the left hand side is negative and the right hand side is positive. Summing (B.6) and (B.7) gives us the inequality (B.4).