MONEY SUPPLY DETERMINATION THEORY AND APPROACHES

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During most of the history of modern economics, analysis of the money stock has failed to produce well-developed techniques of the kind that have been applied to other areas of economic analysis. On the demand side, Hicks[1]) criticized the monetary theorists' practice of using accounting identities intead of the marginalist tools of value theory. On the supply side, matters have not been much different. The money-supply function has been left to the institutionalists to deal with, on the reasoning that the money-supply function is an economic phenomenon influenced to a great extent by institutional arrangaments and legal requirements. One can, therefore, expect changes in the money-supply function as institutions evolve through time, and also because of differences among countries.

One can best study the development of money-supply theory by reviewing and analyzing the significant contributions made to the theory. Before doing so, we need to look at the question of what specifically constitutes the money supply.

DEFINITION OF MONEY

Johnson[2]) distinguishes four schools of thought on the appropriate definition of money. One school emphasizes the role of money as a medium of exchange, defining it as currency plus demand deposits. Latané[3]) is one proponent of this definition. This formulation is also used in the statistical presentations of monetary data by the International Monetary Fund and by many other monetary institutions throughout the world. Some prefer this definition on an *a priori* basis for less developed countries:

*) Royal Scientific Society, Amman, Jordan.

[1]) J. R. Hicks, »A Suggestion for Simplifying the Theory of Money?« *Economica*, NS-2, (February 1935), 1—19.

[2]) H. G. Johnson, »Monetary Theory and Policy«. *American Economic Review*, LII (June 1962), 335—384.

[3]) H. A. Latané, »Cash Balances and the Interest Rate: A Pragmatic Approach«, *Review of Economics and Statistics*, XXXVI (November 1954), 456—460; also »Income Velocity and Interest Rates: A Pragmatic Approach«. *Review of Economics and Statistics*, XLII (November 1960), 445—449.

> In developing countries the problems appertaining to important financial super-structures hardly arise, so that for them emphasis on the control of the money supply... defined as above... should suffice for many years to come.[4])

On the other hand, the school represented by Milton Friedman defines the quantity of money as »a temporary abode of purchasing power«,[5]) and in its empirical work defines the quantity of money more specifically as currency plus total commercial bank deposits. In addition to justifying its definition on the basis of the lack of separate estimates of demand and of time deposits before 1914 for the Unitet States, this school argues that the appropriate criterion for judging whether time deposits are sufficiently close substitutes for other items is the observation whether income is more highly correlated with their sum than with each component separately.[6]) It thereby concludes from empirical results that money in the United States should include currency plus deposits of the commercial banks.

A third school, opposing the position of the former two, consists of those who place emphasis on monetary policy rather then on monetary theory, and explains money according to a broader concept, measurable or unmeasurable concept is exemplified by the long-established Federal Reserve Board theory that it is the total amount of credit outstanding that matters, with the quantity of money exerting an influence only because bank credit is a component of total credit.[7]) An unmeasurable concept is represented by the Radcliffe Committee's[8]) concept of the liquidity of the economy.

Gurley and Shaw[9]) typify the forth school. They are concerned with the implication for velocity of the presence of liquid assets that are close substitutes for money. Gurley[10]) argues that in the United States the behaviour of interest rates is explained by movements in the relationship of liquid assets to the gross national product in current prices.

In this work, money supply is defined as currency plus demand deposits of the public, consistent with the definition used by the Central Bank of Jordan.

MULTIPLE EXPANSION

Studies on factors affecting the money supply usually consider total reserves of comercial banks or some other magnitude as a constraint on money-supply expansion for given reserve requirements, so that central bank

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[4]) E. E. Jucker-Fleetwood, »The Money Supply in Mature and in Developing Economies«. *Irish Banking Review* (March 1961), p. 20.

[5]) M. Friedman and A. Schwartz, *A Monetary History of the United States, 1867—1960*, National Bureau of Economic Research (Princeton: Princeton University Press, 1963), p. 650.

[6]) M. Friedman and D. Meiselman, »The Relative Stability of Monetary Velocity and the Investment Multiplier in the United States, 1897—1958.« Commission on Money and Credit, *Stabilization Policies* (Englewood Cliffs, New Jersey: Prentice-Hall, 1963), 181—183.

[7]) S. E. Harris, *et al.*, »Controversial Issues in Recent Monetary Policy: A Symposium.« *Review of Economics and Statistics*, XLII (August 1960), 245—282.

[8]) Committee on the Working of the Monetary System (Chairman: The Rt. Hon. The Lord Radcliffe, G.B.E.), Report (London: 1959).

[9]) J. G. Gurley and E. S. Shaw, *Money in a Theory of Finance* (Washington, D.C.: The Brookings Institution, 1960).

[10]) J. G. Gurley, *Liquidity and Financial Institutions in the Postwar Economy.* Study Paper 14, Joint Economic Committee, 86th Congress, 2nd Session (Washington, D. C.: Government Printing Office, 1960).

actions affecting total reserves and reserve requirements set the maximum limit on the volume of comercial bank deposits and thus influence the total money supply. Other factors are also considered, such as the reserve requirement on time deposits, currency held by the public, and excess reserves held by the banks.

The basic hypothesis of the multiple-expansion mechanism is that banks, finding themselves with excess reserves, will purchase assets and thereby increase the money supply. The banks do so because it is profitable. The extent to which they are able to do so is limited by the constraints imposed upon them by the public in the form of currency drains, deposit shifts between banks, and shifts between time and demand deposits. There are also constraints imposed by the central bank in the form of reserve requirements, as well as contraints that the banks impose on themselves in the form of excess reserves. A main assumption of the multiple-expansion approach is that these constraints take the form of fixed coefficients.

In his analysis of the money supply, Fand writes:

> In money and banking textbooks there is a simple link between bank reserves, deposits and money. In a world where banks use all their reserves, where there are no free reserves, and where both the banks and the public do not undertake any portfolio changes, there is no need to concern ourselves with the money supply since it is basically a matter of arithmetic.
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> Once we get away from the simple, mechanical link between reserves, deposits and money, the supply of money has an independent existence as an economic variable determined by behavior and subject to analysis.[11])

1. *Phillips*

The simple textbook link between bank reserves and money supply referred to by Fand is generally attributed to Phillips, whose contribution was to show the difference between individual bank and systemwide expansion for a given inflow of reserves.[12]) Phillips explained the way in which cash in commercial banks becomes the basis of manifold loans and deposits. This is the earliest complete treatment of the deposit expansion process in a multi-bank fractional reserve system.[13]) He drew a sharp line of distinction between credit extension by an individual bank and that by banks taken in the aggregate. This was a breakthrough, because earlier accepted statements of banking theory has made no such distinction. It had long been observed that banks were able to extend credit equal to several times their reserves, and the inference had been that what was true of banks in the aggregate was true of each. The inference had been supported by the observed fact that the balance sheet of any representative bank carries loans several times the amount of the reserves held. It was thus reasoned that an addition to

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[11]) D. I. Fand, »Some Implications of Money Supply Analysis.« *American Economic Review*, LVII (May 1967), p. 380.

[12]) C. A. Phillips, *Bank Credit* (New York: Macmillan, 1920).

[13]) J. A. Schumpeter, *History of Economic Analysis* (New York: Oxford University Press, 1954), p. 1116.

the reserve of an individual bank would put it in a position to increase its own loans monifold. Phillips' contribution lies in deriving deposit and loan expansion coefficients and in specifying the amount of new loans which can be supported by new reserves. Assuming that the whole banking system comprises a single bank carrying out the loan and deposit business of the entire country and maintaining a reserve-deposit ratio of R, the net deposit of a given amount of cash or reserve c would enable the bank to lend, in addition to its outstanding loans

$$\frac{1}{R}(c - Rc) \text{ or } \frac{c}{R} - c$$

He also showed that a representative bank in a system is actually able to lend an amount equal to its excess reserves and not a multiple of these reserves, because of the loss of reserves resulting from the creation of new loans. Phillips also showed that the formula of the loan and deposit expansion of the monopoly bank is valid for a multi-banking system. Although Phillips hinted that some cash might be lost as a result of rising prices and a consequent increased demand for money, for retail transactions, he did not attempt to reformulate his analysis to include the effect of this new factor on the loan and deposit expansion. This was left to later economists, who have a more complete statement of the deposit expansion mechanism, taking into account other factors that affect the money supply.

2. *Shaw*

Shaw[14]) illustrated a formula of the loan coefficient that not only included the reserve requirement ratio on demand and time deposits, but also took into account such factors as the relative desire of the public to hold their money in the form of currency, demand deposits or time deposits, and the desire of banks to hold excess reserves.

His explanation of the loan coefficent deals with the relationship between changes in earning assets, on the one hand, and variations in surplus reserves, on the other. He gives an analysis of the loan coefficient for the single bank and for a system of banks, and isolates factors that determine the capacity of banks to buy earning assets, given the volume of surplus reserves. When bank A buys earning assets, there will be drains on its surplus reserves as follows:

$$E_a [(1\text{-}H_a) + r' (sH_a) + (r + r'') H_a (1 - s) (1 - c)]$$

where

E_a = the security purchases of bank A in dollar terms

H_a = the size of bank A. This size is measured with the help of the primary deposit liabilities. If bank A receives 5 percent of the primary deposits originating from the purchase of securities, then its size is 0.05 and the size of the banking system is 1. A primary deposit is one that is not the direct proceeds of a bank's purchase of securities.

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[14]) E. S. Shaw, *Money, Income and Monetary Policy* (Chicago: Irwin, 1950) pp. 122—142.

r' = the legal reserve ratio for time deposits measured as a percentage

r'' = the working reserve ratio for demand deposits. Working reserves are part of the excess reserves of bank A held as a precaution against claims for payment that may arise from the Bank's existing liabilities. The other part of the excess reserves is the surplus reserves, which are available to meet claims arising from additions to the present level of liabilities.

r = the legal reserve ratio for demand deposits, measured as a percentage.

s = the public's demand for time deposits. It is a measure of the proportion of the liquid assets that the public wishes to hold in the form of time deposits.

c = the public's demand for currency. It is a measure of the proportion of the liquid assets that the public wishes to hold in the form of currency.

Let K_a designite all the terms inside the brackets. Then K_a is the coefficient of cash drain for bank A which tells us the amount of surplus reserves that will be lost to bank A for each dollar purchase of earning assets. The reciprocal of K_a is the bank A loan coefficient. If the surplus reserves of A are B_a, then the expression for the possible maximum purchase of securities is $B_a(1/K_a)$, and the relationship between the reserves and the purchased earning assets can be put as either $B_a = E_aK_a$ or $E_a = B_a(1/K_a)$.

If we define the money supply to be equal to currency plus demand deposits, then the gain in the money supply is less than the addition to bank A's earning assets by a proportion of the security purchase. This is measured by the monetary coefficient $\frac{(1-s)}{(K_a)}$, which is the amount by which bank A is capable of adding to the money supply for each dollar of its surplus reserves. The monetary coefficient therefore defines the possible expansion of the money supply.

The coefficients for the entire system of banks can be found by substituting H or 1 for H_a. The coefficient of cash drain is:

$$K = r's + (r + r'') [(1-s) (1-c)]$$

The loan coefficient for the whole system is then 1/K, and the monetary coefficient is $\frac{(1-s)}{(K)}$.

These coefficients define the relationship between surplus reserves and the change in earning assets and the money supply.

This multiple-expansion process has been at the forefront of money-supply analysis since 1920. This is the orthodox analysis presented in present-day money and banking textbooks.

3. *Criticism*

Money supply determination under the multiple-expansion process follows a simplistic mechanical expansion formula with fixed coefficients that

describe the behavior of the public's desire for currency, demand and time deposits, and the banks' demand for liquidity. This approach uses coefficients fixed by institutional considerations rather than by behavioral relationships. Moreover, the multiple-expansion process considers the fixed marginal coefficients to be equal to the average coefficients calculated from the balance-sheet data. Since the central bank controls the reserve base, most macroeconomic theories make the actual money supply exogenous.

The deposit expansion in such forms as those presented by Phillips and Shaw have come under attack. Orr and Mellon[15]) held that such deposit expansion relies on a comparative static deterministic analysis. Since important results in economic theory have been obtained through incorporation of uncertainty into decision models, they explored the potential effects of uncertainty in the cash flows of banks on the expansion of bank credit, and compared the banks' response to excess reserves under uncertainty with the response indicated by the traditional theory. However, since their assumptions regarding portfolio alternatives are restrictive and it is difficult to appraise the effect quantitatively, Orr and Mellon felt that they had reached a tentative rather than a final conclusion. It was that the deposit expansion coefficient derived from their uncertainty model is lower than that derived from the deterministic model.

BANK ADJUSTMENT AND THE RESERVE POSITION

Another study made for the purpose of finding factors that determine a country's money supply is that of Riefler.[16]) Riefler stated that bank indebtedness is the most important factor in the determination of the money supply. According to him, banks borrow at the »Fed« (in the United States) only in necessity and repay their borrowings as soon as possible. Therefore, banks borrow mainly when open-market operations reduce their reserves and repay these funds when open- market operations increase their reserves. The open-market operations of the Fed itself influence bank borrowing, which is the most important element in determining market interest rates. The market interest rates are the main determinants of the public's supply of earning assets to the banks. Hence, through open-market operations, the Fed can control bank credit and the money supply.

Meigs[17]) went a step further. The question he tried to answer was whether the Fed's open-market operations, which were intended to produce a particular rate of growth or contraction of member-bank deposits, should attempt to control the total reserves of the member banks or their free reserves (free reserves = excess reserves-borrowed reserves).

His principal conclusion was that the use of total member-bank reserves as a proximate goal for open-market operations would afford more precise control over the rate of bank deposit expansion or contraction that would the use of free reserves. He developed two main arguments: (1) that

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[15]) D. Orr and W. G. Mellon, »Stochastic Reserve Losses and Expansion of Bank Credit«, *American Economic Review*, LI (September 1961), 614—623.

[16]) W. W. Riefler, *Money Rates and the Money Markets in the United States* (Harper, 1930).

[17]) A. J. Meigs, *Free Reserves and the Money Supply* (Chicago: University of Chicago Press, 1962).

the rate of change of deposits is closely related to the rate of change of total member-bank reserves, but is not closely related to the level of free reserves; and (2) that the use of free-reserve targets may produce perverse results, such as contraction of the money supply in recessions and rapid expansion of deposits during recoveries. Meigs was basically attacking the reserve-position approach to monetary control, which had its origin in Riefler's work.

While Phillips and Shaw dealt mainly with the deposit-expansion mechanism in a multi-bank fractional reserve system, Orr, Mellon, Riefler, and Meigs dealt with the behavioral patterns and functional relations in the response of banks to Fed policy actions.

Meigs made a contribution to the policy making process. The primary point of his work was that the actual level of free reserves was a poor indicator of tightness and an equally poor policy target. The reason was that banks retained in their corporate consciousness a desired level of free reserves based on market rates and the discount rate. They adjusted in that direction irrespective of open-market policy. Meigs'contribution to the development of the theory of money supply was that adjustments by banks constituted an endogenous force in money-supply determination. Banks adjusted according to market rates and the discount rate.

The main implication of the bank adjustment approach for the theory of money supply was that the money supply became an endogenous variable in this system.

SPECIFICATION OF EMPIRICAL MONEY-SUPPLY RELATIONSHIPS

In analyzing the proximate determinants of the nominal stock of tions based on the studies referred to above. Some of the most important of these attempts, taking into consideration the behavior of such variables as the banks' holdings of excess reserves, the public's holdings of currency, and time deposits, were carried out by Friedman-Schwartz,[18]) Cagan,[19]) Brunner,[20]) Brunner-Meltzer,[21]) and Teigen.[22])

Working's[23]) presentation with regard to commodity markets (but equally applicable to the money market) clearly indicated that observed quantities and observed prices reflect the intersections of demand and supply functions. He pointed out that only under the condition that one of the curves is fixed for all the observations will the observed quantities and prices trace out the stationary function. This is not unfamiliar to economics now, but it seems to have made little progress with monetary economists in its day (1920's). Two empirical investigations of money supply which are relatively free of simultaneous estimation bias are those of Teigen and Brunner-Meltzer.

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[18]) Friedman and Schwartz, *op. cit.*

[19]) P. Cagan, *Determinants and Effects of Changes in the Stock of Money, 1875—1960.* National Bureau of Economic Research (New York: Columbia University Press, 1965).

[20]) K. Brunner, »A Schema for the Supply Theory of Money.« *International Economic Review,* II (January 1961), 79—109.

[21]) K. Brunner and A. H. Meltzer, »Some Further Investigations of Demand and Supply Functions for Money.« *Journal of Finance,* XIX (May 1964), 240—283.

[22]) R. L. Teigen, »Demand and Supply Functions for Money in the United States: Some Structural Estimates.« *Econometrica,* XXXII (Octobar 1964), 476—509.

[23]) E. J. Working, »What Do Statistical 'Demand Curves' Show?« *Quarterly Joural of Economics,* XLI (February 1927), 212—235.

1. *Friedman-Schwartz*

In analyzing the proximate determinants of the nominal stock of money in the United States, Friedmen-Schwartz define money supply to include currency plus total bank deposits of the public. The determinants are high-powered money H, the deposit-to-reserve ratio D/R, and the deposit-to-currency ratio D/C. H is and analytical concept cited as a constraint on the maximum size of the money supply. It is sometimes called »monetary base«, and can be calculated by defining either its sources or its uses. The Friedman-Schwartz exposition relies on the use of H — total reserves of the commercial banks R plus currency held by the public C.

D/R depends on legal reserve requirements, and the expectation of currency flows and interest rates. It takes into consideration the decision of banks regarding excess reserves. D/C depends on interest rates, income, and the public's preferences for holding currency. Friedman-Schwartz present the following money-stock identity in terms of these three determinants:

$$MS = H \frac{\frac{D}{R}\ (1 + \frac{D}{C})}{\frac{D}{R} + \frac{D}{C}}$$

The stock of money can therefore be regarded as an arithmetical result of manipulating H, D/R, and D/C. Any change in the stock of money can be attributed to a change in the three determinants. The interaction of changes in H and the two ratios determines changes in the money stock.

Although the Friedman-Schwartz equation is an identity, it nonetheless has a theoretical justification for the process of money-supply determination. H is provided by the monetary authorities. Both the banks and the public compete for its use. The banks need it to meet their reserve requirement and to obtain desired excess reserves. The public needs some of it for use as currency. Since by definition H = R + C, all the H is always claimed.

Hansen[24]) provides the theoretical justification for the functioning of this money-supply process, through the adjustment mechanism of the banks as they react to a discrepancy between their desired and the actual excess reserves, and also through the public as it reponds to a discrepancy between its desired and the actual currency holdings. As the monetary authorities increase H, the actual level of excess reserve of the banks becomes greater than the desired level, *ceteris paribus*. Banks will therefore acquire earning assets, increasing their deposits and reducing their actual excess reserves to the desired level. The public will also adjust its currency holdings. More reserves are needed to maintain the desired ratios because of the increase in deposits, until actual reserves becomes equal to desired reserves.

There can also be a change in money supply even without an increase in H, if changes take place in the ratio D/R or D/C. With this framework,

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[24]) A. H. Hansen, *Monetary Theory and Fiscal Policy*, (New York: McGraw-Hill, 1949).

Friedman-Schwartz concluded that changes in H were the dominant determinant of long-term and major cyclical movements in the money supply, whereas changes in the D/R and D/C ratios exerted an important influence on movements in the money supply during financial panics. Changes in the D/C ratio contributed significantly to movements in the money supply during mild cycles. They reached these conclusions through examination of successive historical episodes in U.S. monetary history between 1867 and 1960.

2. *Cagan*

This attempt is similar to that of Friedman-Schwartz. It was aimed at providing a broad historical analysis of monetary behavior. Cagan directed his study toward three specific tasks; (1) describing the secular and cyclical movements in the money supply and identifying the institutional channels through which they occurred; (2) looking beyond these channels to analyze the under-lying factors and relationships at work; and (3) using the findings of supply factors to clarify the monetary effects on output and prices. Although Cagan uses the same money-supply framework as Friedman-Schwartz, nevertheless he arranges the three proximate determinants differently. Currency is expressed as a ratio of money C/M, and reserves as a ratio of deposits, R/D. His equation is expressed as follows:

$$M = H \frac{1}{\frac{C}{M} + \frac{R}{M} - \frac{C}{M} \cdot \frac{R}{D}}$$

Using this framework, he presents a statistical and descriptive analysis of the ceonomic factors accounting for the relative contribution of such proximate determinant to secular and cyclical changes in the money supply between 1875 and 1960. He concludes that growth in H is the most important factor affecting long-term growth in the money supply. C/M and R/D contribute little to secular change in money supply. H is affected by changes in the gold stock, Fed operations, and Treasury operations. Cagan believes that currency in circulation exceeds the amount needed for retail transactions. Currency therefore serves as a store of wealth. Demand for currency depends not only on transaction uses affected by the volume of consumer expenditure and the cost of checking accounts, but also on wealth holdings affected by total private wealth and interest rates paid on substitutes (for example, savings deposits). The C/M ratio depends upon how the relevant demand factors affect currency and commercial banks diferently. The R/D ratio is analyzed in terms of reserve requirements and desired excess reserves.

3. *Brunner*

While the Keynesian revolution contributed to logical clarification and empirical specification of the demand for money function, Brunner believes that nothing has been done to the theory of the money supply. In his »schema«, Brunner talks of the uncultivated state of money-supply theory and complains that »... most of the literature presents us with and accumu-

lation of analytical fragments which form at best only building blocks of an empirically significant theory«.[25]) His purpose was to extend the existing analysis and »... to construct a schema which can be used to formulate an empirical macro-supply function of money within the institutional framework of the American banking system«.[26])

To Brunner the desired rate of change of the asset portfolio of a bank is related to its surplus reserves S. To build his moneysupply function, he makes use of the »loss coefficient« λ along the lines of Shaw's analysis. The loss coefficient measures the drain in surplus reserves which occurs as a result of a one-dollar expansion of earning assets. He derives λ through a detailed examination of »... the possible forms in which reserves can be drained away whenever earning assets are increased«.[27]) These forms include the withdrawal in the form of currency of a portion of new deposits, the redeposit of some of the new deposits at other banks, the spillover of newly created deposits into time deposits accounts, and the increase in required reserves and desired excess reserves to cover demand deposits left at the expending bank. Consideration of the factors influencing each of these separate loss components leads to an expression that defines the loss of the surplus reserves per dollar of asset expansion. The reciprocal of this measure represents the bank's expansion coefficient which, when multiplied by the dollar amount of surplus reserves available, determines the total supply of bank come from. Brunner describes sounces that can generate the surplus portfolio to the new desired level. Brunner first develops a supply function for a single bank and then weaves the material relating to single banks and their interconnection into a money-supply function for the banking system as a whole.

It is important to understand where the surplus reserves of a given bank come from. Brunner describes sources that can generate the surplus reserves which induce the asset expansion. He classifies the »events and magnitudes« that generate these reserves into eight categories:

1. The currency flows into and out of banks which are dependent on changes in portfolio and deposits.
2. The conversion between demand and time deposits of the public.
3. The transactions between the Fed and a bank, such as bank borrowing and open-market operations involving the public.
4. The net clearing balances for a single bank.
5. The changes in reserve requirements.
6. The reallocation of the assets of a bank between balances with other banks and deposits at the Fed and vault cash.
7. The reallocation of the desired reserves holdings of other banks which cause an inflow of reserves to a given bank.
8. The changes in the desired level of excess reserves of a given bank.

When these eight factors are properly specified, they determine the generation of surplus reserves, s. This figure, together with λ, describes the

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[25]) Brunner, op. cit., p. 79
[26]) Ibid., p. 80
[27]) *Ibid.*, p. 81

response of a single bank to s »... in the form of a demand for earning assets designed to absorb s.«[28])

Brunner proceeds from the position of the individual bank »... to build a theory which contains some general propositions concerning observable patterns of individual banks.«[29] He uses the relationships earlier described to present a framework for the construction of an aggregative schema. This schema specified the rate of change of the money supply induced by the system's surplus reserve position. The money-supply relation thus derived is expressed as follows:

$$M = a - m_1 c_0 + m_2 t_0 + m_0 (B + L^3) + m_4 \dot{\Sigma}_0 + m_c (\gamma_0 - W_0)$$

where

M = the total money supply (DD + C)

m_0 = a multiplier describing the reaction in M to a unit change in the monetary base (high-powered money)

c_0 = a function of a vector of variables expressing the public's demand for currency.

t_0 = a function of a vector of variables expressing the public's demand for time deposits.

$(B+L^3)$ = the monetary base adjusted for changes in reserve requirements. B represents currency in circulation plus total reserves of banks, and L^3 reserves liberated (or frozen) by changes in the reserve requirements or »... changes in the system's average reserve requirements induced by shifts in the relative position of single banks associated with the deposit redistribution mechanism.«[30])

$(\gamma_0 - w_0)$ = a factor to present the banks' demand component for Federal Reserve money in excess of required reserves.

In empirical investigations, Brunner compared the correlation coefficients of (1) a simple hypothesis that acknowledged only B as a determinant of M and (2) extended hypothesis that also considered the effect of c_0, t_0 and L^3 on M. The correlation coefficients are compared on the basis of their interpretation as measures of the »comparative predictive performance« of the hypothesis under consideration. He found out »... that the neglect of c_0, t_0 and L^3 results in a hypothesis with a poor and unreliable predictive power,«[31]) whereas stable results are obtained and the hypothesis is relevant if currency demand, time deposit demand, and the cumulative effect of changes in reserve requirements are included in the explanation of the money supply.

4. *Brunner-Maltzer*

Brunner-Meltzer develop both a linear and non-linear theory of the money supply. Only the linear hypothesis will be dealt with here. This hypothesis is derived from Brunner's »Schema«.

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[28]) Ibid., p. 88.
[29]) Ibid.
[30]) *Ibid.*, p. 92.
[31]) *Ibid.*, p. 98.

The authors adopt high-powered money as the variable limiting the maximum size of the stock, calling it the monetary base B. Contrary to Friedman-Schwartz, they use the source method[32]) of computing the base B. B is controlled by the Fed through open-market operations and the discount rate, so that the Fed can offset changes in the base resulting from changes in the other sources.

The factors of their money-supply function are: currency held by the public C, time deposits at commercial banks T, and bank excess reserves (ER). C and T depend on both money wealth (C, T, and DD) and other economic factors. That part of the change in C or T which results from a change in money wealth is known as the »spillover effect.« The rest of the change in C or T depends on various interest rates, the cost of checking and time deposit accounts, and nonmoney wealth. C_0 and T_0 are used to denote the part of C and T influenced by these variables.

Changes in the bank holdings of excess reserves are divided into two parts. One part is a direct »spillover effect« where a change in excess reserves is induced by a change in bank total private deposits. The other part of the change in excess reserves depends on the reserve requirement, the cost of holding excess reserves (interest rates), and the cost of reserve deficiencies. This part is denoted by ER_0. Their money-supply function is expressed as:

$$M = m_0 + m_1 (B + L) - m_2C_0 - m_3T_0 - m_4ER_0$$

where

$M = DD + C$

m_1 = a money multiplier whose size depends on the average reserve requirements; the currency, time deposits, and excess reserve spillover effects mentioned above; and the pattern of interbank payments.

$(B+L)$ = the extended monetary base. This includes the monetary base (B) and reserves »liberated« by reserve requirement changes and shifts in deposits between classes of member banks, between non-member and member banks, and between time and demand deposits. These liberated reserves are called L, so that $m_1(B+L)$ can be looked upon as the average response of money to changes in the extended base.

m_2C_0 = a part of currency held by the public

m_3T_0 = a part of time deposits at commercial banks

m_4ER_0 = a part of member bank demand for excess reserves.

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[32]) The source method for calculating the high-powered money or the monetary base takes into consideration the following sources of H:
Member-bank borrowings from the Fed
Other Fed credit
Gold stock
Treasury currency outstanding
Treasury deposits at the Fed
Treasury cash holdings
Other deposits and other Fed accounts
In contrast, the use method includes:
Member-Bank reserves
Currency held by the public.

These last three items represent the influence of economic factors other than the spillover effects included in the money multiplier. The m's in these expressions are also multipliers, but they have values different from that of m_1.

The theoretical justification underlying this money-supply process is similar to that of Friedman-Schwartz. Here the surplus excess reserves lead to a change in money supply.

A change in B leads to surplus reserves and thus to a discrepancy between actual and desired excess reserves. The banks react to these surplus reserves by eliminating them through an adjustment of their holdings of earning assets, resulting in a corresponding change in their deposits. Through this adjustment process, money wealth and bank deposits expand, and there are spillover effects into C, T, and ER. These effects are reflected in the size of m_1. The money stock changes by an amount equal to m_1 multiplied by the change in the extended base. Surplus reserves can also arise from changes in C_0, T_0, and ER_0 with no changes in (B+C). The resultant change in the money stock is a function of C_0, T_0 and ER_0 times their various multipliers (m_2, m_3, and m_4).

By investigating the economic forces underlying the demand of the public for C, T, and the banks' demand for excess reserves, Brunner-Meltzer concluded that movements in the money supply are primarily determined in the extended base and the public's currency behavior. Another conclusion is that the Fed's open-market operations are a major determinant of variations in the monetary base, and hence in the money supply. With the exception of the 1930's, the interest rate had very little effect on the money supply.

5. *Teigen*

Teigen attempts to get around the problem of simultaneous-equations bias by estimating a supply-demand model of the monetary sector by means of two-stage least-squares. He deals with supply-demand relations influencing the money stock, attempting an integration of these monetary relations into a simultaneous-equations model. In this model, an aggregate money-supply relation, an interest-responsive transactions demand function, and a reduced-form income equation are estimated jointly for the postwar and interwar periods.

Teigen reduces his analysis of the factors affecting the money supply down to the exogenous factors over which the Fed has some direct control, rather than assuming that the Fed has direct control over the size of the money supply itself. By accepting institutional arrangements and behavioral relations as given at any ons moment of time, he conceives total reserves in the system as determining a maximum attainable money stock. This is broken into two parts: (1) an exogenous element based on reserves supplied by the Fed (unborrowed reserves) and (2) an endogenous element based on reserves created by member-bank borrowing. His purpose is to focus on the relations determining bank borrowing, so as to explain the value of the observed money stock M, to the exogenously determined component of the total potential money stock M*.

To achieve this, Teigan assumes that the banks are motivated primarily by considerations of profit and risk. Therefore, the major determinent of

the degree to which banks will expand the money supply by borrowing from the Fed and creating »endogenous« reserves is the differential between the cost of borrowing and the return from making loans. Teigen states that

> ... the expected relationship between the ratio M/M* and its proposed functional arguments is straightforward. When the return on loans rises, ceteris paribus, banks presumably will shift the composition of their portfolios in such a way that relatively fewer securities will be held, the margin of excess reserves kept as a buffer against unforeseen contingencies will be cut down in size, and in general, an effort will be made to expand loans and deposits, causing a rise in the money stock relative to M*. The opposite effect will result from and increase in the cost of making loans.[33])

The money-supply function used in his empirical tests is a linear relation between the above-mentioned ratio and the differential between the cost of borrowing and the return from making loans, plus two dummy variables to account for changes thought to have occurred in the basic structure of the money-supply mechanism over time:

> ... in particular, it was felt that the structure of the money supply mechanism was likely to have changed over the periods studied, and structural shift variables were added to the regressions to take account of such shifts.[34])

The contribution of simultaneous-equations models to money-supply theory is the explicit recognition of the simultaneous-bias problem and the formulation of a more satisfactory link between the monetary and financial sectors, and vice versa.

GENERAL EQUILIBRIUM

The general-equilibrium approach is an extension of the methodology of the simultaneous-equations system to all monetary and financial markets. It is the application of the Walrasian framework to the monetary and financial markets, where stocks of securities replace commodity flows and relative rates of interest replace relative prices.

The essential conceptual point made by the general equilibrium approach is that all markets are interrelated. The demand for each asset depends upon relative rates of interest and such sector's wealth constraint. In this system, the interrelationships are of a higher order or complexity. Not only do they work through relative rates, but the quantities demaded by one sector affect the wealth constraint of other sectors. The quantity of demand deposits, time deposits, and currency held by the private sector affects the wealth constraints of the banking sector. The quantity of financial intermediary assets demanded by the public determines the wealth or total portfolio constraint of financial intermediaries.

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[33]) Teigen, op. cit., p. 481

[34]) *Ibid.*, p. 482.

In general, the model takes the form of demand and supply equations for each asset as a function of competing rates on assets available to that sector and the sector's wealth constraint.

$$Q^{D}_{1}(r_1, r_2, \ldots, r_n, w) = Q^{S}_{1}(r_1, r_2, \ldots, r_n, w)$$

$$\vdots \qquad\qquad \vdots$$

$$Q^{D}_{n}(r_1, r_2, \ldots, r_n, w) = Q^{S}_{n}(r_1, r_2, \ldots, r_n, w)$$

The general equilibrium approach makes two main contributions to the theory of money supply. First, the methodological breakthrough of the simultaneous-equation system is further advanced to include all markets. Second, the portfolio reactions of the banking sector are extended to include the portfolio reactions of the private sector, so that the significance of a given stock of reserves depends now on the reactions of all agents. No longer do banks automatically »create« a fixed multiple of assets and deposits, and no longer does the private sector automatically hold all the deposits that the banking sector wishes to »create«. The private sector is faced with several choices, including demand deposits, time deposits, currency, financial-institutional instruments, and other private securities. The money supply is now jointly determined by the banking sector, the private sector, and the financial intermediary sector for any given central-bank posture. The money supply is now only one of many variables of equal standing.

A good example is the work of De Leeuw.[35]) Others who have contributed are Gurley and Shaw[36]) and Goldfeld.[37])

BALANCE OF PAYMENTS

By studying the economies of countries under the gold-exchanges standard, Shenoy,[38]) Shannon,[39]) Vienelli,[40]) Blowers and McLeod,[41]) and Friedman and Schwartz[42]) concluded that the money supply was determined by changes in the balance of payments. Both expansion and contraction of the money supply were linked automatically with the balance of payments position.

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[35]) F. de Leeuw, »A Model of Financial Behavior,« *The Brookings Quarterly Econometric Model of the United States*, J. S. Dusenberry *et al.*, editors (Chicago: Rand McNally, 1965), pp. 465—532.

[36]) Gurley and Shaw, *op. cit.*

[37]) S. M. Goldfeld, *Commercial Bank Behavior and Economic Activity: A Structural Study of Monetary Policies in Postwar United States (Amsterdam:* North-Holland, 1966).

[38]) B. R. Shenoy, The Currency, Banking, and Exchange System of Thailand,« *IMF Staff Papers*, I (September 1950), 289—314.

[39]) H. A. Shannon, »Evolution of the Colonial Sterling Exchange Standard,« *IMF Staff papers*, I (April 1951), 334—354; also »The Modern Colonial Sterling Exchange Standard,« *IMF Staff Papers*, II (April 1952), 318—362.

[40]) P. Vinelli, »The Currency and Exchange System of Honduras,« *IMF Staff Papers*, I (April 1951) 420—431.

[41]) G. A. Blowers and A. N. McLeod, »Currency Unification in Libya,« *IMF Staff Papers*, II (November 1952), 439—467.

[42]) Friedman and Schwartz, *op. cit.*

With the exception of Friedman and Schwartz, these economists were satisfied to describe the gold-exchange standard and the automatic relationship existing between the surpluses and deficits in the balance of payments and the stock of money. Friedman and Schwartz showed that, in addition to the balance-of-payments position, one must include the bahavior of the commercial banks and the public in determining the money stock, so that the link between the money supply and the balance-of-payments position is only partially automatic.

SUMMARY

The evolution of money-supply theory has been characterized by: (i) substitution of behavioral relations for the fixed coefficients of the multiple-expension process; (ii) recognition of the fact that the observed money supply is a result of the intersection of the demand and supply functions; and (iii) explicit recognition of a multi-market, Walrasian-type general-equilibrium market framework applied to the entire monetary and financial sector.

The money supply was one thought to be an exogenously determined variable, as in most classical and Keynesian models. Later, however, it has come to be regarded as a variable determined by the behavior of all sectors. Money-supply analysis has correspondingly passed from a simple process to a complicated theory of economic behavior.

(Rad primljen maja 1971.)