

# "The effects of financial innovation on the instruments of monetary policy" \*

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Proper understanding of the effects on the instruments of monetary policy of changes in the technology of making and receiving payments has been marred by failure to observe three distinctions. One is the distinction between changes in technology that overcome regulatory and legal restrictions and changes that would occur in the absence of these restrictions. A second distinction is between money and credit, or more properly the distinction between technical changes or innovations that increase borrowing and lending and innovations that change the demand for and supply of money. A third distinction is between the immediate or impact effect on a particular type of institution and the full equilibrium effect on the economy. In this section, I discuss the first of these issues. The following sections distinguish between money and credit and analyze the impact and final effect of innovation on both money and credit.

I use the terms technical change and innovation as synonyms, but I distinguish two types of technical change. One

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is the substitution of capital for labor. The other is the growth of less regulated institutions relative to the growth of heavily regulated institutions. Within these two types of technical change, there is a need to distinguish some particular features of technical change in the arrangements for making and receiving payments, or for borrowing and lending, that give these changes some distinctive characteristics.

In financial markets and in the payments system generally, a principal form of capital is electronic equipment, and the principal type of substitution discussed is called electronic funds transfer. I accept this convention, although it should be pointed out that many of the changes that have occurred recently or are expected to occur in the future, differ little in broad aspects from the changes that have occurred when other means of communication improved during the past century.

#### *Inducements to Innovation*

Since making payments remains a labor intensive activity, one inducement to innovation is a rising real wage rate. When there is technical progress in non-financial sectors, wage rates rise in the economy. Financial firms compete in the labor market and pay the prevailing wage rates for labor. If there were no opportunities to substitute capital for labor intensive means of making and receiving payments, the cost of making payments would increase, so fewer payments would be made per unit of income produced.

Reducing the cost of making payments encourages individuals and firms to relate payments more closely to purchases. As examples, we have procedures introduced in recent years to deposit paychecks directly to bank accounts, to transfer payments to the seller at the time of purchase (point of sale) and to speed the settlement of interbank transfers.

In a competitive economy, the market directs resources to efficient uses. Producers of goods and services cannot forever pay more than the value of the marginal product

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of labor. Workers are attracted by wage rates to those uses where marginal products rise and deterred from entering occupations with falling marginal product. Capital is substituted for labor in those uses where cost reduction can be achieved.

In a non-inflationary economy much of the technical change in the payments system is induced by rising real wage rates. The speed with which innovations are introduced is governed by the future rise in real wage rates. Technical progress of this kind does not come suddenly, but occurs gradually. Gradual introduction does not imply steady progress at a constant rate of adjustment. It conveys evolutionary adaptation often in response to changes in real wage rates.

Computers and automation did not spread through the economy in a "cybernetic revolution" as some prophesied in the late 1950's or early 1960's. I find no reason to expect a sharp increase in the rate of labor saving technical progress in banking if the principal innovations continue to be the introduction into banking of labor saving computer based technology that has been available in non-financial firms for a decade or more.

The second type of innovation, entirely distinct from the first, is the result of legislation, regulation and inflation. Some of the principal regulations that induce innovation in the United States are:

- (1) prohibition of the payment of interest on demand deposits ;
- (2) maximum or ceiling rates of interest on time and savings deposits at banks and non-bank financial institutions ;
- (3) differences in reserve requirements for types of deposits and types of institutions ;
- (4) non-payment of interest on required reserves of banks ;
- (5) restrictions on lending and borrowing.

Many of these restrictions are found in other countries and innovation to circumvent the regulations and legislation is found also. The social benefit of innovation to circumvent regulation is, at most, equal to the efficiency loss from regulation. The private benefit to individuals or institutions from finding or developing substitutes rises with the rate of inflation.

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If banks and other financial institutions were permitted to pay interest on demand deposits and if there were no ceilings on rates paid on time and saving accounts, there would be fewer substitutes for demand deposits<sup>1</sup>. If there were smaller differences in reserve requirements on different classes of deposits, less effort would be devoted to supplying substitutes for commercial bank demand and time deposits. Fewer resources would be used to staff financial institutions and to circumvent regulations.

When examining the pace of innovation, we must separate those innovations that are induced by the high return to developers of unregulated substitutes for regulated activities. To assess the effect of innovation on the instruments of monetary policy and the speed with which the changes occur, we must recognize that regulation can eliminate particular types of institutions or financial assets by producing unregulated substitutes. Much of the effect of innovation on the instruments of monetary policy depends on the type of regulation carried into the future and on the rate of inflation. The higher rate of return to holders of deposits in unregulated institutions induces a shift of deposits to such institutions and away from banks and regulated thrift institutions that are prevented from raising interest rates as inflation rises.

Some assumptions about regulation and inflation are required, therefore, to analyze the long-run response to innovation in financial markets. If regulations are removed, or limited, interest rate payments on demand, time and saving deposits will change with the rate of inflation. Interest rate changes are a substitute for portfolio changes and for the costly process of developing substitutes that are less regulated. At the opposite extreme, maintenance of current regulations and continued inflation will produce a decline in the relative size and importance of existing institutions.

An efficient financial system does not require owners of assets to shift assets so as to avoid regulation. Changes

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<sup>1</sup> In the United States, money market mutual funds and Now accounts are two rapidly growing substitutes. A general treatment of innovation is in Silber.

in rates are a more efficient means of adjusting to changes in economic conditions. Ceilings on time deposits and savings deposits, and the prohibition of interest payments on demand deposits are inappropriate instruments of monetary policy and should be eliminated.

Some evidence on the speed and variability of technical change in banking and financial markets helps put the discussion in perspective. Innovation in financial markets either reduces the amount of money—both currency and demand deposits—held per unit of income, or increases the amount of money produced per unit of base money—currency of the public and total reserves of the banking system. In a fractional reserve banking system with a lower reserve requirement ratio for time than for demand deposits, a shift from demand deposits to time deposits and negotiable certificates of deposit, enables banks to produce more deposits and loans with the same dollar volume of reserves. If the use of credit cards increases transactions per dollar of currency and deposits, income at market prices rises relative to base money. Innovation raises the rate of growth of base velocity, although base velocity may rise for other reasons.

The annual percentage growth of base velocity for the United States in most of the years of this century is shown in Table 1. The data for the 21 years 1954-1974 show less variability than the data for the earlier years. The average rate of change is now higher but is more consistent. If these data reflect the effects of technical change in financial markets, they suggest that technical change in financial markets has been gradual.

#### *A Model of Credit and Money<sup>2</sup>*

In this section, I discuss the markets for money and credit on the assumption that rates of interest on time and

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<sup>2</sup> The analysis follows the Brunner-Meltzer frameworks as presented in a number of papers. References are included in the bibliography. Extensions of this analysis to the French economy have been made by E. ALPHANDERY, A. FOURCANS and J. MELITZ. P. KORTEWEG and P. van Loo developed the analysis of an open economy With fixed exchange rates.

TABLE I. — *Distribution of 62 Annual Positive and Negative*  
 Percentage Rates of Change in Base Velocity

Range	1900-40		1954-74	
	+	—	+	—
.000-.010	3	4	2	1
.011-.020	2	2	5	1
.021-.030	4	1	2	1
.031-.040	0	0	6	0
.041-.050	3	0	1	0
.051-.060	0	0	1	0
.061-.070	1	1	1	0
.071-.080	2	2	0	0
.081 +	7	9	0	0
	22	19	18	3

saving deposits are permitted to respond to prevailing economic conditions. The principle governing the adjustment of portfolios in response to innovation is that rates of return are equated by the market process for given degree of risk. Since the instruments of monetary policy are used to respond to fluctuations in output and to determine the rate of inflation, I do not assume that the economy is always at a long-run equilibrium. Further, I assume that fluctuating exchange rates are freely floating rates, so I am able to ignore any effects of the balance of payments on monetary policy and on money. Where the assumption of flexible rates is misleading the difference in implications is mentioned. The principal difference, of course, is the restriction on long-run monetary and fiscal policy imposed by fixed exchange

rates. With fixed exchange rates, no country can pursue monetary and fiscal policies inconsistent with the policies in the rest of the world.

Many of the institutional details of the money and credit markets and most of the effects of policy instruments differ for the stocks of money and credit. This section provides a framework that distinguishes the two stocks. Later sections use the framework to analyze the effects of policy instruments on the two stocks and to discuss the effects of innovation.

Wealth consists of three assets, base money,  $B$ , government debt,  $S$ , and real capital including durables, inventories and assets used in the process of production,  $K$ . Debt is valued at the current rate of interest, so  $vS$  is the current market value of debt. Capital is valued at a price,  $P$ .  $W$  is wealth at market prices. The balance sheets of the economy are shown in Figure 1.

FIGURE 1

Public		Central Bank and Government	
$B$			$B$
$vS$			$vS$
$PK$	$W$		

The amount of base money and debt outstanding is a record of past fiscal and monetary policies. Government deficits are financed by issuing base money or by selling bonds to the public. Often, the deficit is financed by selling bonds, then some portion of the bonds are bought by the Central bank, so the net effect is to issue bonds and base money to finance budget deficits and to withdraw bonds and base money to finance surpluses. In addition, the monetary

base records the cumulated balance of payments deficit or surplus, the history of past balance of payments positions. Balance of payments surpluses add to the base and balance of payments deficits reduce the base.

Open market operations are exchanges of base money for bonds. When the Central bank purchases in the open market, base money increases and securities are reduced. When the central bank sells, base money is reduced and the stock of securities held by the public increases. On the consolidated balance sheet of the government sector, shown in Figure 1, open market operations appear as offsetting changes in  $\beta$  and  $vS$ .

The demand functions for base money,  $\beta$ , debt (valued at market prices),  $vS$ , and capital,  $K$ , are shown in eqs. (1), (2) and (3).

$$(1) \quad B = \lambda \left( \bar{i}^+, \bar{P}^+, \dots, \bar{e}^- \right)$$

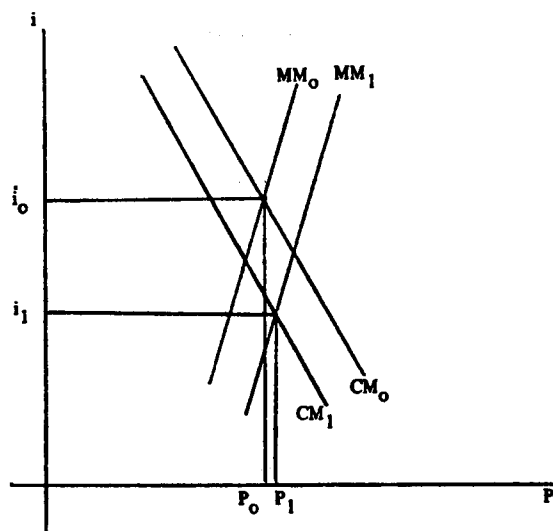
$$(2) \quad vS = \beta \left( \bar{i}^+ - \pi, \bar{P}^+, \dots, \bar{e}^- \right)$$

$$(3) \quad K = K \left( \bar{i}^- - \pi, \bar{P}^-, \dots, \bar{e}^- \right)$$

The + and — signs above the variables in the three demand functions indicate the response of  $B$ ,  $vS$  and  $K$  to the variables with which we are concerned. Two additional variables have been introduced,  $\pi$  the anticipated rate of inflation and  $e$  the anticipated return to real capital per unit of capital. Once any two of the stocks, the asset price level and the interest rate are determined, the third asset can be obtained using the market value of wealth. I use equations (1) and (2) to solve for  $i$  and  $P$  and the equilibrium values of  $\beta$  and  $vS$ .

Figure 2 shows the solution.

FIGURE 2



The *MM* curve of figure 2 shows the combinations of interest rates and asset prices at which a constant amount of base money is held. The curve is positively sloped to reflect the fact that higher interest rates offset the effect of higher asset prices on the demand for base money. The *CM* curve shows the combinations of interest rates and asset prices at which the outstanding stock of government debt is willingly held. The curve is negatively sloped to show that interest rates must fall as asset prices rise to induce the public to hold a given stock of government securities.

The asset markets are in equilibrium at  $i_0$  and  $P_0$ . At these prices, with given anticipations of inflation, the stocks of base money, government debt and capital are willingly held in portfolios. Open market purchases (or sales) exchange money for government debt and change the position of the *CM* and *MM*. The position of the system is shown, after an open market purchase, by the lines  $MM_1$  and  $CM_1$ . The increase in the base shifts *MM* and the reduction in the outstanding stock of debt shifts *CM*. The new

short-run equilibrium is at  $i_1$  and  $P_1$ . Interest rates fall and asset prices rise<sup>3</sup>.

The intersection of  $CM_1$  and  $MM_1$ , relative to the intersection of  $CM_0$  and  $MM_0$ , shows the impact effect of an open market purchase; the reverse movement shows the impact of an open market sale. The initial impact is followed by a change in the difference between current output and full employment output and a change in the price level. A rise in the price level reverses the movements of the two curves. Higher prices, following an open market purchase, raise interest rates and lower asset prices. The terminal equilibrium is in the neighborhood of the initial equilibrium, but differs from the initial equilibrium because the stock of base money is increased relative to the stock of debt. With fixed stock of real capital, interest rates are lower and asset prices higher after adjustment of prices and output.

The basic framework shown in figure II can be extended to include the principal instruments of monetary policy. These include reserve requirement ratios, interest rate ceiling, the rediscount rate and the various rules and regulations affecting reserve computation and discounting. The latter can be expressed as part of the reserve requirements or part of the price discounting, so in the interest of simplicity, the regulations are ignored.

A principal difference between the previous analysis and a more complete framework is the absence of banks and non-bank financial intermediaries. Figure 3 includes balance sheets for financial institutions and time deposits and loans from banks and intermediaries.  $L_b$  is bank loans, and  $L_{nb}$  is loans from intermediaries.  $R$  is the volume of bank reserves;  $A$  is the amount of borrowing from the central bank;  $T_b$  and  $T_{nb}$  are time or saving deposits at banks and non-banks respectively, and  $W_b$  and  $W_{nb}$  are the values of equity.

<sup>3</sup> The rise in asset prices reflects a restriction in the solution of the Brunner-Meltzer model from which these results are obtained. The interest response of the CM curve exceeds the interest response of MM.

FIGURE 3

Public		Banks		Non-Bank Intermediary		Central Bank and Government
$C_p$	$L_b$	$R$	$D_p$	$C_{nb}$	$T_{nb}$	$B - A$
			$D_{nb}$	$D_{nb}$		
$D_p$	$L_{nb}$	$L_b$	$T_b$	$vS_{nb}$		$S$
$T_b$		$vS_b$	$A$	$L_{nb}$	$W_{nb}$	
$T_{nb}$			$W_b$			
$vS$	$W_p$					
$PK$						
$W_b$						
$W_{nb}$						

The intermediaries function by buying assets and issuing liabilities. We can, of course, add liabilities and assets by introducing many specialized intermediaries but no analytic benefits are gained to offset the increased complexity.

Intermediaries hold demand deposits at banks ( $D_{nb}$ ) and a small amount of currency ( $C_{nb}$ ) in their tills. Most of their reserves are held as government debt,  $vS_{nb}$ . The wealth or net worth of banks and intermediaries is the market value of their charters. Since governments do not permit free entry into the industry, there are some potential monopoly profits accruing to banks and financial institutions.  $W_b$  and  $W_{nb}$  summarize these values.

One benefit to the public of having intermediaries is apparent. The public has a larger range of assets from which to choose. The underlying structure of the economy remains as in figure 1, and the wealth of the public is, after consolidation, the same as before. The stock of base money, net of bank borrowing, is now divided between currency and reserves. Redefine  $B$  as the monetary base net of borrowing.

$$(4) \quad C_p + C_{nb} + R - A = B,$$

and the stock of government debt is

$$(5) \quad S_p + S_b + S_{nb} = S.$$

The structure of claims and debts is built on these financial assets.

The presence of non-bank intermediaries increases the detail without adding any new elements. Decisions of the public to shift deposits from banks to non-banks can occur only if the non-banks are capable of paying higher returns. This can occur, for example, if there is increased demand for the type of assets acquired by the intermediaries,  $L_{nb}$ , or if the public accepts higher risk along with higher returns. Since no new types of assets or liabilities are introduced on the non-banks balance sheets, we can neglect the non-bank intermediaries for a time and analyze interaction between the public and the banks using a model of the money-credit process.

A model of the money-credit process differs in four principal ways from the model in equations (1) to (3). First, the monetary base consists of currency and reserves. Shifts between the two components alter the stocks of money and credit in different degree. Second, banks offer types of deposits that differ in maturity, turnover, and the rate of interest paid to holders. Shifts from one type of deposit to another, commonly called intermediation and disintermediation, change the stocks of money — defined as currency and demand deposits — and bank credit in opposite directions. Third, partly as a consequence of the regulation of interest rates paid on different types of deposits, changes in the level of interest rates affect credit and money in different ways. Fourth, differences in reserve requirement ratios and the non-payment of interest on required reserves encourage substitution between types of deposits. Banks and other financial institutions are encouraged to develop substitutes for demand deposits that have many properties of demand deposits but are subject to lower reserve requirements.

From the balance sheet of the consolidated banking system, we have, in the absence of non-bank, intermediaries, bank credit, or earning assets,  $E$ .

$$(6) \quad E = L_b + vS_b = D_p + T_b - (R - A) + W_b$$

Money is defined as:

$$(7) \quad M = C_p + D_p.$$

Since the monetary base,  $B$ , in the absence of non-bank intermediaries is  $C_p + R - A$ ,

$$(8) \quad E = M + T_b - B.$$

Equation (8) shows that from the definitions of credit and money, we obtain the implication that growth of time deposits (intermediation) increases credit relative to money. A simplified framework for analyzing the monetary system brings the role of institutional arrangements and the effects of policy instruments into sharper focus. I have used the institutional arrangements of the United States for illustration, but the system has been adapted to many institutional structure to many institutional structures, and to open economies with fixed and floating exchange rates. The details of the institutional structure are developed in the appendix.

A main implication of this type of analysis is that the production of deposits and the concomittant acquisition of earning assets by banks can be summarized in two equations.

$$(9) \quad M = m(i^+; i^+, \dots) B$$

$$(10) \quad E = a(i^+; i^+, \dots) B$$

It is convenient to represent institutional details and the influence of income and wealth on currency and time deposits by the missing terms in the expressions for the money and credit multipliers. Currency held by non-bank intermediaries,  $C_{nb}$  and deposits,  $D_{nb}$ , can be incorporated in the multipliers also, as shown in the appendix.

The credit market distributes the stock of debt between

intermediaries and the public. The public's supply of earning assets to banks,  $\sigma$ , is defined as

$$\sigma = L_b + v(S - S_p).$$

The equilibrium condition for the bank credit market is

$$(11) \quad a \left( \overset{+}{i}; \overset{+}{i^*} \dots \right) B = \sigma \left( \bar{i} - \pi, \bar{P}, \overset{+}{e}, \dots, \overset{+}{S} \right)$$

with signs of responses shown above the variables.

For the public, buying securities is an alternative to repaying loans, and selling securities is an alternative to borrowing. The amount of loans outstanding and the distribution of government securities between banks and the public is determined jointly with the stock of money and the public's desired holding of money.

Equation (12) is the equilibrium condition for the money market. The demand function for money is reproduced from equation (1). The stock of money now depends on market interest rates, yields on deposits, policy variables, income and wealth.

$$(12) \quad m \left( \overset{+}{i}; \overset{+}{i^*} \dots \right) B = \lambda \left( \bar{i}, \bar{P}, \overset{+}{e}, \dots \right)$$

Lastly, a price setting function determines the interest rate on time deposits. If non-bank intermediaries are analyzed, there is a separate price setting function for each type of deposit.

$$(13) \quad \bar{i}^* = i + \text{constant}$$

#### *Money, Credit and the Instruments of Monetary Policy*

The framework for analyzing the money and credit markets contains all of the principal instruments of monetary policy. Open market operations change the stocks of base money and government debt; changes in reserve requirement ratios and the discount rate change the money and credit multipliers,  $m$  and  $a$ . Ceiling rates of interest for time and saving deposits restrict the banks' choice of  $i^*$ . This section shows the responses to policy instruments.

FIGURE 4

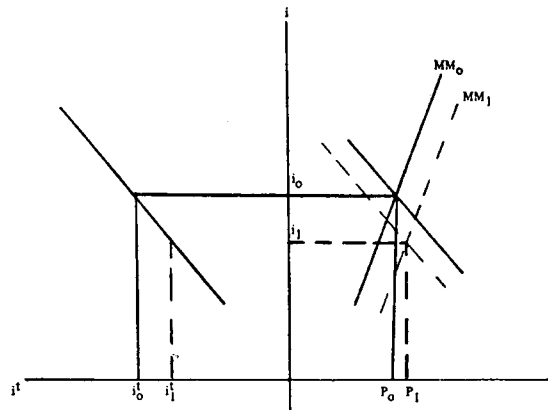


Figure 4 plots eqs. (11) to (13). The *MM* and *CM* curves in the right panel are similar to the curves in figure 2. The difference is that the curves now include policy instruments that were omitted previously. The *MM* curve shows the combinations of interest rates and asset prices that equate the demand for money to the stock of money supplied. The *CM* curve shows the combinations of *i* and *P* at which the credit market is in equilibrium.

The left side of the diagram shows the relation between interest rates on time deposits and rates available on the open market, equation (13). Whenever the open market rate of interest is above the rate paid on time deposits, owners of time deposits seek higher yields. They reduce time deposits and purchase debt for their portfolios. Banks (or other financial institutions) lose time deposits and, as the public acquires a larger share of the stock of outstanding securities, the banks' holdings of securities declines. In the terminology that has become common, there is disintermediation. Disintermediation continues as long as the rate on time deposits,  $i^t$ , is held below the level consistent with the market rate,  $i^4$ .

<sup>4</sup> If there is shift to foreign deposits, the exchange rate (domestic currency per unit of foreign currency) rises. Covered interest arbitrage then assures that the substitution discussed in the text occurs.

An equilibrium position is shown in figure 4. The rate  $i^*$  makes wealth owners indifferent between owning securities directly and holding time deposits at banks (or financial institutions). Interest rate  $i_0$  and asset price  $P_0$  sustain the distribution of assets between money, debt and capital and the distribution of wealth between assets and liabilities.

#### *Open Market Operations*

An open market purchase increases the base and reduces the stock of debt held by banks and the public. Both changes lower interest rates, and the combined effect of the operation increases asset prices<sup>5</sup>. The broken lines show the rate of interest and the asset price level following the open market purchase. These are initial effects.

Rates of interest on time deposits are unchanged at  $i^*$ , so the public acquires time deposits and sells securities on the market. The increase in money, the fall in the rate of interest and the rise in the asset price level increase expenditure and encourage borrowing at the lower rate of interest. Increased borrowing, in response to increased spending, shifts the *CM* curve to the right and the *MM* curve to the left, raising interest rates and asset prices. This process continues and produces the familiar cyclical pattern in output, price level, interest rates and asset prices. If the increased borrowing is financed in whole or part by increasing the monetary base and the stock of money, the timing and magnitude of the changes in  $i$  and  $P$  is altered.

Open market sales have opposite effects to open market purchases. The movement from  $P_1, i_1$  to  $P_0, i_0$  in figure 4 shows the impact effect of an open market sale. If interest rates on time deposits has been fully adjusted to  $i_1$ , time deposit rates are low relative to  $i_0$ . The public reduces borrowing from banks, acquires securities in the open market and reduces time deposits. A ceiling rate on time deposits, if effective, prevents the adjustment of time deposit rates to

<sup>5</sup> The increase in  $P$  occurs only if the interest response of the credit market is larger than the interest response of the money market. This appears to be true where empirical studies have been made.

prevailing market conditions. Zero interest rates on demand deposits have similar effects.

Conclusions drawn about the response to open market purchases and sales are similar to the conclusions reached earlier. The qualitative conclusions do not depend on institutional arrangements and do not change with innovation in the financial system. The conclusions depend on the change in the distribution of wealth between money, bonds and real capital and not on the structures of financial markets. Ceilings on interest rates and other institutional restrictions accelerate the development of substitutes when open market rates rise above the ceilings.

#### *Changes in Reserve Requirement Ratios*

The initial response to a change in reserve requirement ratios is qualitatively similar to the initial response to an open market operation. Increases in the average reserve requirement ratio reduce the money and credit multipliers, raise interest rates and lower asset prices. The banks sell securities on the open market and reduce loans; the public must absorb securities from banks. Reductions in reserve requirement ratios increase the money and credit multipliers, permitting banks to hold more securities and loans at a given monetary base and stock of debt. Interest rates fall and asset prices rise following the change.

The long-run effects of changes in average reserve requirement ratios are on the relative wealth of owners of banks and other assets. The higher are reserve requirement ratios, the smaller is the value of a bank charter relative to a charter in a competing financial institution that is subject to a lower reserve requirement ratio.

A similar conclusion is reached if we analyze changes in the reserve requirement ratios for time and demand deposits. An increase in the reserve requirement ratio for demand deposits relative to the reserve requirement ratio for time deposits lowers the flow of services that banks are willing to pay to hold a dollar of demand deposits. The public shifts from demand to time deposits and to deposits in non-banks that are subject to lower reserve requirement ratios. Banks

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encourage the substitution by offering higher interest payments and more services on the deposits subject to lower reserve requirements. The rate  $i^d$  rises. The effect of the shift, as seen by the banks, is the same as a reduction in the weighted average reserve requirement ratios. The reduction partially offsets the higher reserve requirement ratio for demand deposits posited at the start of the discussion.

Prohibition of interest payments on required reserves leads banks and financial institutions to seek substitutes for existing deposits. Payment of interest on required reserves at market rates reduces the incentive to supply substitutes but would not eliminate the incentive since the public, banks and financial institutions will evaluate risks differently in periods of expansion and contraction. To avoid shifts from one type of deposit to another, required reserve ratios should be uniform for all types of deposits at banks and non-bank institutions and interest should be paid on required reserves.

In figure 3 above, the net worth positions of banks and non-banks ( $W_b$  and  $W_{nb}$ ) are assets on the balance sheet of the public. Reserve requirements for banks and non-banks are a tax on the profitability of banks and therefore on the wealth of owners of banks and non-bank financial institutions. Differences in reserve requirement ratios can, in the long-run, eliminate one type of institution and replace it with another, but the differences do not eliminate the function or service. The service is provided in response to demand.

Changes in reserve requirement ratios are blunt tools that have effects on allocation of wealth and the production of substitutes for financial assets. The production of substitutes is an example of innovation to avoid regulation and is a waste of resources. Without regulation, the skilled resources would be used for more socially productive tasks.

#### *Setting Rediscount Rates*

Changes in rediscount rates also affect money and credit by changing the multipliers of money and bank credit. The qualitative effects of changes in the rediscount rate are much the same as the responses to open market operations and changes in reserve requirement ratios. Increases in the dis-

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count rate (or in the eligibility requirement for the paper discounted) lower the volume of discounts and reduce the stocks of money and bank credit.

### *Ceiling Rates on Deposits*

Ceiling rates of interest on time deposits and similar restrictions for non-banks prevent banks and financial institutions from adjusting to market conditions. Suppose an open market sale, increase in the reserve requirement ratios or other policy action to reduce money and credit has been undertaken. Interest rates rise and asset prices fall from  $i_1$   $P_1$  to  $i_0$   $P_0$  in figure 4.

The public responds to higher interest rates by withdrawing from time deposits and purchasing securities, contracting bank credit relative to the money stock. The bank credit multiplier declines, and the money multiplier expands as time deposits decline relative to demand deposits<sup>6</sup>. The net effect is to raise interest rates on the credit market and to encourage financial institutions to develop less restricted substitutes. The growth of Euro-currencies, commercial paper, money market funds, and other substitutes for time deposits is evidence of the working of this process in recent years. In the absence of a ceiling rate on time deposits, the time deposit rate would increase in figure 4. Existing financial institutions would lose fewer time deposits.

Regulation of interest rates on deposits may provide some short-run protection to particular deposit institutions at the expense of their depositors. Regulation of interest rates is not compatible with the long-run survival of these institutions if market rates for equivalent risks are, on average, higher than the rates paid to depositors.

Zero rates of interest on demand deposits are in all relevant respects similar in their effect to ceiling rates on time deposits. The long-run effects of the prohibition of interest payments encourage alternatives that avoid the restriction and eliminate institutions that are unable to offer substitutes.

<sup>6</sup> The appendix develops the responses to changes in the relative stocks of deposits.

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### *Some Comments on Innovation*

For many of the same reasons that the innovations we observe depend on the types of regulation we impose, the response to labor-saving innovation depends on regulation. A main conclusion of this study is that as the costs of regulation rise, substitutes develop that circumvent regulations. Hence, if the most efficient financial institution is a diversified institution offering a wide range of services, diversified financial institutions will develop. This does not mean that all institutions will be identical. Specialization will remain because the costs of providing identical services at all financial institutions generally exceeds the revenues that can be earned by suppliers.

### *Four Effects of Innovation*

If we assume that regulation does not continue to distort the allocation of reserves in the financial sector, we can draw some tentative conclusion about the effects of innovation. There are four major effects of innovation on the model of money and credit in previous sections. In this section, I briefly discuss the four effects and their implications for monetary policy.

#### *Reduction of Risk*

A major reason for financial innovation is to reduce risk. Current technology reduces the cost of storing information and thereby permits lenders to classify risks more accurately. In the future, risk will be reduced further if computers are extensively used to transfer payments from buyer to seller at time of sale. The cost of maintaining computer access for every seller and current information on every buyer is not negligible. These costs limit the rate of innovation.

Computers permit centralization of information, storage of borrowing and commitments, etc. Records of past payments experience reduce potential losses from non-payment. Those who benefit from assignment to a lower risk class find their costs of borrowing lower; in part, at least, their increased borrowing is offset by the reduced

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borrowing of those whose risk class is appraised as higher. There is no presumption that the aggregate volume of borrowing and lending increases or decreases.

*Changes in the Reserve Ratio and Float*

In the present payments system, there is a lag between the time checks are drawn and the time they are deposited at the account of the payee and a further lag before they are deducted from the account of the payer. The clearing of checks gives rise to float. Faster clearing reduces float.

Banks hold reserves in excess of requirements, partly, to accomodate check clearing. If automated clearing reduces the variability of deposit flows, banks reduce their demand for excess reserves.

A reduction in excess reserves relative to deposits raises the multipliers of money and bank credit and the stocks of money and credit. For the ratio of excess reserves to deposits to fall, excess reserves must fall proportionally more than deposits. Excess reserves are small relative to deposits, so a substantial reduction in the ratio seems unlikely.

*Changes in the Currency/Deposit Ratio*

Credit cards and other forms of *borrowing* at time of sale are substitutes for consumer credit, bank loans, and more traditional forms of borrowing. Credit cards substitute for currency payments and for check payments, so they change both the numerator and denominator of the currency ratio.

There are costs of using credit cards and transferring deposits, and these costs assure that some transactions will be made with currency in the future. If the distorting effect of a prohibition of interest payment on deposits were removed, the ratio of currency to deposits would not have risen as much as it has. A plausible argument can be made that if interest is paid on demand deposits, currency would have declined relative to deposits. A decline in the currency ratio raises the multipliers of money and credit, for a fixed monetary base. Bank credit rises relative to money. The effect is an increase in the market interest rate and most likely a decline in asset prices.

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*Changes in the Time Deposit Ratio*

Technology lowers the cost of transferring assets. A principal effect is to permit owners of assets to hold a large share of their wealth in the form of interest bearing deposits (or at higher interest rates if interest is paid on demand deposits.) In the absence of restrictions *and* differences in reserve requirement ratios, term to maturity becomes a main reason for differences in rates of interest paid on demand and time deposits. To the extent that technological change substitutes lower cost capital for higher cost labor in processing payments, the cost of managing assets falls. The maturity of deposits — demand and time together — increases. An increase in time relative to demand deposits increases bank credit and reduces the money stock — currency and demand deposits. The increase in credit is large relative to the decline in money, so interest rates and asset prices fall, the return to time deposits declines, and equilibrium is restored at a lower market rate of interest.

To these effect on risk and on the ratios that determine the value of the multipliers, some writers add an effect on overdrafts. An overdraft privilege is a type of credit — not money. Overdrafts become money when they are used to make payments.

My analysis reaches the conclusion that improvements in payments technology and an upward sloping yield curve reduce the equilibrium stock of money relative to the stock of credit. The substitution of overdrafts for deposits is one of the ways in which the adjustment of the two stocks occurs.

*Summary and Conclusion*

Analysis of the effects of innovation on the instruments of monetary policy reaches eleven main conclusions. Most of the conclusions are drawn from a model that incorporates explicit effects of the instruments and of intermediation.

(1) Distinctions between labor saving technical change and technical changes that circumvent existing regulation are not always observed in discussions of the effects of

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electronic funds transfer on the economy and on the instruments of monetary policy. Increased regulation and rising inflation together induce innovations that would not occur if rates of interest were permitted to adjust to inflation.

(2) Labor-saving technical changes reduce the cost of making and receiving payments. Technical changes that circumvent regulations are a waste of resources because they duplicate facilities that would be provided in the absence of regulation. They are the market's response to regulation, but resources could be saved if the regulations were removed.

(3) Much of the effect of innovation on particular institutions and on particular instruments of monetary policy depends on regulations, current and future. Some choices are necessary here. Prohibition of interest on demand deposits, regulation of interest on time and saving accounts, and differences in reserve requirements can eliminate particular assets or institutions. Reduction or elimination of regulation will reduce the number and kinds of financial institutions and financial liabilities.

(4) Innovation does not affect the usefulness of open market operations. The central banks can engage in open market purchases and sales and continue to have effects on the price level and on output by open market operations. Open market operations have been a principal instrument of monetary policy in many countries since the twenties. Technological change has not prevented central banks from using open market operation in the past and will not eliminate the effect of open market operations in the foreseeable future.

(5) Differences in reserve requirement ratios encourage substitution of one type of deposit for another. Banks and non-banks offer lower interest and/or fewer services on deposits that are subject to higher reserve requirement ratios and more interest and services on deposits subject to lower reserve requirement ratios. Differences in reserve requirement ratios encourage the growth of institutions and deposits subject to the lowest reserve requirement ratios relative to other instruments and institutions.

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(6) The effectiveness of reserve requirement ratios as instruments of monetary policy is reduced in the long-run by the tendency for deposits to increase at institutions subject to the lowest reserve requirement ratios. Reduced effectiveness is a consequence of innovation to avoid regulation. The public chooses deposits that offer the highest return in interest and services; the banks and financial institutions offer higher returns and services where costs, including reserve requirements, are lowest.

(7) Payment of interest on deposits and interest on *required* reserves would reduce innovation to avoid regulation. Differences in reserve requirement ratios, however, would continue to foster differences in the relative growth of deposits subject to different reserve requirement ratios unless interest payments on required reserves are adjusted frequently to reflect changes in market rates of interest.

(8) A simpler alternative is to make reserve requirement ratios the same for all types of deposits at banks and financial institutions, to pay interest on required reserve balances and to maintain reserve requirement ratios unchanged. Portfolio restrictions and tax rates should be the same for all institutions also.

(9) Innovation does not greatly alter the effectiveness of changes in rediscount rates. As long as reserves are supplied or withdrawn by changing the rediscount rate relative to the market rate of interest, rediscount policy remains effective.

(10) Ceilings for interest payments on time deposits and saving deposits and the prohibition of interest payments on demand deposits encourage innovation that has as its principal purpose avoidance of the restrictions. Restriction on interest payments should be removed to avoid waste of resources.

(11) Overdrafts are a form of credit, not money. Innovations that improve payments technology and an upward sloping yield curve increase credit relative to money. The use of overdrafts (borrowing) as an alternative to holding money (deposits) is one of the ways in which the adjustment is made.

## APPENDIX

## THE U.S. MONETARY SYSTEM

Banks' holding of reserves depends on the reserve requirement ratios and the distribution of deposits between type and size of deposits, locations of bank, and status of membership in the Federal Reserve System. The total required reserve is a weighted average with weighted average reserve requirement ratios for demand and time deposits respectively. Banks satisfy these requirements by holding deposits at Federal Reserve Banks and by holding currency. (Non-member banks hold currency also. Some of these details are neglected.)

Required reserves,  $R^r$  are defined by

$$R^r = r^d D_p + r^t T_b = \bar{r} (D_p + T_b)$$

and total reserves, net of borrowing, include required reserves and free reserves,  $f$ .

$$R - A = \bar{r} (D_p + T_b) + f(i, d) (D_p + T_b) \quad f_i < 0; f^d > 0.$$

The amount of free reserves held depends on the rate of interest,  $i$  and on the discount rate,  $d$ , including all terms and conditions and on the size of the bank.

The public's holding of time deposits relative to demand deposits rises when interest rates increase on time deposits and falls when market rates increase. The volume of time deposits rises relative to demand deposits as income or wealth increases. The prohibition of interest payments on demand deposits increase the effect of changes in interest rates and wealth ( $W_p$ ) on the ratio of time to demand deposits.

$$T_b = t(i^t, i, W_p) D_p \quad t_w, t_{it} > 0; t_i < 0$$

The rate of interest paid on time deposits responds to market rates in the absence of legal restrictions.

Division of money balances between currency and demand deposits depends on current income and perhaps on wealth, the age distribution of the population, the volume of illegal transactions and on transaction costs as in Hess. The currency ratio depends on each of these factors.

$$C_p = k D_p$$

Combining the equations for  $C_p$ ,  $T_b$ ,  $R$ , and  $A$  permits the money and credit stocks to be described in terms of multipliers that depend on policy instruments -  $r^d$ ,  $r^t$ , and  $d$ - the monetary base,  $B$ , the decisions of the public, expressed by  $k$  and  $t$ . The parameters  $k$  and  $t$  depend on technical changes affecting the payments system, and  $f$  depends on technical changes affecting the cost of transferring reserves.

By substituting in equation (4) of the text and rearranging terms, we obtain, first

$$D_p = \frac{1}{(\bar{r} + f)(1 + t) + k} B^a$$

Where  $B^a$  is the monetary base net of member bank borrowing. The stocks of money and bank credit can be expressed as the product of a multiplier and the monetary base.

$$M = mB, \text{ and}$$

$$L_b + vS_b = aB$$

The money and credit multipliers are rational expressions, denoted by  $m$  and  $a$ .

$$m = \frac{1 + k}{(\bar{r} + f)(1 + t) + k}$$

$$a = \frac{(1 + t)[1 - (\bar{r} + f)]}{(\bar{r} + f)(1 + t) + k}$$

The multipliers can be expanded to incorporate the non-bank intermediairies' holdings of currency and deposits at banks.

$$C_{nb} = k_2 D_{nb}$$

$$D_{nb} = k_3 T_{nb}$$

The ratios  $k_2$  and  $k_3$  depend on market rates on securities and on costs of transacting. Further,

$$T_{nb} = t_2 T_b$$

expresses the relation of the two types of depositors. The ratios  $t_2$  and  $t$  depend on the interest paid by intermediairies -  $i^t$ ,  $i_{nb}$  - on income, wealth and perhaps also on asset prices.

The additional detail changes

$$m \text{ to } m = \frac{1 + k}{(\bar{r} + f)(1 + t) + k_2 k_3 t_2 t + k}$$

and correspondingly for  $a$ .

Policy instruments other than the base, affect the stocks of money and credit by changing  $m$  and  $a$ . The reserve require-

ment ratios are included in  $\bar{r}$ ; the discount rate affects the free reserve ratio; interest ceilings affect the time deposit ratio,  $t$ ; all policy operations change market rates of interest, asset prices and eventually output and the price level. The ratios  $f$  and  $t$  depend on interest rates, whereas  $t$  and  $k$  depend on wealth and income, so the responses to policy feedback impulses to money and credit.

The detail incorporated in the multipliers extends the simpler framework of the money credit process described by equations (1) to (3) to include money of the institutional arrangements that characterize the U.S. financial system. These equations determine the stock of money, currency and demand deposits, and the stock of bank credit demanded by banks. The stock of money supplied replaces the fixed amount of base money in eq. (1). The demand for earning assets by banks replaces the demand for government debt in eq. (2).

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