QUARTERLY ESTIMATION OF THE QUANTITY OF MONEY, SEASONALLY UNADJUSTED
June 1923 - December 1942

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Econometric Research Program
Research Paper No. 6
September 15, 1961

The work necessary for the preparation of the present paper has been supported by the National Science Foundation.

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ABSTRACT

When spectral analysis is used, seasonal adjustment is not only useless but also undesirable. The monetary and financial sectors are among those for which fairly long time series data are available, and, this provides an opportunity to apply spectral analysis to a study of various problems concerning these sectors. Unfortunately, the currently available monthly money supply data prior to 1942 (estimated by Friedman and Schwartz) are seasonally adjusted. Further, the seasonal factors are not available, since these data are constructed from different component series in order to obtain seasonally adjusted data. In this paper, the seasonally unadjusted money supply is estimated on a quarterly basis for the period between 1923 and 1942. For the period after 1942, the data are readily available in the publications of the Federal Reserve System.

This work was done in 1961. The author plans to return to a study of monetary and financial sectors in the future. This paper is distributed to invite comments and suggestions on the estimation procedures of the money supply presented here.

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The definition of the quantity of money adopted here is currency outside banks plus demand deposits adjusted. Time deposits are excluded. The data for the quantity of money are readily available on a monthly basis for the period beginning January 1943, and on a biannual basis for the period 1923-1942 as of the end (in some years, almost the end) of June and December, which are call dates for all commercial banks. Furthermore, Mrs. Anna Schwartz has estimated the seasonally adjusted quantity of money on a monthly basis for the period since 1907 (Milton Friedman and Anna Jacobson Schwartz, The United States Money Stock, 1867-1960, forthcoming), but her entire estimating procedure is designed to obtain only the seasonally adjusted data without ever having recourse to the unadjusted data of the quantity of money. This paper is concerned with the un seasonally/adjusted estimation of the quantity of money as defined above for March and September from 1923 to 1942, excluding March 1923.

The outline of the procedure is as follows: Demand deposits adjusted are divided into two parts, those at the member banks and those at the non-member banks. Each part is estimated separately. The data for the currency outside banks are taken from Anna Jacobson Schwartz and Elma Oliver, Currency Held by the Public, the Banks, and the Treasury, Monthly, December 1917 - December 1944, Technical Paper No. 4, National Bureau of Economic Research (1947).

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[1]The author is greatly indebted to Mrs. Anna Schwartz of the National Bureau of Economic Research, whose comprehensive knowledge of banking and monetary statistics enabled the author to start this work. He is also indebted to Mr. Axilrod, Mrs. Cagle, and Mr. Veenstra of the Banking Section, Division of Research and Statistics, Board of Governors of the Federal Reserve System, for their helpful suggestions. Although the author takes full responsibility for the possible errors in this paper, the basic ideas were suggested to him by Mrs. Schwartz and Mr. Veenstra. Mr. Dalton of Princeton University worked painstakingly to improve the presentation and also the accuracy of the calculations.

The present estimation does not take into account the Federal Reserve float, which has been accounted for in the latest revision of the data of money supply by the Federal Reserve Board. The author understands that during the period under consideration here the schedule for crediting the checks in process of collection was slower than it is now, and the Federal Reserve float was relatively smaller. The estimation procedure is designed to arrive at figures accurate to the digit place of 100 millions. The comparison between the results of different estimation methods proposed in this paper indicates a discrepancy of as much as 500 millions in a few cases, even though the discrepancy is usually below 200 million dollars.

Section I

Quarterly Estimation of Demand Deposits Adjusted at the Member Banks

Two different methods of estimation will be presented here. One will be called Method I and the other Method II. The two methods use different sets of data and partly different sets of assumptions for the estimation.

Method I.

[A.] Assumptions which are basic to the estimation procedure:

During the period under consideration the member bank call dates appeared at least twice a year, which were always near the end (or at the end) of June and December. The call dates appeared more than twice in many years, in fact, four times in many years under consideration. However, these call dates other than at the end of June and December vary in regard to their timing from year to year, although many of them appear around the end of March and the end of September.

For Method I the call date figures in June and December are used as bench marks; the other call data figures are not used in this method. Quarterly

demand deposits adjusted are derived from the data of net demand deposits which are readily available.[1] Net demand deposits, which will be abbreviated as n.d.d., are those deposits subject to the reserve requirements of the Federal Reserve System. They have undergone many changes in definition as the banking laws have changed. Demand deposits adjusted (d.d.a.) are the deposits held by the public excluding those held by the Federal Government and other banks. In view of the changes in the definition of n.d.d. and of the changes in the availability of data, the following three periods were analyzed separately:

(I.) 1923 to September 1935.

During this period n.d.d. for a bank were defined as follows:

n.d.d. = all demand deposits - Federal Government deposits - deposits due to other banks + P [deposits due to other banks - deposits due from other banks - cash items in process of collection]

where

$P[A] = 0$ if $A \leq 0$

$P[A] = A$ if $A > 0$.

On the other hand, regardless of the period concerned, demand deposits adjusted for a bank are defined as follows:

d.d.a. = all demand deposits - Federal Government deposits - deposits due to other banks - cash items in process of collection.

The data for net demand deposits are available for the aggregates of all the member banks and of the weekly reporting member banks. In order to derive the demand deposits adjusted for all member banks, the following sequence of assumptions is introduced:

[1] The use of net demand deposit data was suggested to the author by Mrs. Schwartz.

(i) The first assumption is that the variation from month to month of the discrepancy between net demand deposits and demand deposits adjusted, relative to net demand deposits,[1] is roughly accounted for by the variation from month to month of the deposits due to other banks minus the deposits due from other banks, relative to net demand deposits.

In other words,

$$\frac{\frac{\text{n.d.d. - d.d.a.}}{\text{n.d.d.}} \text{ in March of x year}}{\frac{\text{n.d.d. - d.d.a.}}{\text{n.d.d.}} \text{ in June of x year}}$$

$$= \frac{\frac{\text{due to - due from}}{\text{n.d.d.}} \text{ in March of x year}}{\frac{\text{due to - due from}}{\text{n.d.d.}} \text{ in June of x year}}$$

(Actually, the assumption is applied to a period not longer than 3 months.)

The reason why the ratio $\frac{\text{n.d.d. - d.d.a.}}{\text{n.d.d.}}$, rather than n.d.d. - d.d.a., is used is to take advantage of the fact that n.d.d. and d.d.a. move in a fairly stable relation, which was established by tabulating the ratio $\frac{\text{d.d.a.}}{\text{n.d.d.}}$ at all the call dates. The variation from month to month of this ratio is taken rather than the ratio itself because there might be a persistent difference between $\frac{\text{n.d.d. - d.d.a.}}{\text{n.d.d.}}$ and $\frac{\text{due to - due from}}{\text{n.d.d.}}$.

This assumption is made both for all member banks and for all weekly reporting member banks.

The reason why this assumption is reasonable can be explained by a hypothetical, simplified banking structure. Suppose that there are only two types of commercial banks, A-type and B-type. The B-type banks have deposits at some of the A-type banks but no deposits at any of the B-type banks. The A-type banks have no deposits at any of the B-type banks but have some deposits at some of the A-type banks. Then, for the B-type banks, deposits due to other

[1] The ratio of demand deposits adjusted and net demand deposits has been studied by Harris and Currie. See S. E. Harris, Twenty Years of Federal Reserve Policy, Vol. II; Lauchlin Currie, The Supply and Control of Money in the United States.

banks equal zero. Deposits due from other banks are not zero, but because of the definition of P , this does not enter their net demand deposits. For the A-type banks, let us assume that the deposits of each of these banks at other A-type banks are far less than the deposits of the B-type banks at this bank, so that for each of the A-type banks the deposits due to the other banks are far greater than the deposits due from other banks plus cash items in process of collection. Let us ignore the Federal Government deposits because they are subtracted from both demand deposits adjusted and net demand deposits. Then

n.d.d. of the B-type banks = all demand deposits.

n.d.d. of the A-type banks = all demand deposits - deposits at A-type banks owed to A-type banks - cash items in process of collection at A-type banks.

Therefore, the n.d.d. - d.d.a. for all A-type banks are deposits due to other banks at A-type banks - deposits due from other banks at A-type banks. If we could identify the weekly reporting member banks with A-type banks, this be exactly the assumption which was stated above, as applied to the weekly reporting member banks.

When the same assumption is applied to all the member banks, its rigorous justification is not possible even in this oversimplified hypothetical situation. In fact, n.d.d. - d.d.a. at all banks, including both A-type and B-type,

= deposits due to other banks at A-type banks

- deposits due from other banks at A-type banks only

+ cash items in process of collection at B-type banks only.

The assumption as applied to the aggregate of A-type and B-type banks states that the variation of the n.d.d. - d.d.a. relative to n.d.d. is the variation of

deposits due to other banks at A-type banks (deposits due to other banks at B-type banks are zero) - deposits due from other banks both at A-type and B-type banks, relative to n.d.d.

Therefore, the extent to which the assumption can be justified depends upon the extent to which

cash items in process of collection at A-type banks only
- deposits due from other banks at B-type banks only

varies relative to n.d.d.

(ii) The second assumption is that the ratio

$$\frac{\text{member bank deposits due to other banks - deposits due from other banks}}{\text{n.d.d. of all member banks}}$$

for all the member banks is subject to the same variation from month to month as the similar ratio

$$\frac{\text{weekly reporting member bank deposits due to other banks - deposits due from other banks}}{\text{n.d.d. of the weekly reporting member banks}}$$

for the weekly reporting member banks. In other words, suppose that w represents the ratio

$$\frac{\text{due to - due from}}{\text{n.d.d.}} .$$

Then the second assumption states

$$\frac{w \text{ for all member banks in March of year } x}{w \text{ for all member banks in June of year } x}$$

$$\approx \frac{w \text{ for the weekly reporting member banks in March of year } x}{w \text{ for the weekly reporting member banks in June of year } x} .$$

(Again, the assumption is applied to a period not longer than 3 months.)

Some explanation is in order here. The aggregate member bank deposits due to other member banks must be equal to the aggregate member bank deposits

due from other member banks. Therefore, the sum of member bank deposits due to other banks minus those due from other banks is equal to the all member bank deposits due to non-member banks minus those due from non-member banks, i.e., the net deposits owed to the non-member banks by the member banks. The weekly reporting member bank deposits due to other banks minus those due from other banks is equal to the weekly reporting member bank deposits due to the non-weekly reporting member banks and non-member banks minus deposits due from the non-weekly reporting member banks and non-member banks, i.e., the net deposits owed to the non-weekly reporting member banks and non-member banks by the weekly reporting member banks. The weekly reporting member banks are located in 101 large cities and their aggregate behavior is very much like that of the central reserve city and reserve city banks. Therefore, the relation between the member and non-member banks is roughly the same as the relation between the weekly reporting member banks on the one hand and the non-weekly reporting member banks and the non-member banks on the other. Furthermore, the selection of the weekly reporting member banks has been carefully made in order to maintain the same relation between all the member banks and the weekly reporting member banks. (E.g., when a weekly reporting bank went into bankruptcy, another bank similar to it was brought into the weekly reporting banks.) Therefore, assumption (ii) is justified.

Combining assumptions (i) and (ii), we get the variations from month to month of $\frac{\text{d.d.a.}}{\text{n.d.d.}}$ of the all member banks $\approx$ the variation from month to month of $\frac{\text{n.d.d.} - [\text{due to} - \text{due from}]}{\text{n.d.d.}}$ of the all member banks $\approx$ the variation from month to month of $\frac{\text{n.d.d.} - [\text{due to} - \text{due from}]}{\text{n.d.d.}}$ of the weekly reporting member banks.

(II.a) <u>September 1935 to March 1942</u>

In this period net demand deposits were defined as follows:

n.d.d. = all demand deposits - deposits due from other banks

- cash items in the process of collection.

Now the statement made previously in (i) as an assumption is no longer an assumption but a direct implication of the definitions of net demand deposits and demand deposits adjusted, except for the adjustment for Federal Government deposits which are now included in net demand deposits.

(II.b) September 1934 to 1942

Data for demand deposits adjusted at the weekly reporting member banks is available starting from September 1934. Assumption (ii) is replaced by another assumption (iii) in order to make use of the data for demand deposits adjusted at the weekly reporting member banks.

(iii) The ratio,

$$\frac{\text{member bank demand deposits adjusted}}{\text{n.d.d. at all member banks}},$$

for all member banks, is subject to the same variation from month to month as the similar ratio,

$$\frac{\text{weekly reporting member bank demand deposits adjusted}}{\text{n.d.d. of weekly reporting member banks}}.$$

In other words, suppose that w is the ratio $\frac{\text{d.d.a.}}{\text{n.d.d.}}$. Then, this assumption states that

$$\frac{w \text{ for all member banks in March of year } x}{w \text{ for all member banks in June of year } x}$$

$$= \frac{w \text{ for the weekly reporting banks in March of year } x}{w \text{ for the weekly reporting banks in June of year } x}.$$

(Again, the assumption is applied to a period not longer than 3 months.)

Method I consists of taking the mean of the results of two estimation procedures: Method I(A) and Method I(B).

[B.] Details of the Estimation Procedures: Method I(A).

(I.) 1923-1928

Available data

(a) Net demand deposits at all the member banks; monthly; mostly on the last Wednesday of each month, but partly on the other Wednesdays, especially the first or second Wednesday in 1928.

(b) Net demand deposits at the weekly reporting member banks on every Wednesday.

(c) Demand deposits due from and due to other banks at the weekly reporting member banks; during the period 1923-1926, only those at the weekly reporting member banks located at 12 reserve cities are reported, and thereafter those at all the weekly reporting member banks are reported.

(d) Call dates data of the demand deposits adjusted of all member banks.

Procedure

(a) Step 1

For those months for which the available data of net demand deposits at all the member banks is not as of the last Wednesday, net demand deposits on the last Wednesday are estimated as follows:

$$\begin{aligned}&\text{n.d.d. of all member banks on the last Wednesday}\\ &= \text{n.d.d. of all member banks on the } x^{\text{th}} \text{ Wednesday}\\ &\times\left[.7\ \frac{\text{n.d.d. of all weekly reporting banks on the last Wednesday}}{\text{n.d.d. of all weekly reporting banks on the } x^{\text{th}} \text{ Wednesday}} + .3f(t)\right],\end{aligned}$$

where

$f(t) = 1.0$ for t = March and June;

$$f(t) = \frac{\text{n.d.d. of all weekly reporting banks on the last Wednesday}}{\text{n.d.d. of all weekly reporting banks on the x-th Wednesday}}$$

(i.e., the same ratio as that multiplied by .7) for t = September ;

$$f(t) = 1 + \frac{1}{2}\left[\frac{\text{n.d.d. of all weekly reporting banks at the last Wednesday}}{\text{n.d.d. of all weekly reporting banks at the x-th Wednesday}} - 1\right]$$

for t = December.

The formula $f(t)$ for t = December means one-half of the percentage change of n.d.d. between the x^{th} and the last Wednesday plus unity. .7 to .3 is roughly the ratio between the loans and investments of the weekly reporting banks and those of the other member banks; this ratio was virtually constant during the period under consideration.[1] The above definitions of $f(t)$ are made in view of the difference between the weekly reporting banks and the other member banks in regard to the relative movement of deposits within the same month. This difference was analyzed with the use of net demand deposits data in the post-war period under the assumption that pre-war and post-war banking behavior would be similar as far as this problem is concerned. The data for net demand deposits are available for the period 1945 - 1959 with the breakdown between the central reserve city and reserve city banks and the country banks, and also the breakdown between the first half of the month and the second half of the month.[2] These data indicate that the difference between the first half and the second half of March and June months in the net demand deposits of the country banks is very small and does not correspond to the rather systematic difference between the first half and the second half of these two months in the net demand deposits of the central reserve city and reserve city banks. The relative position of the weekly reporting banks to the other member banks is similar to the relative position of the central reserve city and reserve city banks to the country banks. Thus $f(t) = 1.0$ for t = March and June.

[1] Banking and Monetary Statistics, p. 127.

[2] The use of this data was suggested to the author by Mrs. Schwartz. The data for the period 1945-1951 is published in the Federal Reserve Bulletin. The data for the period after 1952 was supplied by Mrs. Cagle from the unpublished file of the Board of Governors of the Federal Reserve System.

The same data as mentioned above indicate that for the September and December months the difference between the first half and the second half of these months in the net demand deposits of country banks has some correlation with the difference in the deposits of the central reserve city and reserve city banks. The coefficients, 1 for September and $\frac{1}{2}$ for December, are visually determined from a scatter diagram.

No explicit consideration was given to the moving dates of Easter, but presumably the two ratios used in Method I, n.d.d. of all weekly reporting banks on the last Wednesday to n.d.d. of all weekly reporting banks on the $x^{\underline{th}}$ Wednesday, and n.d.d. of all member banks for March to n.d.d. of all member banks for June, would reflect the timing of Easter, particularly whether or not Easter falls in March. The only difficulty which would have to be taken into account is that $f(t) = 1$ for March would not be an appropriate assumption if Easter falls in March. This is because $f(t) = 1$ implies that the n.d.d. of the non-weekly reporting banks is constant during the month of March. No adjustment was undertaken.

(b) Step 2

Demand deposits adjusted at all member banks for March (September) are estimated as follows:

$$\begin{aligned}&\text{demand deposits adjusted at all member banks for March (September)}\\ &= \text{demand deposits adjusted at all member banks for June (December)}\\ &\times \frac{\text{n.d.d. at all member banks for March (September)}}{\text{n.d.d. at all member banks for June (December}}\\ &\times \frac{\dfrac{\text{n.d.d. - [due to - due from]}}{\text{n.d.d.}}\ \text{(of weekly reporting banks for March (September))}}{\dfrac{\text{n.d.d. - [due to - due from]}}{\text{n.d.d.}}\ \text{(of weekly reporting banks for June (December))}}\end{aligned}$$

This formula is derived from assumptions (i) and (ii). If we make the further assumption that the day-to-day variation of the ratio $\frac{\text{d.d.a.}}{\text{n.d.d.}}$ within a week of the end of March (September) is the same as the day-to-day variation in late June

(December), the above formula enables us to estimate demand deposits on the same day of the week in late March (September) as the call date in June (December).

It may be of interest to note that the deadline for income tax returns was March 15 throughout the period under consideration.

(II.) 1929-1934 (2nd quarter)

Available data

(a) Net demand deposits at all member banks; monthly; average of daily figures (daily figures for each day were not tabulated).

(b) Net demand deposits at the weekly reporting member banks on every Wednesday.

(c) Demand deposits due from and due to other banks at the weekly reporting member banks.

(d) Call dates data for demand deposits adjusted of all member banks.

Procedure

(a) Step 1

Estimate the figure for the average of several days in the last part of the month for net demand deposits of all member banks by

$$\text{n.d.d. of all member banks, average in the last part of the month}$$

$$= \text{average n.d.d. of the month of all member banks} \times \left[.7 \frac{\text{n.d.d. of the weekly reporting banks (as of the last Wednesday)}}{\text{average n.d.d. of the weekly reporting banks (average of all Wednesdays in the month)}} + .3f(t) \right]$$

where $f(t) = 1$ for t = March, June;

$$f(t) = \frac{\text{average n.d.d. of the weekly reporting banks}}{\text{n.d.d. of the weekly reporting banks (as of the last Wednesday)}}$$

for t = September;

$$1 + \tfrac{1}{2} \left[\frac{\text{average n.d.d. of weekly reporting banks}}{\text{n.d.d. of weekly reporting banks (as of the last Wednesday)}} - 1 \right]$$

for t = December.

This formula is based upon the assumption that for the n.d.d. of the weekly reporting banks

$$\frac{\text{average over the month}}{\text{average over the last few days of the month}} = \frac{\text{average of all Wednesdays figures}}{\text{the last Wednesday figure}} .$$

The reasoning for $f(t)$ is just the same as in Step 1 for the previous period, 1923-1928.

(b) Step 2

The same as in Step 2 in the previous period, 1923-1928.

(III.) 1934 (3rd quarter) - 1935 (2nd quarter)

Available data

(a) Net demand deposits at all member banks; monthly; average of daily figures.

(b) Demand deposits adjusted at all the weekly reporting member banks on every Wednesday.

(c) Net demand deposits of the central reserve city and reserve city banks; monthly; average of daily figures.

(d) Call dates data of demand deposits adjusted at all member banks.

Procedure

(a) Step 1

Let π represent the ratio of d.d.a. to n.d.d.

Estimate demand deposits adjusted at all member banks in March (September) by

$$\text{d.d.a. at all member banks for March (September)} = \text{d.d.a. at all member banks for June (December)} \times \frac{\text{n.d.d. at all member banks for March (September)}}{\text{n.d.d. at all member banks for June (December)}}$$

$$\times \frac{\pi \text{ for the weekly reporting member banks in March}}{\pi \text{ for the weekly reporting member banks in June}} .$$

This formula is derived from assumption (iii).

However, the data for the n.d.d. at the weekly reporting member banks, which are necessary for the above estimation, do not exist. Yet, provided that the n.d.d. of weekly reporting member banks and of the central reserve city and the reserve city banks change over time in a constant proportion, we can substitute the data of n.d.d. of the central reserve city and reserve city banks for the data of n.d.d. of the weekly reporting member banks in the above formula. In fact, this substitution is done here.

(b) Step 2

The above formula would enable us to estimate demand deposits adjusted at the end of March or September (more exactly, the same day of the week as the call dates in June or December) only when the variation of the demand deposits adjusted within June (December) had the same pattern as the variation within March (September). The data for the weekly reporting banks indicates that this is not so.

We wish to have the data for

$$w = \frac{\text{d.d.a. of all member banks toward the end of the month}}{\text{d.d.a. of all member banks as the average of the month}} .$$

For this, w can be used to adjust the figures obtained in Step 1 by the formula:

$$\text{d.d.a. of all member banks as of late March (September)}$$
$$= \text{d.d.a. of all member banks as obtained in Step 1,}$$
$$\times \frac{\text{the ratio } \omega \text{ in March (September)}}{\text{the ratio } \omega \text{ in June (December)}} .$$

In fact, the data for the above ω are not available. However, the data for d.d.a. at the weekly reporting banks as of the last Wednesday of the month and also as

the average of all Wednesdays of the month are available.

Therefore, ω is estimated by

$$w \approx \left[.7 \times \frac{\text{d.d.a. of the weekly reporting banks (as of the last Wednesday)}}{\text{d.d.a. of the weekly reporting banks (average of all Wednesdays)}} + .3f(t) \right] .$$

where, as in the previous formulations, $f(t) = 1$ for t = March and June,

$$f(t) = \frac{\text{d.d.a. of the weekly reporting banks (as of the last Wednesday)}}{\text{d.d.a. of the weekly reporting banks (average of all Wednesdays)}} \quad \text{for } t = \text{September , and}$$

$$f(t) = 1 + \tfrac{1}{2} \left[\frac{\text{d.d.a. of the weekly banks (as of last Wednesday)}}{\text{d.d.a. of the weekly banks (average)}} - 1 \right] ,$$

for t = December .

(IV.) 1935 (3rd quarter) - 1942

During this period net demand deposits include the deposits of the Federal Government. All the explanations for the previous period, 1934-1935, apply to the present period, with the sole exception that the net demand deposits in the previous explanation are now replaced by net demand deposits minus the deposits of the Federal Government.

Since the data for the monthly average of Federal Government deposits at all member banks are not available, the following assumption is made in order to estimate this component:

$$\frac{\text{FGD at All Member Banks (monthly average)}}{\text{FGD at All Member Banks (end of the month)}} \approx \frac{\text{FGD at Weekly Reporting Banks (monthly average)}}{\text{FGD at Weekly Reporting Banks (last Wednesday of month)}} ,$$

where FGD is the abbreviation for federal government deposits.

The figures for the ratio on the right hand side of the "equality" are available, but the end of the month figures for Federal Government deposits at all member banks are not. However, the data are available for this series on call dates (of which there are approximately three or four observations per year). The ratios between these call date figures and Federal Government deposits at

weekly reporting banks (for dates as close to the call dates as possible) are taken during the present period. A linear trend was then fitted through these ratio observations so that an estimate could be made of the relevant missing quarterly ratios.

The final results of the quarterly FGD at all member banks (end of the month) were obtained by dividing the data for the FGD at weekly reporting banks for the respective dates by the corresponding estimated ratios. After this computation, all the data are available for the calculation of the monthly average of FGD at all member banks with the use of the above equality.[1]

[C.] Details of the Estimation Procedures: Method I(B).

The only difference between Method I(B) and Method I(A) is (1) that the March figures are estimated from the December figures in the previous year in Method I(B), whereas in Method I(A) the March figures are estimated from the June figures of the same year; and (2) similarly, that the September figures are estimated from the June figures of the same year in Method I(B), whereas in Method I(A) the September figures are estimated from the December figures. Where the changes in the estimation procedures take place, Method I(B) was not applied. Thus, for March 1929, September 1934, and September 1935, Method I(B) was not carried out.

[D.] Estimation Procedure: Method I.

The estimation procedure, Method I, consists of taking the average of the results of Methods I(A) and I(B), wherever Method I(B) was applied. For the three months mentioned above, the result of Method I(A) is taken as the final result for Method I.

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[1] This part of the work was done by Mr. Dalton.

Method II.

[A.] Differences between Method I and Method II.

Method II is simpler than Method I and can give the estimation of demand deposits adjusted for only about three quarters of all the time points for which the estimation is required. However, Methods I and II use different sets of data and partly different assumptions. Therefore, Method II is useful for checking the results of Method I.

The estimation by Method I used the data of demand deposits adjusted on the call dates in June and December. These call dates always occur in late June or December, whereas the other call dates vary from year to year. These varying call dates are used in Method II. First, these call dates are grouped into three categories. The first category contains those which fall in March or September and which are near the end of either month. The second category contains those call dates which do not occur in late March or September but which occur within 30 days from the end of March or September. The third group is the remainder, and this category is not used at all in Methods I or II.

For the first category of call dates, an estimation procedure called Method II(A) is used. For the second category of call dates, another estimation procedure, Method II(B), is used.

[B.] Estimation procedure for Method II(A):

The demand deposits adjusted on those call dates in the first category, just as they are, are really what we want. However, there is one adjustment which might be considered in order to enable comparison of these data with the results of the estimation procedure in Method I. Theoretically, Method I estimates demand deposits adjusted for the same day of the week in March (or September) as the call dates in June (or December) which are used as bench marks. Therefore, if the day of the call dates in March (or September) in the

first category is not the same as the day of the call dates in June (or December) used as bench marks in Method I, we should expect some consistent difference.

The question which arises as to the comparison between the results of Methods I and II is whether or not there is any consistent pattern in the changes in the ratio of net demand deposits to demand deposits adjusted from one day to another day of the week. Thus, the mean of the ratio of net demand deposits to demand deposits adjusted on the call dates from 1919 to 1935 (June) has been calculated for each day of the week. (The reason why the period is terminated in June 1935 is that net demand deposits after this point include Federal Government deposits at all member banks, the data for which does not exist separately.) The result is that the difference from day to day of the week in the ratio between net demand deposits and demand deposits adjusted is not statistically significant.

[C.] Estimation procedure for Method II(B):

Method II(B) involves the assumptions (i) and (ii) used in Method I and also the use of the correlation between the weekly reporting member bank deposits and the other bank deposits as explained in Method I. A difference between Method I and Method II(B) is that the assumptions (i) and (ii) are applied to a period shorter than 30 days in Method II(B), whereas they are applied to a 3-month period in Method I.

(I.) For the period 1923-1934

(a). Step 1.

Estimate for the weekly reporting member banks

$$\frac{\text{n.d.d. - due to other banks + due from other banks (as of the Wednesday nearest the call dates which belong to the second category and correspond to March (September))}}{\text{n.d.d. - due to other banks + due from other banks (as of the last Wednesday of March (September))}}$$

Let this ratio be $\omega(t)$.

(b) Step 2

Adjust $\omega(t)$ in view of the correlation between the deposits at the weekly reporting and non-reporting member banks:

$$.7\ \omega(t) + .3\ f(t)\ ,$$

where

$$f(t) = 1 \quad \text{for} \quad t = \text{March}$$

$$f(t) = \omega(t) \quad \text{for} \quad t = \text{September}$$

$$f(t) = 1 + \tfrac{1}{2}[\omega(t) - 1] \quad \text{for} \quad t = \text{December}\ .$$

(c) Step 3

d.d.a. on the call dates belonging to the second category $\times\ [.7\ \omega(t) + .3\ f(t)]$.

Thus we estimate the March (September) figures of d.d.a.

(II.) For the period 1934-1943.

(a) Step 1.

Instead of n.d.d. - due to other banks + due from other banks, d.d.a. of the weekly reporting member banks are used. Thus,

$$\omega(t) = \frac{\text{d.d.a. at the weekly reporting member banks as of the Wednesday nearest the call date}}{\text{d.d.a. at the weekly reporting member banks as of the last Wednesday in March (or September)}}\ .$$

(b) Step 2.

The same as in the previous period.

Section II

Quarterly Estimation of Demand Deposits Adjusted at the Non-Member Banks

The biannual data as of June and December call dates are available.[1] But, compared with the member banks, the data for the non-member banks is very scanty.

Method I.

[A.] Assumptions which are basic to the estimation procedure:

As far as the changes in demand deposits are concerned, the behavior of non-member banks is considered to be similar to that of the member banks located in small cities. Therefore, we try to exploit this similarity for the estimation of the demand deposits adjusted at the non-member banks.[2] However, we are also aware of the fact that changes in the status of banks frequently occurred (from non-member to member banks, or vice versa). Further, many small banks disappeared during the Great Depression. Therefore, it is rather dangerous to generalize from the information as to the member banks in small cities in

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[1] The figures given in Banking and Monetary Statistics for demand deposits adjusted at all banks including member and non-member banks differ slightly from the figures given in All Bank Statistics. The difference is due to the revision made upon the publication of the latter. This revision is made only for June data. The following revision for December data is made by us upon the suggestion of Mr. Veenstra of the Board of Governors of the Federal Reserve System. Take the discrepancy in year t, $x(\text{June}, t)$, between the figures in Banking and Monetary Statistics and in All Bank Statistics. Compute

$$\frac{x(\text{June}, t) + x(\text{June}, t+1)}{2}.$$

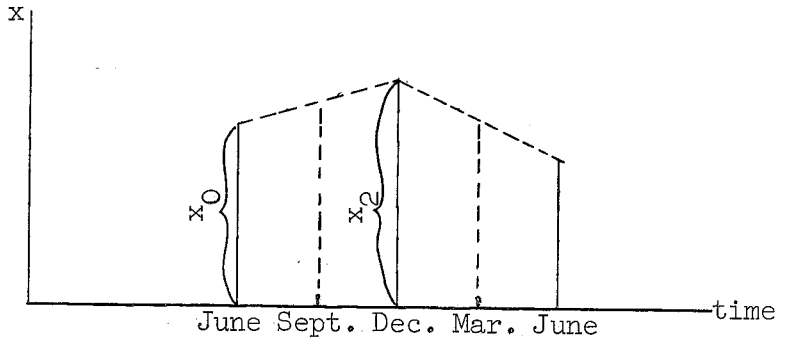
Adjust by this amount the figure given in Banking and Monetary Statistics for December of t year. Again, upon the suggestion of Mr. Veenstra, we obtained the data for demand deposits adjusted at the non-member banks by subtracting the figure for the member banks as published in Banking and Monetary Statistics from the revised figures for all banks. This assumes that all the revisions of the figures for all banks are actually for the figures for the non-member banks. If we estimate the quantity of money at the digit of 100 million dollars, this assumption is justifiable according to Mr. Veenstra.

[2] This was suggested to the author by Mrs. Schwartz.

applying it to the non-member banks.[1]

Two assumptions are necessary:

(i) We assume that the proportion between demand deposits adjusted at the non-member banks and at the member banks located in the cities of population less than 15,000 can be approximated linearly during a 6-month period. For instance,



where x_0 and x_2 are the values of the proportion which we are concerned with respectively for June and December, then the value of this proportion in September is given by

$$\frac{x_2 + x_0}{2} .$$

(ii) We assume that demand deposits adjusted at those member banks located in the cities of population less than 15,000 change in the short period of 6 months in proportion to net demand deposits at these member banks.

Combining assumptions (i) and (ii), we arrive at assumption (iii), that the proportion between demand deposits adjusted at the non-member banks and net demand deposits at the member banks located in cities of population less than 15,000 can be approximated linearly during a 6-month period.

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[1] This point is due to Mr. Veenstra.

[B.] Details of the Estimation Procedures: Method I.

(I.) Available data

(a) Demand deposits adjusted at the non-member banks as of the end of June and December of each year, which are also the call dates for the member banks.

(b) Net demand deposits at the member banks located in the cities of population less than 15,000 for the period 1923-1935; monthly. For the period 1923-1928 the data are mostly as of the last Wednesday of each month, but partly as of other Wednesdays. For the period 1929-1935 the data are the average of daily figures.

(c) Gross demand deposits at the member banks located in the cities of population less than 15,000, for the period 1936-1942; monthly; average of daily figures.

(II.) Procedure

(a) For the period 1923-1935 (2nd quarter)

Compute $\frac{\text{d.d.a. of non-member banks}}{\text{n.d.d. of member banks in small cities}}$

for June and December of each year. Let this ratio be

$x(\text{June}, t)$ and $x(\text{December}, t)$ for year t.

Then compute

$$\frac{x(\text{June}, t) + x(\text{December}, t-1)}{2}$$

for March of year t, and denote it as $x(\text{March}, t)$.

Also compute

$$\frac{x(\text{June}, t) + x(\text{December}, t)}{2}$$

for September of year t, and denote it as $x(\text{September}, t)$.

Using assumption (iii), compute

$$\left(\begin{array}{l}\text{n.d.d. of member banks} \\ \text{in small cities in} \\ \text{March of year } t\end{array}\right) \times x(\text{March}, t)$$

to get d.d.a. of non-member banks in March of year t.

Also compute

$$\left.\begin{array}{l}\text{n.d.d. of member banks}\\ \text{in small cities in}\\ \text{September of year } t\end{array}\right) \times x(\text{September}, t)$$

to get the d.d.a. of non-member banks in September of year t.

(b) For the period 1935 (3rd quarter) - 1936 (1st quarter)

Because of the definitional change of net demand deposits in September 1935, and because the available data starting in January 1936 are gross demand deposits, Method I is not applicable for this period.

(c) For the period 1936 (2nd quarter) - 1942

Use the method described for the period 1923-1935, with the sole change that gross demand deposits are substituted for net demand deposits.

Method II.

[A.] For the 3rd quarter of 1935 and the 1st quarter of 1936.

(I.) Procedure

Method II is a simple linear interpolation, i.e.,

d.d.a. of non-member banks as of September 1935

$= \frac{1}{2}$(d.d.a. of non-member banks as of June, 1935 + d.d.a. of non-member banks as of December 1935).

Similarly for January 1936.

Actually, in order to compare Methods I and II, Method II is applied to all the time points for which estimation is necessary. The discrepancy between the results of the two estimation methods is found to be very small, seldom more than 50 million dollars.

Section III

Results of the Estimation

(See the tables on the following pages.)

		All Member Banks DDA			Non-Member Banks DDA	Total DDA	Currency Outside Banks	Quantity of Money (3) + (4) + (5) (last two digits rounded off)
		Method I (1)	Method II (2)	½(I + II) (3)	(4)	(3)+(4)	(5)	(6)
		(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Billions)
1923								
	II	13,595	13,595	13,595	5,560	19,155	3,675	22.8
	III	13,534	13,322	13,428	5,682	19,110	3,804	22.9
	IV	13,628	13,628	13,628	5,693	19,321	3,765	23.1
1924	I	13,476	13,403	13,440	5,655	19,095	3,778	22.9
	II	13,906	13,906	13,906	5,662	19,568	3,698	23.3
	III	14,472	14,425	14,449	5,868	20,317	3,738	24.1
	IV	15,038	15,038	15,038	6,037	21,075	3,756	24.8
1925	I	14,987	14,765	14,876	6,237	21,113	3,652	24.8
	II	15,227	15,227	15,227	6,347	21,574	3,592	25.2
	III	15,716	15,483	15,600	6,654	22,254	3,654	25.9
	IV	15,943	15,943	15,943	6,606	22,549	3,679	26.2
1926	I	15,423	15,373	15,398	6,579	21,977	3,663	25.6
	II	15,794	15,794	15,794	6,529	22,323	3,638	26.0
	III	15,865		15,865	6,588	22,453	3,669	26.1
	IV	15,783	15,783	15,783	6,294	22,077	3,675	25.8
1927	I	15,455	15,694	15,575	6,290	21,865	3,598	25.5
	II	16,063	16,063	16,063	6,308	22,371	3,563	25.9
	III	16,001	15,752	15,877	6,409	22,286	3,655	25.9
	IV	16,590	16,590	16,590	6,430	22,993	3,617	26.6
1928	I	16,110		16,110	6,326	22,436	3,509	25.9
	II	16,142	16,142	16,142	6,309	22,451	3,577	26.0
	III	15,976	15,905	15,941	6,526	22,467	3,614	26.1
	IV	16,503	16,503	16,503	6,790	23,293	3,617	26.9

		All Member Banks DDA			Non-Member Banks DDA	Total DDA	Currency Outside Banks	Quantity of Money (3) + (4) + (5) (last two digits rounded off)
		Method I (1)	Method II (2)	½(I + II) (3)	(4)	(3)+(4)	(5)	(6)
		(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Billions)
1929	I	16,367	16,057	16,207	6,607	22,814	3,535	26.3
	II	16,324	16,324	16,324	6,448	22,772	3,676	26.4
	III	16,154	16,086	16,120	6,614	22,734	3,680	26.4
	IV	16,647	16,647	16,647	6,423	23,070	3,638	26.7
1930	I	15,781	15,889	15,835	6,151	21,986	3,477	25.4
	II	16,043	16,043	16,043	5,952	21,995	3,415	25.5
	III	15,702	15,787	15,745	5,759	21,504	3,413	24.9
	IV	15,869	15,869	15,689	5,348	21,217	3,645	24.9
1931	I	15,365	15,488	15,427	4,794	20,221	3,537	23.8
	II	15,208	15,208	15,208	4,834	20,042	3,683	23.7
	III	15,022	14,666	14,844	4,477	19,321	4,047	23.4
	IV	13,658	13,658	13,658	3,916	17,574	4,325	21.9
1932	I	12,522		12,522	3,531	16,053	4,402	20.5
	II	12,433	12,433	12,433	3,305	15,738	4,579	20.3
	III	12,352	12,358	12,355	3,196	15,551	4,585	20.1
	IV	12,691	12,691	12,691	3,144	15,835	4,587	20.4
1933	I							
	II	12,089	12,089	12,089	2,423	14,512	4,721	19.2
	III	12,253	12,279	12,266	2,383	14,659	4,598	19.2
	IV	12,674	12,674	12,674	2,413	15,087	4,722	19.8
1934	I	13,386	13,329	13,357	2,513	15,870	4,602	20.5
	II	14,261	14,261	14,261	2,435	16,696	4,586	21.3
	III	14,919	15,124	15,021	2,642	17,663	4,732	22.4
	IV	15,686	15,686	15,686	2,809	18,495	4,719	23.2

		All Member Banks DDA			Non-Member Banks DDA	Total DDA	Currency Outside Banks	Quantity of Money (3) + (4) + (5) (last two digits rounded off)
		Method I (1)	Method II (2)	½(I + II) (3)	(4)	(3)+(4)	(5)	(6)
		(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Billions)
1935	I	15,242	16,039	15,641	2,881	18,522	4,760	23.3
	II	17,530	17,530	17,530	2,973	20,503	4,833	25.3
	III	18,079		18,079	3,189	21,268	4,893	26.2
	IV	18,801	18,801	18,801	3,405	22,206	4,928	27.1
1936	I	18,975	18,950	18,963	3,507	22,470	4,983	27.5
	II	20,284	20,284	20,284	3,608	23,892	5,233	29.1
	III	20,849		20,849	3,873	24,722	5,331	30.1
	IV	21,647	21,647	21,647	3,953	25,600	5,527	31.1
1937	I	21,570	21,352	21,461	3,954	25,415	5,431	30.8
	II	21,401	21,401	21,401	3,919	25,320	5,489	30.8
	III	20,764		20,764	3,913	24,677	5,608	30.3
	IV	20,387	20,387	20,387	3,697	24,084	5,666	29.8
1938	I	20,266	20,271	20,269	3,611	23,880	5,461	29.3
	II	20,893	20,893	20,893	3,547	24,440	5,384	29.8
	III	21,373	21,596	21,386	3,663	25,049	5,516	30.6
	IV	22,293	22,293	22,293	3,798	26,091	5,753	31.8
1939	I	22,191	22,364	22,278	3,823	26,101	5,757	31.8
	II	23,587	23,587	23,587	3,851	27,438	5,920	33.4
	III	24,849	25,156	25,003	4,045	29,048	6,165	35.2
	IV	25,681	25,681	25,681	4,194	29,875	6,388	36.3
1940	I	26,424	26,461	26,443	4,212	30,655	6,464	37.1
	II	27,877	27,877	27,877	4,165	32,042	6,779	38.8
	III	28,628		28,628	4,346	32,974	6,975	39.9
	IV	30,429	30,429	30,429	4,594	35,023	7,329	42.4

		All Member Banks DDA			Non-Member Banks DDA	Total DDA	Currency Outside Banks	Quantity of Money (3) + (4) + (5) (last two digits rounded off)
		Method I (1)	Method II (2)	½(I + II) (3)	(4)	(3)+(4)	(5)	(6)
		(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Millions)	(Billions)
1941	I	31,647	31,734	31,696	4,478	36,174	7,702	43.9
	II	32,678	32,678	32,678	4,714	37,392	8,300	45.6
	III	32,159	33,822	32,491	5,042	37,533	8,742	46.3
	IV	33,754	33,754	33,754	5,297	39,051	9,615	48.7
1942	I	34,633	35,048	34,841	5,100	39,941	10,218	50.2
	II	36,966	36,966	36,966	4,947	41,913	10,969	52.9
	III	39,255		39,255	5,531	44,786	12,312	57.1
	IV	42,570	42,570	42,570	6,407	48,977	13,943	62.9

Section IV

Accuracy of the Estimation

The errors of the estimation in terms of the absolute level of the quantity of money are very small. However, this is not because the estimation method is good. The magnitude of fluctuations of the quantity of money is very small compared with its absolute level. Therefore, any interpolation method would involve very small errors if the errors are expressed in terms of the absolute level.

If the data of the quantity of money presented in the previous section are used for the analysis of the fluctuations of the quantity of money, then there are good reasons to worry about the error of estimation. A large part of the short-run changes in the quantity of money comes from the changes in the demand deposits adjusted at the member banks. The table in the previous section presents two different estimates of these demand deposits adjusted in columns (1) and (2). Although there can be no measurement of estimation errors, we might take the discrepancy between these two estimates as an indication of the uncertainty involved in the reliability of the estimation presented above. (We have compared two different estimates for the components of quantity of money other than the member bank demand deposits, and, as was pointed out earlier, we found no great discrepancies.)

During the period between 1923 and 1934, there are 23 quarters which had to be estimated. (The June and December figures are readily available, and, therefore, only the March and September figures are estimated.) One of the two estimation procedures for demand deposits adjusted at member banks is not applicable for three quarters out of the 23. Thus, we have figures for the discrepancies between the two estimation procedures (for demand deposits adjusted at member banks) for 20 quarters during the period between 1923 and 1934. The

discrepancy is greater than $200 million for 8 quarters, greater than $300 million for 2 quarters, and greater than $400 million for no quarters. These must be judged in light of the fact that the absolute values of the changes in the quantity of money in two consecutive quarters averaged approximately $550 million during the period under consideration.

During the period between 1935 and 1942 the quantity of money increased rapidly, and also the quarterly changes were far greater than in the previous period. However, the size of the discrepancy between the two different estimates of demand deposits adjusted at member banks, in terms of the quarterly changes in the quantity of money, was just about the same as in the previous period.

For a few quarters the discrepancy between the two estimates is annoyingly large. This might reflect some peculiar elements which appeared in these quarters, but we have not made any special studies of them.

One point should be emphasized here. Since the June and December figures are readily obtained from the Federal Reserve System and only the March and September figures are estimated here, the magnitude of errors for June and December figures is far less than that for the March and September figures. One must study the effect this kind of error has upon the conclusions which are drawn from these data.

The present author is using these data for the spectral, cross-spectral, and partial cross-spectral analyses of the quantity of money, national income, and interest rates.