

## Monetary Base and the Control of Credit in Italy (\*)

The most important instrument at the disposal of monetary authorities for the control of credit and the achievement of the economic policy objectives, both domestic and international, consists in the regulation of the quantity of monetary base. Open market operations, credit granted by the central bank to commercial banks and other financial intermediaries, regulation of the indebtedness of banks to foreign institutions, means of financing the deficit of the government, and finally the calling of special obligatory reserves or the liberation of already existing reserves, are all different means through which the monetary authorities regulate the amount of monetary base in the system (1).

Given the required percentages of obligatory reserves, and given the demand of monetary base by the public, which can be influenced only in a negligible way by the action of monetary authorities (via the interest rate), the demand for earning assets of banks (i.e. the supply of credit) and therefore the supply of bank-money, remain

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Dr. Gnesutta has also carried out a comparative statics analysis of the behaviour of the money market, to be published later, where all the derivations and the conditions for obtaining the results of paragraph 1 of this paper are fully specified.

Many estimation problems were discussed with Dr. Giorgio Carducci, who wrote, in cooperation with Mr. Giuseppe La Pera, the regression program using the Almon technique for the estimation of the lag structure.

(1) See the Report of the Bank of Italy for the year 1967 (BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, 1967, Roma, 1968), Ch. II, pp. 248 ff., and the same Report for the year 1968, provisional edition, pp. 228 ff.

The use of different tools has also different effects, both from the macroeconomic and from the sectorial point of view; one can think, for example, of differences in the possibilities of expansion offered by borrowed reserves and by unborrowed reserves; however, we are dealing here with the problem from a rather general point of view and only later we shall introduce some qualifications, when analyzing the supply of credit.

determined. Given the demand for credit and for bank-money by the public, and given also the level of saving and investment, or simply the difference between these two aggregates, the level of interest rates is determined, both on the monetary and on the financial markets.

There is now an abundant literature dealing with the behaviour of the financial sector of the economy and its relationships with the amount of monetary base. Many of such studies are of an empirical character and try also to assess the impact of monetary variables on the main real variables such as investment, consumption, income and employment. For the United States one can see, for example, the studies prepared by Meigs, Teigen, Brunner and Meltzer, Friedman and Jacobson Schwartz, Goldfeld, De Leeuw (2). Only a minor part of the results related to the important research project carried on by the Federal Reserve System in cooperation with a group of M.I.T. economists, has already been published (3). For the studies related to the Italian Economy, one can see the Annual Report of the Bank of Italy (4) and the studies made by Nino Andreatta (5).

The present paper attempts to define the concept of monetary base, in general and in the Italian system, and then, by way of some econometric analysis, tries to estimate the effects of variations in the amount of monetary base on the level of interest rates and on the amount of credit.

The empirical analysis is meant to be a test of the ways through which monetary base affects the amount of credit and interest rates, rather than a complete analysis of the behaviour of the demand for monetary base by the public and of the factors which influence the demand and supply of credit.

(2) A. JAMES MEIGS, *Free Reserves and the Money Supply*, Chicago, 1962, Ch. IV, pp. 42 ff.; MILTON FRIEDMAN and ANNA JACOBSON SCHWARTZ, *A Monetary History of the United States, 1867-1960*, Princeton University Press, Princeton, 1963; RONALD TEIGEN, "Demand and Supply Functions for Money in the United States: Some Structural Estimates", *Econometrica*, 1964; KARL BRUNNER and ALLAN H. MELTZER, "Some Further Investigations of Demand and Supply Functions for Money", *Journal of Finance*, 1964; FRANK DE LEEUW, "A Model of Financial Behaviour", in: *The Brookings Quarterly Econometric Model of the U.S.*, North Holland Publ. Co., Amsterdam, 1965; STEPHEN GOLDFELD, *Commercial Bank Behaviour and Economic Activity, A Structural Study of Monetary Policy in the Postwar United States*, North Holland Publ. Co., Amsterdam, 1966.

(3) See e.g. the Federal Reserve *Bulletin* of January 1968.

(4) BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, op. cit., p. 331, pp. 395 ff., and the same Report for the year 1968, provisional edition, pp. 238 ff., and pp. 360 ff.

(5) NINO ANDREATTA, *Il governo della liquidità*, Milano, 1967.

## 1. The Monetary Base in Different Institutional Arrangements

I shall define the monetary base as the aggregate of those financial assets the variation of which allows a change of a multiple amount in the demand for credit and bank deposits, without changing the level of interest rates. If, on the other hand, the demand for credit and for deposits remains constant, changing the quantity of monetary base entails a change in the same direction in the supply of credit. Assuming non-zero elasticities of demand or supply of credit (or both functions) relative to interest rates, a variation in the monetary base then induces a change, in the opposite direction, in interest rates and, in the same direction, in the amount of credit (and deposits).

The previously mentioned properties belong to different types of financial assets according to the existing rules for obligatory reserves and to other institutional characteristics. Thus it seems opportune to analyze the types of assets to be included in the monetary base in the context of such different rules and characteristics.

### 1.1. *Obligatory reserves composed of central bank and Treasury money and of assets which are equivalent from the point of view of liquidity.*

The excess reserves of banks are always formed of central bank and of Treasury money (i.e. currency) and of other assets which are quickly transformed into it by monetary authorities, at the request of the possessors; the price of transformation of such assets is fixed, or at least does not vary as a function of demand and supply on the internal market, or it can vary, but within limits to be specified later.

If the obligatory reserves are formed only of currency and, possibly, of some of the assets transformable into it, the monetary base of the economic system is composed of the existing amount of central-bank and Treasury money plus the amount of the aforesaid assets.

In effect, this sum determines the upper limit to the expansion of deposits and of credit, for a given level of interest rates.

In order to clarify such a definition, the mechanism through which the complex of the financial assets defined as monetary base affects the amount of credit and interest rates needs to be explained.

Given the level of interest rates (including those on assets which are part of the monetary base) the demand for monetary base by the

public and the desired level of free reserves of the banks are determined; the maximum volume of bank deposits is therefore equal to the reciprocal of the sum of the coefficient of obligatory reserve plus the coefficient of free reserves multiplied by the amount of monetary base held by the banks. If there is now an increase in the demand for credit, this induces an increase in interest rates and therefore reduces the public's demand of monetary base, with the consequence that the amount held by banks is increased. The latter, given the higher interest rates, reduce also the desired level of free reserves; the result is a higher value of the multiplier (reciprocal of the sum of the coefficients of free and of obligatory reserves) and of the multiplicand (monetary base held by the banks), and therefore a higher amount of deposits and, other things being equal, of credit.

In such a process, the level of interest rates of some assets transformable into currency, or usable as reserves, can also increase. In order for them to be included in the monetary base, it is necessary that the decrease in their prices (that is the increase in their yield), be contained within limits such that, because of the gap still existing with respect to the rate on other assets, the public and the banks are still disposed to reduce their demand.

An increase in the demand for credit and for deposits does not involve, on the contrary, an increase in interest rates if, at the same time, there is an increase of monetary base in the system; indeed, the banks can satisfy the higher need for obligatory reserves, without reducing the coefficient of free reserves, and without recalling monetary base from the public through an increase in interest rates (on deposits).

If the increase in currency and equivalent assets is unaccompanied by an increase in the demand for credit, the share of monetary base exceeding the one desired by the public, given the interest rates, will tend to flow towards banks. The latter finding themselves with an amount of reserves higher than desired will tend to dispose of it by increasing credit and, more specifically, by buying bonds and supplying loans at lower rates. The consequence of this action is a decrease of interest rates and an increase of credit and of deposits.

In order that such a process operate, it is necessary that the possible decrease in price, which is a consequence of the increase in supply of those assets which are transformable into currency, and therefore considered part of the monetary base, be contained in such a way that an increase in the supply of credit will result.

1.2. *Obligatory reserves in central bank and Treasury money or equivalent assets, and long-term bonds.*

If obligatory reserves must be composed for a certain minimum percentage of central bank and Treasury money or of assets equivalent to it from the point of view of liquidity, and for a maximum percentage of long term bonds (so that it is possible to utilize currency instead of bonds, but not viceversa) it is necessary to distinguish the case of relative abundance of bonds, with respect to the total amount of currency or equivalent assets, from the case in which such bonds are relatively scarce.

In the first case, assume a situation of equilibrium where banks possess a certain amount of currency and similar assets which they utilize both as obligatory reserves, in the minimum required percentage, and as free reserves in the amount desired at the existing interest rates.

For the bonds usable as reserves assume that the banks possess them in an amount exceeding their need for required reserves.

In this situation, an increase of the supply of such bonds on the market does not allow any increase in the possibility of expansion of credit and of bank deposits; on the contrary, an increase in the amount of central bank and Treasury money, and of assets transformable into it, will have an expansive effect according to the previously described mechanism. The monetary base is then made up by the sum of such money and equivalent assets, and the coefficient of required reserves is equal to the one composed of the same money and assets; the share of reserves covered by long term bonds is only a constraint in the repartition of the earning assets of banks.

Assume now a situation in which the bonds usable as reserves are relatively scarce; with respect to the amount of currency and equivalent assets, so that a share of the required reserves which could be covered by depositing bonds is actually covered by the aforesaid money or assets (6).

In such a case, an increase in the previously mentioned bonds in the hands of the banks, by freeing part of the other assets used as

(6) The banks could find other bonds, usable as reserves, offering higher prices in order to buy them from the public, but we are here supposing that the price is at a level which cannot be conveniently increased.

required reserves, allows to expand deposits and credit further; the same effect can still be produced by an increase of central bank and Treasury money and equivalent assets.

The monetary base is then composed, in this case, by the sum of central bank money, assets which are transformable into it, and of bonds usable as reserves. An increase in any one of such components either causes an increase of credits and deposits and a decrease of interest rates (7), or allows an increased demand for credit without a corresponding increase in interest rates. Whereas in the case of relative abundance of the bonds in order to evaluate the potential expansion of deposits, that is the value of the multiplier, one has to consider the reserve coefficient covered by central bank and Treasury money and equivalent assets only, when the monetary base also includes bonds, one has to consider a reserve coefficient which includes also the share which can be covered by the same term bonds (8).

1.3. *Stabilization of prices of some long-term bonds through open market operations.*

The mechanism through which the regulation of credit and of the level of interest rates is carried on and the components of monetary base are to be reconsidered when the central bank enforces a policy of stabilization of the price of some bonds, in the sense that it buys or sells them at a given price without limit. The creation of central bank-money in this case depends upon the behaviour of the public and of the banks, since they decide the amount of bonds they will sell to, or will buy from, the central bank at the price fixed by the latter. This price also controls the interest rate on credits, the price of the other bonds, and the quantity of credit and deposits,

(7) If the increase of monetary base relates to bonds usable as reserve, the yield of such bonds can also increase (they become relatively less scarce, and therefore their price can decrease).

(8) With respect to the previous case, there is a widening of the types of assets to be included in the monetary base and a reduction of the multiplier. It is possible to hypothesize an intermediate case (a point of separation) where bonds are at the limit of scarcity, without being abundant; in such a case, for evaluating the potential expansion of deposits, it is indifferent whether we refer to the sum of central bank and Treasury money and equivalent assets and consider the reserve coefficient to be equal only to the part which is covered by the sum of such assets, or to the sum of central bank-money, equivalent assets, and bonds which can be used as reserves, considering as coefficient of required reserves the total one covered in any form.

directly and through the quantity of central bank-money, and therefore through the monetary base (9).

To conclude, stabilization of the price of bonds, in addition being a tool for increasing the demand for the same bonds on the part of the public and of the banks (10), by reducing risk attached to their ownership, is a means for regulating indirectly the quantity of monetary base, the expansion of credit, and the level of interest rates.

On the other hand, for a given amount and price of bonds, if the quantity of central bank and Treasury money and of assets equivalent to it from the point of view of liquidity, or else the amount of bonds usable as reserves, when they are relatively scarce, increases, also the possibility of expansion of credit and bank deposits increases. Thus if the demand for credit rises, it is possible to face such a change without being obliged to transform part of the bonds into central bank money.

Central bank and Treasury money, assets equivalent to it from the point of view of liquidity, and the bonds usable as reserves, keep, therefore, also in such a situation, their characteristic of monetary base.

However, an increase in the amount of such assets cannot now induce a decrease in the rate of interest of the bonds whose price is stabilized, since there will be a certain amount of selling of such bonds to the central bank, with the destruction of an amount of money sufficient to eliminate any variation of the rates.

There is an expansive effect on credit and deposits also if the amount of the stabilized price-bonds increases, the amount of monetary base being kept constant (11). However it appears difficult to classify such bonds as part of the monetary base, unless there is an explicit engagement of the central bank to continue in the stabilization policy also in the future.

(9) More precisely, given a system of equations in which a series of exogenous variables, among which the quantity of monetary base determines, among other things, credit, deposits, and the interest rate on bonds, if one makes exogenous the yield of bonds and the amount of monetary base endogenous, an equilibrium value for all the other endogenous variables (beside the amount of monetary base) is determined.

(10) Cf. BANK FOR INTERNATIONAL SETTLEMENTS, *Some Questions Relating to the Structure of Interest Rates*, pp. 41, ff.

(11) Part of such bonds will be transformed into central bank-money, increasing in this way the amount of monetary base. Furthermore banks will "feel" more liquid by having a certain amount of such bonds in their portfolios, so they will reduce the level of desired excess reserves and increase the multiplier.

## 2. The Components of Monetary Base in Italy

In Italy, the following financial assets are at present included in the monetary base: coins and notes issued by the Treasury or by the central bank (currency), deposits held with the central bank or Treasury and Cassa Depositi e Prestiti, Post Office deposits, Treasury bills, unutilized margins of the lines of credit of banks at the central bank, liquid foreign assets held by banks, commercial bills discounted by banks and issued for the financing of compulsory wheat stockpiling.

The inclusion of postal deposits and of deposits at the Treasury is justified by the fact that such deposits are convertible into central bank money at any moment on request of the possessors.

For the Treasury bills, until recently (May 1969) in addition to their relative scarcity with respect to other components of liquidity, taking into account their possible use as reserves, one had to consider their transformability into money of the central bank, always obtainable at the request of their possessors; the price of transformation was practically fixed; for such reasons they were considered part of the monetary base.

Starting from May 1969 there will be instead two different kinds of Treasury bills; a part of them will be issued (every month) in a limited amount, at a fixed price, and will be usable for obligatory reserves only; the other part will be issued in an amount variable as a function of the deficit of the Treasury and with prices variable according to supply and demand on the market. The latter can no longer be included in the monetary base (12).

The inclusion in the monetary base of the unutilized margin of credit of banks at the Bank of Italy also rests on the possibility of transforming it into cash, at any time, according to the banks' will and necessities, by paying the official discount rate on the borrowed sums; the same is true of bills issued for the financing of wheat stockpiling (those issued up to the year 1963-64) which are automatically rediscounted by the central bank, at the official discount rate (13).

(12) BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, 1968, provisional edition, Rome, 1968, pp. 358 ff.

(13) Actually at a fixed rate. Any change in the official rate would leave unaffected the rediscount rate for such bills (BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, 1968, provisional edition, *op. cit.*, *loc. cit.*).

Finally, foreign liquid assets held by banks can be converted at any time into Italian currency, unless they are tied as collateral for the existence of a negative difference between other foreign assets and foreign liabilities for each bank; only the part of liquid assets exceeding this difference can be disposed of and therefore included in banks' liquidity and in the monetary base. The price of conversion into national currency varies according to daily exchange rates; however, one can think that this rate is largely independent of the amount of free foreign assets held by banks, so that an increase of such assets, other things being equal, will bring about an increase of the possibility of expansion of bank credit at a certain level of interest rates.

This is not true if the amount of long term bonds usable as reserves increases. Indeed, the quantity of such bonds on the market is sufficiently large relative to their use as obligatory reserves; consequently an increase of their amount would result in an increase of interest rates, rather than in a greater possibility of expansion of bank credit; for such reasons they are not considered part of the monetary base (14).

### 3. Influence on Credit and on Interest Rates: an Empirical Analysis

The effectiveness of monetary base as an instrument for regulating credit and interest rates, rests essentially upon two factors:

(a) the stability of the functions of demand of monetary base by the public;

(b) the influence on the supply of credit of that part of monetary base which remains at the disposal of banks.

Since the public can exchange the monetary base, or at least its most important component, i.e. currency, with bank deposits, without any impediment and within sufficiently broad limits, the instability of the relative functions of demand would preclude any possibility of graduating the effects of interventions of the monetary authorities. The banks would thus be subject to erratic variations in

(14) BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, 1967, Rome, 1968, Appendix, p. 153.

the level of free reserves, with consequences on the expansion of credit and on interest rates, independent of the regulation of the monetary base by the authorities.

On the contrary, a demand for monetary base by the public, such that it is a stable function of parameters which, in the short run, depend slightly or do not depend at all on the management of monetary policy, allows for the transfers on the excess reserves of banks, of any action on the monetary base. As we shall see later, this seems to be the case for Italy.

The stability of the relationships between the quantity of free reserves, the level of interest rates and credit remains then to be ascertained. Thus even though the amount of the monetary base held by banks always puts an upper limit to the expansion of deposits, a limit which can be reached when all the excess reserves are transformed into required reserves, a sufficient stability of such a relationship is important for the transmission, to the economic system, of expansionary and restrictive impulses, via the interest rate.

The stability of the relationship can be tested through an analysis of the influence of the monetary base of banks on the supply of credit, and by the existence of non-zero elasticities of the supply and demand for credit with respect to interest rates.

#### 3.1. Demand of monetary base by the public.

The public holds monetary base under the form of currency (coins and notes issued both by the central bank and by the Treasury), of postal deposits (demand deposits, savings deposits, and *buoni fruttiferi*, which are a sort of non-negotiable certificates of deposits) and, in a limited amount, under the form of Treasury bills and of deposits at the Treasury (15).

(15) From the following table, one can deduce the importance of the different components of monetary base held by the public (all the data are billion lire).

	Currency	Postal Deposits	Treasury Bills	Deposits at the Treasury
End of 1966 . . . .	4,567.2	4,446.4	10.5	36.5
End of 1967 . . . .	5,052.6	4,901.6	10.4	57.1
End of 1968 . . . .	5,259.8	5,249.3	9.4	24.3

(a) *Currency.*

The stability through time of the demand for currency is already clear from the following table where the values of the ratios between currency in the hands of the public (average of the four end-of-quarter data) and net national income, for the period 1951-1968, are reported.

TABLE I

Year	Ratio	Year	Ratio
1951 . . . . .	0.1181	1960 . . . . .	0.1120
1952 . . . . .	0.1215	1961 . . . . .	0.1176
1953 . . . . .	0.1143	1962 . . . . .	0.1153
1954 . . . . .	0.1113	1963 . . . . .	0.1182
1955 . . . . .	0.1112	1964 . . . . .	0.1161
1956 . . . . .	0.1111	1965 . . . . .	0.1153
1957 . . . . .	0.1096	1966 . . . . .	0.1177
1958 . . . . .	0.1089	1967 . . . . .	0.1175
1959 . . . . .	0.1126	1968 . . . . .	0.1180

The ratios, as can be seen from the table, are contained within very narrow limits, despite the length of the period, and the structural changes which have occurred in the Italian economy during the same interval of time.

The reported ratios suggest that the main determinant of the demand for currency is the level of income. Other phenomena influence however the behaviour of the dependent variable, the most important of which seem to be the level of interest rates and the distribution of income between wages and salaries, on one side, and other incomes on the other (16).

An increase in the interest rates, other things being equal, reduces the demand for currency since people can invest now more profitably in other assets yielding higher returns, or else because credit is more expensive. A redistribution of income in favor of wages and salaries entails, on the contrary, an increase in the amount of circulation, both because payments of wages and salaries are mostly made by currency,

(16) BANCA D'ITALIA, *Assemblea Generale Ordinaria dei Partecipanti*, 1967, Rome, 1968, pp. 254 ff.

and because the increase in such incomes tends to increase consumption, the transactions for which are made almost exclusively by the use of currency (17).

A multiple regression analysis on the basis of quarterly data, covering the period 1959-68 (40 observations) allows to test the influence of the mentioned variables on currency circulation. In the following equations the symbol CIRC indicates the amount of currency in the hands of the public (average of the three end-of-month figures), GNP is gross national product at current prices, W indicates the amount of wages and salaries,  $i_G$  is the average yield during the quarter of long term government bonds (all maturities), and  $i_{DR}$  is an estimate of the average yield of bank savings deposits; ( $\bar{R}^2$ , D.W. and S.E. stand respectively for the coefficient of determination corrected for degrees of freedom, for the Durbin and Watson statistic, and for the corrected standard error of regression).

$$[1] \quad CIRC_t = 273.1 + 0.1122 GNP_t - 59.7 i_{G_t} + 0.761 CIRC_{t-1}$$

(108.5) (0.0085)      (22.4)      (0.020)

$$\bar{R}^2 = 0.999 \quad D.W. = 1.58 \quad S.E. = 30.1$$

$$[2] \quad CIRC_t = 383.0 + 0.1101 GNP_t - 108.4 \left( \frac{i_{DR} + i_G}{2} \right)_t + 0.773 CIRC_{t-1}$$

(151.5) (0.0084)      (41.3)      (0.021)

$$\bar{R}^2 = 0.999 \quad D.W. = 1.55 \quad S.E. = 30.1$$

$$[3] \quad CIRC_t = 301.9 + 0.1600 W_t + 0.0998 (GNP - W)_t - 62.0 i_{G_t}$$

(109.8) (0.0378)      (0.0127)      (22.3)

$$+ 0.718 CIRC_{t-1}$$

(0.039)

$$\bar{R}^2 = 0.000 \quad D.W. = 1.77 \quad S.E. = 29.8$$

$$[4] \quad CIRC_t = 381.4 + 0.1395 W_t + 0.1023 (GNP - W)_t - 105.0 \left( \frac{i_{DR} + i_G}{2} \right)_t$$

(168.7) (0.0383)      (0.0130)      (41.7)

$$+ 0.746 CIRC_{t-1}$$

(0.040)

$$\bar{R}^2 = 0.999 \quad D.W. = 1.63 \quad S.E. = 30.3$$

(17) I have had the opportunity of looking at a fine paper prepared by Dr. Franco Cotula, to be published presently, containing a careful analysis of the determinants of demand for money in Italy. The results shown here do not appear in contrast with the conclusions of that paper.

All the equations show a strong dependence of the demand for currency on income and its components; also the effect of interest rates appears to be quite significant.

The impact effect on currency of one point change in government bond yield is approximately 60 billion lire; the effect of one point change in the mean of government bond and savings deposit yield is remarkably higher (approximately 110 billion lire); this is mainly a consequence of the lower variability of savings deposit yield: actually the standard error of the percentage yield of government bonds is 0.271; the standard error of deposit yield is 0.169; that of the average is 0.193.

The adjustment to equilibrium values appears to take place for approximately 25 per cent in one quarter, from equation [1], [2] and [4], but such a rate could be underestimated, because of the presence of a certain degree of autocorrelation in the residuals. Indeed the Durbin and Watson statistic appears rather low-valued, in spite of the upward bias due to the presence of the lagged dependent variable.

The long run effect of  $i_G$  on the demand for currency, is approximately equal to 250 million lire in equations [1] and [3]. The effect of the average between  $i_{DR}$  and  $i_G$  is approximately equal to 400 billion, in equations [2] and [4].

From equation [3] the adjustment process seems a little faster (30 per cent in one year), though also in this instance it is presumably underestimated.

The standard error of the regression is in all equations less than 1 per cent of the average value of the dependent variable over the estimation period (equal to 3.244 billion lire), and approximately equal to  $\frac{1}{2}$  per cent of the value of the same variable at the end of 1968.

#### (b) Postal Deposits.

Also for postal deposits it is possible to put into light a strong dependence on income and interest rates. In the analysis it is convenient to distinguish between demand deposits, which have the nature of money, on one side, and savings deposits (including *buoni fruttiferi*) on the other.

Several regressions have been run, on the basis of both yearly and quarterly data, and some of the best results are reported here-

after. The explanatory variables are the gross national product (GNP) and the yield of government bonds ( $i_G$ ); as to the dependent variable it has been put equal to the stock for demand deposits ( $DPC/C$ ), and to the flow for savings deposits ( $\Delta DPR$ ). The symbol  $\bar{i}_G$  represents a constant equal to the average value of the variable  $i_G$  over the estimation period; the variables  $S_2, S_3, S_4$  are seasonal dummies, respectively for the second, third and fourth quarter (by multiplying them for the variable GNP, seasonal shifts in the coefficient of the same variable are introduced).

#### Yearly data (Estimation period: 1951-68)

$$\begin{aligned}
 [5] \quad DPC/C &= 0.0093 \text{ GNP} - 23.8 (i_G - \bar{i}_G) \\
 &\quad (0.0004) \quad (18.8) \\
 \bar{R}^2 &= 0.964 \quad D.W. = 0.24 \quad S.E. = 47.1 \\
 [6] \quad \Delta DPR &= 52.0 + 0.0072 \text{ GNP} - 58.1 i_G \\
 &\quad (21.7) (0.0008) \quad (15.1) \\
 \bar{R}^2 &= 0.889 \quad D.W. = 1.02 \quad S.E. = 34.3
 \end{aligned}$$

#### Quarterly data (Estimation period: 1958-68)

$$\begin{aligned}
 [7] \quad DPC/C_t &= -80.9 + 0.0309 \text{ GNP}_t - 0.0008 (i_G - \bar{i}_G) \text{ GNP}_t + \\
 &\quad (14.2) (0.0042) \quad (0.0016) \\
 &\quad - 0.0039 S_3 \text{ GNP}_t + 0.503 DPC/C_{t-1} \\
 &\quad (0.0009) \quad (0.076) \\
 \bar{R}^2 &= 0.976 \quad D.W. = 1.98 \quad S.E. = 20.5 \\
 [8] \quad \Delta DPR_t &= 3.03 + 0.0083 \text{ GNP}_t - 0.0032 (i_G - \bar{i}_G) \text{ GNP}_t + \\
 &\quad (5.2) (0.0008) \quad (0.0007) \\
 &\quad - 0.0053 S_2 \text{ GNP}_t - 0.0036 S_3 \text{ GNP}_t + 0.0111 S_4 \text{ GNP}_t \\
 &\quad (0.0005) \quad (0.0005) \quad (0.0005) \\
 \bar{R}^2 &= 0.977 \quad D.W. = 0.73 \quad S.E. = 9.2
 \end{aligned}$$

In all the equations a significant influence of GNP and of the yield of government bonds appears.

In the equations estimated on quarterly data the standard errors of regression appear to be very low, comparable for demand deposits

to those found for currency, and more limited for savings deposits. (It is to be noticed however that average value of the variable  $DPC/C$  is approximately equal to  $\frac{1}{10}$  only of the average value of the variable  $CIRC$ ).

Postal demand deposits appear to approach the equilibrium values much faster than currency, and the effect of  $i_G$  is in general rather limited; more precisely (for the mean value of GNP) its impact effect is equal to 6 billion lire, and the long run effect approximately twice as much. For savings deposits the effect of one point change in  $i_G$  is equal to 25 billions.

In conclusion, from equation [1] to [8] it appears that the demand of monetary base by the public is a stable function of income (and its distribution) and of interest rates; consequently it is possible to foresee its value in any given situation. Moreover the dependence on interest rates is rather limited, especially in the short run, with the consequence that, for a given value of income, any change in the total amount of monetary base is almost completely transformed into a change in bank reserves (18).

### 3.2. Supply and demand for credit.

The maximum expansion of deposits and credit which can take place for a given amount of monetary base of the banks, that is the

(18) A variation of one point in  $i_G$ , which causes the effects recalled above on the demand of monetary base, is a rather strong one as the range of the same variable was only 1.12 percentage points over the 10 year period 1959-68.

The same remark is true for the variable  $i_{DR}$  which had a range of 0.74 percentage points over the same period and for the average of the two variables, the range of which was 0.70.

Income is rather independent in the short run from monetary policy actions.

Among the interest rates only the yield of government bonds is sufficiently sensitive to monetary policy measures, while the rate paid on bank deposits appears to react very sluggishly to changes in liquidity conditions.

It is also to be remarked however that the absolute values of the coefficients of interest rates are all underestimated because of simultaneous equation bias. Indeed any disturbance in the demand of monetary base by the public, entails an equal change of the opposite sign in bank liquidity, and consequently an impact, of the same sign of the disturbance, on interest rates; this fact introduces an upward bias in the coefficient of the same rate, which then tends to appear higher in relative value and closer to zero. Also the other coefficients are biased, but presumably less seriously.

total minus the share absorbed by the public, depends upon the coefficient of required reserves, and from the maximum coefficient of excess reserves, given the liabilities other than deposits (since the percentage of reserves is related to deposits).

The effective amount of credit depends, on the contrary, not only upon the amount of monetary base, but also upon the demand for credit and for deposits by the public. In addition to a unique value for the amount of credit, for any given set of values of the variables which explain its supply and demand, there is also a unique level of interest rates which clears the market; the relationships among all these variables, and in particular, those between monetary base, on the one hand, and interest rates and credit, on the other, can be analyzed through the estimation of the parameters of the equations of a model of supply and demand for bank credit.

In the model reported hereafter the supply on the part of the banks depends mainly upon the quantity of monetary base at their disposal and upon the level of interest rates. Two different concepts of the supply of credit have been considered, represented respectively by commercial loans and by investment in bonds (excluding the part used for required reserves).

The demand for credit was made a function of gross national income (whose value should represent an index of the need for working capital, to be financed mostly by bank credit) and of the interest rates. On the demand side, only that part of credit which takes the form of loans was considered, because analysis of the share that passes through the financial market, even though necessary for the purpose of eliminating some inconsistencies in the estimation of the parameters, would broaden unduly the limits of the present paper.

A consistent estimation of the parameters of the previously mentioned equations would require indeed the specification of a complete model of the monetary and financial sector of the economy; however the results reported below even though being preliminary, seem in general sufficiently convincing, at least for what concerns the dependence of the supply of credit from monetary base and interest rates, and the demand for credit from interest rates.

The equations were all estimated on the basis of quarterly data covering the period 1958 to 1967 in some cases, and 1958 to 1968 in some others.



The form of the equation of supply of credit is the following (the indices  $t, t-1, \dots$  indicate the reference period):

$$\begin{aligned} CR = & \alpha_1 + \beta_1 BMB_t + \beta_2 BMB_{t-1} + \dots \\ & + \gamma_1 D_t + \gamma_2 D_{t-1} + \dots \\ & + \delta_1 i_{G_t} + \delta_2 i_{G_{t-1}} + \dots \end{aligned}$$

where the symbols have the following meanings:

CR = amount of bank credit, which can assume two different concepts, i.e.: (a) credit granted under the form of commercial loans (symbol CR.IMP); (b) credit under the form of acquisition of long term bonds by banks (symbol CR.TIT).

BMB = monetary base of the banks (excess plus required reserves, minus borrowing from the central bank and from foreign sector, or plus net positive position toward the foreign sector).  
The variable constructed in this way is mostly independent from the behaviour of banks, which influence it especially in the short run, only in a limited way, through variations in the interest rate paid on deposits (recalling part of the monetary base held by the public).

D = Dummy variable which assumes a value equal to that of the previous variable BMB starting from the first quarter 1966 and zero value in the previous periods.  
This variable was introduced in the equation in order to take into account the effect on the supply of credit of the possibility given to the banks, at the end of 1965, of using long-term bonds, instead of Treasury bills, to cover a part of the reserve requirements. This was equivalent to a reduction of the coefficient of obligatory reserves and consequently to an increase of the credit multiplier. The variable also takes into account the effect on the demand for bonds of the stabilization policy for the prices of the same bonds, begun in the first months of 1966. Even though the two effects are different and their timing not entirely coincident, their separate measurement appears difficult for the arising of collinearity problems.

$i_G$  = Level of interest rates, measured by the yield of long term government bonds.

The sum of the values of the coefficient  $\beta_i$ , which are all expected to be positive, is an estimate of the credit multiplier, relative to the concept of monetary base adopted (taking into account the time necessary for the explication of the multiplicative process).

The sum of the values of the coefficients  $\gamma_i$ , which are also expected to be positive, gives an estimate of the effect resulting from the increase of the value of the multiplier and from the increase of the propensity to hold bonds since 1966, as a consequence of the reduction of reserve coefficients and of the stabilization of bond prices.

The coefficients  $\delta_i$ , which must be positive too, measure the effects on the supply of credit of interest rates; the sum of all the coefficients estimates the long run influence.

The form chosen for the equation of demand for credit is the following:

$$\begin{aligned} CR = & \alpha + \beta_1 GNP_t + \beta_2 GNP_{t-1} + \dots \\ & + \gamma_1 i_{G_t} + \gamma_2 i_{G_{t-1}} + \dots \\ & + \delta_1 BMES_t + \delta_2 BMES_{t-1} + \dots \\ & + \epsilon_1 S_1 + \epsilon_2 S_2 + \epsilon_3 S_3 \end{aligned}$$

where the variables have the following meanings:

CR = Amount of credit. For demand only one of the two concepts mentioned above has been used, i.e. commercial loans (symbol CR.IMP).

GNP = Value of gross national product at current prices; quarterly data obtained through elaboration of ISTAT and ISCO data.

$i_G$  = Interest rates (same concept as mentioned before).

BMES = Sum of the items "Treasury" and "foreign sectors" in the balance sheet of the central bank, after having deducted net liabilities of the banks toward the foreign sector, or added their assets.  
The variable obtained in this way measures the quantity of means of payment obtained by the economic system without having recourse to commercial bank credit.

$S_1, S_2, S_3$  = Dummy variables to take into account seasonal adjustments.

The sum of the coefficients  $\beta_i$ , which are expected to be positive, estimates the marginal effect of income on the demand for loans.

The sum of the coefficients  $\gamma_i$ , which are expected to be negative, estimates the effect of the level of interest rates on the demand for credit.

The sum of the coefficients  $\beta_i$ , which are expected to be negative, estimates the reductive effect on the demand for credit due to a variation of the supply of means of payment deriving from sources other than bank credit (surplus of the balance of payments and deficit of the Government). Such a sum can at most be unity; it will, on the contrary, be less than unity if the supply of other means of payment has an impact not only on credit but also on other assets (a positive impact) or liabilities (a negative impact) of the balance sheet of the public.

By using single-stage least squares (and so forgetting about simultaneous equation bias) the following results were obtained for the supply of commercial loans function (the estimation period is 1958-1968, quarterly data).

$$[9] \quad CR.IMP_t = -27922.2 + 1.419 BMB_t + 1.892 BMB_{t-1} + \\ (7577.3) (0.171) \quad (0.227) \\ + 1.419 BMB_{t-2} + 4892.6 iG \\ (0.171) \quad (1411.8) \\ \bar{R}^2 = 0.677 \quad D.W. = 0.15 \quad S.E. = 2556.5$$

$$[10] \quad CR.IMP_t = 0.843 BMB_t + 1.265 BMB_{t-1} + 1.265 BMB_{t-2} + \\ (0.040) \quad (0.060) \quad (0.060) \\ + 0.843 BMB_{t-3} + 0.052 D_{t-2} + 0.083 D_{t-3} + 0.094 D_{t-4} + \\ (0.040) \quad (0.047) \quad (0.075) \quad (0.085) \\ + 0.083 D_{t-5} + 0.052 D_{t-6} + 5181.7 (iG - \bar{iG})_t \\ (0.075) \quad (0.047) \quad (1550.0) \\ \bar{R}^2 = 0.967 \quad D.W. = 0.18 \quad S.E. = 2345.5$$

In the first equation only two lagged values of the variable BMB were introduced. In the second equation beyond three lagged values of variable BMB a dummy starting from period (t-2) was introduced.

The sum of coefficients of the variable BMB in equation [9] is equal to 4.7; in equation [10] the sum of coefficients of the same variable is equal to 4.2 and the sum of coefficients for the dummy is approximately equal to 0.40. The dummies, though being of the right sign, do not appear very significant (equation [9] has been estimated by constraining the regression plane through the origin.  $\bar{R}^2$  is equal to the ratio between the sum of squares of the theoretical values of the dependent variables, and the sum of squares of the observed values of the same variable). The Durbin and Watson

statistic is in both equations very low (19). This makes the standard errors biased downward.

For the supply of credit under the form of acquisition of long term bonds the following equations were estimated (over the period 1958-1968, using quarterly data).

$$[11] \quad CR.TIT_t = 8547.8 + 0.2290 BMB_t + 0.3435 BMB_{t-1} + \\ (2115.6) (0.0464) \quad (0.0695) \\ + 0.3435 BMB_{t-2} + 0.2290 BMB_{t-3} + 0.0434 D_t + \\ (0.0695) \quad (0.0464) \quad (0.0122) \\ + 0.0723 D_{t-1} + 0.0867 D_{t-2} + 0.0867 D_{t-3} + \\ (0.0203) \quad (0.0244) \quad (0.0244) \\ + 0.0723 D_{t-4} + 0.0434 D_{t-5} + 1471.9 iG_t \\ (0.0203) \quad (0.0122) \quad (360.9) \\ \bar{R}^2 = 0.901 \quad D.W. = 0.25 \quad S.E. = 525.7$$

$$[12] \quad CR.TIT_t = -8235.1 + 0.2223 BMB_t + 0.3334 BMB_{t-1} + 0.3334 BMB_{t-2} + \\ (1999.6) (0.0427) \quad (0.0640) \quad (0.0640) \\ + 0.2223 BMB_{t-3} + 0.0365 D_t + 0.0626 D_{t-1} + \\ (0.0427) \quad (0.0089) \quad (0.0153) \\ + 0.0783 D_{t-2} + 0.835 D_{t-3} + 0.0783 D_{t-4} + \\ (0.0191) \quad (0.0203) \quad (0.0191) \\ + 0.0626 D_{t-5} + 0.0365 D_{t-6} + 1431.8 iG_t \\ (0.0153) \quad (0.0089) \quad (344.5) \\ \bar{R}^2 = 0.907 \quad D.W. = 0.23 \quad S.E. = 506.9$$

(19) This is mainly a consequence of the use of the Almon technique for lag estimation (cf. SHIRLEY ALMON, "The Distributed Lag Between Capital Appropriation and Expenditure", *Econometrica*, vol. 3, No. 1). To see how the use of the mentioned technique affects the autocorrelation of residuals, consider the following equation

$$y = X\beta + u$$

where:  $y$  is the vector of dependent variables;  $X$  is the matrix of independent variables;  $\beta$  is the vector of regression coefficients;  $u$  is the vector of — non correlated — disturbances.

In order to avoid multicollinearity the matrix  $X$  is transformed into a matrix  $Z$ , having a minor number of columns, by using the matrix  $\phi$  of Lagrange polynomials

$$Z = X\phi$$

and the following model is estimated by least squares

$$y = Z\hat{\beta} + \hat{u}$$

It is easily seen that now the disturbance vector is equal to

$$u = u + X(\beta - \hat{\beta})$$

so it is autocorrelated as long as

$$\beta \neq \hat{\beta}$$

and the column components of  $X$  are autocorrelated.

Though yielding less efficient estimates, autocorrelation of residuals does not imply in this case any bias in the estimation of coefficients.

In both equations the sum of coefficients of the variable BMB is approximately 1.10, and the sum of coefficients of the dummy variable D is approximately 0.40. All the coefficients appear very significant, in spite of simultaneous equations bias which should affect especially the coefficient of interest rate (20).

For bonds the effect of the decrease of the reserve coefficients turns out to be significant. Beyond an increase of the value of the multiplier, equal approximately to 0.40, there is also a lengthening of the period necessary for the explication of the multiplicative effect (21). Part of the increase in the value of the multiplier can be attributed to the stabilization measures for prices of bonds; by making bonds more attractive, such measures have increased the banks' propensity to hold them. This also means that banks' preferences have been diverted from commercial bonds, and would explain why no significant effect of the dummies was found for the supply of loans.

From equations [10] and [12] the following progression of the multiplicative effect results, for an initial injection of monetary base equal, for example, to 100.

(a) Period 1958-1965

TABLE II

	Supply of loans	Demand for bonds	Total supply of credit
Same quarter . . . . .	84	22	106
After 1 quarter . . . . .	211	56	267
After 2 quarters . . . . .	336	89	425
After 3 quarters . . . . .	420	111	531

(b) Period following the reduction of the reserve coefficient

TABLE III

	Supply of loans	Demand for bonds	Total supply of credit
Same quarter . . . . .	84	26	110
After 1 quarter . . . . .	211	66	277
After 2 quarters . . . . .	341	107	448
After 3 quarters . . . . .	433	137	570
After 4 quarters . . . . .	443	145	588
After 5 quarters . . . . .	451	151	602
After 6 quarters . . . . .	456	155	611

(20) Also in this case however the low value of the Durbin and Watson statistic reveals that all the standard errors are biased downward, because of autocorrelation of residual. This makes the estimation of coefficients less efficient, but it does not introduce any bias in the same.

(21) The method used for the estimation of lags does not yield a precise measure of the length of the period, but after having chosen, by trials and errors, the period, it seems to yield a satisfactory estimate for the sum of coefficients.

For the demand of credit several equations were estimated, one of the best being the following one:

$$\begin{aligned}
 [13] \quad CR.IMP_t = & 724.1 + 0.497 GNP_t - 215.4 i_{G_t} - 0.185 BMES_t + \\
 & (635.2) (0.170) \quad (92.9) \quad (0.124) \\
 & - 180.1 S_1 - 204.6 S_2 - 496.3 S_3 + 0.824 CR.IMP_{t-1} \\
 & (247.2) \quad (141.5) \quad (106.2) \quad (0.080) \\
 \bar{R}^2 = & 0.997 \quad D.W. = 1.22 \quad S.E. = 214.6 \\
 & \text{(Estimation period 1958-67; quarterly data)}
 \end{aligned}$$

From equation [13] significant effects of national income and of interest rates on the demand for credit can be deduced. The long run effect of variable BMES (means of payment got by the system through sources different from bank credit) is quite high, i.e. approximately equal to -1.0, but not very significant. However because of the autocorrelation of residuals (22), which causes an upward bias in the estimation of coefficient of  $CR.IMP_{t-1}$ , also such a long run effect is overestimated; the same is true for the long run effect of interest rates, which is approximately equal to -1,200 billion lire for one point change in the level of interest rates.

Another equation, in which time lags have been estimated by the use of the Almon technique, is the following one (same period and data as before):

$$\begin{aligned}
 [14] \quad CR.IMP_t = & -21.3 + 0.626 GNP_t + 0.835 GNP_{t-1} + 0.626 GNP_{t-2} + \\
 & (1258.0) (0.043) \quad (0.058) \quad (0.043) \\
 & - 231.8 i_{G_t} - 309.1 i_{G_{t-1}} - 231.8 i_{G_{t-2}} - 0.085 BMES_t + \\
 & (71.9) \quad (95.9) \quad (71.9) \quad (0.255) \\
 & - 129.0 S_1 + 355.2 S_2 + 321.9 S_3 \\
 & (197.8) \quad (197.1) \quad (190.1) \\
 \bar{R}^2 = & 0.988 \quad D.W. = 0.26 \quad S.E. = 422.6
 \end{aligned}$$

In this equation the total effect of GNP and of interest rates on credit is more limited than for the previous one; this would confirm that the high value of the coefficient of the variable  $CR.IMP_{t-1}$  is

(22) The Durbin and Watson statistic is itself upward biased (cf. MARC NERLOVE and KENNETH F. WALLIS, "Use of the Durbin Watson Statistic in Inappropriate Situations", *Econometrica*, vol. 34, No. 1), for the presence of the lagged dependent variable.

largely due to autocorrelation of residuals. The influence of the variable BMES however appears now too low.

Attempts at estimating all the reported equations by the use of two stage least squares have yielded estimates for the supply of credit where the interest rate effect is higher and confirmed, in general, all the other results.

As a partial conclusion for this paragraph it can be pointed out that the influence of interest rate on the supply of credit is, in absolute value, remarkably higher than the influence on demand. This means that banks are more sensitive than their customers to changes in interest rates and this, in turn, has implications to be pointed out below.

#### 4. Summing up and Conclusions

Starting from a definition of monetary base as an aggregate capable of influencing the overall liquidity and the level of interest rates, via the bank credit multiplication process, the assets having those characteristics in different institutional regimes have been defined.

It has been possible in particular, for Italy, to single out those financial assets which possess the nature of monetary base.

The demand of such assets by the public appears to be a stable function of income and interest rates so that any change is reflected, in a predictable way, into changes in banks' excess reserves; more specifically, as the demand depends mainly on income and its distribution, which in the short run are largely independent of monetary policy, any action on monetary base brings about a change of almost the same amount in banks' reserves.

Subtracting from banks' reserves that part which is obtained through borrowing from the central bank and from abroad, or adding the part which is lent abroad, an aggregate capable of influencing the supply of credit is obtained.

As the supply of credit is influenced also, and in a remarkable amount, by changes in the level of interest rates, while the demand for credit is negatively influenced by the same rates, variations of the mentioned aggregate (unborrowed reserves) bring about a change in the amount of credit and (of the opposite sign) in interest rates.

Further analyses must ascertain more accurately what at first sight seems a sensible result (not only for Italy, but also for other

countries), i.e. that the interest elasticity of the supply of credit is remarkably higher than that of demand. Such a result indeed would mean that a change in the amount of monetary base, all other things being equal, would bring about only a limited change in the effective amount of credit, the rest being absorbed by a variation of interest rates. In turn this would mean that the regulation of monetary base can be especially suited for the achievement of external objectives, if a sensitivity of capital movements to interest rate differentials has been ascertained (23).

Also the structure of time lags must be analyzed more carefully, studying in particular the behaviour of the system in case of restriction (where rationing effect has also to be taken into account) and in case of expansion, separately (24).

Many of such improvements of the analysis can be carried on only in the context of a more complete model and with more accurate information on interest rates.

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(23) The effects of the restrictive monetary policy measures being taken in the United States seem to suggest an interpretation in line with this conclusion.

(24) For the reasons which explain in Italy the asymmetric effect of monetary policy in case of expansion and in case of restriction see: GUIDO CARLI, "Il processo di aggiustamento delle bilance dei pagamenti", Lecture given before the Society of Political Economy and Statistics of Basle, on November 8, 1968, reproduced in *Mondo Economico*, December 19, 1968.