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Liquidity Traps for Money, Bank Credit, and Interest Rates

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Liquidity Traps for Money, Bank Credit, and Interest Rates

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Few conclusions about economic events have been repeated as frequently or have had as much influence on economists' attitudes toward monetary policy as the assertion that the monetary system of the thirties was "caught in a liquidity trap." Empirical studies of the public's demand for money and the banks' demand for earning assets seemed to support the assertion about a trap and the closely related conclusion that monetary policy had no effect on output, employment, and prices during at least some part of the thirties. Conclusions about the occurrence of a trap and the ineffectiveness of monetary policy were reinforced by central bankers' statements that likened monetary policy to "pushing on a string." Taken together, the empirical evidence and the central bankers' interpretations convinced many economists that some form of a trap had existed (Keynes, 1936, p. 207; Fellner, 1948, pp. 81-83, 91-93; Villard, 1948, pp. 324, 334, 345; Shaw, 1950, pp. 283-85). 3

There are a number of reasons for re-examining these conclusions and reopening the discussion of liquidity traps. First, recent empirical studies

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1 On the trap in the demand for money, see Tobin (1947); for the trap in the banks' demand for earning assets, see Horwich (1963). The statement in the text might be modified to take account of the Pigou effect, but, as the Pigou effect is generally assumed to operate slowly and to be of little short-run significance, we will ignore it until the conclusion of the paper.

2 One excellent example is the statement of Marriner Eccles before the House Banking and Currency Committee; part of the statement is reproduced in n. 20 below.

3 Some of the writers cited, Keynes (1936) in particular, did not regard a liquidity trap as an event that was likely to occur. For an early statement denying the implications of a trap, see Warburton (1950).
of the demand for money by Bronfenbrenner and Mayer (1960), Brunner and Meltzer (1963), and Meltzer (1963a) contradict the earlier finding that there was a "trap" in the public's demand for money during the thirties. Second, both the behavior of interest rates and the responses of the banking system to the doubling of reserve-requirement ratios in 1936-37 are inconsistent with an explanation based on some form of trap. Interest rates rose after the doubling of reserve-requirement ratios but declined to lower levels thereafter. Banks, attempting to restore their excess-reserve positions, reduced earning assets and the money supply in the process. The decline in long-term interest rates after 1938 contradicts the statement that interest rates reached a "floor"; the reduction of earning assets and the increase in excess reserves are difficult to reconcile with the notion that banks regarded excess reserves as a redundant surplus. Third, an alternative interpretation of the behavior of the banking system in the late thirties has been offered. This interpretation attributes the banks' large accumulation of excess reserves to inept and inappropriate Federal Reserve policies which shifted the relation between desired excess reserves and interest rates (Friedman and Schwartz, 1963; Brunner and Meltzer, 1964a, 1964b; Brunner, 1965; Frost, 1966).

Traps have been said to affect interest rates, the banks' demand for excess reserves, the public's supply of loans to commercial banks, and the public's demand for money. Although each of these traps is said to prevent monetary policy from affecting output, employment, and prices, no attempt has been made to establish that conclusion for each of the traps. In most cases, the argument has not proceeded beyond the statement of an assumption that one or another elasticity is at an extreme value—zero or infinity. Such assumptions may be insufficient for the conclusion that monetary policy becomes powerless or may conflict with other implications of monetary theory. It is desirable, therefore, to investigate the conditions for and implications of various liquidity traps as a part of the theory of money.

* Statements about the various traps frequently are not separated carefully. An example that is typical of the treatment in many textbooks is provided by Maisel (1957, pp. 457-58): "Even if money is expanded in a contraction, it may not be a powerful enough weapon to end a deflation. There may be a credit deadlock. Banks have in the past carried large excess reserves for long periods without expanding the money supply. . . . If demand was lacking for other reasons, prospective borrowers would not borrow even if rates were cheap. A minimum interest rate will exist because of precautionary and institutional reasons. At this rate, investment may not be forthcoming."

* One the other hand, at some degree of liquidity people will probably spend. . . . This point, however, may require improbable additions to the money supply." A more succinct statement is contained in Burstein (1963, p. 378).

* This is less true of the traps in the demand for money than for the traps affecting the banking system. See Modigliani (1944) or Klein (1947). For an indication that the traps have generally been stated in terms of elasticities, see Bronfenbrenner and Mayer (1963), Fellner (1946, p. 81), and Shaw (1950, pp. 285 and 325).
LIQUIDITY TRAPS FOR MONEY, BANK CREDIT, AND INTEREST RATES

In this paper, we extend our recent work on the money supply (Brunner and Meltzer, 1964c, 1966) to discuss the interaction of money supply, bank credit, and interest rates. The following section outlines a theory of the monetary process, more fully developed in the appendixes, and uses the theory to explain differences in the cyclical behavior of money and bank credit. We then derive necessary and sufficient conditions for most of the liquidity traps that have been mentioned in the literature and separate the traps into (1) those that are incompatible with the theory and must be rejected if the theory is correct and (2) those that depend on the sign or size of particular parameters. A discussion of some empirical findings and a conclusion complete the paper.

The Interaction of Money Supply, Bank Credit, and Interest Rates

Changes in the money supply and bank credit are used extensively as measures or indicators of the direction of monetary policy. Since money and bank credit often move in opposite directions or change at different rates, the two measures provide different information about the direction of policy. Policy has been relatively more expansive during postwar recessions than during expansions when it is judged by changes in bank credit; it has been relatively more expansive during postwar periods of rising economic activity than during recessions when judged by changes in the stock of money. Although differences in the movements of money and bank credit appear to be systematic, no attempt has been made to link the two indicators in a theory of the money-supply process or to explain their divergent rates of change. This section outlines a framework that combines the banks' demand for earning assets (bank credit), the public’s supply of earning assets to banks, the money supply, interest rates, and the monetary-policy variables. We use the theory to discuss a number of liquidity traps in the following section.

Three variables are used to summarize monetary policy: the weighted-average reserve-requirement ratio, the rediscount rate, and the adjusted monetary base—currency plus reserves minus member-bank borrowing from the Federal Reserve. Allocation decisions of the banks and the public in response to interest rates, policy, and other variables proximately

6 From the start of the Federal Reserve System to the end of World War II, the money supply expanded at a much greater rate than bank credit, so that the ratio of bank credit to money supply declined by 50 per cent. From 1946 to 1964 this ratio moved in the opposite direction and rose by 50 per cent, so that during the first fifty years of the Federal Reserve the ratio of bank credit to money supply declined by only 25 per cent. During postwar half-cycles, the ratio of bank credit to money has generally fallen or grown less rapidly during periods of recovery and expansion and risen or grown more rapidly during cyclical recessions.

7 The principal sources of changes in the adjusted base are open-market operations and gold flows. The sources of the base are described in Appendix II.
determine the equilibrium stocks of money and bank credit. The framework suggests some reasons for the observed differences in the short-run movements of the money supply and bank credit and in the information provided by some of the monetary variables that have been used frequently as indicators of the direction of monetary policy. Appendix II contains a more complete statement of the hypothesis and the underlying assumptions; a glossary of symbols is provided in Appendix I.

The Supply of Money and the Banks’ Demand for Earning Assets

Equations (1) and (2) express the quantity of money supplied \( M_1 = K \) and the quantity of earning assets demanded by banks \( E_0 \) as the product of the adjusted base \( B^a \) and a multiplier, \( m \) or \( a \). The multipliers are assumed to depend on an index of interest rates \( r \) representing yields on loans, government securities, and other earning assets included in the banks’ portfolios; on the reserve-requirement ratios \( r^R \); and on other entities discussed in Appendix II.

\[
M_1 = m_i (i, r^d, \ldots) B^a. \tag{1}
\]

\[
E_0 = a(i, r^d, \ldots) B^a. \tag{2}
\]

Policy variables affect money and bank credit in two distinct ways, one direct, the other indirect. The direct effect of monetary policy is either (1) a change in the monetary \( m_1 \) and earning-asset \( a \) multipliers resulting from a change in the reserve-requirement ratio or in the rediscount rate or (2) the change in the base due to open-market operations. The indirect effect is the change in \( m \) and in \( a \) induced by the change in interest rates that results from the change in policy (that is, from the open-market operation, the change in a reserve-requirement ratio, etc.).

Interest rates are assumed to change the monetary and asset multipliers through three relations expressing desired ratios. (1) The ratio of desired excess reserves to total deposits is assumed to depend on market interest rates and on the rediscount rate. (2) A similar dependence is assumed for the ratio of the desired volume of member-bank borrowing to total deposits. The excess-reserve and borrowing ratios have been combined in a single ratio, the desired-free-reserve ratio, denoted \( f \). (3) The index of market interest rates, the interest rates paid by banks on time deposits, and other variables (see Appendix II) affect the public’s allocation of deposits between time and demand accounts. The ratio of time to demand deposits, \( t \), summarizes this allocation. The dependence of the multipliers on interest

* This subsection is a brief restatement of the argument in Appendix II. The interested reader should refer to the appendix for a more complete definition of the multipliers and a more complete statement of the effect of policy changes on the stocks of money and bank credit.
LIQUIDITY TRAPS FOR MONEY, BANK CREDIT, AND INTEREST RATES

5

rates results from their dependence on the \( f \) and \( t \) ratios and from the dependence of \( f \) and \( t \) on interest rates.\(^9\)

If policy operations, changes in interest rates, and changes in other components of the monetary and asset multipliers (see Appendix II) had an equal effect on both multipliers, the ratio of bank credit to money, denoted \( \beta \), would be constant. The differences in the size and direction of changes in bank credit and money discussed above indicate, however, that the ratio \( \beta \) varies over time. Since equations (1) and (2) are multiplicative, they can be written in logarithmic form. After differentiation, differences in the rates of change of \( E \) and \( M \) can be expressed as differences in the elasticities of the multipliers with respect to the variables on which the multipliers depend. The effect of interest rates and other factors\(^9\) on the difference in the relative rates of change of \( M \) and \( E \) is shown in equation (3), where \( \epsilon(a, i) \) and \( \epsilon(m_x, i) \) are the elasticities of the multipliers with respect to interest rates and \( \epsilon(a, x) \) and \( \epsilon(m_x, x) \) are elasticities of the multipliers with respect to other entities on which the multipliers depend. (The multipliers are discussed more fully below.)

\[
\frac{dE}{E} - \frac{dM}{M} = [\epsilon(a, i) - \epsilon(m_x, i)] \frac{dE}{E} + [\epsilon(a, x) - \epsilon(m_x, x)] \frac{dx}{x},
\]

where \( \epsilon(a, i) - \epsilon(m_x, i) = \epsilon(\beta, i) \). For the present, \( \epsilon(\beta, i) \) is assumed to be positive. In the discussion of liquidity traps below, we will consider the implications of positive, negative, and zero values for this sum of elasticities.

Equilibrium on the Bank-Credit Market

Equilibrium on the market for bank credit requires that the volume of earning assets demanded by banks is matched by the volume of earning assets supplied to banks. The latter quantity \( (E_P) \) is the nominal value of

\(^9\) The details of the \( f \) and \( t \) relations and assumptions about signs of derivatives are given in Appendix II, eqs. (A2) and (A5). The position of \( f \) and \( t \) in the monetary and asset multipliers is shown in eqs. (A6)-(A8), and the response of the multipliers to changes in \( f \) and \( t \) is given by eqs. (A9)-(A13). A more complete discussion of the effect of interest rates on the multipliers appears in the text of a later section and in n. 28 below.

\(^9\) Two problems that require further discussion are ignored at this point. (a) We will show below that the use of elasticities rather than derivatives has little if any bearing on the conclusions that we reach in this section or on the conclusions about liquidity traps in the following section. (b) Several variables on which the multipliers depend—the reserve-requirement ratios, the rediscount rate, etc.—are summarized by a variable, \( x \), in eq. (3) of the text and are discussed more fully at eq. (5) of the text below. The hypothesis in Appendix II implies that the elasticities of \( m_x \) and \( a \) with respect to \( x \) are not uniformly proportional. Interest rates and some of the determinants included in \( x \) modify the comparative growth rates of bank credit and money.
loans obtained from banks and of the stock of government bonds sold to banks. In the process by which equilibrium is established, the outstanding stock of government securities is absorbed into the portfolios of the banks and the public; bank loans are extended or repaid; and interest rates are adjusted on bank loans, government securities, and other financial assets traded on the bank-credit market. A summary description of this process, encompassing a wide range of the public’s financial behavior, is introduced as equation (4).

\[ E_p = s\left(i, \frac{Y}{Y_p}, \frac{W}{P_a}, p, n, i_p\right); \quad (4) \]

\[ s_1 < 0; s_2, s_3, s_4, s_5, s_6 > 0. \]

The sign of the derivative of the stock-supply function with respect to each of the arguments is stated below the equation. Numbers are used to refer to the position of the variable in the equation. The symbols \( E_p \) and \( i_e \) have been introduced above. The other symbols are used to represent the index of transitory income, \( \frac{Y}{Y_p} \); the real stock of non-human wealth, including the stock of government debt outstanding, \( \frac{W}{P_a} \); a price index, \( p_p \) of current output; the yield on real capital, \( n \); and an index of rates on financial assets not traded on the bank-credit market, for example, corporate bonds, \( i_p \).

From the bank-credit-market equations and the market-equilibrium condition, \( E_p = E_b \), we can solve for \( i_e \) and for the equilibrium stock of bank credit, \( E \). These equilibrium values depend, of course, on (1) the variables that enter the stock-supply equation, assumed to be predetermined relative to the bank-credit-market process; (2) the components of the earning-asset multiplier, \( a \), such as the currency ratio and the reserve-requirement ratios; and (3) the adjusted monetary base. Once interest rates and the value of \( \beta \) are determined, the money stock \( M \) is determined also.

Before proceeding to an algebraic statement of the solution on the bank-credit market and some implications of the hypothesis, the discussion to this point is summarized in a diagram. We will, then, relax the assumptions about the signs of the elasticities of the \( E_s \), \( E_p \), and \( \beta \) functions with respect to interest rates and consider the conditions for a number of liquidity traps. Figures 1 and 2 depict the simultaneous determination of the money supply (\( M_s \)), a value of the index of interest rates (\( i_e \)), and the stock of bank credit (\( E \)). The lines labeled \( E_s \) and \( E_p \) represent the banks’ demand for earning assets, described by equation (2), and the public’s supply of

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\( ^{11} \) Strictly speaking, the condition \( E_p = E_s \) requires that \( E_p \) be defined as the supply of earning assets net of Treasury deposits and net worth. The dependence of \( E_p \) on real wealth and prices separately should not suggest “money illusion” in the \( E_p \) function. We have written the equation in the most general way, since the analysis in this paper does not require more detailed discussion of the equation or assumptions about the homogeneity of the function.
assets to banks, equation (4). The ratio of bank credit to money, $\beta$, is graphed on the right-hand panels.

In Figure 1, the bank-credit-market equilibrium is disturbed by expansive monetary policy, for example, an increase in the base or the reduction of a reserve-requirement ratio. Expansive policies increase the banks' demand for earning assets from the solid line $E_{01}$ to the dotted line $E_{ss2}$ and reduce interest rates on the bank-credit market. Interest rates fall from $i_{s1}$ to $i_{s2}$, and the stock of bank credit rises from $E_1$ to $E_2$. Since $\phi(\beta, i)$ is assumed to be positive, $\beta$ falls in response to the fall in interest rates, and

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**Fig. 1.**—Change in equilibrium position after expansionary monetary policy. *Solid lines*, original positions; *dashed lines*, new positions.

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**Fig. 2.**—Change in equilibrium position after increase in the yield on real capital. *Solid lines*, original positions; *dashed lines*, new positions.
the money supply rises by a larger percentage than bank credit to reach the 
new (partial) equilibrium position shown by the broken lines. The magni-
tude, but not the direction, of the change in $\beta$ depends on the specific 
policy variable that is used to expand money and bank credit. A 1 per cent 
change in $B$ induces a larger change in the $E$ curve and in $i$, than a 
1 per cent change in a reserve-requirement ratio.

In Figure 2 the public’s supply of earning assets to banks is assumed to 
increase in response to a technological change that raises the yield on real 
capital. Such a change makes the public desire to borrow more from banks 
at each interest rate and/or to hold a smaller proportion of the outstanding 
stock of government securities. The $E$ function shifts to the left along the 
$E$ curve, raising interest rates to $i_2$ and bank credit to $E_2$. This time 
the $\beta$ line rotates to the left, since interest rates have increased, and the 
money supply expands relatively less than bank credit.

The diagrams suggest the importance of carefully interpreting the mean-
ing of changes in $M, E,$ and $i$. Expansive monetary policies induce a fall 
in interest rates and in $\beta$, the ratio of bank credit to money; increases in the 
public’s supply of earning assets raise $i$, and the ratio $E/M_1$. However, 
interest rates on the bank-credit market generally rise in periods of economic expansion and fall during recessions. We have noted elsewhere 
(Brunner and Meltzer, 1964b) that changes in the base are procyclical 
rather than countercyclical on the average. If changes in the base had a 
dominant effect on $i$, $i$ would fall in periods of economic expansion and 
rise in recessions, just the opposite of the observed movements.12 On the 
other hand, if changes in $i$ dominated the movements of $E/M$, the ratio 
would rise with $i$, in expansions and fall in recessions, opposite to the 
observed movements of the ratio.

This discussion of interest rates and of the observed changes in policy 
variables suggests that the use of changes in interest rates as a measure of the 
current or recent direction of monetary policy is misleading. By inter-
preting the rise in interest rates as an indication of contractive policy, the 
policy-maker ignores the procyclical movements of the policy variables and 
attributes the rise in interest rates to policy action, rather than to the change 
in $E$ resulting from variables (other than interest rates) in the $E$ function. 
The growth rate of the money supply corresponds more closely to the 
growth rate of the policy variables than the growth rate of bank credit or 
changes in interest rates and more clearly reflects the procyclical move-
ments of the policy variables. For this reason, the growth rate of the 
money supply is a better indicator of policy operations than changes in

12 The conclusion in the text must be qualified slightly. The effects of a procyclical 
policy are superimposed on movements of the $\beta$ ratio generated by the components of the 
monetary and asset multipliers discussed in Appendix II. A pronounced pro-
cylical policy remains visible in the accelerations or decelerations of the movements 
of the $\beta$ ratio induced by other factors.
interest rates or the growth rate of bank credit, two variables often used as indicators by economists and policy-makers (see Brunner and Meltzer, 1967).

Solutions for Interest Rates, Money, and Bank Credit

An explicit statement of the equilibrium condition underlying the diagrams is introduced in equation (5). The equation shows that equilibrium on the bank-credit market depends on the factors listed above—interest rates, the variables other than interest rates in the public's asset-supply function, the adjusted base, and the variables on which the bank-credit multiplier, \( a \), depends. The last group includes several symbols not previously discussed: \( r^d \) and \( r \), the weighted-average reserve-requirement ratios for demand and time deposits; the currency ratio, \( k \); and the rediscout rate, \( p \).

\[
a(i_e, r^d, r^t, k, p)B^a = \left( i_e, \frac{Y}{\gamma}, \frac{W}{\gamma}, \frac{P}{\gamma}, p, n, i_e \right).
\]

Equation (5) may be solved for the index of interest rates on bank earning assets (\( i_e \)). Some of the responses of \( i_e \) to policy and other variables are expressed as elasticities in Table 1. The details of the derivations are given in Appendix III.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>ELASTICITIES OF THE INTEREST RATE ( i_e ) WITH RESPECT TO SOME DETERMINANTS OF THE VOLUME OF BANK CREDIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e(i_e, B^e) = -1 )</td>
<td>( e(i_e, B^e) = \frac{\epsilon(s, i_e)}{\epsilon(a, i_e) - \epsilon(s, i_e)} &gt; 0 )</td>
</tr>
<tr>
<td>( e(i_e, \gamma) = \frac{\epsilon(s, i_e)}{\epsilon(a, i_e) - \epsilon(s, i_e)} &gt; 0 )</td>
<td>( e(i_e, n) = \frac{\epsilon(s, i_e)}{\epsilon(a, i_e) - \epsilon(s, i_e)} &gt; 0 )</td>
</tr>
</tbody>
</table>

The assumptions introduced earlier imply that each elasticity has a unique sign. An increase in the base lowers \( i_e \) by an amount that depends inversely on the response of the banks and the public to interest rates. The

| 13 Solutions for the components of the index \( i_e \) depend on other relations. For example, the solution for one component may be obtained from the demand and supply equations for loans, a second from the term structure of interest rates, etc. For more detailed discussion of the portfolio behavior of banks, see Hester (1962); for a discussion of the term structure of interest rates, see Meiselman (1962). We have discussed the determination of the components of \( i_e \) in more detail (Brunner and Meltzer, 1966). |

| 14 Evaluation of the rational expressions that are components of the numerators suggests the following order condition: \(- e(i_e, B^e) > e(i_e, k) > e(i_e, r^d) > e(i_e, r)\). |

See eqs. (A14) and (A15) of Appendix II for the components of the numerators.
larger the response of the banks’ free-reserve ratio to interest rates, the larger is $\epsilon(a, i)$. And the larger $\epsilon(a, i)$ or the absolute value of $\epsilon(s, i)$, the smaller the response in interest rates to variations in the base or any of the other variables.

A preliminary conclusion about one type of liquidity trap can be drawn from a discussion of the elasticities in Table 1 by relaxing our previous assumptions about the slopes of the $E_p$ and $E_b$ functions. Suppose that, in some period, $i_e$ was unaffected by monetary policy, that is, the denominator of $\epsilon(i_e, B^a)$ approached infinity, so that the effect of open-market operations or other policy changes on $i_e$ approached zero. In this case, interest rates on the bank-credit market and other financial interest rates are unrelated, since $\epsilon(i_e, i)$ must approach zero also. A significant positive correlation between yields $(i_e)$ on assets that banks traditionally buy (government bonds) and those that banks do not generally buy (corporate bonds) would be inconsistent with this type of liquidity trap under our hypothesis. In fact, the yields are positively correlated during the period in which the trap is most often said to have occurred, so the data support our hypothesis about the slopes of $E_p$ and $E_b$ and deny the existence of a trap of this kind.\footnote{Monthly interest-rate data from January, 1935, to December, 1939, were used for the correlations. The simple correlation between long-term government bonds and corporate bonds is 0.74 for the period. The partial correlation between the two yields given the bill rate is 0.70. Bill rates have a simple correlation of 0.46 with corporate bonds and 0.78 with long-term government bonds. Partial-correlation coefficients for bill yields were not computed. These results can be compared to the correlations using annual data for 1919–41 and 1952–58. From the annual data, the correlation between government bonds and corporate bonds is 0.91; the correlation between bills and government bonds is 0.81; and between bills and corporate bonds it is 0.85.}

To analyze other liquidity traps that affect the supply and the demand functions for money or bank credit, we require a solution relating the money supply to interest rates and to the determinants of the equilibrium stock of bank credit. Equation (1) expressed the dependence of the money multiplier, $m$, on $i$. If the solution for $i_e$ from equation (5) is substituted in equation (1), the money supply becomes dependent on the variables in the $E_p$ and $E_b$ equations. The solution for the money supply then expresses the interaction of the money supply, bank credit, and interest rates on the bank-credit market. It is the analytic foundation for the solution pictured on the right side of Figures 1 and 2. The equilibrium solution for the money supply plus time deposits, $M_a$, is obtained in the same way. The procedure used to obtain these solutions is described more fully in Appendix III.

The elasticities of the monetary variables—$M_1$, $M_2$, and $E$—with respect to each of the predetermined variables of the money–bank-credit process are derived from the solution equations. Some of these elasticities are shown in Table 2. Each contains a factor $q_i(j = 1, 2, 3)$ defined at the
LIQUIDITY TRAPS FOR MONEY, BANK CREDIT, AND INTEREST RATES

TABLE 2
SOME ELASTICITIES OF THE MONETARY VARIABLES WITH RESPECT TO SOME VARIABLES OF THE MONEY-CREDIT PROCESS

<table>
<thead>
<tr>
<th>WITH RESPECT TO</th>
<th>ELASTICITY OF</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_1$</td>
<td>$1 - q_1$</td>
</tr>
<tr>
<td>$r^*$</td>
<td>$\epsilon(m_1, r^*)(1 - q_1)$</td>
</tr>
<tr>
<td>$\phi$</td>
<td>$\epsilon(\phi, \phi_1)$</td>
</tr>
<tr>
<td>$i_0$</td>
<td>$\epsilon(i_0, i_0_1)$</td>
</tr>
</tbody>
</table>

**Note.**—Definitions of the $q_j$ and $\phi$:

- $q_1 = \frac{\epsilon(m_1, i_0)}{\epsilon(m_1, i_0) - \epsilon(i_0, i_0)}$;
- $q_2 = \frac{\epsilon(m_2, i_0)}{\epsilon(m_2, i_0) - \epsilon(i_0, i_0)}$;
- $q_3 = \frac{\epsilon(r^*, i_0)}{\epsilon(r^*, i_0) - \epsilon(i_0, i_0)}$;
- $\phi_0 = \frac{\epsilon(\phi, \phi_1)}{\epsilon(\phi, \phi_1) - \epsilon(\phi_1, \phi_1)}$.

The interpretation of the $q_j$ is discussed in the text below.

bottom of the table and obtained as a part of the solution process just described. The components of the $q_j$ are interest elasticities of the monetary and asset multipliers and of the public's supply of assets to banks. (See Sec. B of Appendix III for the derivation of the $q_j$.)

A brief explanation will clarify the role of the $q_j$. If an open-market operation had no effect on interest rates, the monetary multipliers ($m_1$, $m_2$, and $a$) would be unaffected by open-market operations, the $q_j$ would be zero, and the elasticity of each of the monetary variables ($M_1$, $M_2$, and $E$) with respect to the base would be unity. Since open-market operations affect interest rates and since the multipliers depend on interest rates, there is a feedback through interest rates to the monetary and asset multipliers and to $E$. Hence there is a feedback to $M_1$, $M_2$, and $E$. If the $q_j$ are between zero and one, the feedback reduces the response of the monetary variables to changes in the policy variables, and the elasticities with respect to the base fall from 1 to $1 - q_j$. At values of $q_j = 1$, changes in the base have no effect on money and bank credit.

The values of the $q_j$, therefore, have an important role in our discussion of several types of liquidity traps. By assuming that the $q_j = 0$, we can examine the implications of the type of liquidity trap under which monetary policy affects the stocks of money and bank credit (but not via interest rates); by assuming that all (or some) of the $q_j = 1$, we can investigate the implications of a trap under which changes in the base affect $i_0$, but not the stocks of money and/or bank credit.16

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16 Some additional points should be noted: (a) the denominators of the $q_j$ are equal to $-\epsilon(i_0, R^*)$ and hence are positive by previous assumption. (b) Until these assumptions are modified below, $q_1$ is assumed to be a proper fraction. (c) Previous assumptions that determined the direction in which the $\beta$ line in Figs. 1 and 2 rotated make $q_2 > q_3$, but do not make $q_3$ positive. This subject will be discussed in the following section. (d) Values of the $q_j$ greater than unity imply that open-market purchases reduce the monetary variables and that open-market sales increase them.
The Conditions for Various Liquidity Traps

Although there is widespread agreement that monetary policy lost "effectiveness" in the thirties, substantial disagreement exists about the reason for the change. Some type of liquidity trap is often suggested as an explanation, but there is little agreement about the type of trap that is said to have occurred. Two main lines of argument are advanced: one asserts that a trap occurred in the demand for money; the second suggests that a trap operated within the banking system either because the banks desired to hold excess reserves and were unwilling to lend or because the public was unwilling to borrow. Agreement appears to be limited to the propositions that interest rates reached—or approached—a "floor" at which some interest elasticity became—or approached—zero or infinity and that monetary policy became powerless to restore full employment (see U.S. Congress, 1935; Klein, 1947; Tobin, 1947; Fellner, 1948; Villard, 1948; and Horwich, 1963).

In this section we consider some of the traps that have been suggested. To analyze the many different statements about the effect of traps, we separate the traps into categories called "absolute" or "asymptotic," "complete" or "partial." If some elasticity is assumed to approach, but not reach, a critical value, the trap is called "asymptotic"; if the critical value is reached, the trap is "absolute." Traps for the money supply or bank credit are said to be "complete" if money or bank credit does not respond to any policy action. "Partial" traps occur if some policy actions become ineffective while others remain capable of inducing changes in the monetary variables. Various combinations are possible; for example, a complete or partial trap may be either absolute or asymptotic.

If the money supply and bank credit responded identically to changes in the policy variables, a trap for one of the monetary variables would, of course, imply a trap for the other. The equality of response of money and bank credit to policy operations is often described as a consequence of the balance sheet of the banking system. Money and credit are regarded as "two sides of a coin." Yet our earlier analysis of the ratio of bank credit to money, β, showed that changes in policy and in predetermined variables induce changes in interest rates and in β. The analysis of this section shows that the equality of relative responses of bank credit and money to policy variables is a part of the necessary and sufficient conditions for some versions of the trap. A denial of the conditions required for equality of the relative responses of the monetary variables is often sufficient, therefore, to deny particular types of liquidity traps.

While the discussion cannot rule out or even consider all possible traps,

17 See the response to a written question submitted to Federal Reserve officials (U.S. Congress, 1961) and the discussion of this subject in Brunner and Meltzer (1964).
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it suggests strongly that a trap is most unlikely to occur if our hypothesis is true. The truth of the hypothesis is assumed provisionally throughout this section, and all of the standard slope properties in Appendixes II and III are assumed to remain operative unless explicitly repealed. Empirical support for the theory is presented in a later section.

Absolute Traps for Interest Rates, Money, and Bank Credit

Necessary and sufficient conditions for six absolute liquidity traps are listed in Table 3. Four of the traps are rejected because they conflict with

<table>
<thead>
<tr>
<th>Type of Trap</th>
<th>Necessary and Sufficient Condition</th>
<th>Conclusion</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interest rate on bank-credit market</td>
<td>$\epsilon(i, B^*) = 0$</td>
<td>Reject</td>
<td>Impossible. $\epsilon(i, B^*)$ can approach but not equal zero</td>
</tr>
<tr>
<td>2. Complete monetary</td>
<td>$q_1 = q_2 = q_3$ = $a = 1$</td>
<td>Reject</td>
<td>Definition of $a$; $a = 1$ if and only if the base equals zero</td>
</tr>
<tr>
<td>3. Complete money supply</td>
<td>$q_1 = a = 1$</td>
<td>Reject</td>
<td>Definition of $a$</td>
</tr>
<tr>
<td>4. Complete bank credit</td>
<td>$\epsilon(r, r^*) = 0$</td>
<td>Obtain empirical evidence</td>
<td>Condition is contrary to assumption of &quot;standard&quot; slope properties but does not involve any other contradiction</td>
</tr>
<tr>
<td>5. Demand for money</td>
<td>$\epsilon(r^<em>, B^</em>) = 0$ and $\epsilon(r, r^*) = 0$</td>
<td>Reject</td>
<td>Definition of $a$. See Table 4 and text</td>
</tr>
<tr>
<td>6. Base trap for both money and bank credit or for money alone</td>
<td>$q_1 = q_3 = 1$ or $q_1 = 1$</td>
<td>Reject or obtain empirical evidence</td>
<td>Several sets of assumptions considered; some cases rejected; others depend on particular signs for parameters</td>
</tr>
</tbody>
</table>

some part of the theory developed in the appendixes and discussed in the previous section. One cannot be rejected without empirical evidence. And one pair of partial traps (row 6) is in an intermediate position; some sets of conditions that imply these traps conflict with the theory; others require empirical evidence. After discussing the six absolute traps, we will consider some asymptotic traps briefly.

When discussing the elasticities in Table 1, we showed that a trap for interest rates, proximately determined on the bank-credit market, cannot be absolute, since $\epsilon(i, B^*)$ cannot equal zero (Table 3, row 1). The reason
is that the elasticities of the $E_p$ and $E_b$ functions are not infinite. In principle, these elasticities may approach infinity and cause $c(i_e, B^a)$ to approach zero. The data for the thirties, however, deny that this occurred, since the evidence suggests that interest rates on assets purchased by banks remained correlated with interest rates on other financial assets, contrary to the implication of this trap.

The denial of a trap for interest rates on bank earning assets shows that some interest rate can always be reduced by expansive policy action. Rejection of this trap denies that interest rates reached an absolute "floor" in the thirties, a conclusion that is common to most of the assertions that some type of trap existed. These conclusions do not depend on the choice of a particular interest rate or on the assumption of constant elasticities. The same conclusions are reached if the analysis is stated in terms of slopes: the derivative of $i_e$ with respect to $B^a$ cannot possibly be zero in a banking system that holds earning assets. However, the fact that interest rates can always be reduced by expansive monetary policy does not establish that such policies must expand bank credit and the money supply. Row 2 of Table 3 shows a necessary and sufficient condition for a trap affecting all of the monetary variables, the complete monetary trap. If the monetary system is in this trap, the monetary authority can do nothing to increase or decrease the stocks of money and bank credit; $M_1$, $M_2$, and $E$ do not respond to any change in the policy variables. In principle, the complete monetary trap could occur if the decrease in $i_e$ resulting from an expansive policy induced banks to hold as excess reserves all of the increase in the adjusted base or in excess reserves brought about by the expansive policy.

18 In n. 22 below, we consider some consequences of assuming that the $E_b$ curve became horizontal. These cases may represent more fully some commonly held views about liquidity traps.

19 The derivative of $i$ with respect to $B^a$, obtained from eq. (5), is

$$i_{B^a} = -\frac{a}{a_i B^a - s_i}$$

where $a_i$ and $s_i$ are partial derivatives of the banks' demand and the public's supply functions for earning assets with respect to $i$, and where $a$ is the bank-credit multiplier. A necessary and sufficient condition for a zero value of $i_{B^a}$ is a zero value for the bank-credit multiplier, $a$. This implies that banks hold earning assets in an amount no larger than their capital. Of course, the slope can approach zero if the denominator of $i_{B^a}$ approaches infinity. But the conditions under which this would occur also make $c(i_e, B^a) \to 0$, so little if any difference in the conclusion about the interest-rate trap results from the use of derivatives rather than elasticities.

20 This seems to have been the situation that Chairman Eccles had in mind when he testified that, even if currency was used to purchase government bonds from the public, there would be no increase in the money supply or in bank credit.

"MR. CROSS: 'Why not pay off all government bonds and get rid of paying any interest—because that would be inflation itself?'

"GOVERNOR ECCLES: 'Here is what would happen: . . . such action would simply increase the reserves of the banking system by the amount of government bonds
The necessary and sufficient conditions for the complete monetary trap imply that the responses of the monetary variables to changes in the policy variables are equal, since all the responses are zero. A subset of these conditions \( q_1 = q_2 = q_3 \) and \( \alpha = 1 \) makes the response of money and bank credit to changes in each of the variables in Table 2 equal, contrary to the argument of the previous section suggesting that the responses are unequal.

The conditions for the complete monetary trap and for the equality of the relative responses of the monetary variables to policy and other variables require that the monetary base equal zero. There is no other condition under which \( \alpha \), the ratio of \( M_0/E \), equals unity.

The complete monetary trap involves a contradiction with one of the basic conditions for a monetary system and is, therefore, rejected. Monetary policy can always increase at least one of the monetary variables.

Since \( \alpha \) cannot equal unity, the complete money-supply trap (row 3) and a similar trap for \( M_2 \) are rejected also. The denial of an absolute trap for the money supply means that either an increase in the base or the lowering of a reserve-requirement ratio, or both, will increase the money supply. At worst, \( q_1 = 1 \) or \( q_1 = 1/\alpha \). Hence, one of three conclusions must be accepted (see Table 2): (1) The direct response of \( M_1 \) to changes in \( B \) is never completely offset by the effect of changes in interest rates, that is, \( q_1 < 1 \); (2) the response of \( M_1 \) to changes in the reserve-requirement ratios (and in the rediscount rate) is not completely offset by changes in interest rates, \( q_2 < 1/\alpha \); (3) or the money supply responds to all policy variables. In short, a trap for the money supply can, at most, be one of the partial traps discussed below. Here we note (1) that monetary policy never is reduced to a completely powerless act as suggested in the metaphor about "pushing on strings" and (2) that our conclusions do not require any specific assumption about the level of interest rates or the size of policy operations.

We have now established that expansive monetary policy always reduces some interest rate and expands the money supply. The conclusion can be extended to show that expansive policies always increase bank credit. A bank-credit trap is impossible, within our framework, if our earlier assumption about the slope of the \( E \) function is maintained. Inspection of Table 2 indicates that the necessary and sufficient condition for which were purchased with currency. The currency would go out; if it was $10 billion or $20 billion or $3 billion, whatever amount the government paid out in currency to retire its bonds; but the currency would immediately go into the banks and from the banks into the Federal Reserve banks... and you would have additional reserves, additional excess reserves... (U.S. Congress, 1935, p. 321).

\[ E = D_p + T - (R - A) = M_2 - B^* = (m_2 - 1)B^* \]

The bank-credit multiplier, \( a \), equals \( m_2 - 1 \) by definition. The ratio \( a(= m_2/\alpha) \) must, therefore, be greater than unity if \( B^* \) is not zero.
a complete bank-credit trap \( q_3 = 1 \) is met if and only if \( \epsilon(s, i_t) \) is zero. This condition means that there are no partial traps for bank credit. Either bank credit responds to all policy variables or to none of them.

However, there is an important difference between the argument used to reject the bank-credit trap and the arguments that reject-liquidity traps for interest rates and the money supply. The latter traps are inconsistent with observations or with a positive value of the monetary base. Rejection of the bank-credit trap depends on an assumption that may not be accepted by proponents of a trap, namely, that the volume of earning assets supplied to banks remained dependent on interest rates. Proponents of liquidity traps generally assert that the standard slope properties did not apply in the depression of the thirties. Hence, we will not conclude that the bank-credit trap is rejected until empirical evidence is presented to support the assumption that \( \epsilon(s, i_t) \) remained negative.

Nevertheless, we can dispose of some statements that are made about a bank-credit trap. For example, it is often suggested that the failure of banks to reduce interest rates, or their willingness to hold as excess reserves any and all additions to reserves, is evidence for a trap of this kind. Our analysis shows that the existence of an absolute bank-credit trap does not depend on assumptions about the behavior of banks\(^{22}\) or on the usual assertion that the public becomes extremely sensitive to small changes in market interest rates. In fact, a bank-credit trap requires that the public becomes completely insensitive to the level of interest rates when borrowing or selling securities to banks, so a trap of this kind does not imply a trap in the demand function for money or the existence of a "floor" to interest rates. On the contrary, the conditions for a bank-credit trap and the condition usually suggested as requirements for a trap in the demand function for money are completely opposed.

**An Absolute Trap in the Demand for Money**

An absolute trap in the demand function for money prevents monetary policy from reducing market interest rates below a minimum level. If the minimum level of interest rate is above the rate required for a full-employment equilibrium of investment and saving, monetary policy is said to be

---

\(^{22}\) An alternative hypothesis in which the absolute bank-credit trap depends on the behavior of banks can be developed. The crucial assumption is a switching rule that makes the bank's demand for excess reserves "horizontal" at some interest rate. Our investigation of this approach leads to the following conclusions: (a) There is a zero correlation between \( i_t \) and \( i_t \), a conclusion denied by evidence. (b) Bank credit and money do not change as a result of any change, positive or negative, in reserve-requirement ratios, a conclusion denied by the response of the monetary system in 1936–37. (c) An increase in the ratio of currency to demand deposits raises the money supply, a conclusion denied by the movement in the money supply in 1929–33 or following other banking panics.
powerless to increase output, employment, and the price level by lowering market interest rates.

We have shown elsewhere that the interest elasticity of the demand for money—estimated from any one of a number of alternative demand functions—did not become extremely large in the thirties. This evidence suggests that a money-demand trap did not occur. However, in the regression equations a particular interest rate was chosen to represent the influence of "interest rates" on the demand for money. It is important to show that the empirical findings hold quite generally and that they do not depend on the choice of a particular interest rate. To do so, the solution for $M_1$, $E_1$, and $i_e$ on the bank-credit market is extended to include the determination of the quantity of money demanded ($D$) and two interest rates, $i_e$ and $i_o$. If both $i_e$ and $i_o$ are unaffected by monetary policy, or if the effect on the quantity of money demanded of changes in one index rate is exactly offset by changes in the other, then it is impossible for monetary policy to create any excess supply or demand for money; there is an absolute trap in the demand for money.

Simultaneous solutions of $i_e$ and $i_o$ are obtained from the credit-market ($E_p$ and $E_s$) and money ($M_1$ and $D$) equations. To simplify the presentation, the solutions for $i_e$ and $i_o$ have been combined in a weighted average, $i^*$, with weights that depend on the interest elasticities of the demand for money. The elasticities of $i^*$ with respect to monetary policy variables, shown in Table 4, are weighted averages of the elasticities of $i_e$ and $i_o$, as shown at the bottom of the table. A necessary and sufficient condition for a money-demand trap is that $i^*$ is invariant with respect to changes in all monetary-policy variables—$B^2$, $r^d$, etc.—as suggested in Table 3, row 5.

---

23 See Brunner and Meltzer (1963), where distributions of the interest elasticities of velocity equations of the "Keynesian" and "wealth adjustment" types are given in the appendix. See also Meltzer (1963b).

24 Since the demand function for money is now included in the system, the solutions for $i_e$ or $(i_e, B^2)$ differ from those given above. The solutions for $(i_e, B^2)$ and $(i_o, B^3)$ in Table 4 are obtained from the matrix of elasticities in this footnote. The first row of the matrix is obtained from the equilibrium condition $E_p = E_s$, the second row from the equilibrium condition $M_1 = D$. The solutions for $(i_e, B^2)$ and $(i_o, B^3)$—

$$
\begin{bmatrix}
\epsilon(a, i_e) - \epsilon(s, i_o) \\
\epsilon(m_1, i_e) - \epsilon(D, i_o) - \epsilon(D, i_e)
\end{bmatrix}
$$

—are then combined in a weighted-average elasticity $\epsilon(i^*, B^2)$ by assuming that

$$
\log i^* = w_1 \log i_e + (1 - w_1) \log i_o,
$$

where

$$
w_1 = \frac{\epsilon(D, i_e)}{\epsilon(D, i_e) + \epsilon(D, i_o)}
$$

and $\epsilon(D, i_e)$ and $\epsilon(D, i_o)$ are interest elasticities of the demand for money. The results and some definitions are shown at the bottom of Table 4. Similar procedures are used to obtain $\epsilon(i^*, r^d)$.

25 Since the conditions that make $\epsilon(i^*, r^d) = 0$ apply to $\epsilon(i^*, r^d)$ and $\epsilon(i^*, r^d)$, the analysis applies to these policy variables as well.
TABLE 4
THE ELASTICITY OF $i^*$ WITH RESPECT TO $B^a$ AND $r^a$

$$\epsilon(i^*, B^a) = \frac{\epsilon(D, i_d)(s, i_d) + \epsilon(D, i_d)(q_1 - 1)(s, i_d) - \epsilon(s, i_d)}{[\epsilon(D, i_d) + \epsilon(D, i_d)]Z} < 0,$$

and

$$\epsilon(i^*, r^a) = \frac{\epsilon(m, i_d)(q_1 - 1)(s, i_d) - \epsilon(s, i_d) - \epsilon(D, i_d)\epsilon(s, i_d)}{[\epsilon(D, i_d) + \epsilon(D, i_d)]Z} > 0,$$

where $Z$ is the determinant of the matrix in n. 24 and

$$Z = \epsilon(s, i_d)\left[\epsilon(m, i_d) - \epsilon(D, i_d)\right] - \epsilon(D, i_d)\epsilon(s, i_d) > 0,$$

$$\epsilon(i^*, B^a) = \frac{\epsilon(D, i_d) - \epsilon(i, i_d)}{\epsilon(D, i_d) + \epsilon(D, i_d)} + \frac{\epsilon(D, i_d)}{\epsilon(D, i_d) + (D, i_d)}\epsilon(i, B^a),$$

$$\epsilon(i^*, B^a) = \frac{\epsilon(D, i_d) - \epsilon(s, i_d)}{\epsilon(D, i_d) + \epsilon(D, i_d)},$$

$$\epsilon(s, B^a) = \frac{\epsilon(m, i_d) - \epsilon(D, i_d) - \epsilon(s, i_d) + \epsilon(s, i_d)}{Z},$$

and $\epsilon(D, i)$ is an interest elasticity of the demand for money.

An absolute trap in the demand for money is impossible. This is shown by examination of the only conditions that we have found that make both $\epsilon(i^*, B^a)$ and $\epsilon(i^*, r^a)$ equal zero, namely, that $q_1 = 1 = \alpha$ and that either $\epsilon(s, i_d)$ or $\epsilon(D, i_d)$ equals zero while other components remain bounded. These conditions contain a contradiction, since we have shown previously that $\alpha$ cannot equal unity. Moreover, neither set of conditions implies that there is a "horizontal" portion, or trap, in the demand curve for money; the traps depend on an inability to increase the money supply by policy operations ($q_1 = 1 = \alpha$) and a $D$ or $E_p$ curve that is vertical with respect to one of the two interest rates. All other assumptions that make the numerator of the elasticities of $i^*$ equal zero make the denominators equal zero also, imply that the money-bank-credit process is indeterminate, and also make the demand function for money vertical. Since these implications have no economic meaning, the conditions that imply them can be safely disregarded. It follows that there is always some policy action that reduces $i^*$. Since interest rates can always be reduced and the money supply can always be increased, there cannot be an absolute liquidity trap in the demand for money. Someone must hold the increased supply of money at the lower interest rates, so the quantity of money demanded must increase. Again, none of these conclusions depends on the use of elasticities in the analysis. Similar results are obtained using derivatives.

Summary and Further Extension of the Theory

We have now shown that the theory of the money-bank-credit process precludes the possibility of absolute traps for interest rates and money. A trap for the stock of bank credit can occur if and only if the public is assumed to be totally insensitive to the level of interest rates when demanding and repaying loans or when selling government securities to banks.
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But even if there is a bank-credit trap, monetary policy remains capable of creating an excess supply of money, lowering interest rates, and thereby inducing changes in output, employment, and prices.

However, we have not shown that open-market operations or other changes in B have an expansive effect, only that there is always some policy action that expands the money supply and lowers interest rates. Table 4 shows that, if \( q_1 = q_3 = 1 \) and if \( \epsilon(D, r_i) \) or \( \epsilon(s, r_i) \) is zero, the monetary system is in a partial trap, "the base trap." Changes in the base have no effect on the money supply, bank credit, or \( r^* \), and the monetary authority must then raise the reserve-requirement ratios or the rediscount rate to increase the money supply and lower \( r^* \). Moreover, the analysis has concentrated on absolute traps. Assumptions that make the various elasticities approach, but not reach, zero or infinity have not been considered. These traps will be discussed briefly after we have analyzed the conditions that imply a base trap.

The components of the interest elasticities of the monetary \( (m_1) \) and asset \( (a) \) multipliers are of particular importance for the discussion of the base trap and the asymptotic traps that follows. These components were introduced earlier as part of the discussion of \( \beta \). Interest rates were described there as operating on \( m_1 \) and \( a \) through the free-reserve \( (f) \) and time-deposit \( (t) \) ratios. Equations (6) and (7) below express the interest elasticities of \( m_1 \) and \( a \) as linear combinations of the interest elasticities of the \( f \) and \( t \) ratios weighted by the elasticities of the monetary and asset multipliers with respect to \( f \) and \( t \). Equations (A9)-(A12) of Appendix II indicate that the latter elasticities are the source of the difference in the interest elasticities of the monetary and asset multipliers.

The first combination of elasticities in equations (6) and (7) shows the effect of interest rates on \( m_1 \) and \( a \) through the free-reserve ratio, \( f \). The partial derivative of \( f \) with respect to \( i \) is negative by assumption, but the sign of the partial interest elasticity of the free-reserve ratio, \( \epsilon(f, i) \), depends on the sign of \( f \). When the free-reserve ratio is positive, \( \epsilon(f, i) \) is negative, and vice versa. But \( \epsilon(f, i) \) always appears multiplied by the elasticity of the monetary or asset multiplier with respect to \( f \). These elasticities, \( \epsilon(m_1, f) \) and \( \epsilon(a, f) \) also have signs that are opposites of the signs of \( f \), so that the first product in the interest elasticities of the monetary and asset multipliers is always positive.

\[
\begin{align*}
\epsilon(m_1, i) &= \epsilon(m_1, f)\epsilon(f, i) + \epsilon(m_1, t)\epsilon(t, i)\epsilon(i, i) + \epsilon(t, i) \epsilon(t, i) \epsilon(i, i) + \epsilon(t, i) \epsilon(t, i) \epsilon(i, i) \epsilon(i, i) \\
\epsilon(a, i) &= \epsilon(a, f)\epsilon(f, i) + \epsilon(a, t)\epsilon(t, i)\epsilon(i, i) + \epsilon(t, i) \epsilon(t, i) \epsilon(i, i) \epsilon(i, i) 
\end{align*}
\]  

(6)

(7)

The reason is that both \( \epsilon(M_1, r^*) \) in Table 3 and \( \epsilon(r^*, r^*) \) in Table 4 change sign as a result of the assumptions in the text. This peculiar conclusion suggests that \( q_1 \) is always substantially less than unity and that there is never a base trap for the money supply. For convenience, we will hereafter omit the subscript on \( i \) unless it is required for clarity.
The second combination of elasticities in equations (6) and (7) describes the effect of interest rates operating through the time-deposit ratio. The public’s desired ratio of time to demand deposits, is, is assumed to depend on the interest rate paid on time deposits, it, on interest rates on alternative assets, i; and on other variables. (See eq. [A5], Appendix II.) A change in i is assumed to affect the time-deposit ratio in three ways. (1) A rise in i reduces the t ratio, that is, δt/δi is assumed to be negative. (2) The rate it paid by banks on time deposits is partially dependent on i. Competition among banks or between banks and non-bank financial institutions induces a positive response in t to changes in i; δt/δi is assumed to be positive. (3) The partial derivative of the t ratio with respect to it is assumed to be positive also. The combined effect of interest rates on the t ratio is expressed in the bracketed partial elasticities obtained from these partial derivatives. The sum of the bracketed elasticities will be positive if the product of the first two exceeds the third in absolute value.

Base Traps

The base traps for the money supply or for both the money supply and bank credit are the last of the absolute traps listed in Table 3. These traps eliminate the possibility of increasing M1, or both E and M1, by open-market operations or other changes in B. To discuss these traps, first we assume that q1 = q2, the necessary and sufficient condition for equal responses of M1 and E to changes in B (see Table 2), and then we derive the conditions that satisfy the equality. We next assume that...

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27 Some support for these assumptions may be found in two recent studies, Christ (1963) and Feige (1964). Both studies suggest that the net effect of interest rates on the time-deposit ratio is probably positive, a conclusion that is suggested also by our own earlier work (Brunner and Meltzer, 1964) on demand functions for money and for money plus time deposits.

28 In the discussion of the β line, 〈a, i〉 was assumed to be positive. This assumption is almost certain to be correct if the bracketed interest elasticity of the time-deposit ratio is positive. (See n. 27.) If the bracketed interest elasticity of the time-deposit ratio is negative, the interest elasticity of the monetary multiplier is positive. If the bracketed elasticity is positive, 〈m1, i〉 depends on the relative magnitude of its two components.

The reason for the possible ambiguity about the signs of 〈m1, i〉 and 〈a, i〉 is that the response of the monetary multiplier to a change in the i ratio, 〈m1, i〉, is most likely negative, while the corresponding elasticity of the earning-asset multiplier, 〈a, i〉, is almost certain to be positive. See eqs. (A10) and (A12) of Appendix II.

Standard economic theory suggests that the sum of the elasticities is positive, since that is equivalent to assuming that the direct elasticity is larger than the cross-elasticity and that 〈i, i〉 is approximately unity in the long run. This is the reason for our assumption in a previous section that 〈a, i〉 and 〈β, i〉 are positive.
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$\epsilon(s, i) = 0$, so that $q_1 = q_3 = 1$, and there is a base trap for $M_1$ and $E$. The necessary and sufficient condition for a base trap affecting the money supply only ($q_1 = 1$) is then obtained by modifying the assumptions slightly.

Since the denominators of $q_1$ and $q_3$ are identical, $q_1 = q_3$ if and only if $\epsilon(m_1, i) = \epsilon(a, i)$. A more useful statement of this equation is obtained by expressing $\epsilon(a, f)$ and $\epsilon(a, t)$ of equation (7) in terms of $\epsilon(m_1, f)$ and $\epsilon(m_1, t)$ of equation (6). Equations (A11) and (A12) of Appendix II permit the substitutions to be made. The difference $\epsilon(a, i) - \epsilon(m_1, i) = 0$ is then given by equation (8), the necessary and sufficient condition for $q_1 = q_3$.

$$\alpha - 1\{\epsilon(m_1, i) + \frac{\Delta}{\alpha}[\epsilon(i, i)\epsilon(i', i) + \epsilon(t, i)]\} = 0,$$

where $\Delta$ is the denominator of the monetary and asset multipliers and all other parameters have been introduced previously.

Two alternative solutions satisfy equation (8). The first, $\alpha = 1$, is impossible if the monetary base is not zero. Only the set of conditions which make the bracketed expression equal zero requires investigation. Suitable transformation of equation (8) yields\(^{29}\)

$$\frac{\delta f}{\delta i} = \left(1 - f\right)\frac{1}{1 + f}. \quad (9)$$

The right side of (9) is positive. Since $\delta f/\delta i$ is negative, the sum of the interest elasticities of the time-deposit ratio must be negative also. Any other sign is logically inconsistent with $q_1 = q_3$ under the hypothesis.

The necessary and sufficient conditions for the equality of $q_1$ and $q_3$ are extremely difficult to satisfy. An empirical finding that the sum of the interest elasticities of the time-deposit ratio is non-negative disposes of any base trap and of the equality of elasticities of money and bank credit with respect to the base. A finding that the sum of the interest elasticities of the $t$ ratio is negative does not assure that $q_1 = q_3$. More restrictive conditions are required, namely, that equation (9) is satisfied by the values of $i, f, t$, etc.

To summarize, the joint base trap for money and bank credit can occur if and only if three conditions are met. First, $\epsilon(s, i)$ must be zero. Second, the sum of the interest elasticities of the time-deposit ratio must be

\(^{29}\) Eq. (6) is substituted into eq. (8), and terms are rearranged as follows:

$$\epsilon(m_1, f)\epsilon(f, i) = \left[-\epsilon(m_1, f) - \frac{f}{\Delta}\right]\epsilon(i, i)\epsilon(i', f) + \epsilon(f, i).$$

Substitution of eq. (A10) from Appendix II shows that

$$\epsilon(i, i)\epsilon(i', i) + \epsilon(f, i) = \frac{(1 - f)f}{1 + f}.$$

Eq. (A9) is substituted for $\epsilon(m_1, f)$. The small terms $\nu\epsilon, v$, and $d$ are ignored in the approximate equality shown in the text as eq. (9).
negative. Third, both the derivative and the elasticities on the left of equation (9) must be bounded. If all these conditions are satisfied, the money supply is unaffected by open-market operations, and bank credit is unchanged by any policy action.

By changing one assumption, we can obtain the conditions under which there is a base trap for the money supply while bank credit responds, at least slightly, to all policy variables. Assume that \( \epsilon(s, i) \) is negative, so that \( q_3 \) is less than one. Then all of the other conditions above, plus the assumption that \( \epsilon(m, i) = \epsilon(a, i) - \epsilon(s, i) \), impose the base trap on the money supply only. A pair of values for \( f \) and \( t \) can then be found to satisfy an equation similar to (9) under the alternative assumption. The values of \( f \) and \( t \) in this case will, of course, differ from those required for the joint base trap. But even if the modified equation (9) is satisfied, the money supply continues to respond to changes in the reserve-requirement ratios and in the rediscount rate.

It is logically possible—but very unlikely—that the stated conditions for the base traps are satisfied by the money–bank-credit relations. We noted earlier that \( \epsilon(s, i) = 0 \) (or approximately so) is a peculiar requirement for a trap, since it implies that the public is willing to borrow the same amount (or sell the same volume of securities to banks) whatever the prevailing interest rates on the bank-credit market. This assumption is difficult to reconcile with the assumption that the public responds to interest rates, albeit negatively, in adjusting its desired ratio of time to demand deposits. Furthermore, the restriction imposed by the requirement that equation (9) must hold continuously makes the base traps very fragile. The problem is that an open-market operation raises the excess- or free-reserve ratio. As \( r \) rises, the ratio on the right of equation (9) falls. For the base traps to remain, the terms on the left of equation (9) must change also to maintain the approximate equality.

The base traps do not imply that interest rates or the demand for money is trapped. Changes in all policy variables continue to affect \( i_e \) (see Table 1), and changes in the reserve-requirement ratios or the rediscount rate induce changes in the money supply, in \( i^* \), and in the quantity of money demanded. However, the responses of \( i^* \) and \( M_t \) to \( r^d, r^f, \) or \( \rho \) are reversed.

A continuous accumulation of excess reserves in the banking system would eventually break the base trap for the money supply, for bank credit, or for both. As \( f \) rises toward unity, \( r^d + f + v \) (see n. 29) becomes greater than unity, and the interest elasticities of the monetary and asset multipliers become unequal. Of course, \( f \) cannot approach unity unless required-reserve ratios are reduced. But the reductions in required-reserve ratios expand the money supply, a point that is reaffirmed in the text just below.

It should be noted that a zero value for \( f \) does not satisfy eq. (9). If the denominator is zero, there is an indeterminacy; if the denominator is non-zero, \( f \) must equal 1. Excess reserves must be equal to total deposits, a condition that has never occurred. Note that a zero value of \( i \) means that all interest rates on all bank earning assets are zero.
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To expand \( M_1 \) and lower \( i^* \), \( r^d \), \( r^r \), or \( \rho \) must be increased. But such actions raise \( i_e \) and thus cause \( i^a \) and \( i_e \) to move in opposite directions, contrary to observations. These peculiar implications cast doubt on the likely occurrence of a base trap. Data for the thirties reinforce these doubts, since the increase in the reserve-requirement ratios lowered the money supply. Moreover, the time-deposit ratio rose during the thirties when interest rates rose and fell when interest rates fell, contrary to the assumption that the sum of the bracketed interest elasticities of the \( t \) ratio is negative. Data for other periods, for example, following the recent changes in Regulation Q, furnish additional evidence suggesting a positive value for the sum of these interest elasticities. Such observations constitute a prima facie case against the base trap. Consideration of more detailed evidence must await parameter estimates. Some are provided after a brief discussion of "asymptotic traps."

Asymptotic Traps

While the responses of the money supply or interest rates to monetary policy operations never become zero, it is often suggested that they may become so small that the monetary authority could acquire all financial assets without having a noticeable effect on output, employment, or prices. This problem is discussed by Patinkin (1965, pp. 349–54). A review of the literature cited in previous sections suggests that many other writers failed to distinguish carefully between asymptotic traps and the absolute traps discussed earlier. It is important, therefore, to consider some cases in which various elasticities (or slopes) converge to zero or infinity and to show that some of the asymptotic traps are impossible while others require values of particular elasticities that are inconsistent with available evidence.

Many of the absolute traps were rejected because \( a \)—the ratio \( M_2/E \)—must be greater than unity. Rising excess or free reserves raise \( a \), so the accumulation of excess reserves by the banking system in the thirties does not negate the arguments used to reject the absolute traps and does not suggest that these traps hold in the limit. Moreover, equation (9) shows that a rising free-reserve ratio does not imply that open-market operations become ineffective. Additional assumptions must be made about \( s/s_i \), the sum of the interest elasticities of the time-deposit ratio and \( (s, i_e) \). In short, the convergence of the interest elasticity of the free-reserve ratio to minus infinity and the accumulation of excess reserves by the banking system do not imply that the money supply becomes independent of monetary policy.\(^{31} \)

\(^{31}\) Necessary and sufficient conditions for some asymptotic traps can be derived using eqs. (6) and (7). Two sets of assumptions make \( q_i \) approach unity and \( q_i \) approach \( 1/a \) so that there is a complete, asymptotic trap for bank credit and a trap for \( M_2 \) for changes in the reserve-requirement ratios and the discount rate. Dividing
The critical assumptions for the monetary system are that the elasticities of $D_m$ and either $m_t$ or $a$ with respect to all interest rates converge to plus or minus infinity together. These assumptions are sufficient to make the responses of interest rates to all policy variables approach zero as shown by the elasticities of $i^*$ in Table 4. (The much simpler assumption, that either $\epsilon(a, i_t)$ or $-\epsilon(s, i_t)$ approaches infinity, implies that the effect of policy on $i_t$ approaches zero in the simpler case presented in Table 1.) Although monetary policy remains an effective means of expanding the supply of money and the banks' demand for earning assets, the increases in $M_t$ and $E$ are absorbed by the public and the banks, respectively, without a noticeable reduction in any interest rate.

A summary of the more important conditions for the various asymptotic traps appears in the following section along with estimates of the values of critical parameters. Before considering the evidence obtained from these estimates, it is useful to recall some of the findings presented earlier. First, interest rates included in the indexes $i_t$ and $i_T$ remained correlated during the thirties, contrary to the assumptions above, which imply that they were uncorrelated. Second, interest rates on long-term securities generally did not reach their lowest levels until the early or middle forties. The decline in long-term interest rates during and after the late thirties is inconsistent with the implication that $i_t$ and $i_T$ reached a "floor." Third, the estimated interest elasticity of the demand for money in the thirties is smaller in absolute value than the estimate for the period 1900–1958, as noted in Meltzer (1963a, p. 242). These findings are incompatible with the conditions required for the various traps.

Some Empirical Evidence for the Propositions

We have now shown that most of the absolute traps and several of the asymptotic traps are inconsistent with the theory of money and bank credit. The evidence presented in this section supports the theory and suggests that it is a reasonably good summary of the money–bank–credit process. The findings, therefore, support the conclusions that have been reached and increase our confidence in the analysis that led us to reject many of the liquidity traps. In addition, the data cast substantial doubt on the likely occurrence of those traps that require a particular elasticity to

both the numerators and denominators of $q_1$ and $q_2$ by $\epsilon(f, i)$ shows the following:

(a) If $\epsilon(s, i_t)$ and the sum of the interest elasticities of the time-deposit ratio approach zero while $\epsilon(f, i)$ is non-zero, $q_1$ and $q_2$ approach the critical values $1/s$ and 1, respectively. (b) If $\epsilon(s, i_t)$ and the sum of the interest elasticities of the $i$ ratio remain bounded while $\epsilon(f, i)$ approaches minus infinity, the same results are obtained. We have found no other assumptions about components approaching plus or minus infinity that imply asymptotic traps for $M_t$ if $\epsilon(s, i_t)$ remains bounded.

Some implications of one of the above sets of assumptions are discussed in n. 22.
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reach (or approach) a critical value. The results suggest that the estimated values and the critical values are far apart.

To obtain empirical estimates, the rates of interest on commercial-bank loans and on corporate bonds were used to measure $i_c$ and $i_n$, respectively, and the elasticities of the monetary and asset multipliers with respect to the reserve-requirement and currency ratios were assumed to be constant. A demand equation for money, similar to the equation used in several of our papers, was estimated as a part of the money-bank-credit process. The results of reduced-form and/or two-stage least-squares regressions of the $i_n$, $M_1$, and $D_m$ equations are shown in Appendix III, Sections C.1 and C.2, along with the computed values of the parameters of the bank-credit and money-supply equations (Tables C1 and C2).

The evidence generally supports our hypothesis about the signs of the elasticities of interest rates and money with respect to policy and other variables and thus supports the analysis that led to the rejection of a number of liquidity traps. The residuals from the computed supply and demand equations for money furnish additional support. Large, systematic overestimates of the quantity of money supplied in the late thirties, and large underestimates of the quantity demanded, would suggest that the banks and the public substantially increased the quantities of reserves and money demanded relative to the amounts they would be expected to

<table>
<thead>
<tr>
<th>YEAR</th>
<th>RESIDUAL FROM THE DEMAND EQUATION (Per Cent)</th>
<th>RESIDUAL FROM THE SUPPLY EQUATION (Per Cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1937</td>
<td>-0.4</td>
<td>-1.6</td>
</tr>
<tr>
<td>1938</td>
<td>-1.3</td>
<td>-2.0</td>
</tr>
<tr>
<td>1939</td>
<td>-1.1</td>
<td>-0.5</td>
</tr>
<tr>
<td>Average absolute value (30 years)</td>
<td>0.8</td>
<td>0.9</td>
</tr>
</tbody>
</table>

* A negative value means that the actual quantity is less than the predicted quantity. The correlation of the residuals from the two equations for the entire period is zero. Both positive and negative residuals are found in the supply and demand equations during the thirties.

The assumption of constant elasticities for $m$ and $a$ with respect to $r^w$, $r^d$, and $k$ is one of the simplest assumptions that can be made. It appears to be quite reasonable for the postwar years but is a somewhat poorer approximation for some of the prewar years that have been included in the data. The difficulties are particularly apparent in the early thirties, 1930-34, when there were substantial changes in the currency ratio. For the postwar period, computation of the elasticities from monthly data for the period January, 1947–March, 1964, supports the assumption of constancy reasonably well. A formal statement of our procedure is given in Appendix III, Secs. C.1 and C.2.

Brunner and Meltzer (1963, 1964c) and Meltzer (1963a). The sources of the data for the supply and demand equations are given in these papers.
<table>
<thead>
<tr>
<th>Type of Trap</th>
<th>Critical Conditions</th>
<th>Finding</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Absolute base traps</td>
<td>$e(t, l) + e(t', l) &lt; 0$</td>
<td>$e(a, l) - e(m, l) \approx 0.2$</td>
<td>Reject</td>
</tr>
<tr>
<td></td>
<td>$e(m, l) = e(a, l) - e(s, l)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$e(a, l) - e(s, l) = 1.96$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$e(m, l) = 0.94$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Complete, absolute bank-credit trap</td>
<td>$e(s, l) = 0$</td>
<td>$e(s, l) \approx -0.83$</td>
<td>Reject</td>
</tr>
<tr>
<td>3. Asymptotic trap for $l_s$, $l^*$, and</td>
<td>$e(D, l^*) \rightarrow -\infty$</td>
<td>$e(D, l^*) = -0.47$</td>
<td>Reject</td>
</tr>
<tr>
<td>$D_m^*$</td>
<td>$e(s, l) \rightarrow \pm \infty$</td>
<td>$q_1$ is significantly different from zero</td>
<td>Reject</td>
</tr>
<tr>
<td>4. Partial trap for $M_1$ with respect</td>
<td>$q_1 = 1/a$ in the thirties</td>
<td>$q_1 = 0.48$</td>
<td>Reject</td>
</tr>
<tr>
<td>to reserve-requirement ratios</td>
<td>$1/a \approx 0.7$ in the late thirties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and rediscount rate</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Read $\approx$ as "approximately equal."
hold at the prevailing levels of the policy variables, interest rates, wealth, etc. Table 5 presents the data and shows that, although our equation overestimates the quantity of money supplied in the late thirties, the overestimate is not substantial. Moreover, the overestimates of the nominal quantity demanded suggest that the public held a slightly smaller quantity of money than would be expected from their behavior in other periods. This finding provides no support for the notion of a trap in the demand for money.

In Table 6 we have listed the conditions for some of the liquidity traps that cannot be rejected without estimates of particular parameters. The results in Appendix III, used to obtain the values shown in the table, suggest that the parameter values required for these traps differ from the values suggested by our estimates. Most of the conditions listed were discussed in detail above, so the findings require only brief comment. A value of \( \phi(a, \epsilon_1) > \phi(m_1, \epsilon_2) \) is inconsistent with the first condition listed. To obtain the estimate of \( \phi(a, \epsilon_1) \), we assume that \( \phi(s, \epsilon_2) \) approximately equals \( -\phi(s, \epsilon_2) \) and use this value with the first sum shown in Table C1 of Appendix III. The same assumption is used to obtain the value of \( \phi(s, \epsilon_2) \) and to reject the second trap in the list. One of the conditions for the third trap requires that \( \phi(s, \epsilon_2) \) approach minus infinity. If this occurs, \( q_1 \) and \( \phi(i_2, \theta) \) approach zero. Our estimates show that \( 1 - q_1 \epsilon \) is significantly different from zero and thus assign a very small probability to \( q_1 = 0 \).

In short, the data support the conclusions reached earlier and lend strength to the analysis that rejected various types of liquidity traps. The connection between monetary policy and the money supply, interest rates, bank credit, and the demand for money does not appear to have been broken.

Conclusion

Our analysis has implications for monetary theory in the broader sense of macroeconomic general-equilibrium analysis and in the narrower sense of the supply and demand for money. Many of the conclusions for the latter branch of monetary theory have been stated already. Of these, the most important is that monetary policy has not become "ineffective." This conclusion follows from the denial of various forms of the liquidity trap.

34 Note that the residuals in the supply equation for money do not suggest that the residuals in the banks' demand equation for total reserves is small in the late thirties. We have not estimated the demand equation for reserves separately. However, comparison of the residuals in the money-supply equation for 1937 and 1938 with the residual for 1939 and other years suggests that the larger residuals for 1937-38 may be due to the changes in the reserve-requirement ratios that were imposed at the time. Large changes in the reserve-requirement ratios change the values of some of the elasticities used to construct the data in the regression equations, contrary to our assumptions. See Appendix III.
denials that are implied by the hypothesis and/or supported by the evidence that has been introduced.

While our analysis is based upon the institutional arrangements prevalent in the United States, the implications for the various liquidity traps do not depend particularly on these arrangements. They apply to any economy in which the monetary base is not zero, in which banks issue types of deposits that are not perfect substitutes and respond to cost and yield changes when adjusting their reserve positions. These conditions are met in the monetary systems of most developed countries.

Differences in the response to policy operations of money and bank credit—variables that are frequently used as indicators of the direction of monetary policy—were discussed. Both money and bank credit are treated as endogenous variables, and their partial-equilibrium responses to monetary-policy changes include a response to the changes in interest rates induced by policy operations. Recognition of the endogeneity of the money supply and other monetary variables permits the factors determining the differences in the relative responses to be analyzed and leads to the conclusion that open-market operations induce a larger relative change in the money supply than in the money supply plus time deposits or in bank credit.

The observed cyclical pattern in the ratio of bank credit to money can be interpreted in terms of the differences in the relative responses of the two variables to policy and other changes. The movements of the bank-credit-money ratio, implied by our analysis and parameter estimates, are consistent with our finding that postwar changes in policy variables have been procyclical rather than countercyclical on the average (Brunner and Meltzer, 1964a, 1964b). It appears likely that failure to carefully distinguish between money and bank credit misleads the Federal Reserve in its interpretation of the direction of its policy actions. By watching the rate of change of bank credit, rather than changes in the money supply or the monetary base, policy-makers often become convinced that a policy of relative ease is in effect when they are pursuing a policy of relative restraint.

Similar conclusions apply to the use of changes in interest rates on financial assets as indicators of the direction of recent monetary policy. The empirical findings suggest that, when the relative growth rates of the monetary base and the principal determinants of the public's supply of earning assets to banks are equal, changes in the determinants of the public's supply of earning assets dominate the movements of interest rates. Thus, the evidence suggests that rising or falling interest rates are not a useful indicator of the current direction of monetary policy.

The effects of monetary policy on real output and prices have not been investigated here. Hence the paper does not discuss these effects or attempt to compute the responses of real variables to changes in monetary policy. Nevertheless, the results have implications for macroeconomic theory.
Our denials of the various liquidity traps do not depend on particular assumptions about the structure of the real sector. Any of a number of widely used models, in which expenditure functions are not completely interest inelastic and in which money wages adjust more slowly than the monetary variables, yield the conclusion that monetary policy affects the pace of economic activity once the liquidity trap is denied. Of course, each hypothesis has different properties that may imply differences in the magnitude of the response to monetary policy. But our conclusion that monetary policy has an effect on the real variables does not appear to be sensitive to changes in the hypotheses about the real sector.

Part of this conclusion is not novel. Most economists agree that open-market operations change prevailing interest rates, alter the relative prices of assets and output, and hence affect real variables. Denial of the liquidity trap, however, adds important support to the generality of this conclusion and suggests that the ability of monetary authority to introduce or remove an excess demand for real balances does not depend on the real-balance effect. In the absence of a liquidity trap in both the supply and demand functions for money, there is little reason to believe that the effectiveness of monetary policy ever requires the assumption that the government sector is unconcerned by the change in the value of its outstanding debt or that the public is unconcerned about changes in future tax burdens.35

Appendix I

Alphabetical List of Principal Symbols Used in the Paper

- \( A \) discounts and advances of member banks
- \( a \) the earning-asset multiplier
- \( B \) the monetary base
- \( B^* \) the adjusted monetary base, \( B - A \)
- \( b \) the ratio of member-bank borrowing to total deposits
- \( C \) treasury currency outstanding
- \( C_p \) total currency held by the public
- \( c \) treasury cash in the sources statement of the base
- \( D \) (or \( D_n \)) the quantity of money demanded
- \( D_p \) demand deposits of the public
- \( D_t \) demand deposits of the Treasury at commercial banks
- \( d \) the ratio of Treasury deposits at commercial banks to the public's demand deposits
- \( E \) earning assets of commercial banks net of Treasury deposits and the banks' net worth
- \( E_b \) the banks' demand for earning assets (net of Treasury deposits and capital accounts)
- \( E_p \) the public's demand for earning assets to banks
- \( e \) the ratio of desired excess reserves to total deposits
- \( f^* \) deposits of foreign banks at Federal Reserve Banks

35 For a summary of the discussion on these points, see Johnson (1962, pp. 337-43).
The ratio of free reserves to total deposits = \( e - b \)
Deposits of the Treasury at the Federal Reserve Banks
An index of interest rates on bank earning assets
An index of interest rates on financial assets other than bank earning assets
The interest rate paid by banks on time deposits
An index of rates on all financial assets, a weighted average of \( i_e \) and \( i_o \)
The ratio of currency held by the public to demand deposits of the public
A weighted sum of the logarithms of the policy variables and the currency ratio

\[
M_1 = \text{The money supply, } C_p + D_p
\]
\[
M_2 = \text{The money supply plus time deposits, } M_1 + T
\]
The monetary multiplier
The multiplier for the money supply plus time deposits
The yield on private capital
The difference between other liabilities plus net worth and other assets on the consolidated balance sheet of the Federal Reserve Banks

\[
P = \text{The Federal Reserve's portfolio of earning assets net of discounts and advances}
\]
\[
P_* = \text{The deflator for wealth}
\]
\[
p = \text{The income deflator}
\]
A ratio of interest elasticities

\[
R^* = \text{Total commercial-bank reserves—base money held by banks including vault cash counted as reserves}
\]
\[
R_e = \text{Desired excess reserves of commercial banks}
\]
\[
R_r = \text{Required reserves of commercial banks}
\]
\[
r = \text{The sum of weighted averages of demand- and time-deposit reserve-requirement ratios plus the vault-cash ratio}
\]
\[
r_d = \text{The weighted-average reserve-requirement ratio for demand deposits}
\]
\[
r_t = \text{The reserve-requirement ratio for time deposits}
\]
\[
r_{10} = \text{The interest rate on loans at commercial banks}
\]
\[
r_{20} = \text{The long-term interest rate, the Durand measure of the interest rate on twenty-year bonds}
\]
\[
T = \text{Total commercial-bank time deposits}
\]
\[
t = \text{The ratio of time deposits to the public's demand deposits}
\]
\[
U = \text{The gold stock}
\]
\[
V = \text{Vault-cash holdings of commercial banks not counted as required reserves}
\]
\[
\nu = \text{The ratio of vault-cash holdings to total deposits}
\]
\[
W = \text{The nominal stock of wealth held by the public}
\]
\[
W/P = \text{The deflated stock of wealth held by the public}
\]
\[
Y_1/Y_p = \text{The ratio of net national product to "permanent" net national product, an index of transitory income}
\]
\[
Z = \text{A combination of elasticities in the denominators of the elasticities of Table 4}
\]
\[
\alpha = \text{The ratio } m_2/e = m_2/m_2 - 1]
\]
\[
\beta = \text{The ratio of } a/m_1
\]
\[
\gamma = \text{The ratio } (D_p + D_t)/(D_p + D_t + T)
\]
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δ  The ratio of member-bank demand deposits of the Treasury and the public to total demand deposits

Δ  The denominator of the simple elasticities in Appendix II and of the monetary and asset multipliers

e  An elasticity

π  Used to represent unspecified variables in the equations of Appendix II

ρ  The rediscount rate

τ  The ratio of member-bank time deposits to total commercial-bank time deposits

Appendix II

Equations of the Underlying Money-Supply Bank-Credit Hypothesis and the Derived Elasticities Required for the Text

Basic Definitions

(D1) \( B = P + U + C - g - o - f^* - c \)

(D2) \( B = R^* + C_p \)

(D3) \( B^* = B - A \)

(D4) \( M_1 = D_p + C_p \)

(D5) \( M_2 = M_1 + T \)

(D6) \( E = D_p + T - (R^* - A) \)

Description

Sources of the base
Uses of the base, total reserves plus currency
The adjusted base, the base minus borrowed reserves
The money supply
The money supply plus time deposits
Bank credit net of Treasury deposits and the banks' net worth

From equations (D3), (D4), and (D6), we note that \( M_1 = E \) if and only if \( B^* = T \).

Other Equations of the Monetary System

The ratio of required reserves plus vault cash outside required reserves to total deposits of member and non-member banks is a weighted average:

\[
V + R_r + r(D_p + D_t + T); \quad r = \gamma \delta \lambda^d + (1 - \gamma) \tau \rho^t + v.
\]

The desired excess-reserve, borrowing, and free-reserve ratios are:

\[
R_e = e(i, \rho, \pi)(D_p + D_t + T), \quad e < 0 < e_p;
\]

\[
A = b(i, \rho, \pi)(D_p + D_t + T), \quad b_i > 0 > b_p;
\]

\[
\frac{R_e - A}{D_p + D_t + T} = f(i, \rho), \quad f_i < 0 < f_p.
\]

The ratio of Treasury deposits to the public's demand deposits is taken as a policy variable,

\[
D_t = dD_p.
\]

The currency ratio \( k \) is dependent on a variety of costs and returns as well as on wealth and other factors. In this paper it is treated as given:

\[
C_p = kD_p.
\]
The time-deposit ratio \( t \) is assumed to depend on interest rates, wealth, and other variables:

\[
T = \left( l, i, \frac{W}{p}, \frac{Y}{p}, m_s \right) D_s; \quad t, t_s > 0; f_s < 0. \tag{A5}
\]

**Solutions for the Monetary and Asset Multipliers**

(A1)-(A5) and (D2)-(D6) permit us to solve for the monetary and asset multipliers and obtain

\[
m_1 = \frac{1 + k}{(r + f)(1 + t + d) + k}, \tag{A6}
\]

\[
m_2 = \frac{1 + k + t}{(r + f)(1 + t + d) + k}, \tag{A7}
\]

and, since \( E = M_2 - B^a = (m_2 - 1)B^a \),

\[
a = m_2 - 1 = \frac{(1 + t) - (r + f)(1 + t + d)}{(r + f)(1 + t + d) + k}. \tag{A8}
\]

**The Elasticities of the Monetary and Asset Multipliers**

We denote by \( \varepsilon(m_1, x) \), \( \varepsilon(m_2, x) \), and \( \varepsilon(a, x) \) the simple elasticities of the monetary and asset multipliers with respect to the factors shaping the multipliers. The discussion in the text makes use of the following relations:

\[
\varepsilon(m_1, t) = \frac{-(r + f + v)t}{\Delta}, \tag{A9}
\]

where \( \Delta \) is the denominator of the monetary and asset multipliers in equations (A6)-(A8),

\[
\varepsilon(m_1, t) = \frac{-(r^* + f + v)t}{\Delta}, \tag{A10}
\]

\[
\varepsilon(a, f) = \varepsilon(m_1, f)a, \tag{A11}
\]

\[
\varepsilon(a, t) = \frac{t}{\Delta} (a - 1) + \varepsilon(m_1, t)a, \tag{A12}
\]

\[
\varepsilon(m_2, f) = \varepsilon(m_1, f), \tag{A13}
\]

and

\[
\varepsilon(m_1, t) = \frac{t}{1 + k + t} \left( \frac{t}{1 + k + t} = \frac{T}{M_2} \right), \tag{A14}
\]

where

\[
a = \frac{m_2}{a} = \frac{1 + k + t}{1 + t) - (r + f)(1 + t + d)}. \tag{A15}
\]

The ratio \( a > 1 \), since \( a = m_2 - 1 < m_2 \).

Solutions similar to (A9) and (A11) are obtained for the parameters \( r^d \), \( r^l \), \( \delta \), and \( \tau \) (but not \( k \)). For example,

\[
\varepsilon(m_1, r^d) = \frac{-r\delta(1 + t + d)r^d}{\Delta}, \tag{A14}
\]

and

\[
\varepsilon(a, r^d) = \varepsilon(m_1, r^d)a. \tag{A15}
\]
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Appendix III

Solution for Equilibrium Values; Derivation of the Elasticities in Tables 1 and 2 of the Text; Values of the Empirical Coefficients

Assume (1) that the elasticities of monetary and asset multipliers in Appendix II may be approximated by constants and (2) that the public's supply of assets to banks, equation (4) of the text, is linear in the logarithms of the variables.

A. Solution for \( i_0 \) on the Bank-Credit Market

\[
\log E_b = \log B_a + \epsilon(a, r^4) \log r^4 + \epsilon(a_2, i_2) \log i_2,
\]

plus similar terms for \( r^4, k, p, W/P_a, p \) and \( Y/Y_p \), where the last three terms occur because of their influence on \( i \).

\[
\log E_p = \epsilon(s, i_3) \log i_3 + \epsilon(s, W) \log W + \epsilon(s, i_s) \log i_s,
\]

plus similar terms for \( p, Y/Y_p \) and \( n \). The equilibrium stock of bank credit, \( E \), and \( i_0 \) are simultaneously determined.

\[
\log i_0 = \frac{1}{\epsilon(a, i_0) - \epsilon(s, i_3)} \left[ \epsilon(s, W) - \epsilon(a, W) \right] \log W
+ \epsilon(s, i_s) \log i_s - \log B_a - \epsilon(a, r^4) \log r^4,
\]  

(A16)

plus similar terms for other variables and parameters, \( W/P_a, Y/Y_p, r^4, n, k, \) and \( p \). By the same procedure the equilibrium solutions for \( M_2 \) and \( M_3 \) are obtained in terms of \( q_2 \) and \( q_3 \). These solutions are used to obtain the
elasticiies shown in Table 2 of the text. Regression estimates for equation (A18) are shown in Section C.2 below.

C.1. Values of Coefficients and Parameters of the Bank-Credit-Market Equation

Using data for 1919–41 and 1952–58, the regression estimates ($t$ statistics are in parentheses) of the reduced-form equation for $r_i$ are:

$$
\log r_i = -6.306 - 0.510 K_3 + 0.908 \log \frac{W}{P_a} + 0.423 \log r_{20} \\
(4.49) \quad (6.67) \quad (2.32)
$$

$$
+ 0.017 \log \frac{Y}{Y_p} + 0.744 \log \rho + 0.254 \log r_i \\
(4.90) \quad (4.44) \quad (3.98) \quad (R^2 = 0.983),
$$

where $r_i$ is the interest rate on bank loans, $r_{20}$ is the Durand yield on corporate bonds,

$$
K_3 = \log B^a + \varepsilon(a, r^d) \log r^d + \varepsilon(a, r^t) \log r^t + \varepsilon(a, k) \log k,
$$

(with elasticities in $K_3$ computed according to the formulas given in Appendix II), and $n$ was omitted from the regression owing to problems of measurement.

The regression coefficients suggest that the parameters have the values shown in Table C1.

### Table C1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Interpretation of Reduced-Form Parameter</th>
<th>Value of Credit-Market Parameter</th>
</tr>
</thead>
</table>

| $K_3$         | $\varepsilon(a, i_d) - \varepsilon(s, i_s)$ | 1.96                             |
| $\log \frac{W}{P_a}$ | $\varepsilon(s, i_d) - \varepsilon(s, i_s)$ | 1.78                             |
| $\log r_{20}$  | $\varepsilon(s, i_s)$                      | 0.83                             |
| $\log \frac{Y}{Y_p}$ | $\varepsilon(s, Y_s) - \varepsilon(s, Y_p)$ | 0.03                             |
| $\log \rho$    | $\varepsilon(s, \rho) - \varepsilon(s, \rho)$ | 1.46                             |
| $\log \rho$    | $\varepsilon(s, \rho) - \varepsilon(s, \rho)$ | -0.50                            |

C.2. Values of the Coefficients and Parameters of the Supply and Demand Equations for Money

Using data for 1919–41 and 1952–58, the regression estimates ($t$ statistics are in parentheses) of the supply equation for money are:

$$
\log M_1 = -4.359 + 0.347 K_1 - 0.145 \log \rho + 0.501 \log \frac{W}{P_a} - 0.459 \log r_{20} \\
(2.10) \quad (-2.27) \quad (2.90) \quad (-2.43)
$$

$$
+ 0.926 \log \rho - 0.008 \log \frac{Y}{Y_p} \\
(4.12) \quad (-1.64) \quad (R^2 = 0.996; \text{Durbin-Watson} = 1.40),
$$
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where

\[ K_1 = \log B_a + \epsilon(m, \rho) \log r^* + \epsilon(m, \rho) \log r^* + \epsilon(m, k) \log k \]

(with elasticities in \( K_1 \) computed according to the formulas in Appendix II).

Two-stage least-squares estimates of the demand equation were obtained using the interest rate \( r_1 \) estimated from the bank-credit-market equation. Again, \( t \) statistics are shown in parentheses; the Durbin-Watson statistic is from the one-stage least-squares estimate. The estimates suggest that the "combined" interest elasticity of the demand for money, \( \epsilon(D, r^*) \), is approximately \(-0.5\). The lack of significance of one rate in these regressions most likely results from the very high correlation between \( r_1 \) and \( r_2 \).

\[
\begin{align*}
\log D_m &= -0.995 + 0.831 \log \frac{W}{P_a} + 1.317 \log P_a - 0.004 \log \frac{Y}{Y_a} \\
(8.71) & \quad (21.20) & \quad (1.18) \\
-0.073 \log r_{20} - 0.399 \log r_1^* & \quad (-3.06) & \quad (R^2 = 0.997; \text{Durbin-Watson} = 1.22).
\end{align*}
\]

Estimates of the \( M_1 \) and \( D_m \) equations obtained from three-stage least-squares regressions do not differ in any important respect and are omitted. The regression estimates of the \( M_1 \) supply equation can be combined with the estimates from the \( r_1 \) (or \( i_a \)) equation to obtain the elasticities of the monetary multiplier (see Table C2).

### TABLE C2

<table>
<thead>
<tr>
<th>Variable</th>
<th>Interpretation of Parameter</th>
<th>Elasticities of the Monetary Multiplier*</th>
</tr>
</thead>
<tbody>
<tr>
<td>( K_1 )</td>
<td>( 1 - q_1 )( \epsilon )†</td>
<td>( q_1 = 0.48; \epsilon(m, \rho) = 0.94 )</td>
</tr>
<tr>
<td>( \rho )</td>
<td>( \epsilon(m, \rho)(1 - q_1)$</td>
<td>( \epsilon(m, \rho) = -0.42 )</td>
</tr>
<tr>
<td>( \frac{W}{P_a} )</td>
<td>( \epsilon\left(m, \frac{W}{P_a}\right) ) − ( q_1 \left[ \epsilon(\rho, \frac{W}{P_a}) \right] )</td>
<td>( \epsilon(m, \frac{W}{P_a}) = -0.35 )</td>
</tr>
<tr>
<td>( \frac{P_a}{W} )</td>
<td>( \epsilon(m, \frac{P_a}{W}) )</td>
<td>( \epsilon(m, \frac{P_a}{W}) = 0.23 )</td>
</tr>
<tr>
<td>( \frac{Y}{Y_a} )</td>
<td>( \epsilon\left(m, \frac{Y}{Y_a}\right) ) − ( q_1 \left[ \epsilon(\rho, \frac{Y}{Y_a}) \right] )</td>
<td>( \epsilon(m, \frac{Y}{Y_a}) = -0.021$</td>
</tr>
<tr>
<td>( a )</td>
<td>( a )</td>
<td>( \alpha = 1.35 ), the average value for the period</td>
</tr>
</tbody>
</table>

* The coefficient of \( i_a \) has a sign opposite to the sign implied by our theory and has been omitted from the table.
† There is a small approximation error. The correct interpretation of the product of the coefficient and variable is

\[
(1 - q_1) \log B_a + (1 - q_1)\epsilon(m, \rho) \log r^* \epsilon(m, \rho) \log r^* + (1 - q_1) \log k, \]

where \( \Delta \) is the denominator of the monetary and asset multipliers in Appendix II.

‡ An alternative estimate of \( q_1 \) can be obtained using \( \epsilon(a, \rho) = -0.59 \) from Table C1 and the equation \( \epsilon(a, \rho) = \epsilon(m, a) \). This estimate gives \( \epsilon(m, a) = -0.37 \) and \( q_1 = 0.45 \).

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