The Monetary Base Adjusted for Required Reserve Ratio Changes

This note is concerned with the relationship between the monetary base and the quantity of money. Money is defined as currency (notes and coin) plus bank deposits held by the public. The monetary base is defined as currency held by both banks and the public, plus other assets that also satisfy bank reserve requirements. In the past the monetary base in Italy has included not only currency and current accounts with the Bank of Italy (central bank money) but also special Treasury bills that satisfy reserve requirements, unused borrowing margins with the Bank of Italy, particular short-term securities that the Bank of Italy promises to purchase, and convertible foreign currencies.[1] Current accounts with the Treasury and Post Office are sometimes included in the definition of the monetary base because of being issued by the monetary authorities. But these accounts are often excluded because of their likeness to ordinary current accounts with commercial banks that are included in the definition of money but not the monetary base.

The term monetary base was probably coined by Karl Brunner[2] and it has been used in his works with Allan H. Meltzer[3] and the so-called international monetarist consortium.[4] Milton Friedman and

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[1] G.F. Caligiuri and B. Sitzia, "Effetti della manovra delle riserve obbligatorie nel periodo 1963-1973", *Moneta e Credito*, 1979, pp. 44-55. G. Vergili and M. Townsend, "Monetary Base and Bank Liquidity as Policy Instruments in Italy, Germany, France, and the United Kingdom", in F. Masera, A. Fazio, and T. Padoa-Schioppa (eds.), *Econometric Research in European Central Banks*, Banca d'Italia, 1975, pp. 421-40.

[2] K. Brunner, "A Schema for the Supply Theory of Money", *International Economic Review*, Vol. 2, No. 1, 1961, pp. 79-109.

[3] K. Brunner and A.H. Meltzer, "Some Further Investigations of Demand and Supply Functions for Money", *Journal of Finance*, May 1964, pp. 240-83.

[4] For example, M. Fratianni, "Bank Credit and Money Supply Processes in an Open Economy in Model Applicable to Italy", *Metroeconomica*, Vol. 24, April 1972, pp. 24-69.

his research colleagues have used the term high-powered money for the same magnitude,[5] high powered — because increases in it tend to be associated with multiple increases in broader monetary aggregates.

The monetary base is created by the monetary authorities (the central bank and government) by exchanging claims on themselves for securities, loans to banks, foreign exchange or, for that matter, anything that a seller is willing to trade for units of the monetary base. Creation of the monetary base is generally linked to (1) government deficits and credit extensions which are financed at least in part by issue of the monetary base or (2) balance of payments surpluses which are absorbed by accumulation of international monetary reserves in exchange for units of the monetary base.

The objective of the present note is not to develop a detailed description of the monetary base for Italy, but rather to explain in simple terms how the monetary base is related to bank deposits and money, and how changes in required reserve ratios have an impact on deposit determination in an equivalent way to changes in the monetary base that result from purchases of securities or foreign exchange by the monetary authorities. Building on this exposition, the paper shows that the method that the Bank of Italy uses to adjust the monetary base for required reserve ratio changes is incorrect.

The monetary base influences the amount of money both directly and indirectly, directly inasmuch as currency held by the public is part of both money and the monetary base, and indirectly insofar as the deposit component of money is affected by the supply of the monetary base. These influences of the monetary base on deposits result both from induced changes in the demand for deposits as the public seeks to restore portfolio balance between deposit and currency holdings and induced changes in the supply of deposits as banks seek to lend or invest surplus funds or restore deficits. The ability of banks to supply deposits is also affected by legal requirements for them to hold assets included in the monetary base as a fraction of their deposit liabilities.

By focusing on the supply of and demand for the monetary base, one can illustrate the main points of the preceding paragraph.

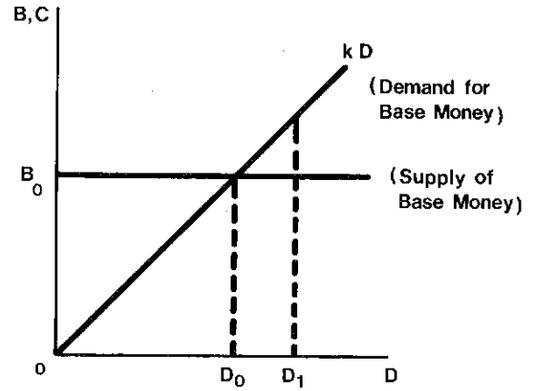
To demonstrate how deposits are limited by currency demand

[5] M. Friedman, "The Role of Monetary Policy", *American Economic Review*, Vol. 58, No. 1, 1968, pp. 1-17.

and the supply of the monetary base, consider the case where banks are assumed to hold no monetary base reserves. Transactions in securities markets are assumed to be so speedy that banks can meet net withdrawals by selling securities to get funds instantaneously to honor depositors' demands. Thus, banks have no monetary base holdings even though legally obligated to pay depositors on demand or under specified terms. Any losses banks might incur on security sales to meet withdrawals are assumed to be covered adequately by bank capital. Even in this admittedly pathological case, deposits are strictly limited as shown in Chart 1.

Chart 1

DEPOSITS LIMITED BY BASE MONEY AND CURRENCY DEMAND



The limiting factor is the willingness of the public to hold deposits which is assumed linked to their currency holdings. The desired currency to deposits ratio is k. Since currency is part of the monetary base, indeed the only part in this illustration, for every level of deposits, D, there is a corresponding demand for currency (and the monetary base) equal to kD. Thus, for a given monetary base, B_0, considered to be independent of the amount of deposits, there is a particular level of deposits ($D_0=B_0/k$) that clears the market. Attempts by banks to issue more deposits than D_0 — say, D_1 — would raise the demand for currency and force withdrawals until the public restored its desired currency to deposit holdings. Thus, the supply of the monetary base, B_0, and the demand for the monetary base, kD, limit the creation of deposits even if banks hold none of the

monetary base. The quantity of money is also limited by the supply and demand for the monetary base since:

$$M \equiv D+C=D+kD=(1+k)D=(1+k)\frac{B_0}{k}$$

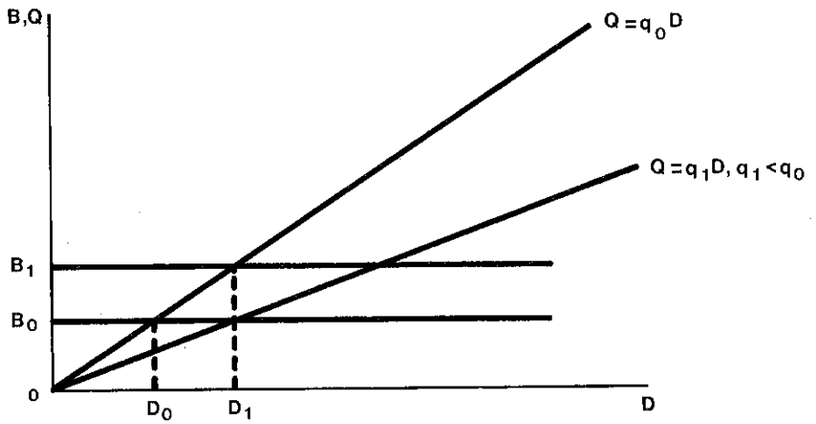
The next hypothetical case illustrates the importance of required reserve ratios which impinge on the ability of banks to issue deposits and extend credit much as the availability of the monetary base does. Assume in this instance that the public holds no currency but only bank deposits and that banks hold no excess reserves but only required reserves. Required reserves are a fraction q of deposits.

Chart 2 shows the supply and demand for the monetary base and the level of deposits that clears the market, D_0. Note that a higher level of deposits, D_1, could result from either a reduction in the required reserve ratio from q_0 to q_1 or an increase in the monetary base from B_0 to B_1. In this sense there is an equivalence between changes in the monetary base and changes in the required reserve ratio. A one lira change in deposits could result from a change in the monetary base, $\Delta B=q_0$ —i.e., $\Delta D=1=\Delta B/q_0$ — or a change in the required reserve ratio, $\Delta q= -q_0^2/(q_0+B_0)$ —i.e., $\Delta D=1=B_0/(q_0+\Delta q)-B_0/q_0$.

There are two ways to prevent deposit increases from accompanying government deficits. One way is to finance the deficit solely

Chart 2

DEPOSITS LIMITED BY BASE MONEY AND RESERVES DEMAND



by selling government securities to banks and the public but not to the Bank of Italy so that there is no associated issue of the monetary base and consequently no increase in bank deposits and money. The other way is to increase the monetary base but also increase required reserve ratios on deposits enough to prevent any increase in deposits. Chart 2 also illustrates this situation. To hold deposits at D_1 when the monetary base increases from B_0 to B_1, the required reserve ratio must increase from q_1 to q_0. Thus, increasing required reserve ratios to prevent the level of deposits from changing in the face of a government deficit is equivalent to the government issuing securities to the banks and the public. One can interpret an increase in required reserves at a given level of deposits as a tax to finance government spending.

It has been shown that required reserve ratio reductions liberate bank reserves which would affect the deposits banks are able and willing to supply correspondingly to the effect of changes in the monetary base. Therefore one can put the two effects together in a measure of the monetary base that incorporates bank reserves liberated (or absorbed) by required reserve ratio changes. The monetary base adjusted for required reserve ratio changes is a sum, monetary base, B, plus a reserve adjustment magnitude, RAM, that is hypothesized to be related to the creation of bank deposits and money in a systematic way.[6] The basic idea of a reserve adjustment magnitude can be understood by reference to Chart 3. The initial level of deposits is D_0, an amount associated with monetary base, B_0, all of which is assumed to be held as required reserves, $Q=q_0D_0$. As previously shown, an increase in the monetary base, ΔB_1, would induce an increase in deposits, $\Delta D_1=(1/q_0)\Delta B_1$. The deposit expansion multiplier is $1/q_0$. For that level of the monetary base, $B_0+\Delta B_1$, a decrease in the required reserve ratio from q_0 to q_2 would induce an increase in deposits

$$\Delta D_2=(B_0+\Delta B_1)[(1/q_2)-(1/q_0)]=(1/q_0)/[(-\Delta q_2)D_2]=(1/q_0) \quad (\Delta RAM_2).$$

The change in the reserve adjustment magnitude is multiplied by the same multiplier, $1/q_0$, as the change in the monetary base was

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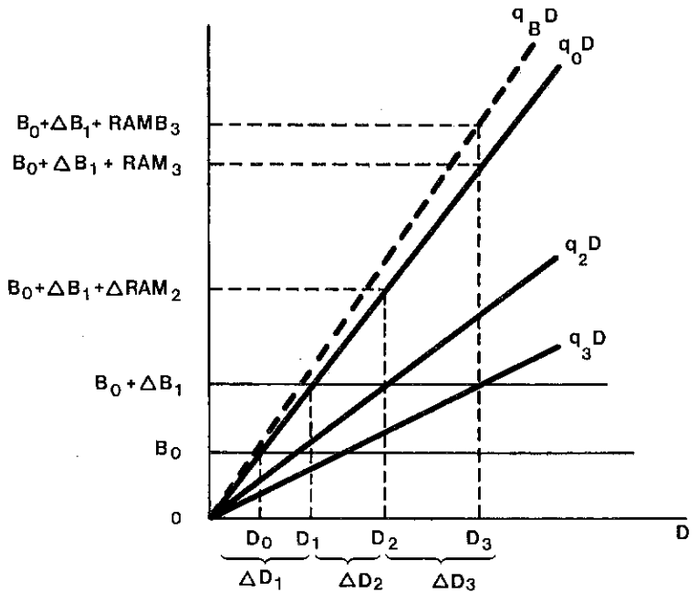
[6] The logic and methodology of the Federal Reserve Bank of St. Louis RAM calculations are discussed in A. E. Burger and R. H. Rasche, "Revisions of the Monetary Base", *Federal Reserve Bank of St. Louis Review*, Vol. 57, No. 7, July 1977, pp. 13-28.

Chart 3

EQUIVALENCE OF BASE MONEY AND THE RESERVE ADJUSTMENT MAGNITUDE



to obtain the associated change in deposits and is thus equivalent in its effect on deposits as a change in the monetary base

$\Delta D_1+\Delta D_2=(1/q_0)\ [\Delta B_1+\Delta RAM_2]$.

The RAM calculations of the Federal Reserve Bank of St. Louis were revised in 1977 to incorporate an important element that had been left out of their previous method of adjusting the monetary base for changes in required reserve ratios, a method that has continued to be used by the Bank of Italy in its calculations. The old method is to calculate the amount of bank reserves absorbed by required reserve ratio changes only for periods when required reserve ratios were changed and then to total such liberated (or absorbed) reserves over time to obtain the reserve adjustment magnitude for a particular period. I will call the resulting sum of liberated reserves RAMB rather than RAM. What is done is illustrated in Chart 3. Consider a second cut in the required reserve ratio, say from q_2 to q_3.

$\Delta RAMB_2=-(q_2-q_0)D_2$ as before and
$\Delta RAMB_3=-(q_3-q_2)D_3$. In total
$RAMB_3=\Delta RAMB_2+\Delta RAMB_3$.

This reserve adjustment magnitude does not incorporate the effect of required reserve ratio changes on changes in deposits that occur subsequently. As a result, increases in deposits from whatever source automatically reduce the money multiplier, shown in Chart 3 as an increase in the required reserve ratio from q_0 to q_B.

The correct reserve adjustment magnitude, RAM, for any period is calculated relative to the required reserve ratio in a particular base period, which is also illustrated in Chart 3. $RAM_3=-(q_3 - q_0)D_3$ — i.e., the negative of the change in the required reserve ratio from the base period times the current level of deposits. The current level of the reserve requirement is q_3D_3; the hypothetical requirement that would have existed if the required reserve ratio had remained at the base period level is q_0D_3; and the difference is the reserves liberated (or absorbed) by the required reserve ratio change from q_0 to q_3. If q_3 is less than q_0,

$$\Delta RAM_3=-(q_3 - q_0)D_3 - [-(q_2 - q_0)D_2]$$

$$=-(q_3 - q_2)D_2 - (q_2 - q_0)\Delta D_3.$$

The first term on the left reflects the direct effect of the current reduction in the required reserve ratio on the last period's deposits; the second term shows the combined effects of the current change in deposits on both current *and previous changes in the required reserve ratio*. This italicized item is left out of the old reserve adjustment calculation that was previously used by the Federal Reserve Bank of St. Louis and continues to be used by the Bank of Italy. In the example, the difference between the two reserve adjustment magnitudes is $RAM_3-RAMB_3=-(q_2-q_0)\Delta D_3$. This difference is a positive quantity for decreases in the required reserve ratio and increases in deposits. It has the effect of lowering the money multiplier — the ratio of money to the monetary base adjusted for required reserve ratio changes — which means that increases in the monetary base — say, through open market operations of the Bank of Italy — automatically induce a decrease in the multiplier. Ideally changes in the reserve adjustment magnitude

and the monetary base would have the same multiplier, and thus the multiplier would not change as a consequence of changes in required reserve ratios. Only changes in the distribution of deposits among different requirement classes would affect the multiplier; but it would not be affected by deposit changes. This ideal is achieved in the new reserve adjustment calculations but not the old because increases in the monetary base or reductions in required reserve ratios that increased deposits would automatically lower the multiplier of the adjusted monetary base. This relationship raises questions about studies that have found a large negative correlation between changes in the monetary base adjusted for required reserve ratio changes and changes in the money multiplier.[7] The negative correlation is partly, at least, simply a matter of arithmetic and not economic behavior. Such empirical work would appropriately be redone and in any event the Bank of Italy should revise its monetary base statistics to incorporate required reserve ratio changes appropriately.

Columbus

WILLIAM G. DEWALD

[7] For example, M. FRATIANNI and M. NABLI, "Money Stock Control in the EEC Countries", 6th International Conference of Applied Econometrics, Monetary and Financial Models, Rome, February 1979 (mimeographed).