MACROECONOMIC MODELING OF MONEY, CREDIT, AND BANKING

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Although financial markets are very competitive, few economists use supply and demand to explain asset yields and quantities. Some instead focus on monetary aggregates, emphasizing deposit creation by banks but slighting interest rates, while others concentrate on interest rates but pay little attention to asset quantities. Each approach has difficulty analyzing a variety of important and interesting financial market events. While few academics use a supply-and-demand approach (some exceptions are Brainard and Tobin [1968], Friedman and Roley [1977], Hendershott [1977], and Tobin [1969]), many financial market participants believe that interest rates are determined by the supply and demand for credit, and closely monitor federal deficits, foreign capital movements, and household saving — influences that are conspicuously absent from conventional deposit-multiplication models and interest rate equations.

This paper compares a supply-and-demand model of financial markets to deposit-multiplier models, interest rate reduced forms, the textbook IS-LM model, and the credit market. A linear approximation is used to analyze a variety of events, and a nonlinear simulation model gives concrete examples of plausible events that simpler models find paradoxical: some events stimulate the economy but contract M1; open market purchases need not be multiplied by the banking system to be powerful; business-cycle fluctuations in tax revenue can have strong effects on financial markets; and increased intermediation can be contractionary.

A FRAMEWORK

Because we are interested in the effects of financial events on aggregate demand, we focus on the demand side of the economy, using a discrete-period model to facilitate analysis of the effects of saving and dissaving on financial markets. The model's balance sheets are shown in Table 1.[1] The entries in Table 1 are nominal flows — uses of funds are positive and sources are negative; variables with -1 subscripts are the stocks at the end of the previous period. We won't analyze the consequences of changes in the price level, inflation expectations, and inherited asset stocks and so have omitted these functional arguments.

TABLE 1
Balance Sheets

	Households	Non-financial Businesses	Private Banks	Treasury	Central Bank
Wages, profits and taxes	$T - Y$	Y	0	$-T$	0
Goods and services	$C[\overset{+}{Y - T}]$	$I[\overset{+}{Y}, \overset{-}{R}] - Y$	0	G	0
Cash and reserves	$A[\overset{+}{Y - T}, \overset{-}{S}, \overset{-}{R}] - A_{-1}$	0	$k(D - D_{-1})$	0	$-(H - H_{-1})$
Bank deposits	$U[\overset{+}{Y - T}, \overset{+}{S}, \overset{-}{R}] - U_{-1}$	0	$-(D[\overset{+}{(1 - k)R - S}] - D_{-1})$	0	0
Credit	$V[\overset{+}{Y - T}, \overset{-}{S}, \overset{+}{R}] - V_{-1}$	$-(E[\overset{+}{Y}, \overset{-}{R}] - E_{-1})$	$L[\overset{+}{(1 - k)R - S}] - L_{-1}$	$-(F - F_{-1})$	$B - B_{-1}$

Y =	national income	V =	household securities
T =	tax revenue	E =	business securities
C =	consumption spending	L =	bank loans
I =	investment spending	F =	Treasury securities
G =	government spending	B =	central bank securities holdings
A =	currency outside banks	R =	interest rate on securities
D =	bank deposits	S =	interest rate on deposits
H =	monetary base	k =	reserve requirement
U =	household deposits		

The first transaction row in Table 1 encompasses wages and profits distributed by businesses and taxes paid by households. The second row is purchases of goods and services, and, in the IS-LM tradition, aggregate demand, $C + I + G$, determines how much output Y firms produce, which is, in turn, how much income firms distribute as wages and profits [Smith, 1980a]. The last three rows encompass financial markets. Cash is the nation's monetary base: currency held by the public plus bank reserves. Bank deposits pay an interest rate S while credit pays an interest rate R. Households, businesses, and government finance much of their spending from internally generated funds—income, profits, and taxes, respectively. However, a substantial amount is financed externally, and much of this borrowing passes through financial intermediaries. "Credit" excludes the funds that flow into financial institutions (or between institutions) and includes the funds that flow out to finance spending since it would be double-counting to include both depositor loans to banks and bank loans to customers.

There are, of course, many different financial intermediaries and many types of deposits. Because our model emphasizes the consequences of shifts among assets with different reserve requirements, "deposits" include only transaction accounts, which, in the United States, are currently subject to a 10 percent reserve requirement. For our macroeconomic purposes, there is no difference between funds in a money market deposit account, a money market fund, or in T-bills and so these are all treated as direct purchases of securities.

Households allocate their disposable income $X = Y - T$ among commodities and three financial assets: $Y - T = C + A - A_{-1} + U - U_{-1} + V - V_{-1}$. Consumption depends only on disposable income. Asset demands are assumed to be gross substitutes, in that a higher deposit rate increases the demand for deposits and reduces the demand for cash and credit instruments, while a rise in the credit rate increases the demand for securities at the expense of cash and deposits. Using subscripts to denote partial derivatives, the adding-up restrictions are $C_X + A_X + U_X + V_X = 1$; $A_S + U_S + V_S = 0$; and $A_R + U_R + V_R = 0$.

Businesses distribute all income as wages and profits, and borrow to finance investment spending — which is encouraged by a high level of economic activity, but discouraged by high interest rates. The budget constraint $E - E_{-1} = I$ implies the adding-up restrictions $E_Y = I_Y$ and $E_R = I_R$. Banks provide credit by lending a fraction $1 - k$ of deposits. The fraction k held as idle reserves is determined by the central bank's reserve requirements, with excess reserves ignored. Since a dollar of deposits costs S and earns $(1 - k)R$, the bank supply of deposits hinges on the rate differential $Z = (1 - k)R - S$. The budget constraint $D = kD + L$ implies the adding-up restriction $L_Z = (1 - k)D_Z$.

This model encompasses several simpler models. We examine three of these and then show the extensions provided by our more general approach.

Deposit Multiplication

Those economists who focus on a monetary aggregate, such as M1, emphasize the deposits created by fractional reserve banking. Equilibrium of monetary base demand and supply (the third row in Table 1) implies $A + kD = H$, and rearrangement gives the multipliers for deposits,

$$D = \{1/(k + A/D)\}H \tag{1}$$

and for the monetary aggregate *M1*,

$$M1 = D + A = \{(1 + A/D)/(k + A/D)\}H \tag{2}$$

both of which depend on k (bank reserves relative to deposits) and on A/D (private currency holdings relative to deposits).[2] Deposits are a bank liability, matched on the asset side of the balance sheet by reserves and loans. The budget constraint $D = kD + L$ implies the loan multiplier

$$L = (1 - k)D = \{(1 - k)/(k + A/D)\}H$$

Any increase in bank deposits brings a corresponding increase in bank credit and appears unambiguously expansionary — but, as we will soon show, this is not necessarily so.

Interest Rate Trees

Other economists focus on quasi-reduced-form equations for interest rates, allowing assets to be imperfect substitutes and incorporating various demand and supply factors that influence interest rate differentials [Friedman and Roley, 1977]. For instance, the MIT-Penn model used for many years by the Federal Reserve equates U.S. monetary base demand and supply in order to determine the T-bill rate and then uses a "rate tree" to determine other interest rates. The bill rate influences the commercial paper rate, which influences the corporate bond rate, which influences the yields on commercial loans, municipal bonds, mortgages, and equity. Some rate branches depend on demand and supply factors: the municipal bond rate is affected by the ratio of commercial loans to time deposits and the commercial loan rate is affected by the ratio of commercial loans to bank deposits.

This approach is plausible and, indeed, may implicitly reflect the partial solution of demand and supply equations [Ando and Modigliani, 1975]. However, an explicit demand and supply approach can reveal inadvertently overlooked explanatory variables and yield valuable *a priori* information about parameter values [Smith, 1975; Smith and Brainard, 1976; Friedman, 1985]. In addition, reduced form equations for interest rates slight asset quantities that may be of interest, such as M1, bank loans, or total credit.

Credit

In the 1960s, Gurley and Shaw [1960] and Tobin [1969] argued for a "new view" of banking, insisting that a focus on deposit liabilities neglects bank assets, and thereby ignores half of the role of financial intermediaries — borrowing from some in order to lend to others. In our increasingly deregulated banking environment, with a plethora of near-moneys and near-banks, it is clear that there is more to financial intermediation than the size of a few liabilities in a few selected institutions. While deposit intermediaries are an important link between savers and investors, they are not the entire story. Currently, less than 30 percent of the aggregate outstanding credit in the United States is supplied by deposit intermediaries and only 17 percent of this is raised through transaction accounts. The remaining 70 percent consists of direct lending and intermediation by insurance companies, money market funds, and other non-deposit institutions.

Why do academics pay so much attention to money and so little to credit? One reason is the monetarist perception that there is a stable relationship between nominal GDP and money, somehow defined, that allows a central bank to stabilize aggregate demand by aiming at a money target. The apparent stability of M1 velocity in the 1970s encouraged the Fed's October 1979 decision to pay more attention to monetary quantities and less to interest rates. Its monetary targets were subsequently undermined by an unexpected collapse of M1 velocity in 1982, 1985, and 1986. After the 1986 surprise, the Fed stopped setting a target range for M1. A focus on the monetary base and/or deposits, neglecting overall credit, can be a misleading barometer of the economy, as we will now show.

THE MODEL'S SOLUTION

The model in Table 1 is an extension of the familiar IS-LM model, with deposits a third financial asset. Because there are three endogenous variables (Y, R, and S), the deposit market can be incorporated into the LM curve, bearing in mind that deposit market events can shift the LM curve and that the deposit rate itself changes as the economy moves along the LM curve.

An Augmented LM Curve

Using linear approximations for U and D, deposit equilibrium[3]

$$U_0 + U_Y Y + U_S S + U_R R = D_Z((1 - k)R - S)$$

implies

$$S = [-U_0 - U_Y Y + \{(1 - k)D_Z - U_R\}R]/(U_S + D_Z)$$

The substitution of the equilibrium deposit rate into the demand and supply for monetary base

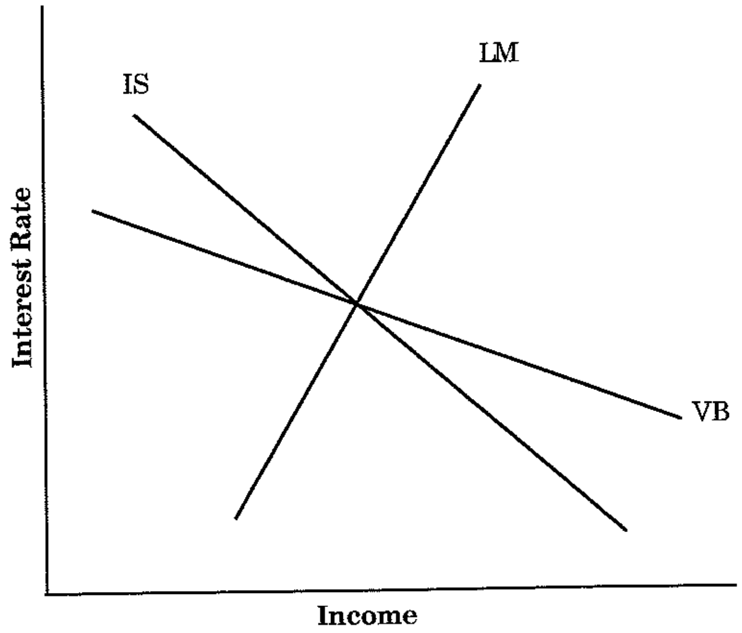
$$A_0 + A_Y Y + (A_R + k(1 - k)D_Z)R + (A_S - kD_Z)S = H$$

gives the augmented LM condition

$$\begin{aligned}(3)\quad & A_0 + \{(kD_Z - A_S)/(U_S + D_Z)\}U_0 + [A_Y + \{(kD_Z - A_S)/(U_S + D_Z)\}U_Y]Y \\ & + [A_R + k(1 - k)D_Z + (A_S - kD_Z)\{(1 - k)D_Z - U_R\}/(U_S + D_Z)]R = H\end{aligned}$$

Money demand is positively related to income Y, but the relationship to the credit rate R is not unambiguous. If the deposit rate is constant, an increase in the credit rate leads households to acquire more securities and to hold less cash and deposits. This decline in deposits reduces bank demand for reserves, so that the two components of monetary base demand, cash outside banks and bank reserves, both decline. In our deposit equilibrium model, an increase in the credit rate encourages banks to raise the deposit rate. With both interest rates up, the demand for cash outside banks falls, but bank deposits (and hence reserves) may increase. Banks will resist increas-

FIGURE 1
The IS, LM, and VB Curves



ing deposit rates as much as credit rates, because a fraction k of each dollar of deposits must be kept on reserve. If deposit rates don't keep up with security rates, then households aren't likely to reduce security holdings and any increase in bank deposits must be at the expense of cash (and the transfer of a dollar from cash to deposits reduces the net demand for monetary base by $1 - k$). In terms of our model's parameters, a sufficient condition to sign the effect of R on augmented money demand is

$$V_R + (1 - k)V_S \geq 0. \tag{4}$$

If the credit rate rises 1 percent and the deposit rate $(1 - k)$ percent, the net effect on securities demand is $V_R + (1 - k)V_S$. If this term is positive, then we can be certain that any increase in household deposits is not at the expense of securities and, as explained above, that the net demand for monetary base declines.[4]

With this assumption, the LM curve described by equation (3) gives a positively sloped relationship between Y and R. It is not certain whether the deposit rate rises with R along this LM curve: the increase in disposable income enlarges household demand for deposits, but the rise in R reduces household demand and increases bank willingness to supply deposits.

Tobin [1983a; 1983b] has argued that financial deregulation has steepened the LM curve, leaving the economy more vulnerable to purely financial shocks. He reasons that,

> The marginal costs of disintermediation are probably fairly constant over normal ranges of variation in the volume of bank deposits and assets. Thus the competitive deposit rate will be below the rates on bank loans and other assets by a fairly constant differential. The public's demand for deposits, on the other hand, depends principally on the interest differential and on transactions volume. If the differential becomes a constant, the demand for deposits will be independent of the *level* of interest rates. A rise in market interest rates will not reduce the demand for deposits as it does in the old regime and in the standard model, because the rate paid on deposits will rise too. [1983a]

However, an important intermediation cost is the foregone interest on required reserves, and this cost rises with the level of interest rates. The relevant interest rate differentials are $(1 - k)R - S$ for banks and $R - S$ for depositors. If banks hold $(1 - k)R - S$ constant, then, with a 10 percent reserve requirement, each percentage point rise in R pulls S up by only 90 basis points, increasing $R - S$ by 10 basis points and reducing the demand for deposits. The flexibility of deposit rates does have important implications for monetary theory, but does not necessarily make the LM curve steeper.[5]

The LM curve is shifted rightward by a central bank open market purchase and leftward by a shift in demand to cash from either deposits or securities. A shift in demand from securities to deposits also shifts the LM curve leftward, a contractionary effect that is not widely recognized.[6] Indeed, the deposit-multiplier logic is so firmly entrenched that many automatically assume that any enlarged demand for bank deposits must be expansionary. But this textbook conclusion only applies to a shift from cash to deposits. A shift from securities to deposits reduces the overall supply of credit because, unlike securities, deposits are subject to reserve requirements. We will return to this important distinction.

A Credit Market Curve

Although Walras' law implies that the credit market can be neglected, an explicit examination may clarify our understanding of the consequences of various economic events. A credit market equilibrium curve analogous to the LM curve above can be derived by using substitutions to eliminate the deposit rate from the deposit equilibrium equation. Equation (4) is a sufficient condition for the credit supply curve to be upward sloping, for much the same reasons given in conjunction with the LM curve. An increase in income has conflicting effects on the demand for credit. As income expands, household saving supplies additional credit and government tax revenue also swells, reducing their demand for credit. The one contrary influence is that a

TABLE 2
A Simulation Model

Households	
Taxes:	$T = -650 + 0.3Y$
Consumption:	$C = C_0 + .91_1(Y - T)$
Wealth:	$W = 5800 + Y - T - C$
Cash:	$A/W = A_0/W + 0.045 + 0.015l_2(Y - T)/W - 0.005l_3\ln(S) - 0.005l_3\ln(R)$
Deposits:	$U/W = U_0/W + 0.040 + 0.035l_2(Y - T)/W + 0.020l_3\ln(S) - 0.015l_3\ln(R)$
Securities:	$V/W = V_0/W + 0.915 - 0.050l_2(Y - T)/W - 0.015l_3\ln(S) + 0.020l_3\ln(R)$
Businesses	
Investment:	$I = 2Y/(l_4R + 8 + I_0)$
Banks	
Deposits:	$D = D_0 + 800l_6(R(1 - k) - S) - 150l_6(R(1 - k) - S)^2$

stronger economy increases business demand for credit. We assume here that, on balance, credit supply increases by more than demand when national income increases ($V_Y + T_Y > I_Y$). If so, credit equilibrium implies a downward sloping VB curve, as sketched in Figure 1.[7] As the economy moves down the VB curve, the deposit rate falls along with the interest rate on securities. The VB curve is shifted upward by an increased supply of securities or by a diminished demand, either a shift from securities to cash or from securities to deposits (a shift from direct to indirect credit supply, with reserve requirements absorbing funds and raising security yields). A shift in demand from deposits to cash also shifts the VB curve upward.

THE CONSEQUENCES OF VARIOUS EVENTS

This model can be used to examine the effects of a variety of economic events on interest rates and asset quantities. The algebraic analytics for a linear approximation are sketched in an appendix and discussed below. The nonlinear simulation model in Table 2 is used to illustrate and confirm the logic.

In the simulation model, the homogeneity in wealth for a given income-wealth ratio follows Tobin [1969]; we have omitted lagged asset stocks and other variables that are held constant. The marginal tax rate is 30 percent and the marginal propensity to spend out of disposable income is 0.9, with the remaining 10 percent of an increase in disposable income allocated among cash, deposits, and securities. The initial solutions for household cash, deposits, and securities are \$177 billion, \$399 billion, and \$5521 billion, respectively, while GDP is \$3325 billion, the credit rate 11.3 percent, and the deposit rate 9.4 percent. Interest rates are measured in percentage points in the demand equations, and (at the initial solution) a one-percentage-point rise in the deposit rate increases the demand for deposits by \$12 billion while reducing the demand for cash by \$3 billion and for securities by \$9 billion. A one-percentage-point rise in the yield on securities increases securities demand by \$10.3 billion, while reducing cash demand by \$2.5 billion and deposit demand by \$7.8 billion.

A \$100 billion increase in national income raises business investment by \$10.4 billion, while a one-percentage-point increase in the credit rate reduces investment by \$17 billion, from \$344.6 billion to \$327.6 billion. Bank deposit supply is a quadratic function of the interest rate differential. A one-percentage-point rise in this differential (from 0.56 percent to 1.56 percent) more than doubles bank deposit supply, from \$400.3 billion to \$883.0 billion.

These specific assumptions are consistent with econometric estimates and other simulation models (e.g., Friedman [1978; 1985]; and Smith [1980b]) and may provide some suggestive predictions of the consequences of a variety of economic events. To gauge the model's sensitivity, five key parameters l_i were allowed to vary by up to 50 percent, adjusting the appropriate intercepts to maintain the initial solution. The marginal propensity to consume out of disposable income was varied from 0.45 to 0.99, by letting l_1 range from 0.5 to 1.1, in steps of 0.1; the other four l_i ranged from 0.5 to 1.5 in 0.1 steps.

The parameters l_2 and l_3 vary the income and interest elasticity of money demand. The short-run income elasticity of M1 demand ranges from 0.14 to 0.35 and the elasticity of M1 demand with respect to R ranges from 0.11 to 0.31 if S is held constant and from 0.02 to 0.07 if S changes by $(1 - k)$ times the change in R. The parameter l_4 gives different interest elasticities of investment spending, ranging from 0.29 to 0.88; l_5 varies the interest elasticity of deposit supply from 0.43 to 1.30.

Each of seven events was simulated with 102,487 different combinations of values of the sensitivity parameters. Each cell in Table 3 shows three different results. The middle row in each set of three rows presents the base solution, with all $l_i = 1$. The upper row is the maximum value obtained for any combination of the parameter values; the lower row is the minimum value. Our discussion focuses on the base solution, with the minimum and maximum values gauging its robustness.

Increased Spending and Credit Demand

An increase in consumer, business, or government spending financed by the sale (or reduced purchase) of securities shifts the IS and VB curves rightward. Increased expenditures raise output, while the sale of securities to finance these expenditures pushes the credit rate upward. The change in the deposit rate is uncertain: the higher credit rate makes banks more eager for deposits and households less so, putting upward pressure on deposit rates; but the increase in national income enlarges saving and may expand household deposits enough to reduce deposit rates. Nor is the direction of change in deposits and M1 certain: the demand for money is enlarged by higher Y, diminished by higher R, and complicated by the uncertain change in S.

In our simulation model, it turns out that deposit rates, deposits, and M1 all rise. The first column of Table 3 shows the specific numbers accompanying a \$5 billion increase in government spending. National income rises by \$15.63 billion and tax revenue by \$4.69 billion, forcing the government to sell \$0.31 billion in securities. The

TABLE 3
Simulation Results

	$5 Govt Spending Financed by Bonds	$1 Open Market Purchase of Bonds	$1 Govt Spending + $1 Bond Purchase	Reserve Require. Down by .0025	$1 Shift in Demand from Cash to Bonds	$1 Shift in Demand from Cash to Deposits	$1 Shift in Demand from Deposits to Bonds
National	+23.69	+38.31	+41.93	+39.20	+38.31	+33.60	+4.65
Income	+15.63	+10.89	+14.03	+11.39	+10.89	+9.55	+1.33
	+5.29	+1.89	+3.52	+2.02	+1.89	+1.65	+0.23
Credit	+0.15	-0.10	-0.09	-0.10	-0.10	-0.08	-0.01
Rate	+0.05	-0.16	-0.15	-0.17	-0.16	-0.14	-0.02
	+0.01	-0.34	-0.33	-0.35	-0.34	-0.30	-0.04
Deposit	+0.13	-0.08	-0.08	-0.06	-0.08	-0.07	-0.01
Rate	+0.04	-0.14	-0.13	-0.12	-0.14	-0.12	-0.02
	+0.01	-0.30	-0.29	-0.28	-0.30	-0.27	-0.04
Bank	+1.09	+0.63	+0.75	+0.8	+0.63	+1.54	-0.88
Deposits	+0.58	-0.23	-0.12	+0.12	-0.23	+0.78	-1.01
	+0.23	-0.59	-0.52	-0.28	-0.59	+0.46	-1.08
Cash Plus	+0.96	+1.56	+1.67	+1.77	+0.56	+1.36	-0.77
Deposits	+0.51	+0.80	+0.90	+1.10	-0.20	+0.68	-0.89
	+0.20	+0.48	+0.54	+0.74	-0.52	+0.40	-0.96
Household	+2.94	+4.09	+4.52	+4.04	+5.09	+3.60	+1.49
Securities	+0.58	-0.03	+0.08	-0.30	+0.97	-0.01	+0.98
Purchases	-0.80	-1.37	-1.45	-1.54	-0.37	-1.20	+0.82
Bank	+0.96	+0.56	+0.66	+1.77	+0.56	+1.35	-0.77
Securities	+0.51	-0.20	-0.10	+1.10	-0.20	+0.68	-0.89
Purchases	+0.20	-0.52	-0.46	+0.75	-0.52	+0.40	-0.95
Central Bank Securities							
Purchases	0	+1.00	+1.00	0	0	0	0
Treasury	+3.41	-0.57	-0.06	-0.60	-0.57	-0.50	-0.07
Securities	+0.31	-3.27	-3.21	-3.42	-3.27	-2.87	-0.40
Sales	-2.11	-11.49	-11.58	-11.76	-11.49	-10.08	-1.40
Business	+2.27	+11.76	+11.87	+12.04	+11.76	+10.32	+1.43
Securities	+0.78	+4.03	+4.19	+4.21	+4.03	+3.53	+0.49
Sales	-1.38	+1.29	+1.41	+1.38	+1.29	+1.13	+0.16

expansion of national income increases household saving by $1.09 billion, of which $0.58 billion is used to buy securities and $0.58 billion is deposited in banks which, after reserve requirements are met, buy another $0.51 billion in securities. Business securities sales increase by $0.78 billion, as they are crowded into, not out of, financial markets.

An Open Market Purchase

A central bank purchase of securities increases the supply of money, shifting the LM curve rightward, and increases the demand for securities, shifting the VB curve downward. The credit rate falls and output increases. The deposit rate falls too, because the rise in output increases household deposits, reinforcing banks' diminished enthusiasm for deposits as the credit rate declines.

If deposit rates were fixed, as is the return on cash, then both cash and deposits would gain equally relative to assets whose market-determined rates are falling, and the ratio of cash to deposits might be roughly constant — so that the increase in the monetary base is reliably multiplied into an increase in deposits and the monetary aggregate as in equations (1) and (2). However, a flexible deposit rate declines, increasing the ratio of cash to deposits and reducing the deposit multiplier. The direction of change in deposits is theoretically ambiguous, though the monetary aggregate definitely increases if equation (4) holds.[8]

Table 3 shows the specific simulation results for a $1 billion open market purchase. Notice how little resemblance there is here to the textbook model of banks as creators of money. It is not money multiplication that converts $1 billion in monetary base into $4.03 billion in business credit; in fact, bank deposits and loans both contract. Increased corporate borrowing is accommodated by the stronger economy, which provides more saving by households and requires less borrowing by the Treasury. Those who sell securities to the central bank do not have to deposit the proceeds in banks for there to be a strong economic stimulus. Indeed, as we will soon see, the consequences are stronger the less bank intermediation takes place.

Monetized Deficits

Consider now an increase in government spending that the central bank monetizes with an open market purchase (or, equivalently, an increase in private spending financed by a diminished demand for cash). The VB curve is fixed, while the IS and LM curves shift rightward. Output increases and both the credit and deposit rates fall.[9] In Table 3, the central bank's $1 billion purchase plus the diminished Treasury sales provide $4.21 billion in additional credit availability. The household credit supply increases somewhat, while bank deposits drop slightly. Business investment and borrowing increase by $4.19 billion, with banks playing virtually no role.

A Reduction in Reserve Requirements

The ratio of bank reserves to assets in the United States has fallen substantially over the years (from 6.2 percent in 1970 to 3.5 percent in 1980 and 1.8 percent in 1990) as reserve requirements have declined and, more importantly, banks have been allowed to introduce liabilities that are subject to little or no reserve requirements. At the conclusion of World War II, nearly 70 percent of all bank funds in the United States came from transaction accounts. Now less than 25 percent does.

The 1980 Deregulation and Monetary Control Act and subsequent legislation accelerated these trends by reducing reserve requirements and by authorizing banks to raise funds in new ways. In 1983, the pendulum swung back to the extent that more attractive bank transaction accounts (subject to stiff reserve requirements) lured deposits out of money market funds with no reserve requirements. These sorts of developments make a big difference to the amount of credit flowing through financial institutions. A 10 percent drop in effective reserve requirements immediately frees about $5 billion of bank reserves, just as if the central bank had used open market purchases to increase the nation's monetary base by $5 billion. (For 1993 as a whole, the U.S. monetary base increased by about $35 billion.)

A comparison of the second and fourth columns of Table 3 shows that the consequences of lower reserve requirements and increased open market purchases are very similar. In an open market purchase, the central bank uses new money to purchase securities; when reserve requirements are reduced, private banks use newly freed money to buy securities. A drop in reserve requirements also widens the gap between $(1 - k)R$ and S, encouraging banks to seek more deposits for lending; this effort causes R to fall more and S not so much and, on balance, further stimulates the economy.

A Shift From Cash to Securities

Financial innovations have allowed many agents to hold less idle cash and more interest-bearing securities, either directly or indirectly through money-market funds and other means. The macroeconomic effects are identical to an open market purchase, because a reduced demand for cash and increased demand for securities is equivalent to an increased supply of cash and reduced supply of securities: the LM curve shifts rightward and the VB curve shifts downward.

A comparison of the second and fifth columns of Table 3 shows that the only difference is whether it is households or the central bank that acquires a billion dollars in securities. However, this unimportant distinction always creates a $1 billion difference in the behavior of M1, which turns out here to be the difference between an increase and a decrease. Although a demand shift from cash to securities is clearly expansionary, bank deposits and M1 both decline. Even if a deposit-multiplier model could correctly predict the drop in deposits and in M1, it would give the wrong signal about the effects on economic activity.

A Shift From Cash to Deposits

An increased availability of credit cards and automatic-funds-transfer systems reduces the demand for cash and increases the demand for interest-paying deposits. As discussed earlier, the LM and VB curves are both shifted downward by such an event. Deposit and credit rates both fall, while output expands. This is the usual story of banks as creators of money: a conversion of idle cash into deposits that will be loaned out, supplying credit, stimulates the economy. In Table 3 a $1 billion shift in demand from cash to deposits increases national income by almost as much as an open market purchase, because it is equivalent to a central bank decision to acquire $1 billion in deposits rather than securities — an action that is slightly less potent because deposits are subject to reserve requirements.

A Shift from Deposits to Securities

A shift from deposits to securities is expansionary because $1 billion in deposits is partly absorbed by reserve requirements and doesn't yield a full $1 billion in credit supply. The details are shown in the last column of Table 3. Once again, the LM and VB curves shift downward, for the reasons given along with the description of the LM and VB curves. Contrary to the moral of the bank deposit-multiplier model, disintermediation causes a substantial decline in bank deposits and M1, but is nonetheless expansionary.

One of the most important institutional developments in the United States in the late 1970s was the expansion of money market funds. If we consider these funds financial intermediaries, their increased importance reduced the average reserve requirements on financial intermediaries and it follows immediately that money market funds eased credit market conditions as surely as if legal reserve requirements had been reduced. Now think of money market funds as a thinly veiled direct purchase of business credit by individuals, with the fund merely acting as a securities broker: since money market funds expand credit, disintermediation expands credit. Another way to see this point is to consider a simple deposit-multiplier model in which the cycle of a deposit, loan, expenditure, and redeposit is interrupted after each expenditure by a direct loan and expenditure before the money is redeposited. The extra loan and expenditure during each round is expansionary, yet the deposit-multiplier model treats it a non-event.

Institutional developments (congressional legislation, judicial rulings, or new securities offered by financial entrepreneurs) that encourage direct lending in place of deposits that are subject to reserve requirements expand overall credit. Institutional developments that make deposits subject to reserve requirements more attractive relative to direct lending tighten credit markets. In 1982, 1985, and 1986, M1 surged in the United States while the economy muddled along — causing a large, unexpected drop in velocity. Many observers (e.g., Federal Reserve Bank of San Francisco [1985], Nuetzel [1987], Wenninger and Radecki [1985/86], and Yardeni and Johnson [1986]) attributed this velocity collapse to an asset swap by investors, from non-M1 assets into transaction deposits, and argued that such a shift wasn't necessarily expansionary if investors merely wanted to park their money and not spend it. The lesson of our model is that such asset swaps are actually contractionary.

CONCLUSION

James Tobin [1983a] has written that, "As deposits come to bear competitive interest rates, monetary theory ... will have to be rewritten." His "new view" of banks correctly argued for a balanced treatment of bank assets and liabilities. But bank assets are not the only source of credit. In the simulations conducted here, the credit market and, in particular, government saving and dissaving have prominence commensurate with the attention paid by financial market participants, and an understanding of financial market developments requires more than a myopic focus on a narrowly defined monetary aggregate.

Table 3 shows that no single monetary rule consistently gauges the change in aggregate demand accurately. The primary problem with interest rate targets is that shifts in the IS curve cause R to move procyclically, while LM shifts move R countercyclically. Thus increases in interest rates cannot be reliably associated with economic strength or weakness, an observation exploited by Poole [1970] and others. The same moral applies to monetary aggregates, to the extent their velocities are influenced by interest rates. When interest rates increase, rising velocity causes money to grow slower than GDP; when interest rates fall, velocity declines and money grows faster than nominal GDP. The first two columns of Table 3 illustrate how equally expansionary fiscal and monetary policies affect M1 differently. The last three columns show that shifts in asset preferences can cause wide disparities in the behavior of M1 and GDP.

After repeated exposure to partial-equilibrium deposit-multiplier models, most economists believe instinctively that it is deposit multiplication that makes monetary policies powerful, by converting high-powered money into a much larger amount of M1. But monetary policy can be powerful without deposit multiplication — indeed, such policies are *more* powerful the less deposit multiplication takes place; i.e., the more funds people invest directly, rather than through intermediary accounts subject to reserve requirements. Conversely, an increase in M1 caused by a shift to transaction accounts from assets not subject to reserve requirements tightens financial markets and is actually contractionary. Explicit models of supply and demand can help us understand financial markets and recognize some of the complexities that undermine simple-minded rules.

APPENDIX

Arbitrarily omitting the credit market, a linear approximation is

$$\begin{bmatrix} 1-C_Y-I_Y & -I_R & 0 \\ A_Y & A_R+k(1-k)D_Z & A_S-kD_Z \\ U_Y & U_R-(1-k)D_Z & U_S+D_Z \end{bmatrix} \begin{bmatrix} Y \\ R \\ S \end{bmatrix} = \begin{bmatrix} C_0+I_0+G_0 \\ H-A_0 \\ -U_0 \end{bmatrix}$$

The Jacobian determinant

$$|J| = (1 - C_Y - I_Y)[A_R U_S - A_S U_R + D_Z\{(1-k)A_R + (1-k)^2 A_S - k(V_R + (1-k)V_S)\}] + I_R\{A_Y U_S + A_Y D_Z - A_S U_Y + kD_Z U_Y\}$$

is negative if equation (4) in the text holds.

Matrix inversion yields these signs discussed in the text:

	$\Delta(C_0+I_0+G_0)$	ΔH	$\Delta H = \Delta G_0$	ΔA_0	ΔU_0	$\Delta U_0 = -\Delta A_0$
ΔY	+	+	+	-	-	+
ΔR	+	-	-	+	+	-
ΔS	?	-	-	+	?	-
ΔD	?	?	?	?	+	+
$\Delta M1$	?	+	+	?	+	+

NOTES

We are grateful for the very careful, helpful suggestions from the *Journal*'s referees.

1. Our model is most similar to Tobin [1969], though he does not include an IS curve and looks at only a few multipliers.
2. Miller [1980] shows how money-multiplier equations can be derived from a market equilibrium model, but doesn't pursue the comparative statics multipliers.
3. The term U_Y (and A_Y, V_Y, and C_Y analogously) is defined as follows: $U_Y = \{\delta U/\delta(Y-T)\}\{\delta(Y-T)/\delta Y\}$ When wealth is explicitly included in the asset demand equations, as in the later simulation model, $U_Y = \{\delta U/\delta(Y-T)\}\{\delta(Y-T)/\delta Y\} + (\delta U/\delta W)(\delta W/\delta Y)$
4. Multiplication of the coefficient of R by $U_S + D_Z$ and substitution of the adding-up restrictions $A_S + U_S + V_S = 0$ and $A_R + U_R + V_R = 0$ yields $A_R U_S - A_S U_R + D_Z\{(1-k)^2 A_S + (1-k)A_R - k(V_R + (1-k)V_S)\} < 0$
5. In a fixed-rate model, an increase in Y raises household demand for currency and deposits (enlarging bank reserves), while an increase in R has the opposite effects; the LM curve is positively sloped because increases in Y and R keep the demand for monetary base constant. As argued above, with a flexible deposit rate, the rate paid on deposits and even the quantity of deposits may either increase or decrease as we move along the LM curve, with higher interest rates on securities and higher levels of national income. Thus the effect on bank demand for reserves is ambiguous. Depending on the relative interest sensitivities of deposit and currency demands, the market adjustment of deposit rates can reinforce or offset the demand for monetary base, making the LM curve either flatter or steeper.
6. Equation (3) shows that the demand for money is enlarged by an increase in either A_0 or U_0, implicitly accompanied by a corresponding decrease in V_0, and also increased by a rise in A_0 and decline in U_0, holding V_0 constant.
7. If the VB curve is upward sloping, it still lies between the IS and LM curves, as drawn, because any point that is on the IS curve but below the LM curve has an excess demand for money and therefore an excess supply of securities, placing this point below the VB curve.
8. Benavie and Froyen [1982, 945] find that "under a flexible deposit rate all the monetary policy instruments considered here have an indeterminate effect on the money stock [M1]." Their model has a federal funds market, but no IS curve, assumes that output is exogenous, and uses continuous time, with fixed wealth, rather than discrete periods with wealth affected by saving.
9. An alternative interpretation of monetized deficits is that the deficit is financed by Treasury securities that are closer substitutes with money than with corporate securities. Friedman [1978] explores these issues by comparing a model with money, bonds, and capital to one with money, short-term bonds, long-term bonds, and capital. As there are no deposit intermediaries in his models, the focus is very different from ours.

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