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The Monetary Base, Credit, and Bank Deposits
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PREFACE

This study, prepared in the Research Department of the Bank of Italy, is part of a research program under the direction of Prof. Francesco Masera concerning the modus operandi of monetary policy instruments in Italy. An initial version of the model described in section 5 can be found in the internal document entitled Costruzione di un modello econometrico per lo studio dell' economia italiana, published by the Centro Elettronico of the Bank of Italy in May 1964 and edited by Dr. Renato de Mattia.

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The author bears responsibility for any errors. The ideas expressed are the author's own, and do not engage the responsibility of the Bank of Italy.

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APPENDIX

1 -- Introduction

The monetary base (1) consists of all those financial assets which can be used by banks to meet reserve requirements or which, on demand of the owners, must be immediately converted by the monetary authorities into instruments that can be credited to reserve accounts (2). Where there is no system of required reserves the items going to make up the monetary base are principally the currency circulation and all financial assets which the monetary authorities must convert into legal tender on request of the owners.

Among the economic units which acquire monetary base elements it is necessary to distinguish between banks on the one hand and the public on the other, the public including not only private individuals and companies but also all institutions which cannot create money. Whereas the public holds monetary base elements in proportion to its spending requirements or certain habits in the use of savings, banks, to meet their own needs for required or customary reserves, make use of that part of the monetary base which the public decides to leave on deposit with them. From this it follows that the increase in deposits can never be larger than the amount of the monetary base elements remaining in the hands of the banks multiplied by the inverse of either the required minimum reserve ratio alone, or this ratio increased by any minimum ratio of free reserves.

Notes to the text are found beginning on page 46 .

Since financial assets become elements of the monetary base by decision of the authorities, who also determine their increase or decrease, it follows that changing the monetary base is a means of restraining or encouraging the expansion of the assets and liabilities of the banking system. For example, when monetary base elements accrue to the economy, they tend to accumulate at the banks, thereby inducing an increase in deposits and a decline in interest rates, which in turn can have expansionary effects on some components of aggregate demand and on income (3).

The purpose of the present work is to analyse the channels and means through which changes in the size of the monetary base affect deposits, credit and interest rates.

We shall begin with a brief exposition of the analytical device which is usually employed in the analysis of these relationships, viz., the theory of the monetary multiplier. Even in its traditional form this theory constitutes a model of the monetary system, albeit extremely simplified. For this reason, and also because it does not contain any explicit mention of interest rates, in interpreting reality the theory is shown to have serious limitations, which will be discussed analytically. These limitations have led various authors to introduce modifications and extensions (4) to make the model more suitable for the purposes of analysis and forecasting. In similar fashion we shall eventually describe other models of the monetary sector in which the size of the money supply

and the level of interest rates are determined by the inter-action of demand on the part of the public and the supply offered by the banking system; the actual size of the money supply and interest rates change, therefore, because of changes in the size of the monetary base (5).

These models, too, will appear on critical examination to be overly aggregated and simplified, and consequently unsuitable for describing real situations in a sufficiently accurate manner; we will then proceed to sketch the general outlines of a full model, constructed in such fashion as to take account of Italian institutional arrangements and the possibility of statistical estimation based on past experience. The last part of this paper, therefore, will be devoted to a discussion of the individual equations and to an examination of the structural logic and the functioning of the model; the empirical estimation will be left for a later work.

2 -- Theory of the monetary multiplier

As was said above, the simplest tool for analysing quantitative relationships between the monetary base and bank deposits is the theory of the monetary multiplier, also called the theory of deposits (6).

This theory, which supposes certain equilibrium relationships for banks between reserves (a part of the monetary base) and deposits, and for the public between the amount of monetary base elements and deposits, establishes a fixed relationship between the size of the monetary

base of the system on the one hand, and the total of bank deposits on the other (7).

More precisely, it is supposed that:

a) the assets making up the monetary base are in part used directly by the public as a means of payment, or a form of saving, and for the remainder are held by banks as a reserve against deposits;

b) the public desires a fixed relationship between legal tender (the monetary base elements which it possesses) and bank deposits;

c) the banks are required, or simply desire, to maintain a fixed relationship between reserves and deposits.

These three assumptions can be expressed by means of the following three-equation model:

(2.1) $MB = MBP + MBB$

(2.2) $MBP = c \cdot DEP$

(2.3) $MBB = k \cdot DEP$

where:

MB is the monetary base;

MBP is the portion of the monetary base held by the public;

MBB is the residual part of the monetary base held by the banks;

DEP is the amount of bank deposits;

c is a parameter expressing the relationship between the amount of monetary base elements in the hands of the public and deposits;

k is a parameter expressing the relationship between banks' liquid reserves and deposits.

Equations (2.1), (2.2), and (2.3) constitute a system of three unknowns MBP, MBB, and DEP. Their solution gives:

$$(2.4)\quad MBP = MB \frac{c}{c + k}$$

$$(2.5)\quad MBB = MB \frac{k}{c + k}$$

$$(2.6)\quad DEP = MB \frac{1}{c + k}$$

Defining the money supply (M) as legal tender in the hands of the public plus deposits, we have:

$$(2.7)\quad M = MBP + DEP = MB \frac{1 + c}{c + k}$$

Defining credit (C) as the difference between deposits and bank reserves, we obtain:

$$(2.8)\quad C = DEP - MBB = MB \frac{1 - k}{c + k}$$

The coefficients $\frac{1}{c + k}$, $\frac{1 + c}{c + k}$, and $\frac{1 - k}{c + k}$ can be defined, respectively, as the deposit multiplier, the money supply multiplier, and the credit multiplier. They represent the proportionality relationships theoretically existing between deposits, money supply, and credit on the one hand, and the monetary base on the other.

The relationships expressed by equations (2.6), (2.7), and (2.8) are to be understood as equilibrium relationships and they are generally valid both for stocks of the quantities referred to and for changes; that is, if we call ΔDEP the change in deposits occurring during a certain period of time and ΔMB the change in the monetary base, we can say that:

$$(2.6') \quad \Delta DEP = \Delta MB \frac{1}{c + k} \qquad (8)$$

Given a specified increase in the monetary base, we can try to forecast, by means of formulas (2.6) and (2.6') shown above, the increase occurring in deposits, in the money supply, and in credit (9).

3 -- Criticisms of the theory of the multiplier.

The results obtainable from such a theory cannot, in general, be considered satisfactory. This is because some of the hypotheses on which the theory is based do not conform to reality, and because some elements fundamental to the explanation of the credit expansion process are absent.

3.1 -- Absence of an equation for demand for credit or deposits.

First of all, if the relationship between free reserves and deposits is found to be too high, the banks can try to bring it down to the desired level by causing either a reduction in the monetary base, through repayment of debt to the central bank or foreign creditors (10), or an expansion of credit, such as by a reduction in the rate of interest charged to

customers. But the theory lacks any mention of interest rates and nothing is said about how the public would react to a change in interest rates; in other words, an equation for credit demand is lacking. If the public is not inclined to become further indebted to the banking system or to increase its demand for deposits, an excess of bank liquidity cannot be translated into an increase in credit or in deposits (11).

Continuing to accept for the moment a constant relationship between monetary base elements held by the public and deposits, as well as a constant minimum reserve ratio for the banks, it is more correct to reformulate the theory of the multiplier starting, rather than from equations (2.1), (2.2), and (2.3), from the following:

(3.1.1) $MB = MBP + MBB$

(3.1.2) $MBP = c \cdot DEP$

(3.1.3) $MBB \geq k \cdot DEP$

From this system of two equations and one inequality we obtain the solution for deposits:

$$(3.1.4)\quad DEP \leq MB \frac{1}{c + k}$$

or, considering only the monetary base elements held by banks:

$$(3.1.5)\quad DEP \leq MBB \frac{1}{k}$$

The system is therefore not in a condition to determine the amount of deposits or credit, nor the values of the variables MBP and MBB, but only their upper limit.

A solution is likewise obtained if, instead of the absolute amount of credit, we determine the absolute amount of deposits or of monetary base elements held by the public or by the banks.

From the absence of functions capable of determining the values in question it follows that the theory of the multiplier can determine only the maximum possible expansion of deposits, not the actual expansion.

3.2 -- Constancy of the parameter c. It seems that the relationship desired by the public between monetary base elements held by it and bank deposits should not be considered constant. Legal tender and deposits in fact fulfill different functions, and are not rigidly complementary as would be indicated by a constant relationship with regard to either stocks or changes. It follows that the two quantities react in different ways to changes in certain variables such as, for example, the volume of business transactions, wages, income, and the interest rates on which these quantities partly depend, so that only in special cases and for limited periods is their relationship constant, or approximately so. If we consider changes in these aggregates rather than stocks, the relationship also appears very unstable through time (12).

3.3 -- Constancy of the parameter k. The relationship desired by the banks, i.e., the equilibrium relationship, between reserves and deposits is also not constant. This is because of the behavior of free reserves, the desired level of which varies as a function of the level of, and expected changes in, interest rates, as well as, among other things,

bankers' expectations about the demand for credit and the public's demand for currency. Moreover, the actual level of free reserves, observed at a given moment, can scarcely be considered as an equilibrium level; in fact, in the short run part of those reserves serves as a cushion; those reserves embody the excess liquidity of the system, defined as the difference between the monetary base, net of required reserves, and the amount of monetary base elements desired by the public (13).

4 -- Adaptations of the multiplier theory. Other aggregative analyses.

The foregoing criticisms make clear that the modifications to be made in the theory of the multiplier, if it is intended to make the theory suitable for the analysis of the real world, consist of abandoning the assumption of fixed coefficients and integrating the theory with functions that express the amount of deposits or credit desired by the public.

4.1 -- Analysis of Friedman and Schwartz. M. Friedman and A.J. Schwartz have moved in the direction of considering the coefficients as being variable; in their monetary history of the United States (14) they start from a formulation of the type

$$M = MB \frac{1 + c}{c + k}$$

and, substituting for the constants c and k, respectively, the relationships MBP/DEP and MBB/DEP observed in the various years of the period examined by them, they reduce the explanation for observed changes in M

to the factors which produced changes in MB, in the relationship MBP/DEP, and in the relationship MBB/DEP (15). The analysis, carried out in descriptive terms, is, however, based on a careful study of historical-institutional character prepared by Phillip Cagan (16).

The authors do not explicitly consider a credit demand function and seem to want to explain the observed changes in the relationship MBB/DEP with reference to the behavior of the banking system (17); that is not entirely correct, as was seen in section 3.1. However, the considerations set forth there are especially valid in a short-run analysis, since consideration has not been given (cfr. note 11) to the possibility for the banks to invest in securities and to affect the volume of loans by changing their interest rates; the analysis of Friedman and Schwartz being of the long-run type, it can be said that in such a case the banks are in a position to adjust the relationship between liquid reserves and deposits to the level desired by them.

4.2 -- Analysis of Brunner and Meltzer. Friedman and Schwartz limit themselves to an historical analysis and do not offer empirical rules for the a priori determination of the values which the relationships MBP/DEP and MBB/DEP will probably assume in particular situations. The argument has been taken up by Brunner and Meltzer (18) who, in a study relating to the United States economy, try to determine by multiple regressions the variables which affect the relationships desired by the public and the banks between the monetary base and deposits.

For the banks the strategic variables are the levels of interest rates on loans, yields on securities and the discount rate; interest rates and yields are here introduced in explicit fashion. Once the relationships desired by the banks between liquid reserves and various categories of deposits become known, it is possible to determine the total amount of deposits offered by the banks on the basis of a given amount of monetary base elements in their possession.

The proportion desired by the public between monetary base elements and deposits is further determined as a function of income, wealth, and interest rates, as well as the absolute value of the money supply. Therefore, there remains to be determined the absolute value of the monetary base elements held by the banking system and, in consequence, the supply of deposits.

In short we have a system of two equations, for the supply of and the demand for bank deposits, capable of determining the amount of deposits and the level of interest rates.

In the solution to this system, the values assumed by these two variables will depend on the official discount rate, income, and wealth, in addition to the size of the monetary base. The relationship between deposits and the monetary base, i.e., the multiplier, therefore no longer has a fixed value, but depends on other variables; in fact, the model is so constructed that the parameters appearing in the multiplier itself depend on these other variables, directly or indirectly by way of interest rates.

4.3 -- Analysis of Ronald Teigen. On the subject of adaptations of the theory of the multiplier for the purpose of analysing relationships between the monetary base and the money supply, mention should be made of a study by Ronald Teigen, also relating to the U.S. economy, carried out with econometric methods using quarterly data, and consequently intended to analyse short-run movements (19). Contrary to Friedman and Schwartz and to Brunner and Meltzer, Teigen starts from a formulation in which the multiplier does not serve to determine the actual quantity of money and deposits but only their maximum possible quantities, given the size of the monetary base.

Such a maximum is found by supposing a constant relationship between currency and bank deposits and by assuming minimum legal reserves for the banks. Therefore the maximum expansion occurs when the banks do not have reserves in excess of those required.

The actual expansion of credit will then depend on the banking system's demand for free reserves, as well as on the public's demand for bank money in absolute terms; in turn, both of these depend, among other things, on the level of interest rates. Thus there is defined a system of two equations (demand for and supply of money) which simultaneously determine the quantity of money and the level of interest rates. It is also possible to calculate the relationship between the actual money supply expansion and the monetary base which can be defined as the effective multiplier; this latter is not constant, but varies as a function of the variables which determine the public's demand for money and the banking system's demand for free reserves.

4.4 -- Analysis of A.J. Meigs. In this connection, interest also attaches to the analysis of A.J. Meigs designed to explore the relationships existing between the expansion of deposits and the level of bank reserves in the United States.

The author begins with certain interest rates on the one hand, and on the other a desired relationship between deposits and banks' free reserves (i.e., monetary base elements held by banks less the amount of such elements acquired by recourse to central bank credit). Whenever the desired relationship differs from the actual, the banks react by expanding credit and buying securities or by contracting credit and selling securities, as the case may be; in this way they bring about an increase or decrease in deposits and therefore in the money supply.

The speed with which the banks adjust to their new position is assumed to be a function of the difference between the desired and actual levels of the relationship between free reserves and deposits. In this way a relationship is determined between the rate of change of deposits on the one hand, and on the other the amount of free reserves in relation to deposits and the level of certain interest rates; that is to say, a function for the supply of bank money is obtained (23). This function has been empirically investigated using monthly data, with satisfactory results (24).

5 -- The need for larger models. A model of the monetary sector of the Italian economy.

The analyses presented in the preceding section, by overcoming some of the objections that have been raised against the theory of the multiplier, are useful for an understanding of the fundamental relationships linking the principal variables of the monetary sector. Nevertheless, they are still inadequate for examing the real world and, *a fortiori*, for serving as the basis for economic decisions; in fact:

a) they are presented in terms of large aggregates such as total deposits, total money supply, or a single interest rate considered as representative of the entire structure;

b) they do not pay explicit attention to the behavior of the asset items in the consolidated balance sheet of the banking system (loans and investments);

c) they do not take account of the interactions between the money market and the financial market, or of those between the money market, Treasury operations and the balance of payments (25).

Mention has already been made (in section 3.2) of the difference in behavior between currency and deposits; furthermore, different categories of deposits tend to behave differently.

With regard to interest rates, even if they all tend to move in the same direction, we cannot (particularly in a short-run analysis) excuse ourselves from a separate examination of the behavior of interest rates charged by banks and paid by them, or of interest rates in the financial market.

Finally, with reference to the behavior of bank loans and investments it should be noted that in greater or lesser degree the amount of deposits is partly explained by changes in these loans and investments. The change in the asset entries of the banks' combined balance sheet in fact sometimes precedes, logically and in point of time, the creation of deposits; if explicit account is not taken of this, it is impossible to isolate with precision the forces which, especially in the short run, act on the volume of deposits themselves.

It is possible to avoid excessive aggregation, or the failure to consider variables or markets important to the explanation of the functioning of the system, by having recourse to more complex models than those presented in the foregoing sections. The idea of analysing the behavior of the monetary system by means of models with more equations is anything but new, and for an investigation of the more important contributions in this area the reader is referred to the Appendix.

The remaining part of this paper is devoted instead to the description of a model which may serve to analyse the behavior of the monetary sector of the Italian economy.

The individual equations are presented in more simplified form than they will later assume in the course of empirical estimation; in that process it will also be necessary, for the purposes of better adherence to reality, to engage in further disaggregration of the variables. The simplifications and aggregations to be introduced are such, however, as to preserve the essential characteristics of the model.

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The model is composed either of ten equations with ten endogenous and thirteen exogenous variables, or of nine equations with nine endogenous and fourteen exogenous variables, depending on whether or not the central bank imposes restrictions in granting credit to the banking system or in allowing the banks to borrow abroad. Consequently, the variable defining the amount of monetary base elements created by recourse to the central bank or foreign markets is endogenous in the case of no restrictions; if restrictions exist it becomes exogenous (or more appropriately a policy variable), since its value is determined arbitrarily by the monetary authorities, and the relevant equation is eliminated from the model.

The real sector flows, and particularly income, saving, and investment, are taken as given and therefore are exogenous. The financial assets and liabilities being considered include the monetary base, bank deposits, bank loans, and securities.

5.1 -- Sources and uses of the monetary base. A model designed to bring out the relationships between the monetary base on the one hand and credit, deposits, and the money supply on the other, should first of all consider the sources from which the monetary base is created and the uses to which it is put in the economic system (the public and the banks).

Therefore, we designate by the symbol ΔMBEX that part of the increase in the monetary base which is held to be exogenous with respect to the behavior of the banks; such an increase is caused by a balance

of payments surplus, or a Treasury cash deficit not covered by the issue of long-term bonds, or by central bank open market operations. In the case of a balance of payments deficit, a Treasury cash surplus, or a sale of securities by the central bank, the monetary base is reduced and the variable has a negative sign. In contrast, we designate by the symbol ΔMBEND that part of the monetary base created when the banking system has recourse to central bank credit or credit from abroad; its amount, when not arbitrarily fixed by the monetary authorities, is an endogenous variable which reflects the degree of liquidity of the banking system in relation to the demand for credit which the banks intend to satisfy (section 3.1).

The change in the monetary base of the system is always identically equal to the sum of the change in the monetary base elements held by the public (ΔMBP), the change in bank liquidity (ΔBL), and the change in required reserves (ΔRRB) (26).

Thus we can write the equation:

$$(5.1)\quad \Delta MBEX + \Delta MBEND = \Delta MBP + \Delta BL + \Delta RRB \qquad (27)$$

5.2 -- Demand for monetary base elements on the part of the public. The portion of the monetary base that is held by the public, including non-bank institutions, to be used as a means of payment or in the form of a temporary or permanent investment of liquid funds, depends basically on national income at current prices, on the distribution of national income as between payrolls and other incomes, and on the level of interest

rates. More precisely: an increase in income causes an almost proportional increase in the amount of monetary base elements held by the public; an increase in the payrolls share of national income also results in a positive change (28), especially because of the practice in Italy of paying wages and salaries in the form of banknotes; on the other hand, an increase in interest rates induces the public to get rid of monetary base elements held by it in order to employ the funds in other ways. Furthermore, since the relative level of interest rates is an indicator of the general scarcity of liquidity in the market, the banks try to acquire monetary base elements held by the public by offering, for example, more attractive terms for deposits.

Briefly, the function for the public's demand for monetary base elements can be written as follows:

$$(5.2)\quad \Delta MBP = f_2\ (Y,\ d,\ i_T,\ i_{DT},\ i_{DD})$$

where MBP is the above mentioned portion of the monetary base, Y is national income at current prices, d is an index of income distribution equal to the payrolls share of the total, i_T is an interest rate representative of the whole structure of yields on medium-and long-term securities, i_{DT} us the rate paid on time deposits, and i_{DD} is the rate paid on demand deposits.

Recalling that

$$MBP = MBP_{(t-1)} + \Delta MBP$$

we can write the following instead of (5.2):

$$(5.2')\quad MBP = f_2\ (Y,\ d,\ i_T,\ i_{DT},\ i_{DD}) - MBP_{(t-1)}$$

which has the advantage of considering flows instead of stocks of the monetary base, consistent with what was done in the first equation and will be done in those that follow.

From what has been said above we have:

$$\frac{\partial f_2}{\partial Y} > 0; \quad \frac{\partial f_2}{\partial d} > 0; \quad \frac{\partial f_2}{\partial i_T} < 0; \quad \frac{\partial f_2}{\partial i_{DT}} < 0; \quad \frac{\partial f_2}{\partial i_{DD}} < 0$$

5.3 -- Consolidated balance sheet of the banking system. The following equation imposes the restriction that the change in total assets in the consolidated balance sheet of the banking system must equal the change in total liabilities. This equation also specifies the degree of disaggregation of the balance sheet items that is desired. For the purposes of the present analysis this equation can be written:

$$(5.3) \quad \Delta BL + \Delta RRB + \Delta L + \Delta T = \\ = \Delta MBEND + \Delta DT + \Delta DD + \Delta OA$$

The meaning of the symbols used for the first time is as follows: ΔL is the change in bank loans in the period considered; ΔT is the net change in banks' holdings of securities (at their balance sheet values); ΔDT is the change in time deposits outstanding; ΔDD is the change in demand deposits outstanding; and ΔOA is the change in the outstanding value of the other accounts (net worth and the balance of minor asset and liability items) (29).

5.4 -- Formation of demand deposits. Since demand deposits serve primarily as a means of payment, their underlying movement can be considered as being linked to that of national income. Other things being equal, the relationship between the stock of deposits and the flow of income is determined by the level of interest rates; a higher ratio, that is to say a decrease in the velocity of circulation, corresponds to higher rates of interest on the deposits themselves; on the other hand, the ratio is lower if the interest rates on other financial assets (time deposits and securities) are higher.

Given the levels of income and interest rates, the actual quantity of demand deposits may differ from the desired, or equilibrium, quantity because of a temporary accumulation of balances stemming from an expansion of bank loans and investments more than in proportion to income, or from money creation brought about by a balance of payments surplus, a Treasury deficit, or central bank open market operations. On the other hand, the actual level of deposits may be smaller than the desired level, for given values of income and interest rates, if the expansion of bank loans and investments has been less than in proportion to income, or if there has been a dignificant destruction of liquidity because of a balance of payments deficit or a Treasury cash surplus.

Briefly stated, the function expressing the change in demand deposits can be written:

$$(5.4) \quad \Delta DD = f_4 \left(\Delta Y, i_{DD}, i_{DT}, i_T, \Delta L + \Delta T, \Delta MBEX \right)$$

Y is the change in income at current prices, $\Delta L + \Delta T$ is the sum of the

5.7, 5.8 -- Demand for and supply of loans. The amount of loans and the terms on which they are granted can be considered as determined by the intersection of a function for loan demand on the part of economic units and a function for loan supply on the part of the banking system (32).

The tendency to incur debt towards the banks varies in accordance with working capital needs, the rate of interest inclusive of miscellaneous charges for the credit received, and the cost of alternative means of financing. The demand for loans is also influenced by the provision of liquid funds resulting from a balance of payments surplus, a Treasury cash deficit, and open market operations (33). Finally, since a considerable portion of fixed investment expenditures can be prefinanced by recourse to ordinary credit, the demand for the latter also varies as a function of such investment expenditures, increasing ceteris paribus when investments are increasing and decreasing when investments decline.

Measuring fluctuations in working capital requirements by fluctuations in national income at current prices, and calling i_{CR} the effective interest rate on the loan (i.e., inclusive of ancillary charges), i_T the cost of alternative means of financing, and I fixed investment expenditures, the loan demand function can be written:

$$(5.7)\quad \Delta L = f_7 (\Delta Y, i_{CR}, i_T, \Delta MBEX, I)$$

the partial derivatives being

$$\frac{\partial f_7}{\partial \Delta Y} > 0; \quad \frac{\partial f_7}{\partial i_{CR}} < 0; \quad \frac{\partial f_7}{\partial i_T} > 0; \quad \frac{\partial f_7}{\partial \Delta MBEX} < 0; \quad \frac{\partial f_7}{\partial I} > 0$$

The supply of loans can be considered a function of changes in the monetary base (excluding the part held by the public) as well as of the amount of free reserves already held by the banks. At all times a certain amount of liquid reserves accrues to the banks which, together with reserves already held, and as regards that part exceeding some minimum desired level, constitutes a base upon which to expand loans and investments in securities. In particular, an excess of liquid reserves at banks induces the latter to get rid of them by loans and security purchases; a shortage of reserves, on the other hand, leads them to make their own assets more liquid, by selling loans and securities or not renewing them at maturity.

The supply of loans is also influenced by the level of the rate of interest which the loans can earn, by the yield on alternative investments for the banks (essentially securities), and by the cost of providing funds, principally the rates paid on deposits (34).

Assuming that alternative investments are made up of long-term securities, and calling $BL_{(t-1)}$ the banks' liquid reserves at the beginning of the period, the lean supply function can be written:

$$(5.8) \quad \Delta L = f_8 (\Delta BL + \Delta RRB, BL_{(t-1)}, i_{CR}, i_T, i_{DT}, i_{DD}) \qquad (35)$$

The signs of the partial derivatives are as follows:

$$\frac{\partial f_8}{\partial (\Delta BL + \Delta RRB)} > 0; \qquad \frac{\partial f_8}{\partial BL_{(t-1)}} > 0; \qquad \frac{\partial f_8}{\partial i_{CR}} > 0; \qquad \frac{\partial f_8}{\partial i_T} < 0;$$

$$\frac{\partial f_8}{\partial i_{DT}} < 0; \qquad \frac{\partial f_8}{\partial i_{DD}} < 0,$$

5.9 -- The banking system's demand for securities. The function for the banking system's demand for securities contains essentially the same variables which appear in the loan supply function.

We have, then:

$$(5.9)\quad \Delta T = f_9 (\Delta BL + \Delta RRB, \Delta BL_{(t-1)}, i_{CR}, i_T, i_{DT}, i_{DD})$$

For the signs of the partial derivatives we have:

$$\frac{\partial f_9}{\partial(\Delta BL + \Delta RRB)} > 0; \quad \frac{\partial f_9}{\partial BL_{(t-1)}} > 0; \quad \frac{\partial f_9}{\partial i_{CR}} < 0; \quad \frac{\partial f_9}{\partial i_T} > 0;$$

$$\frac{f_9}{i_{DT}} < 0; \quad \frac{\partial f_9}{\partial i_{DD}} < 0;$$

5.10 -- The banking system's recourse to central bank credit and credit from abroad. The monetary base elements accruing to the banks during a given period of time are equal to the increase in the total monetary base less the increase in the share held by the public; to it is added the liquidity already possessed by the banking system at the beginning of the period. The total thus obtained is used to meet the need for required reserves consequent upon the expansion of deposits during the same period, and also to satisfy the banks' demand for liquidity. Since demand deposits, because of their higher rate of turnover and higher amount of individual transactions, presumably require higher liquid reserves than do time deposits, the demand for bank liquidity depends not only on the volume of deposits but also on their composition, in addition to the difference between the rates of interest earned on

loans and investments in securities and the rates obtainable on liquid assets (36).

Because a part of the liquidity of the banks can arise out of borrowing either from the central bank or in foreign markets, the demand for that liquidity will be inversely related to the level of the official discount rate (r_d) and the rate paid on loans obtained from foreigners (r_f).

From what has been said above it is seen that we can write the following behavior function:

$$(5.10) \quad \Delta MBEX + \Delta MBEND - \Delta MBP + BL_{(t-1)} = \Delta RRB + f_{10}(DT, DD, i_{CR}, i_T, r_d, r_f)$$

The function f_{10} expresses the demand for liquid reserves on the part of the banks; it has the following signs for the partial derivatives:

$$\frac{\partial f_{10}}{\partial DT} > 0; \quad \frac{\partial f_{10}}{\partial DD} > 0; \quad \frac{\partial f_{10}}{\partial i_{CR}} < 0;$$

$$\frac{\partial f_{10}}{\partial i_T} < 0; \quad \frac{\partial f_{10}}{\partial r_d} < 0; \quad \frac{\partial f_{10}}{\partial r_f} < 0.$$

From (5.10) we easily obtain the equation which expresses the banking system's demand for credit from either the central bank or foreign markets.

$$(5.10') \quad \Delta MBEND = \Delta RRB + \Delta MBP - \Delta MBEX + f_{10}(DT, DD, i_{CR}, i_T, r_d, r_f) - BL_{(t-1)}$$

It can be seen that this function may be broken down into two parts, the first tending to neutralize the excessive absorption (or reflow) which the required reserves and the liquidity of the public produce with

respect to exogenous increases in the monetary base (the difference: $\Delta RRB + \Delta BL - \Delta MBEX$), and the second tending to adjust the initial liquidity to the amount desired at the end of the period (the difference: $f_{10}(\ ) - BL_{(t-1)}$).

The amount of free reserves which the banks have available at the end of each period will in general be different from the value given by f_{10}, because in the short run bank liquidity reflects the difference between unexpected increases in the monetary base and the absorption of the monetary base by increases in required reserves and in the liquidity of the public; indeed, these movements generally do not or can not be immediately reflected in the variable $\Delta MBEND$. The value of ΔBL is in fact determined by equation (5.1) as a difference between $\Delta MBEX$ and $\Delta MBEND$, on the one hand, and ΔMBP and ΔRRB on the other.

Whenever the amount of the banks' recourse to central bank credit or credit from abroad is set by the monetary authorities, the variable $\Delta MBEND$ becomes exogenous or, more properly, a policy variable. Equation (5.10) is consequently eliminated from the model.

5.11 -- Determination of the supply of securities to the banks. The model analyses the behavior of five financial aggregates, viz., the monetary base, loans, fixed-income securities, time deposits, and demand deposits.

The equations in the model are capable of determining the amounts demanded and supplied of these assets, and the price of only

two of them. The rate of interest on the monetary base is nil or is determined exogenously (official discount rate or rates in foreign markets) and rates on bank deposits are assumed to be exogenously determined either by cartel arrangements among the banks or by the monetary authorities.

Although a market for fixed-income securities is not explicitly considered, the model is capable of determining the yield on them, since the equation for the supply of securities to the banks is a linear combination of equations (5.1) and (5.3).

If the values of saving and investment are considered to be determined exogenously, the balance sheet of the public gives us:

$$(5.11.1) \quad I + \Delta MBP + \Delta DT + \Delta DD = S + \Delta L + \Delta T^P$$

where S indicates saving and T^P the net supply of fixed income securities on the part of the private sector, equal to the total of securities issued less those (issued by either the private or public sector) purchased.

The over-all supply of securities to the banks, i.e., the total of new issues less the part bought by the private sector, can be obtained by taking from (5.11.1) the value of T^P and adding to it the total issues of public sector securities net of the amount acquired by the monetary authorities through open market operations; indicating this last-named value by $\overline{\Delta T}$, we see that the total supply of securities to the banks, which must equal the demand for them, is given by

$$(5.11.2) \quad \Delta T = \Delta T^P + \overline{\Delta T} = I - S - \Delta L + \Delta MBP + \Delta DT + \Delta DD + \overline{\Delta T}$$

Equation (5.11.2) and equation (5.9) describe the market for fixed-income securities. However, it is possible to demonstrate that equation (5.11.2) is always satisfied in the same way as are equations (5.3) and (5.1).

To do this it must be remembered that the sum of the variables $\Delta MBEX$ and $\overline{\Delta T}$, which represent the financing of the Treasury deficit and the net surplus on the current account in the balance of payments, is identically equal to the excess of saving over investment. Neglecting the term ΔOA, we have:

$$(5.11.3)\quad S - I = \Delta MBEX + \overline{\Delta T}$$

Subtracting equation (5.1) from equation (5.3) term by term, rearranging the terms and keeping in mind the relationship in (5.11.3), we obtain exactly what is found in (5.11.2).

In cases where there are international capital movements such as purchases and sales of securities or foreign debts, the exogenous change in the monetary base takes account of the net movement. Equation (5.11.3) is then written:

$$(5.11.3')\quad S - I = \Delta MBEX + \overline{\Delta T} - \Delta T^{f}$$

where ΔT^{f} represents net issues of securities or debts by foreigners which are purchased by residents. The same variable also appears in (5.11.1) and (5.11.2) and the latter is then written:

$$(5.11.2')\quad \Delta T = \Delta T^{p} + \overline{\Delta T} - \Delta T^{f} = I - S - \Delta L + \Delta MBP + \Delta DT + \Delta DD + \overline{\Delta T}$$

By subtracting (5.3) from (5.1) and making use of (5.11.3') we end up by obtaining equation (5.11.2') (37).

It may be useful in the analysis to keep in mind equations (5.11.2) and (5.11.2') even if the information given by them is, to be technically correct, already completely contained in equations (5.1) and (5.3), so that it is not necessary to introduce them explicitly in the model.

5.12 --Summary of the model. For the convenience of the reader, we here repeat the equations and the explanations of the symbols for the entire model, distinguishing between the endogenous variables and the other variables.

Sources and uses of the monetary base:

$$(5.1) \quad \Delta MBEX + \Delta MBEND = \Delta MBP + \Delta BL + \Delta RRB$$

The public's demand for monetary base elements:

$$(5.2') \quad \Delta MBP = f_2 (Y, d, i_T, i_{DT}, i_{DD}) - MBP\ (t-1)$$

Consolidated balance sheet of the banking system:

$$(5.3) \quad \Delta BL + \Delta RRB \quad \Delta L + \Delta T = \Delta MBEND + \\ + \Delta DT + \Delta DD + \Delta OA$$

Formation of demand deposits:

$$(5.4) \quad \Delta DD = f_4 (\Delta Y, i_{DD}, i_{DT}, i_T, \Delta L + \Delta T, \Delta MBEX)$$

Formation of time deposits:

$$(5.5) \quad \Delta DT = f_5 (Y, i_{DT}, i_T, i_{DD}, \Delta L + \Delta T, \Delta MBEX)$$

Required reserve deposits:

$$(5.6) \quad \Delta RRB = k(\Delta DT + \Delta DD)$$

Public's demand for loans:

$$(5.7) \quad \Delta L = f_7 (\Delta Y, i_{CR}, i_T, \Delta MBEX, I)$$

Supply of loans by the banking system:

$$(5.8)\quad \Delta L = f_8 (\Delta BL + \Delta RRB, BL_{(t-1)}, i_{CR}, i_T, i_{DT}, i_{DD})$$

Banking system's demand for securities:

$$(5.9)\quad \Delta T = f_9 (\Delta BL + \Delta RRB \Delta BL_{(t-1)}, i_{CR}, i_T, i_{DT}, i_{DD})$$

Banking system's recourse to credit from the central bank or foreign markets:

$$(5.10')\quad \Delta MBEND = \Delta RRB + \Delta MBP - \Delta MBEX + f_{10} (DT, DD, i_{CR}, i_T, r_d, r_f) - BL_{(t-1)}$$

The endogenous variables are:

1) Δ MBEND -- Endogenous increase in the monetary base (credit to the banking system from the central bank and foreign markets).
2) Δ MBP -- Change in monetary base elements held by the public.
3) Δ RRB -- Change in required reserves.
4) Δ BL -- Change in bank liquidity
5) Δ L -- Change in bank loans (credit).
6) Δ T -- Net investments in securities (purchases <u>less</u> sales) of the banking system, at balance sheet values.
7) Δ DT -- Change in time deposits.
8) Δ DD -- Change in demand deposits.
9) i_T -- Yield on medium-and long-term securities.
10) i_{CR} -- Rate of interest on bank credits (loans).

The exogenous variables are:

1) ΔMBEX -- Exogenous increase in the monetary base caused essentially by the balance of payments surplus, by the cash deficit of the Treasury to the extent it is not covered by issuing long-term securities, and by open market operations.

2) i_{DT} -- Rate of interest on time deposits.

3) i_{DD} -- Rate of interest on demand deposits.

4) k -- Legal reserve ratio.

5) r_d -- Official discount rate.

6) r_f -- Rate of interest paid by banks on loans obtained from foreign lenders.

7) Y -- National income at current prices.

8) ΔY -- Change in national income at current prices.

9) I -- Fixed investment expenditures at current prices.

10) d -- An index of the distribution of income as between payrolls and other incomes.

11) OA -- Change in net worth and minor items in the consolidated balance sheet of the banking system.

12) $MBP_{(t-1)}$ -- Amount of monetary base elements held by the public at the beginning of the period.

13) $BL_{(t-1)}$ -- Free reserves (liquidity) of the banks at the beginning of the period.

In the case where the value of ΔMBEND is fixed directly by the monetary authorities, equation (5.10') drops out and the model becomes one of nine endogenous and fourteen exogenous variables.

6 - Qualitative analysis based on the model.

We here propose to examine, from a qualitative standpoint, the solutions obtained for the endogenous variables using different values for some of the exogenous variables.

In particular, we shall discuss the different solutions obtained by using different values for: a) the exogenous increase in the monetary base; b) income; c) rates of interest on time and demand deposits.

When a different value is assigned to any one of these exogenous variables, it will be assumed that the other exogenous variables remain unchanged. It will not always be possible to give unequivocal results; in many cases the results are based on assumptions about the magnitudes (other than the sign) of some of the partial derivatives or coefficients of the individual equations (38).

The analyses are merely illustrative and are presented mainly for the purpose of emphasizing the structure of the model and the interactions of the different variables considered in it. More complete analyses will obviously be possible only when statistical estimates of the coefficients of the various equations are available, i.e., by recourse to simulation methods.

6.1 - Different values for the exogenous increase in the monetary base.

Assume two identical situations except with regard to the exogenous increase in the monetary base.

If, as a first approximation, we assume that the increase in the

amount of monetary base elements held by the public remains unchanged, the additional liquidity flows to the banks, thereby increasing the supply of loans and banks' demand for securities (equations 5.8 and 5.9).

At the same time, however, there is a contraction of the demand for loans (equation 5.7) and a decrease in the supply of securities available to the banking system. The latter effect becomes clear in equation (5.11.3), which says that the greater the value of ΔMBEX the smaller is the exogenous supply of securities $\overline{\Delta T}$; a change of this type is a typical result of open market operations by the monetary authorities.

It follows that the change in loan expansion and security purchases by the banks is of uncertain sign; in the aggregate, however, it can be assumed that if the analysis concerns rather short time periods the changes will be negative (39). The reduction in interest rates on loans seems a certainty because of the decline in demand and increase in supply; the increase in deposits appears equally certain, since the decline in loans and security investments scarcely would offset the effect on deposits produced by both the exogenous increase in the monetary base and the reduction in the rate of interest on securities (equations 5.4 and 5.5). The amount of monetary base elements absorbed by the public also tends to be greater because of the decline in these rates of interest. Indebtedness to the central bank and to foreign markets tends to contract, even though the amount of liquidity desired by the banks increases (equation 5.10); these last two changes, by taking away monetary base elements from the banks, tend to mitigate all the preceding effects.

6.2 - Different values for income. Assume two situations which differ only with respect to income; since by hypothesis saving and investment are identical in the two situations, the difference in income is to be attributed to a difference in the propensity to save and to import (40).

When income is higher, larger values are obtained for the amount of monetary base elements held by the public, for demand deposits, and for time deposits, as shown by equations (5.2), (5.4), and (5.5).

Equation (5.11.1) states that the sum of loans and of securities issued by the public also increases, to finance the increase in liquid assets (given the value of saving and investment); the higher value for loans is explicitly given from equation (5.7), but it is likely also that net issues of securities by the public and, in consequence, the absorption of them by the banks, will turn out to be at higher levels.

Since the exogenous increase in the monetary base remains unchanged, while the public's holdings of monetary base elements increase, rates of interest on loans and securities tend to rise. Because of the public's increased holdings of monetary base elements and because of the higher value for required reserves necessitated by the higher level of deposits, recourse to central bank or foreign credit also tends to be greater.

6.3 - Different values for interest rates on deposits. When rates of interest paid by banks on deposits are low, it is apparent from equations (5.4) and (5.5) that the formation of both time and demand deposits tends to decline.

There is a rise in the public's holdings of monetary base elements, but presumably not of such magnitude as to offset the reduction in deposits. For this reason, there is also a drop in the use of monetary base elements to meet minimum reserve requirements. The effect on the amount of liquidity desired by the banks, and on the endogenous monetary base, is of uncertain sign.

Supposing for the moment that the expansion of bank loans remains unchanged, it is apparent from equation (5.11.1) that net issues of securities by the private sector are reduced because of the increased absorption of securities by economic units in the private sector who are reducing their holdings of deposits. Such a movement of necessity brings about a decline in the yield on securities (41).

Equation (5.9) tells us that the lower yield on securities induces banks to buy less of them; given the fact that, for the same reason, the demand for funds tends to shift from the bank loan market to the financial market (equation 5.7), the decline in the yield on securities tends to transmit itself to the rate of interest on loans as well. Because of the lessened demand, the expansion of loans falls off.

The results of the foregoing analyses can be summarized in a short table, the columns of which show the three exogenous variables for which changes have been considered, and the rows of which contain the endogenous variables of the model; at the intersection of column and row, the sign (+) indicates that a change in the first (i.e., a

column variable) causes a change in the second (the row variable) that is in the same direction; the sign (-) indicates the contrary. A question mark denotes the doubtful cases.

	Exogenous variables		
Endogenous variables	Δ MBEX	Y, Y	i_{DT}, i_{DD}
MBP	(+)	(+)	(-)
MBEND	(-)	(+)	(?)
L	(-)	(+)	(+)
DT	(+)	(+)	(+)
DD	(+)	(+)	(+)
i_T	(-)	(+)	(+)
i_{CR}	(-)	(+)	(+)

7 - Conclusions.

The considerations set forth in the opening sections concerning the relationships between the monetary base and other monetary and financial variables led us to abandon some systems which assumed very simple relationships between the monetary base, credit, deposits, and, when considered, interest rates; in the succeeding sections a more flexible scheme of analysis was put forth, consisting of a model of the monetary sector. This model, although presented in simplified form, allowed us to deduce, in qualitative fashion, the interrelationships among the monetary base and other monetary variables, including among the latter some important variables the determination of which is exogenous with respect to the money market.

After disaggregating some of the variables, increasing the number of arguments in some of the equations, and putting the functions in explicit form, the model can be estimated on the basis of data from Italian experience; solving for the endogenous variables, we then have the quantitative determination of the interrelationships, during the period selected for the estimates, between each one of the endogenous variables and all of the exogenous variables.

Assuming a certain stability through time on the part of the estimated functions, these quantitative relationships may be used for the purpose of forecasting the values of each endogenous variable, using a series of hypothetical values for the exogenous variables.

The model thus permits us to give a quantitative answer to the problem posed in the introduction, that is, the problem of determining the relationships which link the monetary base to credit, deposits, and interest rates. As already mentioned, the presentation of the econometric estimates of the various equations is deferred until a later work.

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APPENDIX

A - Structure of some econometric models of the monetary sector.

In recent years various econometric models have been published which describe the monetary and financial sector of the economy.

What follows is a brief examination of the most important of these works, with the object of bringing out the essential aspects of their structure (42). The models examined are those of Frank de Leeuw (43) and Stephen Goldfeld (44) as concerns the monetary and financial sector of the American economy, and of Nino Andreatta (45) for the monetary sector of the Italian economy.

A.1 - Model of Frank de Leeuw. This is a model of the monetary and financial sector of the American economy consisting of nineteen equations (fifteen behavioral equations and four identities) estimated on the basis of quarterly data, describing the inter-relationships among the principal variables of the monetary and financial markets and the effects produced on them by the real variables. The demand for each of the financial assets considered is generally explained as a function of its own yield and the yields on other assets, as well as a function of income or wealth. More precisely, the model attempts to describe the demand for and supply of seven financial instruments and hence the determination of their prices or yields. These assets are: 1) bank reserves, 2) currency circulation, 3) demand deposits, 4) time deposits, 5) government bonds,

6) deposits at non-bank financial institutions and life insurance reserves, and 7) securities issued by, and loans to, the private sector. Three of these instruments have a zero rate of interest (bank reserves, currency, and demand deposits).

Demand and supply relating to these assets emanate from various economic units such as households, business enterprises, the banking system, non-bank financial institutions, and of course the government and the monetary authorities.

A group of five equations describes the creation of reserve funds, i.e., the monetary base, and their allocation among different uses; more precisely, they consist of an equilibrium condition expressing equality between sources and uses (equation 19), an equation for the public's demand for currency (equation 1), two demand equations for, respectively, free reserves (equation 11) and required reserves (equation 16) of banks, and an equation for recourse to central bank credit (equation 10); the remaining supply of monetary base elements has an exogenous character (unborrowed reserves) (46).

The variables to be determined in the market are only four, viz., the currency circulation, free reserves, required reserves, and recourse to Federal Reserve credit, these being assets which have a zero yield or a rate fixed exogenously, such as the official discount rate.

A second group of three equations describes the formation of bank deposits; there are two demand equations, one for demand deposits

(equation 2) and one for time deposits (equation 3), and an equation determining the rate of interest on time deposits (equation 13). The equations are equal in number to the number of variables to be explained, viz., two quantities and one rate of interest.

A third group of six equations concerns the markets for short-, medium-, and long-term government securities; there are four demand equations relating to households, business firms, non-bank financial institutions, and banks (equations 5, 6, 14, and 9); an identity between the total demand and the exogenous supply (equation 18); and one equation determining the differential between the short-term rate and the rate for medium- and long-term maturities. In this case as well, the equations are equal in number to the endogenous variables, viz., four quantities and two interest rates.

A single equation explains the flow of savings into deposits with non-banking institutions and to life insurance companies (equation 4); since the yield on such assets is assumed to bear a fixed relationship to the interest rate on time deposits with banks, a separate equation is not needed to determine it.

The final group of four equations concerns the market for corporate securities and loans to the private sector; there is an equation for the supply of loans by non-banking institutions (equation 15); an equation determining the rate of interest on them (equation 12), which logically represents as well the equation for the supply of bank loans; an equation for the demand for loans on the part of households

(equation 7); and a total demand-supply identity (equation 17). In this market there are five variables to be explained, viz., the demand for loans by households and business concerns (two variables), the supply of loans by banks and by non-bank financial institutions (two variables), and one interest rate; another variable, the demand for loans from abroad, is considered to be exogenous. The number of endogenous variables to be explained in this market consequently exceeds the number of equations.

The missing equation, as stated explicitly, is the one for the demand for loans by business enterprises; the change therein is presumably to be obtained as the difference of the changes in all the other financial assets and liabilities held by the public, if saving and investment are given. However, because the equation for the balance sheet of the banks if also missing, which equation according to de Leeuw serves to fix the values of the other accounts of the banks, the residuals to be determined are two in number, a fact which might prevent the model from having a solution. Nevertheless, it will be recalled that in the markets for monetary base elements there is one equation too many, which fact helps to determine one of the residuals (probably it is the equation for the demand for liquidity by the banks which determines the value of the other accounts), and therefore renders the model determinate.

A.2 - Model of Stephen Goldfeld. Goldfeld's model of the American economy contains thirty-two equations, of which twenty-one are behavioral and eleven are identities; estimated on the basis of quarterly data, it

is used to show the interaction among monetary and financial variables, the influence of real variables on monetary and financial variables, and the effects of the latter on the components of aggregate demand. This model is notable for disaggregation into "country banks" and "non-country banks" as regards recourse to central bank credit and certain banking activities; this disaggregation appears useful in the estimation and permits better adaptation of the model to the underlying reality because behavior is quite different as between the two categories of banks.

The model is structurally similar to that of de Leeuw, but is simpler inasmuch as it considers only the components of the monetary base and those financial assets which appear among the assets and liabilities of the banking system.

Equilibrium between sources and uses of the monetary base is given by equation 27; the demand for central bank credit on the part of the two categories of banks is determined by equations 3 and 4, and the desired amount of free bank reserves is given by equations 1 and 2. In addition, there is a demand for required reserves (equation 25) and a demand for currency by the public (equation 12). In this model as in de Leeuw's, for the markets for monetary base elements the number of equations is greater by one than the number of quantities to be determined. But it can be assumed that the equation for equilibrium between sources and uses of the monetary base serves to determine the level of the interest rate on 3-month Treasury bills, since a market for short-term

government securities is not considered; equations 16 and 17 explain the differences between the short-term rate, on the one hand, and the medium- and long-term rates on the other.

As concerns the composition of banks' assets and liabilities, it should be brought out that both sight and time deposits are determined by the demand of the public (equations 13 and 14), and their distribution as between "country banks" and "non-country banks" is determined on the basis of certain exogenous empirical constants (equations 29, 30, 31, 32); the amount of loans is also given by the public's demand (equation 15), while the function for loan supply on the part of the banks is represented by an equation for interest rates on bank loans (equation 11); the distribution of the volume of loans between the two categories of banks is obtained on the basis of an exogenously determined constant relationship (equations 24 and 28); the other components of bank assets, viz., investments in various types of securities, are determined by the demand on the part of the banks (equations 5, 6, 7, 8, 9, 10).

The remaining equations in the model are identities or are meant to determine the effect of financial variables on the components of aggregate demand. In conclusion, note should also be made of the absence in this model of an equation for balance sheet equilibrium for the two categories of banks considered; in this model, in which an equation for the balance on securities is lacking, such an omission can give rise to a discrepancy between changes in bank assets and liabilities.

A.3 - Model of Nino Andreatta. This is a model which, instead of eight equations as stated in Andreatta's text, should be considered as made up of nine equations, of which five behavioral and four identities.

Although this model attempts to determine the rate of interest on securities, this rate is not mentioned among the endogenous variables (47). The excluded equation is clearly the one which determines the public's demand for monetary base elements; it reappears among the statistically estimated equations, albeit with reference solely to the currency circulation. If this last equation is introduced and if the rate of interest is considered as an endogenous variable, then the model acquires a logically coherent structure.

Two equations respectively define a concept of "unborrowed reserves", equal to the exogenously created part of the monetary base (excluding the portion held by the public), and establish equality between sources and uses of the monetary base.

One equation defines the amount of endogenous monetary base elements obtained by the banks by borrowing from the central bank or abroad (equation 4), and two equations establish the use of the monetary base for, respectively, required reserves (equation 8) and money supply in the hands of the public (equation not mentioned but estimated). The liquidity of the banks is determined as a difference, the same as in the model presented in the text.

As regards the determination of the other assets and liabilities in the consolidated balance sheet of the banking system, the model includes

a function for the demand for deposits (equation 5), a function for the demand for loans (equation 3), and a function for the demand for securities on the part of the banks (equation 2).

The model also has a balance sheet identity for the banking system which guarantees equality between changes in assets and liabilities, and which is interpreted as an equation for the supply of deposits. It would perhaps be more appropriate to regard it as an equation for the supply of loans on the part of the banks; in fact, since the author considers the interest rates on deposits to be institutionally fixed, the banks accept all deposits demanded by the public at that rate. It should be made clear, however, that in the structure of the model this equation, together with that for sources and uses of the monetary base, contributes to the determination of the yield on long-term securities (48).

NOTES TO THE TEXT

1. The term "monetary base" is used in the final considerations of the Governor in the annual report (Relazione) of the Bank of Italy for the year 1965, as well as in the text and the final considerations of the report for the year 1966.

The term "monetary base" is frequent in economic literature in the United States (for example, cfr. K. Brunner and A.H. Meltzer, "Some Further Investigations of Demand and Supply Functions for Money", Journal of Finance, 1964; also Karl Brunner, "Institutions, Policy, and Monetary Analysis", Journal of Political Economy, 1965; A.H. Meltzer, "The Behavior of the French Money Supply, 1938-54", Journal of Political Economy, 1959); Friedman and Schwartz use the term "high-powered money" (cfr. M. Friedman and A.J. Schwartz, A Monetary History of the United States, 1867-1960, Princeton University Press: Princeton, 1963). The term has been picked up by Baffi (cfr. Paolo Baffi, "L'alterna vicenda del quinquennio 1961-65", Studi sulla moneta, Milan, 1965). To designate these liquid assets the Federal Reserve System adopts the term "reserve funds" (for example, cfr. The Federal Reserve System: Purposes and Functions, 4th edition, prepared by the Board of Governors of the Federal Reserve System, Washington, 1961); the term is also common in United States economic literature. In British literature, to designate the sum total of liquid assets on which the expansion of bank deposits is based, the term "credit base" is sometimes used (total liquid assets usable as customary reserves of the banks).

2. The assets which currently go to make up the monetary base in Italy are the following:

a) Notes and coins of the central bank and the Treasury;

b) Sight deposits with the central bank, the Treasury, and the Cassa Depositi e Prestiti;

c) Deposits with the postal system;

d) Treasury bills;

e) The unutilized portion of the banks' advances account with the central bank;

f) Sight assets abroad in convertible currency;

g) Grain stockpiling bills held by the banks and issued to finance activity in agricultural years up through 1963-64.

The medium- and long-term securities which can be used as required reserves are included among the sources and uses only to the extent they are effectively used as such (cfr. Bank of Italy, Annual Report for the Year 1966, Rome, 1967). Implicit in such a practice is the idea of considering as part of the monetary base only the currency circulation and assets equivalent to it, and of considering the use of medium- and long-term securities, used as reserves, as saving in the form of monetary base elements.

3. Increases or decreases in the monetary base in Italy are brought about with the following instruments:

a) Direct granting of credit by the central bank to the banking system;

b) Regulation of foreign borrowing by the banking system;

c) Locking up liquid assets in required reserves, or restitution of those reserves;

d) Open market operations;

e) Methods of financing the cash deficit of the Treasury.

4. See in particular M. Friedman and A.J. Schwartz, A Monetary History..., op. cit.

Also see the references cited in the following note.

5. See in particular K. Brunner and A.H. Meltzer, "Some Further Investigations...", op. cit; Ronald Teigen, "Demand and Supply Functions for Money in the United States: Some Structural Estimates", Econometrica, 1964. See also A.J. Meigs, Free Reserves and the Money Supply, Chicago, 1962, Chapter IV, pp. 42 et seq.

6. See for example Costantino Bresciani Turroni, Corso di economia politica, Milan,1960, pp. 115 et seq.

For an attempt to apply it to Italy see Bruno Brovedani, "Sulla esecuzione di programmi monetari: il caso italiano", Moneta e Credito, 1964.

7. The first complete exposition of the theory of the multiplier is found in J.E. Meade, "The Amount of Money and the Banking System", Economic Journal, 1934.

8. It can also be supposed that the relationships between MBP and DEP and between MBB and DEP have the following form:

$$(2.2') \quad MBP = c_o + c_1 DEP$$

$$(2.3') \quad MBB = k_o + k_1 DEP$$

where c_o, c_1, k_o, and k_1 are constants. This leads to a relationship of the type:

$$(2.6') \quad \Delta DEP = \frac{MB}{c_1 + k_1}$$

and to analogous expressions for money supply and credit.

The constants c_1 and k_1 are in this case to be interpreted as, respectively, the relationship between the marginal increase in monetary base elements held by the public and the increase in deposits, and the relationship between the increase in bank reserves and the increase in deposits. The increases are all for a given period of time.

9. We are not interested here in describing the dynamic adjustment process from one equilibrium position to another. For such a purpose suppose that now and then the public, which comes into possession of a certain amount of monetary base elements and which is already in an equilibrium situation, deposits a part of these elements with the banks in order to maintain a desired ratio between currency and deposits. This creates excess liquidity for the banks, which are also supposed to be in equilibrium as concerns the ratio of reserves to deposits; the banks react by lending to the public a part of the deposits received, thereby generating a renewed excess of monetary base elements held by the public. The process repeats itself an infinite number of times, the amount of liquid assets passing back and forth between the public and the banks decreasing in geometric progression. Because in a geometric progression the sum of an infinite number of terms smaller than one approaches a finite limit, the total amount of new deposits is limited.

It can be shown to be exactly equal to the product of the change in the monetary base and the deposit multiplier, as defined above. (See for example J.H. Rogers, "The Absorption of Bank Credit", Econometrica, 1933; Rogers was the first to obtain a result of this type, but he makes the assumption that there is no absorption by the public of the newly-created liquidity. Also see Costantino Bresciani Turroni, Corso di economia politica, op. cit.; Erich Schneider, Money, Income, and Employment, London, 1962, pp. 30 et seq.). It is of course not necessary that the process of new deposit creation happen in accordance with the dynamic scheme described above. It can in fact be imagined that the banking system, having excess liquid reserves and finding itself confronted with a sufficient demand for credit, might extend loans and create deposits on a scale such as to reach instantaneously the desired ratio between liquid reserves and deposits: obviously it is assumed that the public is willing to hold these deposits.

10. In other words, in the short run the size of the monetary base cannot be considered as given, since it depends on conditions affecting the relative abundance of liquidity. A similar situation can occur in conditions of a liquidity shortage which is accompanied by opportunities for recourse to credit from the central bank or foreign markets.

11. For the moment we abstract from the possibility for banks to invest in securities and expand their deposits in that way. In any event the supply of securities to the banks is another form of demand for credit.

12. The following table shows the relationships observed, in the period 1958-66, between monetary base elements held by the public and deposits. The relationships for stocks are based on end-of-year values, and those for changes on the increases occurring during the year indicated. The monetary base elements in the hands of the public are currency, deposits with the postal system and the Treasury, and Treasury bills.

	Ratio of monetary base elements held by public to deposits		Ratio of currency to deposits	
Year	Stocks	Changes	Stocks	Changes
1958	0.5344	0.2650	0.2658	0.1459
1959	0.5003	0.2973	0.2475	0.1446
1960	0.4745	0.3057	0.2340	0.1458
1961	0.4588	0.3666	0.2301	0.2074
1962	0.4343	0.3047	0.2210	0.1729
1963	0.4312	0.4078	0.2231	0.2386
1964	0.4286	0.3984	0.2204	0.1903
1965	0.4018	0.2507	0.2039	0.1110
1966	0.3826	0.2571	0.1929	0.1206

13. The public can always be considered to be in equilibrium, or nearly so, as regards the monetary base elements it holds; an excess of this type of liquidity gets deposited with the banks, while a deficiency is immediately met by withdrawing deposits.

14. M. Friedman and A.J. Schwartz, A Monetary History..., op. cit., Appendix A, pp. 776 et seq.

15. Substituting for MB, c and k the values obtained from equations (2.1), (2.2), and (2.3), we have:

$$M = (MBP + MBB)\ \frac{1 + \frac{MBP}{DEP}}{\frac{MBP}{DEP} + \frac{MBB}{DEP}} = MBP + DEP$$

But the sum of MBP + DEP (monetary base elements held by the public plus deposits) is equal to M (the money supply) by definition; therefore, the expression used by Friedman and Schwartz reduces to an identity which is always satisfied.

16. Phillip Cagan, Determinants and Effects of Changes in the Stock of Money, 1875-1960, New York, 1965. Also see Phillip Cagan, "The Demand for Currency Relative to the Total Money Supply", Journal of Political Economy, 1958.

17. James Tobin, "The Monetary Interpretation of History--A Review Article," The American Economic Review, 1965.

18. K. Brunner and A.H. Meltzer, "Some Further Investigations..", op. cit.

19. Ronald Teigen, "Demand and Supply Functions..."op. cit.

20. The monetary base is defined to be net of the banking system's recourse to the central bank. The maximum expansion of deposits can therefore be exceeded when the difference between bank liquidity and recourse to the central bank is negative.

21. Teigen's analysis thus coincides, from the conceptual standpoint, with that of Brunner and Meltzer in the determination of an effective multiplier. Teigen's article preceded and is based on a

dissertation completed at Massachusetts Institute of Technology in 1962. Teigen deserves credit for being the first to put forth the idea that the demand function for money cannot be estimated, for the purposes of correct valuation of the coefficients, independently of the supply function. With this objective, he specifies a supply function for money starting from the value of the maximum possible expansion, as given by the multiplier. Teigen's contribution is important, from the standpoint of econometric methodology, as concerns the estimation of the demand function for money, but it incidentally shows how, given the size of the monetary base, only the maximum possible expansion of deposits is defined and not the actual expansion, until a function is explicitly introduced which determines the absolute value of the quantity of money demanded.

22. A.J. Meigs, Free Reserves..., op. cit.

23. Ibid., Ch. IV.

24. Ibid., Ch. V.

25. In this paper the term "financial market" is used to designate the market for long-term funds.

26. For the balance sheet of the monetary base in Italy cfr. Bank of Italy, Annual Report for the Year 1966, op. cit., pp. 265 et seq., as well as pp. 162-163 of the appendix to that Report. The sources side of this balance sheet shows the sectors whose financing leads to the creation of the monetary base, viz., 1) the Treasury; 2) the foreign sector; 3) the banks; and 4) other sectors. As a first approximation it may be assumed that the exogenous part of the monetary base is that

produced by the financing of the Treasury, the foreign sector, and the "other sectors"; the endogenous part is that which originates from the financing of the banking system.

27. The analogy between equation (5.1) and equation (2.1) should be noted. Equation (2.1) can also be defined as an equation of sources and uses of the monetary base, where MB is the monetary base stock and MBP and MBB are the portions held by the public and the banks, respectively.

28. For the dependency of the public's demand for currency on total income and on payroll income see P. Baffi and A. Occhiuto, "Osservazioni sull' andamento della circolazione", in Contributi all' analisi di alcuni fenomeni trattati nella Relazione annuale, prepared by the Bank of Italy, Rome, 1954; also, for example, Bank of Italy, Annual Report for the Year 1966, Rome, 1967, pp. 302-321. Currency makes up a large share of the part of the monetary base held by the public and this justifies the assumption made in the text; for some of the other components (postal deposits, Treasury bills and other minor items) the dependency on income and especially on its distribution is less pronounced or is non-existent.

29. When necessary for a more detailed analysis, all the aforesaid items are susceptible of further disaggregation. For example, it is possible to distinguish among various types of loans in lire and in foreign currency, different categories of securities, different types of time and demand deposits, etc.

30. Probably because of money market imperfections, changes in the level of deposits are not immediately reflected in interest rates and in income. In addition to the rate of interest, income, and the change in income, it seems appropriate to include the exogenous increase in the monetary base and the expansion of bank loans and investments as arguments in the equation for deposits. This implies that deposits, once they have been created, are retained passively by the economy, within certain limits of course. It should be noted, however, that the explicit introduction of $\Delta MBEX$ and $\Delta L + \Delta T$ into the equations is not indispensable for obtaining from the model solutions for deposits which are functions of these variables.

To prove this, equation (5.3) iw written in the following form:

$$\Delta DT + \Delta DD = \Delta BL + \Delta RRB - \Delta MBEND + \Delta L + \Delta T - \Delta OA$$

For the variable ΔBL substitute the value given by equation (5.1), viz.:

$$\Delta BL = \Delta MBEX + \Delta MBEND - \Delta RRB - \Delta MBP$$

We then have:

$$\Delta DT + \Delta DD = \Delta MBEX - \Delta MBP + \Delta L + \Delta T - \Delta OA$$

This last equation can be considered as the supply of bank deposits. Now write the equation for the demand for deposits by the public as:

$$\Delta DT + \Delta DD = f\ (Y, \Delta Y, i_T, i_{DT}, i_{DD})$$

The requirement of equilibrium between demand and supply shows that the values assumed by deposits in any case change as a function of the variables appearing in the supply function.

31. The complications stemming from the possibility of meeting part of the reserve requirement through the deposit of long-term securities, and the existence of different reserve ratios for the various categories

of banks, can be resolved with the addition of more equations explaining the various ways in which reserves are held, together with quantitative relationships among deposits in the different categories of banks.

32. For an approach of this type the reader may consult Claudio Gnesutta, "I 'molteplicatori bancardi': riformulazione ed analisi della loro natura", Bancaria, 1967.

Indeed, it is statistically proven that, ceteris paribus, in periods when the balance of payments is in surplus and/or the Treasury is running a deficit, loans tend to expand less rapidly than is customary, while deposits rise more rapidly. This phenomenon is fully discussed with reference to a number of countries in P. Baffi and A. Occhiuto, "La componente esterna della liquidita e le regole della condotta monetaria," Giornale degli Economisti e Annali di Economia, 1960.

34. This latter variable assumes particular importance in a one-bank system where it is realized that to expand loans is to expand the bank's own deposits. This is true as well, although in lesser degree, for imperfect markets where one bank enjoys a dominant position.

35. A more accurate specification of function (5.8) requires introducing the concept of "desired" reserves, because, as stated in the text, it is only the excess with respect to such a level which stimulates loan expansion. The level of desired reserves is inversely related to the excess of interest rates on loans and investments compared to the rate earned on monetary base elements, and is positively related to the amount and composition of deposits. (On this point see A.J. Meigs,

Free Reserves..., op. cit., Ch. IV.)

If the required reserve ratio is changed during the period considered, it is necessary to take account of such changes explicitly in the function. Finally, account should be taken of the fact that to some extent reserves are mortgaged, for example, to the central bank, and must be handed back in a short time. Such reserves are not a stimulus, or are a weaker stimulus, to expansion.

36. From this standpoint the demand for liquidity becomes the other side of the portfolio problem consisting of allocating resources among loans, investments ("earning assets" in the Anglo-Saxon literature) and liquid funds. For simplicity's sake, the yield on liquid reserves is assumed to be nil or constant and therefore does not explicitly appear as an argument in the demand function; within limits, such a hypothesis can be considered a good approximation of the Italian situation, where the yield on liquid reserves from 1958 to the present has fluctuated almost solely as a result of changes in the compositon of those reserves.

37. It would obviously have been possible to obtain the changes in deposits, or monetary base elements held by the public, or loans, residually, from saving and investment and the change in the other financial assets and liabilities, considering explicitly the functions for the supply of and demand for fixed-income securities. But having the behavior of the money market the main purpose of the analysis, it seemed appropriate to eliminate the securities market equation rather than the monetary base balance sheet or the consolidated balance sheet of the banking system.

38. It is pratically impossible, given the size of the model and the variety of the interrelationships among the variables, to apply the method suggested in P.A. Samuelson, The Foundations of Economic Analysis, 6th printing, Cambridge: Harvard University Press, 1961, Ch. III, pp. 23 et seq.

Since use is not made of knowledge relating to the magnitudes of the coefficients, in the majority of cases we would arrive at results of indeterminate sign.

39. The eventual changes depend on the length of the period chosen for the analysis. As the period lengthens the expansion of the supply of credit and banks' demand for securities assumes larger values, and in the aggregate can more than make up for the decline in the demand for credit and the supply of securities. Such an outcome is particularly valid for credit.

40. The Treasury deficit and exports are given and assumed to be the same in the two situations.

41. Net issues of securities by the private sector (supply less demand) are of necessity inversely related to the yield on securities, inasmuch as the demand for other financial assets (deposits and monetary base elements) is inversely related to the yield on securities and the demand for short-term credit is positively related to that yield. In other words, an increase in the rate on securities is accompanied by an increased demand for bank loans and therefore by smaller issues of securities, as well as a reduced demand for deposits and a higher demand for securities.

42. For a study with wider objectives than the principal econometric models of the monetary and financial sector, the reader may consult Carlo d'Adda, II finanziamento dell' economia, Franco Angeli Editore, Milan (no date).

The numbers assigned to the equations cited in this appendix are the same as in the original models.

43. Frank de Leeuw, "A Model of Financial Behavior", included in The Brookings Quarterly Econometric Model of the United States, edited by J.S. Duesenberry, G. Fromm, L.R. Klein, and E. Kuh, Amsterdam: North Holland Publishing Co., 1965.

44. Stephen Goldfeld, Commercial Bank Behavior and Economic Activity, A Structural Study of Monetary Policy in the Postwar United States, Amsterdam: North Holland Publishing Co., 1966.

45. Nine Andreatta, II governo della liquidità, Franco Angeli Editore, Milan, 1967.

46. In the analysis of the monetary base this model differs from that described in section 5.11 of the text for the following reason: in the former there is a function for the demand for free reserves side by side with an equation for recourse to central bank credit, whereas in the latter the demand for free reserves is logically included in the demand for endogenously-created monetary base elements, and their actual amount gets determined as the difference between monetary base expansion and the alternative uses thereof.

47. Nino Andreatta, II governo della liquidità, op. cit., pp. 136-138.

48. In this connection see section 5.11 of the text.