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## The monetary base properly extended

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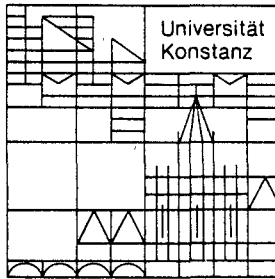
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**The Monetary Base  
Properly Extended**

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THE MONETARY BASE PROPERLY EXTENDED

Nikolaus K. A. Läufer

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Serie A: Volkswirtschaftliche Beiträge

Serie B: Finanzwissenschaftliche Arbeitspapiere

Serie C: Betriebswirtschaftliche Beiträge

## S U M M A R Y

The available concepts of an extended monetary base are seriously defective. They provide equal measurements for differently sized impulse forces of monetary policy and different measurements for equally sized impulse forces of monetary policy. A new concept is suggested that allows to avoid these measurement errors. It is shown that an extended base with a minimum of defects may be obtained by subtracting from the ordinary monetary base all required reserves. Thus, the best extension of the monetary base turns out to be a simple reduction. The view expressed in this paper may also be interpreted to be a prescription for the appropriate choice of the base period in the construction of an extended base as suggested by the St. Louis Federal Reserve Bank. With such a choice changes in the structure of reserve requirements as under the Monetary Control Act of 1980 would not cause problems and would not require special actions and revisions for a proper extension (adjustment) of the monetary base.

## I N T R O D U C T I O N

The concept of an extended monetary base has been introduced into money supply analysis in an attempt to extract and transfer the reserve requirements impulses of monetary policy from the money multiplier into the monetary base. The extended base is expected to concentrate all the monetary policy impulses while the associated money multiplier - after the transfer - is not any more influenced directly by monetary policy but only indirectly through policy induced changes in the array of interest rates. The construction of an extended base should produce two effects:

- 1) The associated money multiplier should become independent from changes in reserve requirements (independence).
- 2) The extended base should incorporate all the impulses of monetary policy (concentration).

These effects form the targets of the construction of an extended monetary base<sup>1)</sup>. The independence and the concentration targets are equivalent. One is the implication of the other.

The available constructions of an extended base do not reach these targets. It is well known that the old St. Louis concept of the extended base suffers from historical path dependence<sup>2)</sup>. The new St. Louis concept is an improvement over the old one<sup>3)</sup>. However, since the money multiplier associated with the new St. Louis concept still contains the rate of required reserves of a base period, changes in reserve requirements have not been completely extracted from the money multiplier. Changes in reserve requirements that have taken place between a period with zero reserve requirements and the chosen base period are still present. Thus, the independence and concentration targets of a monetary base extension still have not been reached by the new St. Louis concept. We shall demonstrate that, because of its

dependence on the reserve requirements ratio of a base period, the new St. Louis concept also suffers from historical path dependence. While historical path dependence of the old St. Louis concept is well known, the historical path dependence of the new St. Louis concept of an extended base has gone unnoticed so far.

It will be demonstrated in section IV that, due to historical path dependence, both St. Louis concepts of an extended base quite generally may give equal measurements for differently sized impulse forces and different measurements for equally sized impulse forces. Thus, historical path dependence is a serious conceptual error, and it seems worthwhile to look for a concept that is free of these defects, particularly, if we remind ourselves that many researchers and official institutions including the Deutsche Bundesbank and the Board of Governors of the Federal Reserve System in addition to the Federal Reserve Bank of St. Louis have been trying to transform changes in reserve requirements into changes in base money.

In section I we shall apply the independence target as a criterion to develop a new concept of an extended base which will be interpreted in the same section. We shall discuss, in section II, some possible objections against our new concept. In section III we shall clarify our notion of historical path dependence and shall derive the liberated reserves associated with our new extended base concept. A comparison with the two St. Louis concepts of liberated reserves will bring out the differences between the three concepts most clearly as far as historical path dependence is concerned. More importantly, using the liberated reserves, we can demonstrate, in section IV, how historical path dependence of both St. Louis concepts produces measurement errors of the kind just described above and implies arbitrary dynamics, i. e. dynamics not supported by theory. In section V we shall state some important implications of our new concept. In particular, we shall point out that our concept of an extended base implies a prescription about the appropriate choice of a base period for the new St. Louis concept of an extended base.

More importantly, we shall show that if our concept is applied, then changes in the structure of reserve requirements, as f. e. under the Monetary Control Act of 1980, will not cause any problem, do not require special actions and will not call for revisions in order to obtain correct time series of the properly extended (adjusted) monetary base.

A properly extended monetary base should also be independent of the behaviour of the public and the commercial banks if the ordinary base is given exogenously. In section VI we shall show that for any concept of an extended base this requirement can only be satisfied, if reserve requirements are formulated by fixing volumes of required reserves and not, as is common central bank practice, by fixing ratios of required reserves independent of the volume of deposits.



I

In this section we shall present and derive our new concept of an extended base. We shall demonstrate that the proper way to incorporate into the monetary base the impulses of changes in reserve requirements is to deduct from the source base all required reserves. We shall derive this result at first by means of a verbal argument. A more formal derivation then follows.

Let us begin by looking at the effects of reserve requirements. There exist both direct liquidity effects and indirect or interest rate effects of changes in reserve requirements. In this paper we totally neglect indirect or interest rate effects. Even if we say "all effects", we do not include interest rate effects but only liquidity effects of reserve requirements. In order to simplify the exposition suppose, for the time being, that reserve requirements are formulated as a fixed total volume of required reserves independently of volumes of deposits and not - as is common practice - as fixed ratios of required reserves. This is indeed only a simplification because if the rate of required reserves rises and the source base remains constant, then the volume of required reserves rises although the volume of deposits will decline. Thus, a rise in the volume of required reserves may obviously be interpreted to be the result of a rise in the ratio of required reserves.

For a given source base reserve requirements determine the amount of base money that is available (left over) for excess reserve holdings of commercial banks and for currency holdings of the public. Now, for the size of the money stocks it is not the the ordinary monetary base that is relevant but that part of it which is available for excess reserve and currency holdings. If total required reserves are increased then less of a given source base remains available for currency and excess reserve holdings. Given the propensities of the public to hold currency and of the commercial banks to hold excess reserves the increase in reserve

requirements will reduce the money stock (supply). Correspondingly, the difference between the source base and required reserves will decrease. Suppose, however, that both the source base and required reserves are lowered at the same time and by the same amount. Then the amount available for excess reserve and currency holdings obviously does not change. With given propensities to hold excess reserves and currency the money stock (supply) will not change either. Correspondingly, the difference between the source base and required reserves will remain unchanged. If the source base is increased and if reserve requirements are lowered by the same amount then the amount of base money that is available for excess reserve and currency holdings will increase by twice the amount of the increase in the source base or, equivalently, by twice the amount of decrease in required reserves. With given propensities for excess reserve and currency holdings the increase in the money stock (supply) will be twice the increase we would observe if only either the source base were increased or reserve requirements were lowered by the amount considered. Correspondingly, the difference between the source base and required reserves will increase by twice the amount of increase in the source base.

For anyone who is not misled by the ruling mispractice of extending the monetary base (see f. e. the old and new St. Louis procedures) the following conclusion should emerge from these simple statements. If we want to incorporate all the effects of reserve requirements on the money supply into the monetary base we have to look at that part of the source base which remains available for currency and excess reserve holdings after reserve requirements have been met. In order to compute that part we simply have to deduct the total of required reserves from the ordinary base. The difference between the ordinary base and required reserves is our new concept of an extended base. Since the monetary base can only be used for holdings of currency, excess and required reserves, this difference will give the sum of actual currency and actual excess reserve holdings. Whether these actual holdings are also desired holdings does not matter. If they are not yet desired holdings then the money supply process has not yet reached its equilibrium.

Yet, in practice, reserve requirements are not formulated as a fixed total volume of required reserves but as fixed ratios of required reserves. This implies that the amount of required reserves is an endogenous variable. It is not predetermined by monetary policy to the degree that monetary policy may predetermine the

monetary base. In fixing the volume of the source base and ratios of required reserves monetary policy uses two instruments that are inhomogeneous (volumes vs. ratios) and are not ideal for aggregation. However, this inhomogeneity is a problem that is facing not only our new but any concept of an extended base. We shall discuss this problem more in section VI where we demonstrate that this inhomogeneity can only be overcome by changing the system of reserve requirements and not by changing the concept of an extended base.

For further clarification of the effects of reserve requirements we may compare two worlds: one with and one without reserve requirements. In a model without reserve requirements the total of the monetary base may be defined from the uses' side by adding currency of the public to excess reserve holdings of the banks. With no reserve requirements all reserve holdings would be excess reserves. In such a model the total of the monetary base is available for currency and excess reserve holdings. As soon as reserve requirements are introduced only a fraction of the monetary base remains available for currency and excess reserve holdings, the other part being absorbed by reserve requirements. In order to incorporate all the effects of reserve requirements into the monetary base one has to compute that part of the monetary base that is available for currency and excess reserve holdings, i. e. from the monetary base one has to subtract that part which is absorbed by reserve requirements.

We now turn to a more formal derivation of our new concept of an extended base. We shall proceed in an indirect way. At first we shall derive the money multiplier associated with a properly extended monetary base. From the money multiplier we then derive the associated (extended) monetary base. The structure of our argument is as follows. Suppose we purge the money multiplier but not the money stock (supply) from changes in reserve requirements, then the effect of changes in reserve requirements must be contained in the ratio of the two. This ratio is our new extended base. A more extensive statement of this argument will be given next.

It follows at once from the independence target that the money multiplier associated with a properly extended monetary base should not contain any ratio of required reserves. This money multiplier should contain only those kind of ratios that you may find in a multiplier of a world or model where there exist no reserve requirements at all. (We do not postulate here anything about the quantitative size of the ratios included in the multiplier. In particular, we do not require or implicitly assume that the money multiplier associated with the properly extended monetary base is numerically equal to the multiplier in a system with no reserve requirements.) If any ratio of required reserves is left in the money multiplier, then the effects of changes of reserve requirements would not have been extracted completely from the money multiplier and - as will be shown in section III - historical path dependence would still be present and cause serious measurement errors of the kind indicated above. Therefore, the money multiplier (for  $M_1$ ) associated with a properly extended monetary base may be written as follows:

$$m = \frac{1 + k}{r^e(1 + t + s) + k}$$

where  $k$ ,  $t$  and  $s$  are ratios of currency ( $C^P$ ), time ( $T$ ) and savings ( $S$ ) deposits with respect to demand ( $D$ ) deposits, while  $r^e$  is the ratio of excess reserves ( $R^e$ ) to total bank deposits ( $D+T+S$ ).

For the sake of comparison let us state the money multiplier (for  $M_1$ ) associated with the new St. Louis concept of an extended base:

$$m = \frac{1 + k}{(r^e + r_0)(1 + t + s) + k}$$

This money multiplier still contains the ratio of reserve requirements of the base period ( $r_0$ ). For this reason it is not independent

of the changes in reserve requirements that took place between a period when the ratio of required reserves was zero and the period which has been chosen as a base period. Therefore, the new St. Louis concept of an extended base does not reach the independence target.

Having specified the money multiplier associated with a properly extended monetary base, that base itself may be derived from a division of the money stock by this particular multiplier:

$$\frac{M_1}{m} = \frac{(1+k) D}{\frac{(1+k) D}{[r^e(1+t+s)+k] D}} = R^e + C^p$$

Thus, the properly extended monetary base is equal to the sum of excess reserves and currency holdings of the public, excess reserves being defined as the difference of total reserves minus required reserves. This is a definition of the extended base from the uses' side. It is consistent with the following more general definition that holds both for the uses' and the sources' side: The properly extended monetary base is equal to the ordinary base minus required reserves.

In the new St. Louis concept the extended base is computed by deducting only that part of total reserves that exceeds (positively or negatively) required reserves as computed with the ratio of required reserves ruling in the base period. However, there exists no theoretical reason whatsoever why only part of required reserves should be deducted.

Thus, the properly extended monetary base is equal to the ordinary monetary base minus the total of required reserves. This holds true both for the uses' and the sources' side of the definition. Considered from the uses' side the properly extended monetary base is given by the sum of currency and excess reserve holdings. Obviously, the monetary base properly extended turns out to be a reduced base.

## II.

Our results may look counterintuitive at least to someone who is misled by the St. Louis concepts of an extended base. Indeed, he might argue as follows:

"If reserve requirements on checkable deposits were increased and the source base was not changed, the money stock would decline, but there would not necessarily be any change in excess reserves plus currency. Therefore the proposed specification of an extended base would not transfer the reserve requirement impulses of monetary policy from the money multiplier into the monetary base and the proposed specification of an extended base does not conform to a basic criterion for such a measure."

With excess reserves defined and computed as total reserves minus required reserves such an argument can easily be shown to be false by the following counterargument. If the source base was not changed, but reserve requirements were increased, then the immediate effect would be a drop in excess reserves provided currency holdings and total reserves and therefore the source base were unchanged. The reduction of excess reserves would imply a reduction of our extended base and therefore this policy impulse would certainly be captured by our new concept of an extended base.

One may question the validity of this counterargument in the case where there is such an increase in required reserves that total reserves become insufficient to satisfy the total of reserve requirements. However, with the source base and currency holdings unchanged, excess reserves as defined would become negative and would reduce our extended base below currency holdings. Again our concept would incorporate the policy impulse and the argument quoted would still be false.

However, if excess reserves are negative, then reserve requirements are not met and this may not be a sustainable situation. Does this affect our counterargument? The answer is no. Whether negative excess reserves are sustainable or not is not relevant for our concept of an extended base. In order to illustrate,

let us suppose that the central bank somehow "forces" the commercial banks to meet the reserve requirements, while it still keeps the source base unchanged. (There may exist appropriate penalties "inducing" the commercial banks to call back loans prior to their maturity.) Under the given circumstances a successful attempt of the commercial banks to make excess reserves zero or positive (non-negative) must imply a shift of base money out of the public's portfolio into the portfolio of commercial banks. This shift would have been induced by the policy impulse but would not be a policy impulse itself. Therefore, such a shift should not change the extended base. Since such a shift would leave  $C^P + R^e$ , the sum of currency and excess reserve holdings, unchanged, while the negative  $R^e$  is increased and raised at least to zero and  $C^P$  is lowered by an equal amount, our extended base would in fact not be changed by such a shift. In addition, it is not relevant for our new concept whether the central bank will or will not, under the circumstances, increase the source base in order to allow the commercial banks to meet their reserve requirements without forcing them to call back loans before maturity. If excess reserves had turned negative due to increased reserve requirements a rise in the source base, with currency holdings of the public unchanged, will increase excess reserves (make them "less negative") and at the same time increase our extended base. Thus, an increase of the source base, following the increase of reserve requirements, would be an additional policy impulse that certainly would also be captured by our concept of an extended base.

Before turning to our discussion of liberated reserves, we shall clarify a definitional problem that may arise on the uses', but not on the sources' side of our new concept of an extended base. If our new extended base is considered from the uses' side the way in which excess reserves are defined matters. So far we have assumed - and after this short digression we shall continue to do so for the rest of this paper - that excess reserves are defined as the difference between total reserves and required

reserves. With such a definition excess reserves may become negative. Suppose instead that for some technical reason, which does not need to be specified here, excess reserves are defined as the difference between total reserves and required reserves only if required reserves do not exceed total reserves and are defined to be zero if required reserves exceed total reserves. Here, by definition, excess reserves are always nonnegative. For purely definitional reasons they cannot become negative even if reserve requirements are not met. With such a definition of excess reserves our concept of an extended base, if stated and computed from the uses' side, would require to form the sum of currency plus excess reserves, of the kind which by definition can never become negative, minus the excess of required reserves over total reserves, provided the latter is positive, but minus zero otherwise. Since excess reserves do not appear on the sources' side of the definition of the monetary base, our extended base concept does not require to be modified on the sources' if excess reserves are defined in such a peculiar way.

### III

In this section we shall derive the liberated reserves associated with our new concept of an extended base and compare them with the liberated reserves associated with the old and the new St. Louis concept. In this comparison our notion of historical path dependence will play a prominent role. Therefore we shall first clarify that notion and its significance.

The ruling ratio of required reserves,  $r_t$ , may have been arrived at, historically, in very different ways. To illustrate, the current ratio  $r_t$  may have been fixed by the central bank when reserve requirements were introduced for the first time and



then may have been kept constant over time until period  $t$ . Or, alternatively, the current  $r_t$  may have been reached in incremental steps distributed over time perhaps with intermittent downward movements. Now, the multiplier analysis underlying the construction of an extended base is a static framework. (For our purposes here, the dynamics due to lagged reserve requirements may be safely neglected.) In a static framework the effect of a given ratio of reserve requirements,  $r_t$ , on the money supply is independent of the particular path of changes in reserve requirements in which that  $r_t$  has been arrived at historically. Conceptually, the extended base and liberated reserves are supposed to capture the effects of reserve requirements in a static framework. Therefore, they should satisfy this independence requirement. If a concept of an extended base or of liberated reserves does not satisfy this independence requirement then we shall say that it suffers from historical path dependence. Exploiting the historical path dependence of the new St. Louis concept as an example, we shall demonstrate that in a static framework such historical path dependence is a sign for the presence of arbitrary dynamics, i. e. dynamics that is not supported by theory. The significance of historical path dependence is that it will produce the disastrous kind of measurement errors that were already described in the introduction and will be studied more closely in section V. Historical path independence is therefore an essential criterion and test for any concept of liberated reserves or of an extended base. Both the old and — the new St. Louis concept do not pass this test. Historical path dependence of the old St. Louis concept is well known<sup>4)</sup>, while that of the new St. Louis concept has gone unnoticed so far. It will be demonstrated at once. In dealing with liberated reserves we should keep in mind that if liberated reserves are dependent on the historical path of reserve requirement changes, then the extended base will also be dependent on this historical path and vice versa. This is so because the extended base is given by adding liberated reserves to the ordinary base.

Liberated reserves (LR) may quite generally be defined as the difference between the extended and the ordinary monetary base. The precise concept of liberated reserves varies with the concept of an extended base and vice versa. In order to highlight their differences the three concepts to be analysed will be stated in comparable fashion.

$$\begin{aligned} \text{"Old" St. Louis: } LR_t &\equiv - \sum_{\tau=1}^t (r_{\tau} - r_{\tau-1}) D_{\tau} \\ &= - \left[ (r_t - r_{t-1}) D_t + (r_{t-1} - r_{t-2}) D_{t-1} + \dots + (r_1 - r_0) D_1 \right] \end{aligned}$$

$$\begin{aligned} \text{"New" St. Louis: } LR_t &\equiv -(r_t - r_0) D_t \\ &= - \left[ (r_t - r_{t-1}) D_t + (r_{t-1} - r_{t-2}) D_t + \dots + (r_1 - r_0) D_t \right] \end{aligned}$$

Suggestion of this paper:

$$\begin{aligned} LR_t &\equiv -r_t D_t = -(r_t - 0) D_t \\ &= - \left[ (r_t - r_{t-1}) D_t + (r_{t-1} - r_{t-2}) D_t + \dots + (r_1 - r_0) D_t \right. \\ &\quad \left. + (r_0 - r_{-1}) D_t + (r_{-1} - r_{-2}) D_t + \dots + (r_{-s} - 0) D_t \right] \end{aligned}$$

In the formulas we have assumed that reserve requirements have been introduced into the system of monetary policy  $s$  periods before the base period with time index zero. For the sake of algebraic simplification time and savings deposits are neglected. From the expressions in square brackets we find that changes in reserve requirements prior to the base period are neglected both by the old and by the new

St. Louis concept of liberated reserves. These changes have been given weight zero. Changes in reserve requirements that took place in time periods following the base period are weighted equally by the current volume of deposits,  $D_t$ , in the new St. Louis concept. In the old St. Louis concept we observe unequal weighting, by deposit volumes, of reserve requirement changes in periods following the base period. This is the source of the well known historical path dependence of the old St. Louis concept. In that concept the numerical value of LR depends on the particular history of deposit volumes even though that history is of no relevance in measuring the impulse force of past and current changes in reserve requirements on current money supply. Recognition of this defect of the old St. Louis concept has caused the transition to the new St. Louis concept. However, in the new St. Louis concept reserve requirement changes in periods preceding the base period still have a weight zero and therefore, in general, a weight different from the one applied to changes of reserve requirements in periods following the base period. Due to this asymmetric weighting pattern the significance, that the new St. Louis concept attaches to the currently ruling rate of reserve requirements as an impulse force of monetary policy, depends on the particular historical path of changes in reserve requirements. If all the changes took place prior to the base period, then the significance is zero. If some changes in reserve requirements happened to occur after the base period, then that significance is positively non-zero. The asymmetric weighting pattern causes historical path dependence and the kind of measurement errors to be discussed in section IV. In our own concept of liberated reserves all changes in reserve requirements, that occurred since a time period when the rate of required reserves was zero, are weighted equally with the current volume of deposits. Thus, the weighting pattern of our own concept is entirely symmetric and is no source of historical path dependence.

A mirror image of the weighting pattern in LR may be discovered in the associated money multiplier. We have noted above that the money multiplier associated with the new St. Louis concept does

not incorporate the changes in the rate of reserve requirements that occurred in periods following the base period while changes occurring in periods prior to the base period have not been extracted and still are present. This is a mirror image of the weighting pattern observed in the associated concept of liberated reserves. Thus, we find that all changes in reserve requirements are incorporated somewhere: if not in liberated reserves then in the associated money multiplier and vice versa. It is the deficiency of the new St. Louis concept not to include all changes of the rate of required reserves in the liberated reserves, but to let an entirely arbitrary series of changes remain in the money multiplier. Our own concept is free of this defect.

Using the new St. Louis concept as an example, we shall now show that the presence of historical path dependence implies the presence of arbitrary dynamics. The arbitrary dynamics of the new St. Louis concept may easily be identified by analyzing its associated money multiplier. As stated above this money multiplier contains ratios of two different time periods: the ratio of required reserves of the base period,  $r_0$ , and other ratios,  $r_e$ ,  $k$  etc., from the current period. Variables with two different time indices imply the presence of dynamics. Lack of theory for the choice of a base period causes the dynamics to be of arbitrary nature. The money multiplier associated with our own concept does not contain variables with different time indices. By implication it is free of any dynamics and in particular free of arbitrary dynamics.

#### IV.

We have emphasized in the introduction that the historical path dependence of the St. Louis concepts of an extended base implies serious measurement errors of the impulse force of reserve requirements and therefore of monetary policy. In particular we have stated

that both St. Louis concepts of an extended base quite generally may give equal measurements for differently sized impulse forces and different measurements for equally sized impulse forces. It is sufficient to demonstrate this implication for the new St. Louis concept, because the old St. Louis concept is equivalent to the new concept if the volume of deposits has remained constant over time since the base period. Our demonstration will consist of giving two numerical examples. In each example two cases will be compared.

In our first example the two cases only differ with respect to the historical path of changes in reserve requirements that have led to the same current ratio of required reserves. In every other respect the two cases are assumed to be identical. In particular the ratio of required reserves, the source base and all other instruments of the central bank (discount rate etc.) have identical current values in the two cases. More generally, the current impulse forces of monetary policy are assumed to be equal in the two cases. The functions describing the behaviour of the public and of the commercial banks are also assumed to be identical in the two cases. The difference between the two cases is exclusively related to the historical path leading to the current ratio of required reserves as follows:

Case 1: We assume that the current rate of required reserves today in 1982 is 10 % and the base period chosen is January 1974. We further assume that the rate of 10 % has been arrived at in two steps: an increase from zero to 5 % before January 1974 and an increase from 5 % to 10 % after January 1974.

Case 2: The current rate of required reserves is again 10 % but has been arrived at in a single step from zero to 10 % in a period following the base period (January 1974). Before this step the rate has always been zero.

In a static framework these differences will not affect the current behaviour of the public or commercial banks. Therefore the current values of the ratios  $r^e$  and  $k$ , the current money supply and the

current volume of deposits are all equal in the two cases. However, if current liberated reserves are computed according to the new St. Louis concept, then they turn out to be different in the two cases, implying different values for the current extended base in the two cases. This difference is due to the concept's defective historical path dependence. Within our new concept liberated reserves are equal in the two cases due to independence from historical paths.

In the second example the two cases differ with respect to both the current ratio of required reserves and the historical path of changes in reserve requirements, while both the source base and all other instruments of the central bank are again assumed to have identical current values. With respect to reserve requirements the two cases are specified as follows:

Case 1: Unchanged as in example 1.

Case 2: Similar to example 1; however, the current ratio of required reserves is 5 % and the single step change is now from zero to 5 %.

In addition to these assumptions at least one of the behavioural functions of the public and the commercial banks,  $r^e$  and  $k$ , are assumed to be different in such a way that the current volume of deposits is identical in the two cases in spite of the difference in the ruling ratios of required reserves. Now, even in a static framework the current impulse forces of reserve requirements and of monetary policy as a whole differ in the two cases of the second example. However, according to the new St. Louis concept, current liberated reserves in the two cases turn out to be numerically equal. Using our new concept, we find current liberated reserves in the two cases not to be equal in the second example but to differ by a multiplicative factor of two.

These examples show that historical path dependence of the new St. Louis concept may produce different results in measurements of identical impulses and also may produce equal results in measurements of different and unequally size impulses. Our new concept of liberated reserves is free of such defects<sup>5)</sup>.

V.

So far our analysis implies that not only the old but also the new St. Louis concept of an extended base does not perform satisfactorily and that both should be replaced by the new concept suggested in this paper. In this section further implications of our new concept will be given and will be used to formulate arguments in its favour.

In empirical applications the new St. Louis concept involves the choice of a base period, a choice which so far had to be made without theoretical guidance, therefore was arbitrary and likely to produce serious measurement errors. From the viewpoint of our own concept that choice does not need to be arbitrary. Our concept may be interpreted to be equivalent to the new St. Louis concept combined with a theoretical foundation for the proper choice of the base period. Thus, our concept implies for the new St. Louis concept that in order to completely transfer monetary policy impulses from the money multiplier into the monetary base, i. e. in order to obtain historical path independence of the extended base, a period in which reserve requirements were zero should be chosen as base period. If there are many such periods available for selection, then the choice among them is arbitrary.

One might formulate the following comment against our suggestion and interpretation:

"The fact that the level of the monetary base multiplier depends upon the base period is irrelevant for choosing a method for calculating the monetary base. The extended monetary base is an index number used to measure the effects of policy actions on the money stock. The extended base is measured in dollars to facilitate calculations of a monetary base multiplier".

However, this point is not well taken. In the construction of index numbers the choice of a base period has always been a major problem and one has become accustomed

to an agnostic attitude towards that problem. Something of that attitude seems to be present in this comment, but quite unnecessarily so. In order to see why, it is important to note that in this paper we do not suggest just another method for calculating the extended base that still has a base period problem. To the contrary, we suggest a method without a base period problem and one that at the same time solves the base period problem of the new St. Louis concept. If our solution is not applied, measurements will have defects of the kind already described in section IV.

Let us turn now to more practical arguments in favor of our new concept. To begin with, our concept implies that in order to construct a time series for a properly extended base it is not necessary to compute liberated reserves and to adjust the monetary base accordingly. It suffices to add data on currency and excess reserve holdings<sup>6)</sup>, data which in most countries are readily available. This is a computational advantage which adds to the theoretical superiority of our new concept of an extended base.

More importantly, with our solution to the base period problem of the new St. Louis concept, changes in the structure of reserve requirements, f. e. as under the Monetary Control Act of 1980, do not cause any problem and do not require special actions in order to obtain correct time series of the properly extended base. More specifically, changes in deposit classification, extensions of reserve requirements to additional institutions (f. e. to nonmember banks of the Federal Reserve System), lagging reserve requirements and other structural changes in reserve requirements do not require a revision in the method of extending (adjusting) the monetary base. In order to verify this statement, we shall, at first, take the point of view of our new concept and then, equivalently, the point of view of the new St. Louis concept combined with our suggestion for the proper choice of a base period.

We may recall that the extended base is a concept developed for the purpose of analysing aggregative and not structural or



allocational aspects of monetary policy. From the point of view of extending the monetary base it is therefore totally irrelevant whether changes in required reserves are due to changes of ratios within a given structure of reserve requirements or due to a structural change in the system of reserve requirements. Consequently, up to the degree that measuring the total of required reserves at the current ratios of a newly structured system does not cause any problems, the measurement of the extended monetary base according to our new concept is a simple and straightforward matter even with the most bewildering of structural changes in the system of reserve requirements.

We now take the point of view of the new St. Louis concept combined with our suggestion for the proper choice of a base period. Here, liberated reserves are the difference between required reserves computed at base period ratios and required reserves computed at current ratios. How does a structural change affect this difference and its measurability? In order to find the answer to this question, we shall look at the elements of this difference separately. With our choice of the base period the value of currently required reserves computed at base period ratios is zero both within the old and within the new structure of reserve requirements. This is implied by the following almost trivial argument. If, given our choice of base period, the base period ratios of required reserves are zero for deposit categories and bank institutions that did already exist in the base period and had already been subject to reserve requirements in the past, then, a fortiori, the base period ratios of required reserves are zero for those deposit categories and bank institutions that either had not yet existed or had been excluded from reserve requirements prior to the structural change. Consequently, given our choice of the base period, structural changes in reserve requirements will affect liberated reserves only by changing the total of required reserves as computed by current ratios of required reserves. If there is no problem in measuring total required reserves with current ratios according to the new structure of reserve requirements, then there is absolutely no problem in adjusting the extended base to structural changes.

Obviously, if our method is applied, then a structural change in reserve requirements would and should not change the numerical

values for the properly extended base in periods prior to the structural change.

From this analysis we may conclude that struggles for a consistent time series of an extended monetary base of the kind documented in recent publications of the Federal Reserve Bank of St. Louis<sup>7)</sup> not only can be avoided if the proper concepts are applied, but, if the measurement errors of the kind that we have described in section IV are to be prevented, then that kind of struggle even should be avoided.

#### IV.

We now turn to a further requirement. A properly extended base should be independent of the behavioural parameters of the public ( $k$ ,  $t$ ,  $s$ ) and the commercial banks ( $r^e$ ). We shall demonstrate that, for a given source base, this requirement cannot be satisfied by any concept of an extended base within the ruling systems of reserve requirements where the requirements are specified by fixing ratios and not by fixing volumes of required reserves independent of the volume of deposits.

With unlagged reserve requirements liberated reserves are endogenous and dependent on the current values of the parameters  $r^e$ ,  $k$ ,  $t$ , and  $s$ . Thus, the ordinary base and the extended base cannot, in general, be independent of these parameters both at the same time. For the St. Louis concept of an extended base this may be demonstrated as follows. Using

$$D_t = \frac{1}{(r + r^e) (1 + t + s) + k} B$$

in order to substitute for  $D_t$  in the definition of liberated reserves we receive

$$B_{\text{New St. Louis}}^e = \frac{(r_0 + r^e)(1+t+s) + k}{(r+r^e)(1+t+s) + k} B$$

By choosing  $r_0 \equiv 0$  one obtains the corresponding relationship for the concept of an extended base as suggested in this paper, while for the old St. Louis concept we have:

$$B_{\text{Old St.L.}}^e = B_{\text{New St.L.}}^e + \sum_{\tau=1}^{t-1} (r_{\tau} - r_{\tau-1}) D_{\tau} + (r_{t-1} - r_0) D_t$$

It is obvious that, for an exogenous ordinary monetary base, the extended base is dependent of the current values of  $r^e$ ,  $t$ ,  $s$ , and  $k$ , while, for an exogenous extended base, it is the ordinary monetary base that is dependent of these behavioural parameters.

For an extended base to become independent of the current values of  $r^e$ ,  $k$ ,  $t$ , and  $s$ , one either must allow the ordinary monetary base to be endogenous, i. e. depend on these parameters, or one must change the system of reserve requirements. Instead of fixing ratios of required reserves monetary policy would have to fix volumes of required reserves independent of deposit volumes. By fixing the volumes of required reserves the ratios of required reserves would become endogenous in a way excluding that changes in  $r^e$ ,  $k$ ,  $t$ , and  $s$  affect the holdings of required reserves via changes in deposit volumes.

With lagged reserve requirements in ratio form liberated reserves are independent of the current values of the parameters  $r^e$ ,  $k$ ,

t, and s, while they remain dependent on lagged values of these parameters. If independence from both the current and past values of  $r^e$ , k, t, and s is required, then again fixing of volumes of required reserves instead of fixing ratios of required reserves becomes necessary.

This discussion implies that any deficiency of our concept of an extended base with respect to the independence requirement from the parameters k, t, s, and  $r^e$  is not a specific defect of our own concept but is a defect that is shared by any other available or conceivable concept of an extended base.

#### C O N C L U S I O N

We have suggested that the monetary base should be extended by subtracting total required reserves from the ordinary monetary base.

As demonstrated this extension of the monetary base produces a money multiplier that is independent from changes in reserve requirements and an extended base that incorporates all the impulses of monetary policy. The alternative concepts available from the literature do not satisfy these requirements and are seriously defective. They suffer from historical path dependence, arbitrary dynamics and produce errors in measurements. They produce equal measurements for differently sized monetary policy impulses and different measurements of equally sized monetary policy impulses. This result does not depend in any way on whether the extended base is used as an indicator or as a target of monetary policy. Historical path independence and the avoidance of arbitrary dynamics are criteria which apply both to the indicator and target function of a series.

If the monetary base is extended according to our suggestion, then changes in the structure of reserve requirements, as f. e. under the Monetary Control Act of 1980, do not require revisions or other special actions in order to obtain a correct time series for the properly extended monetary base. Any remaining defect of our new concept, f. e. the dependence on the behavioural parameters of the public and of the commercial banks, is shared by the competing concepts. Thus, on balance our new concept is definitely superior to the available and conceivable alternatives.

F o o t n o t e s

- 1) A properly extended monetary base should also be independent of the behaviour of the public and the commercial banks if the ordinary monetary base is given exogeneously. Until the start of section VI the following discussion does not relate to this requirement.
- 2) See A. E. Burger and R. H. Rasche (1977), Peter A. Frost (1977), W. G. Dewald (1979) and Nikolaus K. A. Läufer (1981).
- 3) The standard of reference for our distinction between old and new St. Louis concepts of the extended base is A. E. Burger and R. H. Rasche (1977) where these concepts are described and compared. The St. Louis concepts of an extended base are defined by adding the St. Louis concepts of liberated reserves to the ordinary monetary base. Definitions of the St. Louis concepts of liberated reserves will be given and discussed later in this paper.
- 4) See Footnote 2.
- 5) If the ratios of reserve requirements do not change, then the extended base will grow at the same rate as the ordinary monetary base provided all other ratios ( $r^e$ ,  $t$ ,  $s$ ,  $k$ ) either remain constant or change in a way such that  $(r + r^e) (1 + t + s) + k$  remains constant. Thus, the construction of a reserve adjustment variable as suggested in this paper solves what Peter A. Frost (1977) in his discussion of the old St. Louis concept called "the basic problem associated with the additive reserve adjustment variable L". In contrast to the old St. Louis concept, the new St. Louis concept does solve this problem, too.

Compared to Frost's (1977) logarithmic adjustment variable our concept of liberated reserves has two advantages:

1. It needs to be constructed and calculated only once even if different base and reserve measures are to be adjusted.
2. It separates the effects of reserve requirements completely from the monetary multiplier.

From our discussion in this paper it follows that any incompleteness in the separation of reserve requirements from the monetary multiplier results in historical path dependence (arbitrary dynamics) of the reserve adjustment variable. Thus, like the new St. Louis concept of liberated reserves, Frost's logarithmic reserve adjustment variable also suffers from the defect of historical path dependence.

- 6) Excess reserves should be defined as total reserves minus required reserves.
- 7) See R. Alton Gilbert, Revision of the St. Louis Federal Reserve's Adjusted Monetary Base, and John A. Tatom, Issues in Measuring An Adjusted Monetary Base, both in: Review, Federal Reserve Bank of St. Louis, December 1980.

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