Improving the Monetary Aggregates

Staff Papers

Board of Governors of the Federal Reserve System

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Washington, D. C.

Preface

In early 1974 the Board of Governors of the Federal Reserve System appointed the Advisory Committee on Monetary Statistics to provide a technical evaluation of, and a report on, the quality of the monetary aggregates used by the Federal Reserve in the formulation and implementation of monetary policy *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* was published by the Board in June 1976

The Advisory Committee on Monetary Statistics was chaired by Professor G L Bach (Stanford University), Professor Phillip D Cagan (Columbia University) served as Executive Secretary Other members of the Committee were Professor Milton Friedman (University of Chicago), Professor Clifford G Hildreth (University of Minnesota), Professor Franco Modigliani (Massachusetts Institute of Technology), and Dr Arthur M Okun (the Brookings Institution) Professor Paul W McCracken (University of Michigan) was a member of the Committee originally, but withdrew because of the pressures of other duties

At its final meeting, the Advisory Committee requested the publication of certain of the research papers that had been prepared by the Board staff for the Committee's use The Committee concurred with a recommendation of the Board staff that revisions of the studies be prepared for publication, provided that the final versions would contain essentially the same information that had been made available to the Committee during the course of its deliberations The Committee also requested further investigation of its tentative proposal for an alternative method of calculating M_1, and a paper presenting this further work is included in this volume

For three other papers, additional staff research is also presented, this work serves to support the analysis originally presented to the Committee "Transitory Variations in the Monetary Aggregates" expands upon the sources, estimation, and interpretation of transitory variations in the aggregates "Demand Deposit Ownership Survey" contains new staff research on the demand for demand deposits by various sectors Finally, in "Foreign Demand Deposits at Commercial Banks in the United States," additional results are presented from attempts to model the demands for foreign deposits included in M_1

Support of the work of the Advisory Committee on Monetary Statistics by the staff of the Board of Governors was supervised throughout most of the period by James L Pierce, who at the time was Associate Director of the Division of Research and Statistics and is now Professor of Economics at the University of California at Berkeley, subsequent staff work was overseen by Edward C Ettin, Associate Director of the Division of Research and Statistics Board staff economists working closely with the Committee, aside from the authors of the papers in this volume, were Arthur B Hersey and Thomas Thomson

J Charles Partee, Member of the Board
Chairman, Board Committee
on Research and Statistics

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Transitory Variations in the Monetary Aggregates

Richard D Porter, Agustin Maravall, Darrel W Parke, and David A Pierce

Most of this work was completed in early 1977 Since then updated estimates of transitory variations in the aggregates have been computed for the 1968–76 period These estimates are similar to the estimates reported here, though there appears to have been a small increase in the transitory variations in 1975 and 1976 Also, alternative methods of interpolating components that are not observed daily have been tried, and it seems that the choice of interpolation procedure has very little effect on the resulting estimates of transitory variation

The views presented here are those of the authors and do not necessarily represent the views of the Board of Governors of the Federal Reserve System This paper contains materials presented to the Advisory Committee on Monetary Statistics as well as additional materials developed later We believe that the principal findings of this study are consistent with evidence that the Committee reviewed in making its recommendations It is hoped that additional results reported here improve the estimation of transitory variations in the aggregates *We wish to thank Greg Connor for very able assistance in all phases of this work We also wish to thank Darwin Beck, Edward Ettin, Donald Hester, John Kalchbrenner, David Lindsey, Juan Perea, and Steven Zeller for helpful comments*

Day-to-day movements in the not seasonally adjusted monetary aggregates display several systematic patterns Overall, there is a gradual upward trend in the series with some cyclical variations Strong and fairly systematic shorter cycles for monthly, weekly, and even intraweekly time spans are also evident For example, the demand deposit component of M_1 tends to fall on Friday, while the currency component tends to rise Nevertheless, after accounting for these systematic effects, unsystematic, or transitory, day-to-day variations remain In this paper, the magnitudes of these unobserved transitory variations are investigated in order to appraise the significance of observed variations in the monetary aggregates

Day-to-day variations in monetary aggregates spring from short-run payments flows between the nonbank public and commercial banks, the Treasury, or the Federal Reserve Potential sources of day-to-day variation in private deposit balances include (1) compositional shifts in the allocation of private balances—decisions by the public to shift from currency to demand deposits, from time deposits to demand deposits, and so forth, (2) shifts in balances held by the U S Government and commercial banks in relation to the public's holding of balances, (3) variations in the rate at which private deposits are created in the banking system, (4) fluctuations caused by items delayed in transit or by reporting errors

To date, only limited theoretical and empirical work has been done on deposit variability at commercial banks [1] The report of

NOTE—The authors are on the staff of the Division of Research and Statistics

[1] See, for example, Lyle E Gramley, "Deposit Instability at Individual Banks," in *Essays on Commercial Banking* (Federal Reserve Bank of Kansas City, 1962), pp 41–53, C Rangarajan, "Deposit Variability in Individual Banks," *National Banking Review*, vol 4 (September 1966), pp 61–71, and Frederick M Struble and Carroll H Wilkerson, "Bank Size and Deposit Variability," *Monthly Review*, Federal Reserve Bank of Kansas City (November–December 1967), pp 3–9, and "Deposit Variability at Commercial Banks," *Monthly Review*, Federal Reserve Bank of Kansas City (July–August 1967), pp 27–34

the Advisory Committee on Monetary Statistics was, in fact, the first study of day-to-day transitory variations in monetary aggregates.[2]

Like the report of the Advisory Committee, this paper approaches the problem of measurement of transitory variations empirically. It neither attempts to explain in economic terms which part of observed variations is transitory and which is not, nor relates the systematic component to other relevant series in calculating the transitory component. Rather, four different statistical models are considered. Each model contains a different specification and, therefore, a different measurement of transitory and systematic variations.

Each of the models allows for two types of systematic effects: *intraweekly effects* that account for systematic differences between Mondays and Tuesdays, Mondays and Wednesdays, and so forth, and *longer-run trends* that include seasonal movement (other than intraweekly effects) as well as trend and cyclical movements in the usual sense. Because there is no need to obtain separate estimates of seasonal and trend-cycle parts, both will be grouped into one term, the "trend."

In each model, the observations are the logarithms of the measured aggregates, and trend is determined locally in each model by smoothing or averaging the observed series around each daily observation. The four models differ essentially in the precise weights used in computing the local trend. The estimated transitory component (the part of the series due to transitory variations) in each model is obtained by subtracting the estimated systematic part from the series.

Daily trend estimates for three of the four statistical models are based on an average of five weekday observations.[3] In the analysis-of-variance (ANOVA) model, the estimated trend for each weekday in a given statement week (Thursday to Wednesday) is the arithmetic mean of the five weekday observations in that statement week. In contrast, daily trend estimates in the symmetrical equal weights (SEW) model are based on an arithmetic moving average of five observations centered on the current day. Thus, estimated daily trend in the SEW model changes from one day to the next within a statement week. Finally, in the symmetric quadratic weights (SQW) model, the estimated daily trend is a weighted moving average (centered on the current day) with the largest weight attached to the current day.

In the fourth model, the trend for a given day is also a symmetric weighted average of the observations centered around the current day. However, the weights are not fixed a priori as in the three previous models but are estimated directly from the aggregate series. Under certain assumptions, aggregate data may be used directly to obtain the optimal statistical decomposition (OSD) of the aggregate series into its transitory and trend components, each is a symmetric weighted average of the observations on the aggregate. Because the time-series characteristics of different series are not identical, the weights used in the OSD trend estimate will be specific to each series.

The paper proceeds in the following way. First, there is a short summary of the empirical results. A description of the four statistical models is presented in the following section. Next are sections dealing with the estimation of the models and related statistical tests, empirical comparisons of the sources of transitory variations, and examination of confidence-interval estimates of the systematic component. The conclusions are followed by two technical appendixes.

Summary of empirical results

On balance, empirical estimates for the 1968–74 sample period indicate that 95 per cent of the observed, annualized, monthly growth rates of M_1 and M_2 lie within 4 and 2 per cent, respectively, of the unobserved systematic growth rates. Corresponding values for

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[2] *Improving the Monetary Aggregates: Report* (Board of Governors of the Federal Reserve System, 1976).

[3] The day-to-day variation in the aggregates is considerably less on weekends than on weekdays. Thus, the analysis was limited to weekday observations; see the section "Intraweekly heteroskedasticity," p. 19, for a further discussion of this point.

TABLE 1 95 Per Cent Confidence Intervals for Monthly Annualized Growth Rates, Alternative Methods

Percentage points

Method	Monetary aggregate				
	Currency	Demand deposits	M_1	Other time and savings deposits	M_2
ANOVA	4 2	5 7	4 5	1 0	2 3
SEW	2 4	4 4	3 3	9	1 6
SQW	1 6	3 3	2 5	7	1 2
OSD	n a	4 3	n a	n a	n a

n a Not available

the four different statistical models are presented in Table 1 For example, the ANOVA estimate for M_1 of 4 5 per cent indicates that about 95 per cent of all measured monthly growth rates of M_1 will lie within 4½ percentage points of the (unobserved) systematic growth rate of M_1, and about 5 per cent of all measured monthly growth rates will depart from the systematic growth rate of M_1 by larger amounts These estimates apply only to not seasonally adjusted data For data that are seasonally adjusted using the Census X-11 program the values would be smaller, about nine-tenths of those in Table 1

Methodology

Because monetary aggregates tend to grow as the economy expands, transitory errors, measured in dollars, can be expected to have a long-run positive trend in absolute terms Thus, it is convenient to put the statistical problem in relative terms and work with the natural logarithm of the daily aggregate This logarithmic transformation will tend to stabilize the transitory variance The equation of interest is, therefore,

$$y_t = \eta_t + \beta_t + \epsilon_t \qquad (1)$$

where

- y = the natural logarithm of the aggregate
- η = the systematic trend (for y)
- β = the systematic day-of-week term
- ϵ = the nonsystematic or transitory term
- t = a time subscript index (in days)

The index t runs over successive 5-day periods excluding weekends[4] The sum $\eta_t + \beta_t$ represents the systematic part of the model The parameter β_t allows for systematic differences between days within a week The trend term η_t represents long-run trends, including seasonal movement (other than the intraweekly seasonal β_t) as well as trend and cyclic movements in the usual sense If the systematic intraweekly effects are constant across weeks, as we shall assume, then

$$\beta_t = \beta_{t+5}$$

for all t The function β_t is thus a periodic function of time with period equal to 5 The day-of-week terms will be normalized to sum to zero over a week,[5] that is, for any t,

$$\beta_t + \beta_{t+1} + \beta_{t+2} + \beta_{t+3} + \beta_{t+4} = 0$$

We assume that the trend changes gradually and, therefore, it is estimated by averaging observations near t Given a particular specification of the trend, it may then be estimated along with the day-of-week effect

The term ϵ_t in Equation 1 reflects the transitory variations in the observed series, y_t It is generally assumed that ϵ_t has expected value zero $[E(\epsilon_t) = 0]$ and constant variance $[E(\epsilon_t^2) = \sigma^2]$, and is serially independent In other words, the effect of transitory components on y_t is, on average, zero with variance uniform (homoskedastic) across days, weeks, and months, and the current transitory error is independent of past or future transitory errors The assumption of homoskedasticity within a week will be relaxed in part of the analysis, and separate (heteroskedastic) estimates of the transitory variance for each weekday will be computed

[4] We have excluded weekend observations because they require a substantially different treatment from weekday observations, see the section "Transitory variations in averages of daily data," pp 18–21

[5] Although this simple specification of the day of week terms will be adequate for most weeks, weeks containing bank holidays may require some special modifications, see the section "Empirical results," pp 8–15

The ANOVA, SEW, and SQW models for transitory variations

The four models differ in their specification of trend The report of the Advisory Committee on Monetary Statistics assumes a constant trend for all days within a week but allows the trend to vary over different weeks [6] That model is a standard two-way analysis of variance (ANOVA) model with five day-of-week column effects and as many row effects as there are weeks in the sample [7]

To assume, alternatively, that the trend for each day is appropriately estimated by a symmetric 5-day weighted average of y_t centered around that day affords a more symmetric treatment of days within weeks than is furnished by the ANOVA model That is, each day is viewed as lying in the center of its own week (rather than a fixed calendar or statement week), and the trend for that day is estimated by

$$(2) \quad \hat{\eta}_t = \sum_{s=-2}^{2} c_s y_{t+s} = c_{-2}y_{t-2} + c_{-1}y_{t-1} + c_0 y_t + c_1 y_{t+1} + c_2 y_{t+2} = c(B)y_t$$

where for symmetry $c_s = c_{-s}$, B is the backshift operator defined by $B^j y_t = y_{t-j}$, $c(B) = \sum_{s=-2}^{2} c_s B^s$, and

$$(3) \quad \sum_{s=-2}^{2} c_s = 1$$

or $c(1) = 1$ [8]

The estimate in Equation 2 is a (symmetric) weighted average of y_t—the result of applying a *linear filter* to y_t If the weights $\{c\text{'s}\}$ are equal,

$$(4) \quad c_s = \frac{1}{5}, s = -2, -1, 0, 1, 2$$

such a trend filter will be called the symmetric equal weights (SEW) filter

The SEW model is quite similar to the ANOVA model Assuming the sample consists of an integral number of weeks, the day-of-week effects in both models can be estimated by taking the differences between the average of all Mondays and the over-all average, the average of all Tuesdays and the over-all average, and so forth In addition, for the middle-of-the-week or third observation, the estimated residual and trend will be the same in both the SEW and ANOVA models As stated earlier, the ANOVA model specifies trend as the arithmetic mean of the observations in a fixed week But for the third or middle observation of a fixed week, the SEW estimate will average the same 5 days as the ANOVA, and hence both models will return the same residuals and trend estimates for this day Thus, if we define a week as the statement-week interval from Thursday to Wednesday, both models will show the same trend estimates and residuals on Monday—midway through the statement week The SEW model is less arbitrary than the ANOVA model, then, since the SEW treats each day as the center of a moving 5-day week, whereas the ANOVA treats days as members of fixed, arbitrarily defined weeks [9]

Of course, the essential difference between the two models is the degree of smoothness in the trend estimate Trends across weeks change more smoothly in the SEW model than in the ANOVA model [10]

Further generalizations of the ANOVA model are possible Within the framework of Equations 2 and 3 the weights do not need

[6] *Improving the Monetary Aggregates Report,* pp 26–28

[7] It is primarily the continual shift of the trend between weeks that distinguishes the transitory component in Equation 1 from the "irregular" component of seasonal adjustment models In the latter models the definition of the trend is generally more restrictive (see, for example, David A Pierce, Neva Van Peski, and Edward R Fry, "Seasonal Adjustment of the Monetary Aggregates," this volume), thus the irregular variance is higher than the transitory variance in this paper

[8] For a discussion of such approaches, see Theodore W Anderson, *The Statistical Analysis of Time Series* (Wiley, 1971)

[9] On the other hand, reserve requirements for member banks are based on average deposits over a Thursday through Wednesday week To the extent that reserve requirements affect deposits, choosing Thursday through Wednesday to compute the trend is not entirely arbitrary

[10] A related point is that under suitable assumptions, the estimated series on ϵ_t is stationary for the SEW estimate of the trend but not for the ANOVA estimate For example, using the statement week, the last day (Wednesday) estimate is completely determined by the previous day's estimates, a property one would not ordinarily want to ascribe to the transitory component of a series

to be equal Suppose that the weekly trend were a polynomial of degree 2,

(5) $\eta_{t+j} = \omega_{0t} + \omega_{1t} j + \omega_{2t} j^2$
$j = -2, -1, 0, 1, 2$

where ω_{0t}, ω_{1t}, and ω_{2t} are parameters Then the appropriate symmetric filter in Equation 2 has weights given by[11]

(6) $c_0 = 17/35, c_{-1} = c_1 = 12/35,$
$c_{-2} = c_2 = -3/35$

Because the weights displayed in Equation 6 are designed to eliminate quadratic trends, we will refer to Equations 2 and 6 as the symmetric quadratic weights (SQW) model Given a 5-day smoothing interval, the SQW model is the highest-order detrending filter available, within the class of linear symmetric filters, for eliminating polynomial time trends

Stochastic process rationalization of the transitory models: the OSD model

The trend weights that have been considered so far are given a priori and, moreover, are chosen according to a "deterministic" assumption about trend—that is, that locally it is well approximated by a polynomial in time Yet, the trend estimates (and hence the estimates of the transitory component), which are symmetric moving averages or filters of the observed series, are appropriate for a model in which the data contain a "stochastic" component as well [12]

Consider Equation 1, rewritten as

(7) $x_t = y_t - \beta_t -$ (over-all mean)
$= \eta_t + \epsilon_t$

but where the redefined trend η_t is assumed to follow a stationary, nondeterministic, zero-mean stochastic process [13] Under suitable conditions, the nature of such a process is determined by its autocovariances,

$$\gamma_\eta(k) = E(\eta_t \eta_{t-k})$$

which for lags $k = 1, 2,$ specify the way in which η_t is related to its own past By the stationarity assumption, the autocovariances do not change with the time t—that is, $E(\eta_t\eta_{t-k}) = E(\eta_{t-s}\eta_{t-s-k})$ for all s and k The lag 0 autocovariance, $E(\eta_t^2) = \sigma_\eta^2$, is the variance of η_t, and $\gamma_\eta(k) = \gamma_\eta(-k)$ As before, ϵ_t is assumed to be serially independent—that is, a white-noise process, $\gamma_\epsilon(k) = 0$, $k \neq 0$—and independent of η_t Consequently,

(8) $$\sigma_\epsilon^2 = \sigma_x^2 - \sigma_\eta^2$$

Given $\{x_t\ t = 0, \pm 1, \pm 2,\ \}$, the optimal (minimum mean square error) estimate of η_t is of the form

(9) $$\hat{\eta}_t = c(B)x_t$$

where $c(B)$ is a symmetric filter as in Equation 2 but is now given by

(10) $$c(B) = \frac{G_\eta(B)}{G_\eta(B) + \sigma_\epsilon^2}$$

where

$$G_\eta(B) = \sum_{k=-\infty}^{\infty} \gamma_\eta(k) B^k$$

is the autocovariance-generating function of the series $\{\eta_t\}$ [14]

For example, suppose η_t follows a first-order autoregressive process

(11) $$\eta_t = \varphi\eta_{t-1} + \epsilon_t',\ |\varphi| < 1$$

where $\{\epsilon_t'\}$ is a white-noise process with mean zero that is independent of ϵ_t Then the autocovariance-generating function of η_t is

(12) $$G_\eta(B) = \frac{\sigma_{\epsilon'}^2}{(1 - \varphi B)(1 - \varphi B^{-1})} = \frac{\sigma_{\epsilon'}^2}{1 - \varphi^2}\left[\sum_{s=-\infty}^{\infty} B^s \varphi^{|s|}\right]$$

[11] For the derivation of these weights and further discussion of this approach, see Anderson, *Statistical Analysis,* pp 46–56

[12] The remainder of this section is more technical than much of this paper and may be neglected without losing the essential ideas of the study

[13] See, for example, George E P Box and Gwilyn M Jenkins, *Time Series Analysis Forecasting and Control* (Holden-Day, 1970), Wayne A Fuller, *Introduction to Stationary Time Series* (Wiley, 1976), and Peter Whittle, *Prediction and Regulation by Linear Least Square Methods* (English Universities Press, 1963) In the subsequent applications to the aggregates, x_t will not be stationary and further transformations will be required, see the discussion concerning Equation 20 below

[14] See Whittle, *Prediction and Regulation,* p 57

and $c(B)$ is of the form

(13) $$c(B) = \frac{\beta}{\lambda\varphi(1-\beta^2)}\sum_{s=-\infty}^{\infty} B^s\beta^{|s|} = \frac{\sum_{s=-\infty}^{\infty}\beta^{|s|}B^s}{\Delta}$$

where[15]

$$\beta = \frac{1+\lambda(1+\varphi^2)-\Delta}{2\lambda\varphi}, \ |\beta| < 1$$

$$\Delta = \sqrt{1+2\lambda(1+\varphi^2)+\lambda^2(1-\varphi^2)^2}$$

$$\lambda = \sigma_{\epsilon'}^2/\sigma_\epsilon^2$$

Thus, the span of the weights is infinite, but the weights approach zero since $|\beta| < 1$

The variances of both η_t and ϵ_t can be estimated directly from observations on x_t alone, provided the process generating x_t obeys certain restrictions To illustrate this result, rewrite Equations 7 and 11 as

(14) $$x_t = \varphi x_{t-1} + \epsilon_t' + \epsilon_t - \varphi\epsilon_{t-1}$$

Then, multiplying successively by x_{t-1} and x_{t-2} and taking expectations,

(15) $$\gamma_x(1) = \varphi[\gamma_x(0) - \sigma_\epsilon^2]$$

(16) $$\gamma_x(2) = \varphi\gamma_x(1)$$

Since x_t is observed, its variance $\gamma_x(0)$ and lagged covariances $\gamma_x(1)$ and $\gamma_x(2)$ may be estimated Then, from Equations 15 and 16,

(17) $$\varphi = \frac{\gamma_x(2)}{\gamma_x(1)}$$

(18) $$\sigma_\epsilon^2 = \gamma_x(0) - \frac{\gamma_x(1)}{\varphi}$$

Thus, if η_t follows a first-order autoregressive process, all the parameters in Equation 11 may be estimated directly from observations on the x_t process alone, that is, the model (for η_t) is identified[16] Moreover, this example is not an isolated special case but exemplifies a general result

Theorem Let $\{\eta_t\}$ be a stationary stochastic process in continuous time Let η_t be measured with error at uniform discrete time intervals according to the equation $x_t = \eta_t + \epsilon_t$, where ϵ_t is a white-noise random error that is independent of η_t Then the stationary and invertible autoregressive-moving average (ARMA) processes that approximate the continuous process in discrete time are identified (almost everywhere) from observations on x_t

Without going through the proof, the content of the result can be set out[17] Note first the assumption that the aggregate exists in continuous time At every instant there is a well-specified aggregate, but it is measured or sampled at discrete time points, say, at the close of each business day At each instant, the aggregate (actually the log of the aggregate) is equal to the sum of a systematic part, η_t, and a transitory part, ϵ_t,

$$x_t = \eta_t + \epsilon_t$$

where η_s and ϵ_t are mutually independent for all s and t The process on ϵ_t is assumed to be independent between days but may be autocorrelated within a specified day Further, η_t is assumed to follow a continuous-time stationary process, which can be written as

$$\eta_t = \int_{-\infty}^{t} c(t-u)d\psi(u)$$

where $\{\psi(t)\}$ is a continuous process with independent stationary increments and with differential $d\psi(u)$. Given these assumptions, the resulting process for the trend, η_t, at the discrete sampled points ($t = 0, \pm 1, \pm 2, \pm$) is an autoregressive-moving average model of order $(n, n-1)$[18]

(19) $$\eta_t - \sum_{i=1}^{n}\varphi_i\eta_{t-i} = \epsilon_t' - \sum_{i=1}^{n-1}\theta_i\epsilon_{t-i}'$$

[15] Ibid, pp 35, 58–59

[16] While Equations 17 and 18 indicate that φ and σ_ϵ^2 are identified, they do not necessarily provide the most efficient means for estimating these parameters

[17] The proof is developed in Agustin Maravall, "Estimation of the Permanent and Transitory Component of an Economic Variable with an Application to M_1," Special Studies Paper 85 (Board of Governors of the Federal Reserve System, 1976)

[18] The approximation mentioned in the theorem is based on the following result Every linearly regular, stationary, stochastic process in continuous time is the limit in a Hilbert space of discrete-time autoregressive-moving average processes of order $(n, n-1)$, as n approaches infinity

where $\{\epsilon_t'\}$ is a white-noise process that is independent of $\{\epsilon_t\}$ [19] Finally, whenever the autoregressive part of the model has a greater order than the moving average part, all of the underlying parameters are identified in the econometric sense [20] Further, the $2n + 1$ parameters, $\varphi_1, \varphi_2, \ldots, \varphi_n, \theta_1, \theta_2, \ldots, \theta_{n-1}, \sigma_\epsilon^2, \sigma_{\epsilon'}^2$, can be estimated solely on the basis of observations on x_t

Under the same conditions, the argument can be applied to discrete-time stochastic processes in which the natural time unit of the process is small relative to the interval in which observations are available Finally, the systematic part, η_t, can have a nonzero and even nonconstant mean (for example, a deterministic day-of-week effect) and be generated by a homogeneously nonstationary process

Homogeneously nonstationary processes include processes that may be transformed into stationary processes by application of one or more differencing operations Thus, the transformation from the homogeneously nonstationary process, η_t, to the stationary process, δ_t, is achieved by

$$(20) \qquad \delta_t = \prod_{i=1}^{h} (1 - B^{s_i})^{d_i}\eta_t = D(B)\eta_t$$

where s_i and h are positive integers and the d_i are nonnegative integers Letting

$$z_t = D(B)y_t$$

and

$$e_t = D(B)\epsilon_t$$

in terms of the transformed series we have

$$(21) \qquad z_t = \delta_t + e_t$$

Since δ_t is stationary, it can be approximated to any desired degree of accuracy by an ARMA model of order (p, q) for some p and q

$$(22) \qquad \delta_t - \sum_{i=1}^{p} \varphi_i\delta_{t-i} = \epsilon_t' - \sum_{i=1}^{q} \theta_i\epsilon_{t-i}'$$

The condition on p and q in Equation 22 that is necessary for identification of the parameters on the right-hand side of Equation 21 is that $p + d > q$, where[21]

$$d = \sum_{i=1}^{h} d_i s_i$$

In the stationary case without differencing (Equation 19) $p = n$ and $q = n - 1$, so the parameters of the discrete-signal process are identified [22] But for situations in which $p + d \leq q$, the parameters are not identified For example, consider a weekly stationary time series in which the weekly observation is an average of seven daily observations, ending on Wednesday Thus, the weekly observation can be seen as systematic sampling (every Wednesday) of an aggregate of daily observations Assume that the underlying stochastic process for the daily time series is continuous and representable by a differential equation While the discrete-time ARMA equivalent would be of order $(p, p - 1)$, the prior operation of aggregation over a week would transform the model into an ARMA (p,p) Finally, systematic sampling would produce an ARMA of order (p,p) [23] Hence, the correct weekly model is not identified However, it still may be possible to determine an upper bound for σ_ϵ^2 from the data (see the section on empirical results)

Expressions for the signal in terms of the parameters are also readily available Corresponding to Equations 9 and 10 we have

$$\hat{\delta}_t = d(B)z_t$$

where

$$d(B) = \frac{G_\delta(B)}{G_\delta(B) + D(B)D(B^{-1})\sigma_\epsilon^2}$$

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[19] The φ's must satisfy appropriate stationarity restrictions that imply that the roots of the polynomial equation, $\varphi(B) = 0$, lie outside of the unit circle, where

$$\varphi(B) = 1 - \varphi_1 B - \varphi_2 B^2 - \cdots - \varphi_n B^n$$

To identify the moving average part of the model, it is also assumed that the roots of $\theta(B) = 0$ lie on or outside the unit circle, where

$$\theta(B) = 1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_{n-1} B^{n-1}$$

[20] See Marcello Pagano, "Estimation of Models of Autoregressive Signal Plus White Noise," *Annals of Statistics*, vol 2 (January 1974), pp 99–108, and Agustin Maravall, *Identification in the Shock Error Model* (Springer-Verlag, forthcoming)

[21] For a proof, see Maravall, 'Estimation "

[22] See Pagano, "Estimation of Models "

[23] See Kenneth R W Brewer, "Some Consequences of Temporal Aggregation and Systematic Sampling for ARMA and ARMAX Models," *Journal of Econometrics*, vol 1 (June 1973), pp 133–54

and

$$G_\delta(B) = \sum_{k=-\infty}^{\infty} \gamma_\delta(k) B^k$$

Last, given $d(B)$, the linear filter for the signal

$$\hat{\eta}_t = c(B) z_t$$

can be constructed [24]

Empirical results

Standard error estimates for the ANOVA, SEW, and SQW models

Estimated transitory standard errors are displayed in Table 2 for five aggregates and for three detrending techniques, the ANOVA, SEW, and SQW Because the transitory errors in dollars turn out to be small relative to the levels of the aggregates, the transitory standard errors of the logarithm of an aggregate can be interpreted (approximately) as a percentage of the aggregate's level (Appendix 1 shows that the error in this approximation is very small) These standard errors are estimated by using 1,815 daily residuals for an integral number of weeks from 1968 through 1974 The residuals from each model are grouped by day of week, by year, and collectively For each entry, the sum of squared residuals is divided by an appropriate constant to obtain an estimate of the standard deviation [25]

The aggregate displaying the most transitory variation (expressed as a per cent of the level) is demand deposits, followed in order by M_1, by currency, by M_2, and by other time and

[24] See, for example, Whittle, *Prediction and Regulation*, chap 8

[25] Let N_i be the number of residuals associated with column i of Table 2 The divisor, D_i, is

$$D_i = N_i - N_\eta - N_D$$

where N_η is a number associated with the detrending procedure (reflecting the fact that the residuals are estimates of $[1 - c(B)]\epsilon_t$ rather than ϵ_t themselves), and N_D is the "prorated" share of the degrees of freedom lost by estimating the day of-week parameters For the ANOVA model, N_η = the number of weeks in N_i For the SEW or SQW

$$N_\eta = c_0 N_i$$

where $c_0 = 1/5$ for the SEW and 17/35 for the SQW, see Anderson, *Statistical Analysis*, p 53, Equation 28

TABLE 2 Estimates of the Standard Deviation of the Transitory Component, Alternative Methods

Per cent

Aggregate and method	Days					Years							
	Mon	Tues	Wed	Thu	Fri	1968	1969	1970	1971	1972	1973	1974	1968–74
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Currency													
ANOVA	4167	4121	5963	7331	3922	4988	5065	4847	5156	5475	5662	5666	5273
SEW	4165	2522	2664	3298	2275	2849	3243	2993	3019	3187	3143	2974	3062
SQW	2468	1816	1542	1776	2005	1642	2044	1776	2015	2112	2023	1964	1947
Demand deposits													
ANOVA	7164	5912	8436	8116	5460	6517	7824	7428	6603	6516	7251	7601	7116
SEW	7162	5355	4850	5329	4307	4598	5540	5773	5636	5104	5360	6301	5485
SQW	5278	4404	3311	3571	3973	3285	4074	4356	3935	3506	4437	5272	4166
M_1													
ANOVA	5159	4724	6750	6609	4405	5168	6206	5815	5219	5090	5749	5999	5614
SEW	5157	4207	3762	4017	3313	3534	4309	4454	4236	3764	3960	4649	4137
SQW	3804	3255	2560	2782	2967	2534	3099	3344	2945	2497	3261	3844	3104
Other time and savings deposits													
ANOVA	1469	0919	1161	1193	1383	0972	1180	1044	1209	1010	1491	1658	1240
SEW	1468	0852	0743	0902	1361	0878	1060	0921	0920	0950	1405	1459	1104
SQW	1152	0639	0489	0612	1105	0601	0740	0821	0693	0679	1073	1164	0846
M_2													
ANOVA	2491	2380	3366	3406	2279	2771	3312	3192	2648	2449	2724	2650	2828
SEW	2490	2110	1816	2009	1687	1850	2310	2399	2075	1805	1802	2011	2041
SQW	1779	1521	1278	1428	1510	1346	1603	1844	1467	1209	1385	1650	1512

NOTE —The estimates are expressed as a percentage of the level Thus, the entry in column 1 for the ANOVA model of the logarithm of currency indicates that the estimated standard deviation on Mondays was 4167 per cent of the level of currency The ANOVA estimates differ slightly from the estimates reported in *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* (Board of Governors of the Federal Reserve System 1976), table 5, p 27 The yearly estimates here are based on day of week effects estimated for the entire sample period, in table 5 of *Improving the Monetary Aggregates Report*, the annual estimates are based on separate ANOVA's for each calendar year The table above also corrects a minor data error in the ANOVA calculations in *Improving the Monetary Aggregates Report* for both the other time and savings component of M_2 and M_2 itself savings deposits The estimates provided by the ANOVA method are uniformly higher than those from the other two methods Evidently, the more restrictive trend specification results in greater variability in the residual Except for other time and savings deposits, the ANOVA estimates are about 2 to 2 5 times as large as the SQW estimates and about 1 3 to 1 7 times as large as the SEW estimates For other time and savings deposits, the ANOVA estimates are about 1 5 times as large as the SQW estimates and about 10 per cent larger than the SEW estimates

Assessment of intraweekly heteroskedasticity

The over-all validity of the various models depends on, among other things, the validity of the assumptions concerning the residuals, namely, homoskedasticity and lack of serial correlation Serial correlation is treated later in the discussion of autocorrelation tests Concerning heteroskedasticity, if the transitory variance itself exhibited a systematic pattern—for example, an intraweekly pattern—the foregoing efforts could not be aimed at a single measure of transitory variability but only at a composite or average of such measures It is, therefore, important to ascertain if heteroskedastic patterns exist

The degree of heteroskedasticity across weekdays is reported in columns 1 through 5 of Table 2 for different aggregates and methods For each of the methods, there are significant differences in the estimated intraweekly standard deviations Observe that the ANOVA and SEW models are virtually equal on Mondays As noted earlier, this equality holds because a Thursday-to-Wednesday statement week was used to define a week in the ANOVA method It is interesting, therefore, to compare Monday standard deviations with the other intraweekly standard deviations for the three methods Table 3 presents the ratio of the standard deviation of each day of the week relative to the standard deviation for Monday, for each method On the basis of the SEW and SQW estimates, it appears that

TABLE 3. Relative Intraweekly Standard Deviations for M_1 and M_2

Method	Tuesday	Wednesday	Thursday	Friday
M_1				
ANOVA	92	1 31	1 28	85
SEW	82	73	78	64
SQW	86	67	73	78
M_2				
ANOVA	96	1 35	1 37	91
SEW	85	73	81	68
SQW	85	72	80	85

NOTE —Computed from columns 1 through 5 in Table 2

Monday has the highest transitory standard deviation With the ANOVA estimates, on the other hand, it appears that Wednesday and Thursday are the most noisy days within the week For the ANOVA method it appears, moreover, that the relative ranking of the 4 days depends on how far the day of the week is from the center of the statement week (Monday) Assuming that the underlying trend is centered on each day, the ANOVA method distorts what is occurring by estimating the trend using three-fifths of the appropriate days for Wednesday and Thursday and four-fifths for Tuesday and Friday Thus, if it is true that Mondays have the highest transitory variance, the resulting intraweekly pattern in the ANOVA estimates is fully explicable Tuesday and Friday trend estimates contain only one spurious day, so their standard deviations are smaller than the Wednesday and Thursday estimates, which contain two spurious days each The ANOVA heteroskedasticity may, therefore, be regarded as evidence of the inappropriateness of the detrending procedure for this method

In the other procedures (SEW and SQW), the observed differences between the estimated daily transitory variances appear to be smaller Nonetheless, there is evidence that Monday's transitory variation is largest This additional random movement on Mondays may reflect desired adjustments of balances by the public and banks that emerge after the close of business on Friday but are not implemented until Monday transactions take place In what follows, it is important to recognize also that Friday tends to have less transitory variation than the over-all estimate

Autocorrelation tests

Recall that one of our assumptions is that the transitory component, ϵ_t, is serially uncorrelated Indeed, if it were autocorrelated (at least at lags other than a day or two), such a feature could scarcely be considered "transitory"[26] On the other hand, it is important to note that each of the detrending methods induces intraweekly serial correlation in the residuals In the ANOVA procedure, the residuals are constrained to sum to zero over a statement week, in the two moving-average procedures, the residuals are estimates not of ϵ_t but of $[1 - c(B)]\,\epsilon_t$ The induced autocorrelations, say, ρ_1, ρ_2, ρ_3, and ρ_4 can be calculated on the assumption that ϵ_t is itself serially uncorrelated (Table 4) Also affected are the standard errors of the sample autocorrelations of the residuals, as they depend on the population autocorrelations $\{\rho_k\}$,[27] they are also shown in Table 4

Based on these results, statistics bearing on the adequacy of the serial-independence assumption for the transitory component, ϵ_t, are displayed in Table 5 The actual sample autocorrelations of the residuals, r_k, minus the theoretical autocorrelations ρ_k, are presented for lags 1 to 4 Also, beneath each autocorrelation is the statistic, $z_k = (r_k - \rho_k)/\sqrt{\text{var}(r_k)}$ A value of z_k larger than 2 in absolute value is evidence of serial correlation Inspection reveals *substantial low-order autocorrelation for all aggregates and methods* The z statistics in column 1 for the lag 1 autocorrelation are all highly significant Columns 5, 6, and 7 present the autocorrelations for monthly, quarterly (r_{65}), and annual (r_{260}) lags[28] For the ANOVA and SEW, the correlation at these lags

TABLE 4. Expected Residual Autocorrelations and Their Standard Errors Under Alternative Detrending Methods

Method	Lag				
	1	2	3	4	≥5
ANOVA	− 160 (021)	− 120 (023)	− 080 (024)	− 040 (025)	* (024)
SEW	− 300 (016)	− 350 (014)	100 (027)	050 (028)	* (028)
SQW	− 800 (0091)	400 (030)	− 114 (036)	014 (038)	* (038)

* Negligible

NOTE —The autocorrelations are derived under the null hypothesis that ϵ_t is not serially correlated Standard errors are shown in parentheses For a white noise process, the standard error is $1/(1815)^{1/2}$ = 0235

is unquestionably significant and often important For example, consider the annual autocorrelation in the ANOVA model for currency, $r_{260} = 0\ 65$ The autocorrelations at the next two multiples of 260 are $r_{520} = 0\ 34$ and $r_{780} = 0\ 11$ Ignoring all the other autocorrelations in the currency residuals, this would suggest that the residuals follow a process of the form[29]

$$\epsilon_t = 65\epsilon_{t-260} + u_t$$

where u_t is the true transitory (white noise) process with variance

$$\sigma_u^2 = (1 - 65^2)\sigma_\epsilon^2 = 5775\sigma_\epsilon^2$$

That is, the implied daily transitory standard deviation for currency would be about $0\ 76\sigma_\epsilon = 0\ 4007$ per cent, and not 0 5273 per cent Only the residuals from the SQW model display some signs of serial independence at the monthly and quarterly lags Also, it is worth noting that except for other time and savings deposits, the magnitude of the autocorrelation at the annual lag for the SQW model is markedly lower than that for the other two models However, the ANOVA and SEW methods have substantial monthly and quarterly effects that have not been eliminated The monthly effect is quite noticeable in the individual autocorrelations for M_1 that are listed in Table 6 for the three methods Observe that for the ANOVA and SEW models, there are persistent autocorrelations at a monthly frequency (20 or 21 days and multiples thereof)

[26] For example, if ϵ_t were seasonal, part of the component could be predicted on the basis of what occurred a month ago, a year ago, and so forth

[27] $$\text{var}(r_k) = \frac{1}{N}\sum_{i=-\infty}^{\infty}[\rho_i^2 + \rho_{i-k}\rho_{i+k} - 4\rho_i\rho_k\rho_{i-k} + 2\rho_i^2\rho_k^2]$$

where N = the sample size, see Maurice S Bartlett, *An Introduction to Stochastic Processes*, 2nd ed (Cambridge, England Cambridge University Press, 1966)

[28] The monthly effect has a lag of about 20 or 21 days, the maximum of the two r_m's is reported

[29] See Box and Jenkins, *Time Series Analysis*

TABLE 5 Residual Autocorrelations and Related Statistics, Selected Lags

Method and aggregate	$r_1 - \rho_1$ (1)	$r_2 - \rho_2$ (2)	$r_3 - \rho_3$ (3)	$r_4 - \rho_4$ (4)	r_m (5)	r_{65} (6)	r_{260} (7)
ANOVA							
Currency	51 (24 3)	− 02 (− 9)	− 20 (−8 3)	− 25 (−9 9)	40 (16 7)	51 (21 3)	65 (27 1)
Demand deposits	33 (15 9)	− 08 (−3 6)	− 14 (−5 7)	− 16 (−6 4)	16 (6 7)	36 (15 0)	47 (19 6)
M_1	34 (16 2)	− 09 (−3 9)	− 16 (−6 9)	− 16 (−6 2)	22 (9 2)	42 (17 5)	48 (20 0)
Other time and savings deposits	19 (8 9)	− 21 (−9 0)	− 22 −(9 0)	− 06 (−2 5)	24 (10 0)	19 (7 9)	24 (10 0)
M_2	35 (16 8)	− 09 (−4 0)	− 17 (−7 1)	− 16 (−6 5)	22 (9 2)	45 (18 8)	48 (20 0)
SEW							
Currency	49 (30 3)	03 (2 1)	− 31 (−11 6)	− 11 (−4 0)	18 (6 4)	21 (7 5)	48 (17 1)
Demand deposits	26 (16 5)	− 06 (−4 3)	−0 1 (−3 7)	− 03 (−1 0)	10 (3 6)	11 (3 9)	24 (8 5)
M_1	28 (17 3)	05 (3 8)	− 10 (−3 8)	− 04 (−1 4)	10 (3 6)	14 (5 0)	22 (7 9)
Other time and savings deposits	25 (15 6)	− 13 (−9 6)	− 29 (−10 8)	− 02 (− 9)	21 (7 5)	21 (7 5)	17 (6 1)
M_2	30 (18 7)	− 04 (−2 9)	− 13 (−4 7)	− 06 (−2 1)	11 (3 9)	16 (5 7)	21 (7 5)
SQW							
Currency	06 (7 0)	− 11 (−3 6)	05 (1 4)	− 02 (− 7)	02 (5)	03 (8)	30 (7 9)
Demand deposits	07 (7 5)	− 15 (−5 1)	12 (3 3)	− 03 (− 8)	− 02 (− 5)	− 01 (− 3)	16 (4 2)
M_1	07 (7 8)	− 16 (−5 4)	13 (3 6)	− 02 (−1 1)	− 01 (− 3)	− 01 (− 3)	13 (3 4)
Other time and savings deposits	06 (7 0)	− 15 (−5 1)	19 (5 5)	− 25 (−6 8)	20 (5 3)	13 (3 4)	16 (4 2)
M_2	07 (7 6)	− 15 (−5 2)	12 (3 5)	− 03 (−1 0)	− 02 (− 5)	01 (3)	08 (2 1)

NOTE —Figures in parentheses are z_k values

and that these autocorrelations show no tendency to die out as the lag increases This pattern suggests that the underlying process for ϵ_t has a seasonal (monthly) nonstationarity

Holiday effects

Bank holidays likely represent an additional source of variation in the time series models under consideration Several attempts were made to incorporate dummy variables for major bank holidays into the specifications of the ANOVA, SEW, and SQW models While these results most often yielded statistically significant regression coefficients for major bank holidays, on balance it appears that most of the effect is confined to Monday bank holidays

The problem can readily be illustrated by considering the outliers for demand deposits from the ANOVA method In the sample, there were 29 Monday holidays on which all or a substantial portion of commercial banks were closed, all of the residuals from these Monday holidays for the ANOVA model for demand deposits were negative, and all but one were greater in absolute value than one standard error The root mean square residual for the Monday holidays is 1 35 per cent of the level of demand deposits, which is nearly twice as large as the over-all standard error for Mondays The source of the problem is an interaction between the day-of-week effects and Monday holidays A holiday on which all or substantially all of the banks are closed should properly receive the day-of-week effect on the nearest preceding day that banks were open Thus, Monday holidays should receive the Friday day-of-week effect rather than the Monday day-of-week effect

The average residual on the Monday holidays was −1 30 per cent of the level of demand deposits This value is highly signifi-

TABLE 6. Autocorrelations for M_1

Lags	Lags 1	2	3	4	5	6	7	8	9	10	11	12
						ANOVA residuals						
1–12	18	–21	–24	–20	–06	05	07	–06	–04	–03	00	04
13–24	07	02	–13	–10	–08	–05	07	22	09	03	–00	–04
25–36	–01	–00	02	–01	–06	–16	–01	13	14	01	–16	–10
37–48	–02	05	04	00	–08	–03	04	11	21	07	–02	–10
49–60	–12	–13	–05	13	02	–04	–10	–03	–02	–09	04	–12
61–72	–13	–14	–07	14	42	19	03	15	14	04	02	04
73–84	–03	–03	–06	–01	05	09	03	–09	–11	–09	–04	04
85–96	19	10	04	–03	–03	03	02	01	–02	–07	–15	01
97–108	15	10	–01	–16	–03	02	07	01	–06	–10	–05	02
109–120	–16	28	08	–04	–10	–13	–11	–03	10	03	–02	–07
121–132	–06	01	08	04	–11	–13	–12	–05	14	39	18	–03
133–144	–13	–11	–08	02	08	–01	–08	–09	–02	07	11	02
145–156	–11	–09	–09	–02	05	13	05	06	00	–04	05	02
157–168	02	–01	–07	–17	01	12	10	–01	–15	–06	–01	–06
169–180	02	–07	–10	–07	01	13	30	–10	–06	–10	–11	–07
181–192	–03	–05	00	–03	–02	–01	–01	–04	–04	–08	–14	–13
193–204	–08	12	38	17	03	11	–10	–05	–02	04	03	05
205–216	–09	–00	05	11	04	–11	–08	–06	–02	02	08	01
217–228	03	03	04	07	02	00	–05	–09	–15	02	15	11
229–240	–02	–17	–08	02	07	02	–08	–12	–06	00	16	29
241–252	09	–06	–09	–10	–11	04	06	00	–01	–03	–02	01
253–264	04	02	–04	–13	–18	–11	09	43	20	–05	– '6	–14
265–276	01	05	06	–06	–08	–08	01	09	08	00	–11	–07
277–288	–05	–02	03	05	–00	03	04	04	09	01	–02	–03
289–300	–06	–13	–01	11	10	–00	–13	–07	01	10	02	–11
						SEW residuals						
1–12	–02	–40	–00	01	–09	–02	02	–08	–01	11	07	01
13–24	–04	01	–03	–06	–02	–06	–04	02	10	16	06	–05
25–36	–02	–05	–03	–01	03	–03	–04	05	08	02	–02	–03
37–48	–02	–05	–03	–02	–10	02	21	14	–03	–04	00	–07
49–60	–08	00	–01	–01	01	05	04	–00	00	00	–02	–08
61–72	–07	–05	–00	05	14	18	04	–09	–09	–03	–04	01
73–84	–02	–01	03	06	03	–01	–00	00	–07	–05	–02	–05
85–96	01	09	13	04	–02	–00	–04	–07	–02	01	–02	–04
97–108	06	03	02	–00	–02	01	–02	–05	–05	–06	–01	12
109–120	17	05	–04	–02	–06	–08	–01	–02	01	–02	05	08
121–132	–04	–01	02	–01	–10	–04	–02	–07	05	18	12	00
133–144	–02	–01	–10	–07	04	–01	–04	03	01	04	04	–03
145–156	–01	–01	–07	–04	–02	–05	03	20	10	–05	–03	–03
157–168	–05	–01	00	–03	–02	03	05	02	–04	01	03	–06
169–180	–06	–03	–04	–01	08	11	09	01	–01	–06	–10	00
181–192	01	–03	–02	03	07	02	00	–03	02	–03	–12	–04
193–204	–03	01	15	16	03	–05	–04	–05	–05	–01	–02	–02
205–216	01	06	03	–02	–01	02	–03	–04	–05	–04	–04	02
217–228	14	12	02	–04	–04	–03	–02	–01	–05	–04	05	07
229–240	04	–03	–03	01	–04	–03	–01	–09	–05	08	19	09
241–252	–03	–04	–01	–07	–06	03	–03	–04	04	06	04	04
253–264	–05	–04	03	–06	–09	–08	–06	22	22	03	–05	–06
265–276	–07	–04	02	–03	–02	–02	04	09	01	–05	–01	–00
277–288	–04	–06	00	–05	–02	14	12	02	–03	–02	–05	–08
289–300	01	–01	–07	01	08	06	–00	–05	01	04	–09	–09
						SQW residuals						
1–12	–73	24	02	–03	–00	–02	06	–06	01	03	–04	05
13–24	–05	04	00	–05	08	–08	03	–01	–01	02	01	–05
25–36	04	–01	–01	–00	02	–01	–01	01	01	–02	02	–03
37–48	03	–02	–02	06	–06	01	02	00	–02	–00	02	–00
49–60	–04	05	–04	02	–00	–01	02	–03	03	–03	04	–05
61–72	05	–04	03	–02	–01	03	–02	02	–04	08	–09	08
73–84	–06	03	–01	01	–00	00	–02	05	–05	02	02	–04
85–96	03	–03	03	–01	–02	02	–00	–02	02	–03	05	–08
97–108	09	–06	02	01	–03	03	–01	–01	02	–01	–01	00
109–120	01	00	–03	03	01	–05	08	–09	08	–06	–00	07
121–132	–09	08	–07	07	–07	02	03	–06	04	–01	01	–00
133–144	–03	06	–04	–01	04	–01	–04	06	–05	02	02	–03
145–156	01	02	–04	02	–00	02	–06	07	–02	–04	04	–01
157–168	–00	–00	02	–02	00	01	–01	02	–02	–00	03	–03
169–180	01	01	–00	–02	03	–03	04	–03	00	04	–07	06
181–192	–02	–01	02	–04	05	–06	07	–06	03	03	–07	08
193–204	–02	–03	03	–01	01	–02	02	00	–02	03	–02	02
205–216	–03	02	–01	01	–02	04	–04	03	–02	01	01	–04
217–228	05	–03	02	–02	02	–00	–01	01	01	–04	05	–05
229–240	04	–02	–01	04	–02	–02	06	–06	04	–04	05	–03
241–252	01	02	03	01	04	08	03	00	01	01	04	05
253–264	03	–02	05	–02	–04	11	–16	–13	04	02	–02	01
265–276	–03	–05	03	–07	–05	02	–01	04	–02	–01	02	–02
277–288	04	–07	07	–03	–03	05	–03	01	–01	01	01	–03
289–300	01	02	–04	02	01	–02	02	–02	–01	04	–02	–04

TABLE 7 Differences in Day-of-Week Effects in the ANOVA Model for Demand Deposits

Days	Difference
Thursday, Friday	95
Friday, Monday	−1 31
Monday, Tuesday	04
Tuesday, Wednesday	34
Wednesday, Thursday	− 02

cant[30] But if our assessment is correct, on average the Monday holiday residuals should be approximately equal to the difference between the Friday day-of-week effect and the Monday day-of-week effect, which is −1 31 per cent (Table 7) The data are thus remarkably consistent with our hypothesis[31] Table 7 also indicates why the holiday problem is essentially a problem only for Monday holidays Most of the other differences are small, and the only possible competitor, Friday, is a day with a relatively small number of holidays in most years This interpretation is also supported by an outlier analysis of those holidays that were switched to Mondays by an act of the Congress George Washington's Birthday, for example, did not contain persistent residual outliers until 1971, when it became tied to Monday

Fortunately, this misspecification in the day-of-week effect is rather small For example, if the Monday-holiday residuals were dropped from the sample, the over-all ANOVA standard error would fall only from 0 7116 to 0 6966

Estimates based on the OSD model

The model for optimal statistical decomposition (OSD) discussed earlier is applied in this paper only to weekly (7-day average) data on the demand deposit component of M_1 over a 215-week sample period from November 24, 1971, to December 31, 1975[32] The logarithm of the series, say z_t, appears to be nonstationary and a stationary series has the form

$$(23)\quad z_t = (1 - B^{52})(1 - B^{13})y_t = y_t - y_{t-13} - y_{t-52} + y_{t-65}$$

that is, both quarterly and annual differencing of the data are required to achieve stationarity

Letting

$$S_j(B) = 1 + B + B^2 + \quad + B^{j-1} = \frac{1 - B^j}{1 - B}$$

then

$$z_t = (1 - B)^2 S_{13}(B) S_{52}(B) y_t = D(B) y_t$$

and it follows that z_t may be thought of as being generated in the following way First, pass the logarithm of the aggregate through two successive annual and quarterly smoothing filters, $S_{52}(B)$ and $S_{13}(B)$, and then take second differences of the smoothed series Consequently, the stationary quantity, z_t, represents the *acceleration* (difference in the rate of growth) of a highly smoothed aggregate In Appendix 2, it is explained how Equation 7, together with

$$(24)\quad \delta_t = D(B)\eta_t$$

$$(25)\quad \delta_t = \varphi \delta_{t-1} + \epsilon'_t$$

$$(26)\quad z_t = \delta_t + e_t$$

(where $e_t = D(B)\epsilon_t$), is a reasonable first approximation to the data Equation 25 indicates that the systematic trend component is, after differencing and smoothing, a first-order autoregressive process

Using a quasi-maximum-likelihood technique an iterative algorithm was devised to estimate Equations 24 to 26[33] The estimates obtained by this procedure are

$$\hat{\varphi} = 89, \ \hat{\sigma}^2_{\epsilon'} = 226 \times 10^{-4}$$

$$\hat{\sigma}^2_{\epsilon} = 561 \times 10^{-5}$$

If the daily transitory errors are serially independent, the daily standard error associated with this weekly value of σ^2_ϵ is

$$\sqrt{561 \times 10^{-5}} \times \sqrt{7} = 006267$$

[30] The appropriate test statistic is

$$t = \frac{-1\ 30}{\hat{\sigma}_\epsilon/\sqrt{n}} = \frac{-1\ 30}{7116/\sqrt{29}} = -9\ 84$$

[31] Similar results were obtained for the SEW and SQW models

[32] In subsequent work we shall apply this technique to all aggregates at a daily level For a fuller description than that presented here, see Maravall "Estimation "

[33] Ibid , pp 12–16, for further details

This calculation assumes the errors have the same variance in each day Alternatively, one may wish to assume that the error on Saturday and Sunday is essentially that of Friday, which implies that the daily standard deviation of demand deposits is

$$\sqrt{561 \times 10^{-5}} \times \sqrt{49/13} = 004598$$

or it can be assumed that the error on Sundays is equal to that of Saturdays, which implies that the daily standard error is[34]

$$\sqrt{561 \times 10^{-5}} \times \sqrt{49/9} = 005527$$

Thus, the implied standard deviation for daily demand deposits runs from about 0 46 per cent to 0 63 per cent depending on the treatment of weekend observations This range of values is below the ANOVA estimate of 0 71 per cent but includes the SEW estimate of 0 55 per cent

Strictly speaking, the use of weekly-average data to implement the OSD model is not appropriate That model applies only to data sampled once in some interval, not to the average of successive sampled values, and it applies strictly only to *stationary* series It follows that we cannot invoke the aggregation-continuity interpretation of that section to justify the empirical specification of Equation 7 and Equations 24 to 26 However, there is an alternative way of completing the model that has a legitimate basis

To bring out the essential ideas in this alternative approach, let us temporarily simplify the problem and suppose that e_t in Equation 26 is a white-noise process To recap the model, then, we observe z_t

(27) $$z_t = \delta_t + e_t$$

and have decided on the basis of empirical evidence that z_t is generated by an ARMA model of order (1,1)

(28) $$z_t = \varphi z_{t-1} + a_t - \theta a_{t-1}$$

where a_t is a white-noise process There are two possible models for the signal δ_t that are consistent with the over-all model for z_t in Equation 28 Either δ_t is a pure autoregressive process,

(29a) $$\delta_t = \varphi \delta_{t-1} + \epsilon'_t$$

or δ_t is also an ARMA model of order (1,1),[35]

(29b) $$\delta_t = \varphi \delta_{t-1} + \epsilon'_t - \theta \epsilon'_{t-1}$$

If daily data were being used, we could adopt Equation 29a on the basis of the results above With weekly-average data, however, there is no reason to reject the less restrictive specification Equation 29b, which is still consistent with the over-all *observed* model for z_t But there is a catch in this alternative specification The model consisting of Equations 27 and 29b is not identified in the econometric sense To identify the model, additional restrictions on the parameters must be imposed One useful restriction is to set $\theta = -1$ in Equation 29b This choice is optimal if one does not wish to understate the impact of the transitory variations, or, equivalently, if one wants to minimize the contribution of the systematic variation to the over-all observed variation[36]

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[34] The relationship between weekly and daily standard errors will be discussed in more detail later

[35] Strict notation would require that we distinguish between the white noise errors in Equations 29a and 29b Also, Equation 29a is a special case of Equation 29b when $\theta = 0$ Nevertheless, it is useful to consider these as distinct models because they differ in the number of parameters

[36] To see this explicitly, observe that

(A) $$\sigma_z^2 = \gamma_z(0) = \left(\frac{1 + \theta^2 - 2\varphi\theta}{1 - \varphi^2}\right)\sigma_{\epsilon'}^2 + \sigma_\epsilon^2$$

(B) $$\gamma_z(1) = \frac{(1 - \varphi\theta)(\varphi - \theta)}{1 - \varphi^2}\sigma_{\epsilon'}^2$$

(See Box and Jenkins, *Time Series Analysis*, Equation 3 4 7) Thus, maximizing σ_ϵ^2 given $\gamma_z(0)$ and $\gamma_z(1)$ and φ (which is identified) is equivalent to minimizing

(C) $$\left[\frac{1 + \theta^2 - 2\varphi\theta}{(1 - \varphi\theta)(\varphi - \theta)}\right]\gamma_z(1)$$

with respect to θ Differentiating Equation C with respect to θ and setting the derivative equal to zero, it can be shown that $\theta = -1$ gives the minimum value for σ_δ^2, or maximum value for σ_ϵ^2, given $\gamma_z(1)$ and φ

The idea of closing the model in this way was taken from two papers, David A Pierce, "Seasonal Adjustment When Both Deterministic and Stochastic Seasonality Are Present," and George E P Box, Stephen Hilmer, and George C Tiao, "Analysis and Modeling of Seasonal Time Series," presented at the National

Returning to the more general specification in which $e_t = D(B)\epsilon_t$, a similar analysis shows that the maximum value for the transitory variance, σ_ϵ^2, consistent with the observations on z_t is also achieved where $\theta = -1$ in Equation 29b And it can also be shown that the maximum transitory variance, say, σ_ϵ^2 (max) and σ_ϵ^2 in the (1,0) ARMA specification (29c), are related by the equation

$$(30) \qquad \sigma_\epsilon^2\,(\max) = \sigma_\epsilon^2 + \frac{25\sigma_{\epsilon'}^2}{(1+\varphi^2)}$$

Substituting into Equation 30 the estimated values for φ, $\sigma_{\epsilon'}^2$, and σ_ϵ^2, we find that

$$\sigma_\epsilon^2\,(\max) = 561 \times 10^{-5} + \frac{25 \times 226 \times 10^{-4}}{(1\ 89)^2} = 7192 \times 10^{-5}$$

$$= (2\ 682 \times 10^{-3})^2$$

The alternative daily standard deviations are then

$$\sqrt{7192 \times 10^{-5}} \times \sqrt{7} = 007095$$

$$\sqrt{7192 \times 10^{-5}} \times \sqrt{49/13} = 005206$$

$$\sqrt{7192 \times 10^{-5}} \times \sqrt{49/9} = 006257$$

Thus, depending on the assumptions made concerning transitory errors on the weekends, values of the daily transitory standard error can be found that are very close to one of the three predetermined trend weights Table 8 provides a summary of corresponding values

TABLE 8 Standard errors for OSD and Alternative Methods

Per cent of the level of demand deposits

Transitory standard error	Conversion factor		
	$\sqrt{7}$	$\sqrt{49/13}$	$\sqrt{49/9}$
σ_ϵ			
OSD estimate	6267	4598	5527
Nearest alternative estimate			
Estimate	5485	4166	5485
Method	SEW	SQW	SEW
σ_ϵ (max)			
OSD estimate	7095	5206	6257
Nearest alternative estimate			
Estimate	7116	5485	5485
Method	ANOVA	SEW	SEW

Sources of transitory variations in the aggregates

Transitory variations for any aggregate that is the sum of various components may be expressed as a weighted average of the variations in the component parts and the covariance terms between the transitory parts of each of the components Thus, the transitory variance in M_1 is equal to a weighted average of the transitory variances in currency and demand deposits, and the covariance between the transitory components of demand deposits and currency

The separate sources of transitory variations in an aggregate are assigned in the following way Let Y_t be an aggregate that is equal to the sum of m component aggregates Y_{it},

$$(31) \qquad Y_t = \sum_{i=1}^{m} Y_{it}$$

Recalling that

$$y_t = \ln (Y_t) = \eta_t + \beta_t + \epsilon_t = f_t + \epsilon_t$$

it follows that

$$Y_t = \exp (f_t) \exp (\epsilon_t)$$

Because ϵ_t is generally very small (for example, the standard error of ϵ_t for demand deposits is about 005), the first-order approximation

$$(32) \qquad \exp (\epsilon_t) = 1 + \epsilon_t$$

is an identity for all practical purposes[37] Thus, from Equation 32

$$(33) \quad Y_t \doteq \exp (f_t)(1 + \epsilon_t) = F_t + E_t$$

$$(34) \quad F_t = \exp (f_t), E_t = Y_t - F_t \doteq \epsilon_t F_t$$

In Equation 34, if $\epsilon_t =$ 005, the error in the approximation amounts to about 3¾ millions

Bureau of Economic Research–Census Conference on Seasonal Analysis of Economic Time Series, Washington, D C , September 9–10, 1976, in these papers similar restrictions were imposed on seasonal adjustment filters

[37] This approximation is almost as accurate as that listed in Table A-1 in Appendix 1

for an aggregate totaling 300 billion Note also that

$$(35)\qquad \epsilon_t = \frac{E_t}{F_t} = \frac{E_t}{Y_t}$$

where the second approximation is also highly accurate (see Appendix 1)

Returning to Equation 31, it is desired to assess the contribution of the transitory variation in each component aggregate, Y_{it}, to that of Y_t itself Note that the relations analogous to Equations 32 to 35 hold for each component aggregate, for example,

$$Y_{it} = F_{it} + E_{it}$$

$$\epsilon_{it} = y_{it} - f_{it} = \frac{E_{it}}{Y_{it}}$$

Thus, we have

$$\epsilon_t = \ln (Y_t/F_t) = \ln \frac{F_t + E_t}{F_t}$$

$$(36)\qquad = \ln\left(1 + \frac{E_t}{F_t}\right)$$

$$(37)\qquad = \frac{E_t}{F_t} = \frac{E_t}{Y_t} = \sum_{i=1}^{m} \frac{E_{it}}{Y_t} = \sum_{i=1}^{m} \frac{Y_{it}}{Y_t}\ \frac{E_{it}}{Y_{it}}$$

where the approximations in Equation 37 follow from Equations 32 and 35 Letting

$$(38)\qquad w_{it} = \frac{Y_{it}}{Y_t}$$

Equation 37 becomes

$$(39)\qquad \epsilon_t = \sum_{i=1}^{m} w_{it}\epsilon_{it}$$

Assuming that the deposit shares are fixed, the relative transitory variance of Y_t is approximated by

$$(40)\qquad \sigma_\epsilon^2 = \sum_{i=1}^{m} w_i^2\sigma_{\epsilon_i}^2 + \sum_{i=1}^{m} \sum_{\substack{j=1 \\ j\neq i}}^{m} w_i w_j \operatorname{cov}(\epsilon_{it}, \epsilon_{jt})$$

where $\operatorname{cov}(\epsilon_{it}, \epsilon_{jt})$ denotes the covariance between the component transitory errors [38] This expression indicates that the over-all transitory *variance* of an aggregate may be expressed approximately as a weighted average of the component variances and the covariance terms

Table 9 lists three decompositions—for gross deposits less cash items at member banks, for M_1, and for M_2 In each decomposition, the terms on the right-hand side of Equation 40 are listed separately as a percentage of the over-all transitory variance All numbers are based on the ANOVA estimates, though we believe that the other methods would produce very similar results [39] The discrepancy term is introduced to account for the error in Equation 40 that arises because the deposit shares do not stay constant over the sample periods and because Equation 40 is an approximate relation

For M_1 and M_2 Table 9 shows that almost all of the variation in both of these aggregates is due to the volatility in demand deposits The contributions of the variations in currency and other time and savings deposits are very small in relation to demand deposits, as are the contributions of the covariance terms

The other variance decomposition given is that of gross deposits less cash items at member banks This aggregate was chosen because a very high proportion of transactions involves offsetting changes in gross deposits and cash items For gross deposits less cash items, the relative contributions are somewhat more equal, with demand deposits adjusted and interbank bank deposits accounting for much of the variation The direct effect of government deposits declined significantly by the end of the sample period Though the share of government deposits is quite small—averaging around 3 3 per cent of the level of gross deposits less cash items—its daily transitory standard deviation was far larger than any other aggregate, averaging about 14 7 per cent

[38] The approximation error is potentially much larger over longer time intervals, but the empirical decompositions given later indicate that it is generally quite small

[39] This belief follows from the empirical result that alternative methods give approximately the same relative ranking of transitory standard deviations for different aggregates For example, the ratio of the transitory standard deviation of M_1 to that of M_2 was about 2 for each method

TABLE 9 Relative Contribution to the Over-All Transitory Variance of Selected Aggregates, 1968–74

In per cent

Aggregate and source of variation	1968	1969	1970	1971	1972	1973	1974	1968–74
Gross deposits less cash items at member banks								
Demand deposits adjusted (DDA)	66 5	74 0	76 7	101	73 4	40 7	36 7	58 3
Government (GOVT)	99 3	72 9	56 5	33 8	37 0	24 3	12 4	32 0
Interbank (IB)	23 5	34 0	58 8	118	86 0	48 1	52 2	47 8
Covariance (DDA, GOVT)	−60 9	−46 6	−35 6	−11 9	−23 2	−13 1	−6 9	−17 3
Covariance (DDA, IB)	−9 7	−16 0	−43 7	−140	−58 1	2 0	−7 9	−21 0
Covariance (GOVT, IB)	3 2	−3 8	2 2	11 0	−5 7	*	12 1	4 3
Discrepancy	−21 8	−14 6	−15 0	−11 8	−9 4	−2 0	1 4	−4 1
M_1								
Currency	4 47	3 2	3 3	4 8	5 8	5 1	4 8	4 3
Demand deposits	98 6	98 0	99 3	96 6	99 4	95 1	94 7	97 4
Covariance	−3 01	−1 1	−2 5	−1 4	−5 1	1	7	−1 6
Discrepancy	− 07	− 01	*	*	*	− 2	− 3	− 2
M_2								
Currency (CUR)	4 5	3 2	3 1	4 7	6 0	5 4	5 5	4 3
Demand deposits (DD)	99 0	98 7	92 5	95 6	103 9	101 8	107 1	98 1
Other time and savings (OTS)	2 5	1 5	2 3	4 6	4 5	7 1	9 5	4 7
Covariance (DD, CUR)	−3 0	−1 1	−2 3	−1 4	−5 4	1	8	−1 6
Covariance (DD, OTS)	−2 7	−2 9	3 5	−4 7	−9 7	−16 7	−25 8	−7 0
Covariance (CUR, OTS)	− 3	*	8	7	5	2 5	3 0	7
Discrepancy	*	5	2	5	1	− 2	− 1	8

* Negligible

NOTE —For each aggregate decomposition, the weighted variance terms, $w_i^2\sigma_{\epsilon_i}^2$, are listed as a per cent of the over-all transitory variance for that aggregate, that is, as 100 $w_i^2\sigma_{\epsilon_i}^2/\sigma_\epsilon^2$ Beneath the variance components are the relative covariance terms, 200 $w_i w_j$ Cov$(\epsilon_i,\epsilon_j)/\sigma_\epsilon^2$ The discrepancy is also expressed as a per cent of σ_ϵ^2

of the level of government deposits over the 1968–74 sample period [40]

From the M_1 and M_2 decompositions, it appears that demand deposits are the major source of transitory variation in these aggregates However, recent developments may alter this pattern In particular, passbook savings accounts at commercial banks probably now behave more like demand deposit accounts in the short-run payments mechanism [41] These developments appear to stem from several recent changes in bank regulations including passbook savings accounts for corporations and State and local governments, telephonic transfers between passbook savings accounts and demand deposit accounts, and negotiable orders of withdrawal (NOW) accounts As a result of these changes, fluctuating payments between the public and commercial banks or between the public and the Treasury are more likely to include some very short-run variation in aggregate passbook savings deposits at commercial banks To investigate this possibility, we constructed ANOVA models of transitory variation for aggregate passbook savings accounts at member banks over two periods, before the introduction of corporate passbook accounts and after the introduction of such accounts [42] The estimated standard error before the change was 0 111 per cent of the level, it jumped to 0 160 per cent after the change in regulations regarding corporate passbook accounts The appropriate F-statistic to test the equality of the transitory variances in the two periods is F(127,1423) = 2 03 Thus, the data indicate a highly significant increase in the transitory variance of passbook savings accounts at member banks since corporations have become eligible to hold passbook savings accounts [43]

[40] Government deposits is the only aggregate we have considered for which the approximation represented by Equation 32 is not highly accurate

[41] See John D Paulus and Stephen H Axilrod, "Regulatory Changes and Financial Innovations Affecting the Growth of the Monetary Aggregates," staff memorandum (Board of Governors of the Federal Reserve System, November 1976)

[42] Corporations became eligible to hold such accounts on November 10, 1975, about a year later than State and local governments The two periods used in this paper were from 1969 through the statement week ending on November 5, 1975, and from the statement week beginning on November 13, 1975, to June 30, 1976

[43] The data also indicate that the change did not occur much earlier If the initial ANOVA estimates are derived from the beginning of 1974 to November 5, 1975, the resulting standard error is only slightly larger, 112 instead of 111 The associated F-statistic—F(127,379) = 1 94—is also highly significant

Transitory variations in averages of daily data

To examine transitory variations in intervals longer than a day, one must investigate transitory variances of sums or arithmetic means of aggregates. Let Y_s^n be the arithmetic mean of n successive daily observations for which σ_ϵ is the daily transitory standard deviation of the natural log of Y_t measured daily. (The subscript s indexes the n-day period contrasted with t, which denotes the daily index.)

As before, it is assumed that the transitory errors in the daily aggregates are statistically independent of the systematic movements. This independence implies that the Federal Reserve does not intervene and does not alter the systematic trend in the aggregates to offset some or all of the accumulated transitory variations that occur. Estimates of the impact of transitory variations on monthly and quarterly growth rates, which will be considered below, are sufficiently small so that this independence assumption is unlikely to be violated in most periods.

If the errors, ϵ_t, are serially independent, it is natural to assume that the relative transitory standard deviation for Y_s^n is[44]

$$(41) \qquad \frac{\sigma_\epsilon}{\sqrt{n}}$$

In fact, a more appropriate formula is

$$(42) \qquad \frac{\sigma_\epsilon}{\sqrt{n}}\sqrt{1 + V_n}$$

where V_n is the coefficient of variation for the systematic part of Y_s^n over the period s.[45]

If, instead of the arithmetic mean, the geometric mean were used, then the simpler Expression 41 for the transitory standard deviation would be appropriate. Because Expression 41 is always smaller than Expression 42, the geometric mean will have a uniformly lower transitory standard deviation than the arithmetic mean. It follows that the rate of growth of an aggregate formed by taking the geometric mean of daily observations will have a lower observed transitory variance than will a daily-average aggregate. Empirical calculations confirm this result. However, the differences between the estimated variances are extraordinarily small and have no practical significance. (They are nearly equal because rates of change in the aggregates—at least for daily, weekly, monthly, or quarterly data—are generally so small that arithmetic and geometric means will be very close to each other as will their transitory variances.) A related empirical calculation indicates that the term V_n in Expression 42 is very small so that Expressions 41 and 42 are practically equal. Accordingly, we will adopt the simpler expression, $\sigma_\epsilon/\sqrt{n}$, to represent the relative standard deviation of a daily average of n observations.

Serial correlation in the residuals

If the transitory errors are serially correlated, then the autocorrelations must be taken into account when computing the standard deviation of the daily averages. Because the large autocorrelations in the estimated models tend to be positive, the implied reduction in the standard deviation—from σ_ϵ daily to $\sigma_\epsilon/\sqrt{n}$ for Y_s^n—is probably too large.[46] On the other hand, if one were to model the residuals from the ANOVA, SEW, or SQW model as a stationary stochastic process, the resulting estimates of the transitory standard deviation would be lower. This is true because there would be useful information in the model residuals about future "transitory" residuals and the fundamental uncertainty about the true transitory component would

[44] Throughout this section, the standard deviation of a daily aggregate will be expressed relative to the level of that aggregate (expressed either as a percentage or 1/100 of a per cent).

[45] The matter is complicated owing to the nonstationarity of the systematic part of Y_t; generally, the current "level" of the series is substituted for the nonexistent population mean in V_n.

[46] The actual standard deviation is $\sigma_\epsilon\sqrt{k/n}$, where

$$k = 1 + 2\sum_{j=1}^{n-1}(1 - j/n)\rho_j$$

and ρ_j is the autocorrelation of lag j.

actually be less Models with a large degree of serial correlation in the transitory component (estimated residuals) seem to belie the notion of "transitoriness" and redoing these models by incorporating a time series model to explain the serially correlated residuals would lower the standard error [47] Thus, it seems reasonable to regard the estimate $\sigma_\epsilon/\sqrt{n}$ as an upper bound for the underlying transitory standard deviation of Y_s^n and to expect the bound to be closer to the correct standard deviation for models and aggregates having a smaller amount of autocorrelation in the residuals

From daily to weekly estimates

By excluding weekends it is a straightforward matter to go from estimates of daily standard errors to monthly or quarterly estimates However, because alternative values for the weekend effects will be considered, it is convenient to work with an aggregate Y_s^n in intervals of $n/7$ weeks

Let σ_ϵ be the daily standard deviation and assume that the transitory components are independent from day to day If the weekly average is an average of seven independent daily figures, the implied standard deviation in the weekly figures is, in accordance with Expression 41,

$$(43) \qquad \sigma_\epsilon/\sqrt{7} = 378\sigma_\epsilon$$

This estimate treats the transitory component on weekends as being fully equivalent to the component on weekdays But banks are closed on Sundays, making the Saturday observation identical with Sunday's Thus, whatever transitory part exists in the Saturday observation is also present in the Sunday observation When it is assumed that the Saturday transitory component counts twice, the weekly transitory standard deviation becomes

$$(44) \qquad \sqrt{\frac{(1+1+1+1+1+2^2)}{7^2}\,\sigma_\epsilon^2} = \sqrt{\frac{9}{49}\,\sigma_\epsilon^2} = 3/7\sigma_\epsilon = 429\sigma_\epsilon$$

If the Friday transitory component remains in both weekend observations and if it is assumed that there is no independent source of transitory variation on Saturday itself, then the Friday transitory component counts three times in computing the transitory standard deviation for the weekly observation [48] Under this assumption the implied weekly transitory standard deviation is

$$(45) \qquad \sqrt{\frac{(1+1+1+1+3^2)\sigma_\epsilon^2}{7^2}} = \sqrt{\frac{13}{49}\,\sigma_\epsilon^2} = 515\sigma_\epsilon$$

The correct weekly deflating factor is probably much closer to Equation 45 than to Equation 44 A convenient compromise figure is to assume that

$$(46) \qquad \sigma_w = \sigma_\epsilon/2$$

is the weekly standard deviation for a daily aggregate

Intraweekly heteroskedasticity

All of the foregoing blow-up factors fail to account for the intraweekly variation (heteroskedasticity) in the estimated standard deviations As noted above, Friday estimates are weighted more heavily than those of other weekdays in deriving weekly standard deviations Because of the apparent difference between the standard deviation for Fridays and the over-all standard deviation, it is useful to consider the modifications that occur by taking these differences into account Instead of Equation 45, the appropriate substitute for the weekly standard deviation is

$$(47) \qquad \left(\sum_{j=1}^{4} \sigma_{\epsilon j}^2 + 9\sigma_{\epsilon 5}^2\right)^{1/2} \Big/ 7$$

where $j = 1$ denotes Monday, $j = 2$, Tuesday, and so forth

From weekly to longer intervals

To go from weekly standard deviations to monthly, quarterly, or other standard devi-

[47] That is, the residuals from the times series model would have a lower standard deviation

[48] The Advisory Committee on Monetary Statistics adopted this assumption in its report, *Improving the Monetary Aggregates Report,* p 28

ations, one must, essentially, count the number of weeks in the time interval[49] Consider an "average" month in a 365-day year, which is viewed as having 28 days with probability 1/12, 30 days with probability 4/12, and 31 days with probability 7/12 For this average month the transitory variance, σ_m^2, is

$$(48)\quad \sigma_m^2 = \frac{\sigma_w^2}{12}\,[7/28 + 4(7/30) + 7(7/31)] = \frac{35987}{156240}\,\sigma_w^2$$

where σ_w^2 is the weekly transitory standard deviation In view of Equation 46, the monthly transitory standard deviation is

$$(49)\quad \sigma_m = (½)\sqrt{\frac{35987}{156240}}\,\sigma_\epsilon = 240\,\sigma_\epsilon$$

Similar expressions exist for 2-month averages ($2m$), quarterly averages (q), semiannual averages (sa), and annual averages (a)

$$(50)\quad \sigma_{2m} = \sqrt{\frac{\sigma_w^2[(7/59) + 2(7/62) + 9(7/61)]}{12}} = 1694\sigma_\epsilon = \frac{\sigma_m}{\sqrt{2}}$$

$$(51)\quad \sigma_q = \sqrt{\frac{\sigma_w^2[(7/90) + (7/91) + 2(7/92)]}{4}} = 1385\sigma_\epsilon = \frac{\sigma_m}{\sqrt{3}}$$

$$(52)\quad \sigma_{sa} = \sqrt{\frac{\sigma_w^2[(7/181) + (7/183) + (7/184) + (7/182)]}{4}} = 0979\sigma_\epsilon = \frac{\sigma_m}{\sqrt{6}}$$

$$(53)\quad \sigma_a = \sqrt{\frac{7}{365}\,\sigma_w^2} = 0692\sigma_\epsilon \doteq \frac{\sigma_m}{\sqrt{12}}$$

Growth rates

Let $g_s^n = (Y_s^n - Y_{s-1}^n)/Y_{s-1}^n$ be the growth rate at time s for an aggregate Y measured as an n-day average Notice that $\ln(1 + g_s^n) = \ln(Y_s^n) - \ln(Y_{s-1}^n) \doteq g_s^n$ Hence g_s^n has approximately the same transitory variance as $\ln(Y_s^n) - \ln(Y_{s-1}^n)$ But the relative transitory variance of Y_s^n is identical to that of $\ln(Y_s^n)$ Accordingly, the variance of g_s^n is

$$(54)\quad \sigma^2_{g_s^n} = \frac{2\sigma_\epsilon^2}{n}$$

assuming that the averages Y_s^n and Y_{s-1}^n are uncorrelated Given the special treatment of weekend observations this result can be expressed for the growth rates of designated averages

$$(55)\quad \sigma_{g(m)} = \sqrt{2\sigma_m^2} = 3394\sigma_\epsilon$$

$$(56)\quad \sigma_{g(q)} = \sqrt{2\sigma_q^2} = 1959\sigma_\epsilon$$

$$(57)\quad \sigma_{g(2m)} = \sqrt{2\sigma_{2m}^2} = 2396\sigma_\epsilon$$

$$(58)\quad \sigma_{g(sa)} = \sqrt{2\sigma_{sa}^2} = 1385\sigma_\epsilon$$

$$(59)\quad \sigma_{g(a)} = \sqrt{2\sigma_a^2} = 0979\sigma_\epsilon$$

where $g(\ )$ denotes the growth rate of the average within the parentheses

By convention monthly growth rates for the monetary aggregates at the Federal Reserve Board are put at annual percentage rates of change by multiplying the simple monthly growth $g(m)$ by 1,200, for quarterly growth rates the corresponding factor is 400, and so forth for other statistics Because the standard deviations for the transitory components are expressed as a *per cent* of the level to obtain the standard deviation for the transitory component of an "annualized" growth rate, each of the expressions 55 through 59 should be multiplied by an annualizing factor 12 for monthly averages, 4 for quarterly averages, and so forth

Interval estimators for the systematic component of an aggregate

Let $z_{\alpha/2}$ be the point on a standardized (mean = 0, variance = 1) normal distribution such that the probability that a standardized normal random variable exceeds $z_{\alpha/2}$ is $\alpha/2$

[49] It also matters how many Fridays are in, say, a month and the configuration of weekends within the month However, these aspects will be ignored in the discussion that follows as they tend to average out over time

Then with confidence coefficient $1 - \alpha$, the interval

$$12g(m) \pm 12z_{\alpha/2}\sigma_{g(m)}$$

is a $100(1 - \alpha)$ per cent confidence interval for the systematic part of an annualized monthly growth rate [50] If $\alpha = 0\ 05$, $z_{\alpha/2} = 1\ 96$, the 95 per cent confidence interval is

$$12g(m) \pm 12(1\ 96\sigma_{g(m)}) \text{ or}$$

(60) $$12g(m) \pm 7\ 983\sigma_{\epsilon}$$

in view of Expression 55

To illustrate these calculations let us take the SEW estimate of the daily transitory standard deviation for M_1 of 0 4137 per cent for the 1968–74 period (Table 2) The implied confidence interval is

$$12g(m) \pm (7\ 983)(\ 4137) = 12g(m) \pm 3\ 3 \text{ per cent}$$

Table 10 presents the relevant information for constructing confidence-interval estimates for two aggregates (M_1 and M_2), three methods (ANOVA, SEW, and SQW), and five confidence coefficients (50, 80, 90, 95, and 99 per cent) These estimates are based on the overall standard errors for each model for the 1968–74 sample period The table shows that if, for example, the measured monthly average growth rate were 8 per cent, the 95 per cent interval estimate for the systematic growth rate in M_1 would range from 4 7 per cent to 11 3 per cent based on the SEW method

The label "2-month—A" refers to growth rates computed by using Equation 50 while the label "2-month—B" refers to the 2-month growth rates considered in certain short-run policy specifications of the aggregates [51] The growth rates for 2-month—B are computed by taking $6(Y_{s+1} - Y_{s-1})/Y_{s-1}$, where s denotes the current month when the specifications are chosen, for example, in September the growth rate for the September–October period is chosen based on the October average relative to the August average Panel B displays comparable information using the alternative heteroskedastic formula, Equation 47 The entries in Panel B are generally slightly smaller than those in Panel A

User-specified time intervals

Consider Y_s^n for various n The larger n is, the smaller will be the transitory standard deviation of Y_s^n How large must n be so that the $(1 - \alpha)100$ per cent confidence interval for an n-day growth rate will have a predetermined length r? For example, suppose we wish to determine for the ANOVA estimate of M_1 the appropriate n, such that 95 per cent of observed growth rates will be within 1 per cent of the systematic growth rates In general, we have

(61) $$\left(\frac{365}{n}\right)\left(\frac{14}{n}\right)^{1/2}\left(\frac{\sigma_{\epsilon}}{2}\right) z_{\alpha/2} = \frac{r}{2}$$

and wish to determine n, given σ_{ϵ}, α, and r For the present example, $r = 2$, $z_{\alpha/2} = 1\ 96$, $\sigma_{\epsilon} = \ 5614$, so from Equation 61

$$n\sqrt{n} = 365\sqrt{14}\left(\frac{\ 5614}{2}\right) 1\ 96$$

which yields

$$n = 82\ 64$$

For this example, then, growth rates based on 83-day averages will have the desired property of being within 1 per cent of the systematic growth rate in 19 out of 20 "trials "

Effects of seasonal adjustment on estimates of transitory variations

A rather thorny problem in the assessment of transitory variations, which is not considered either in the report of the Advisory Committee on Monetary Statistics or thus far in this paper, is the effect on transitory variations of seasonal adjustment of the data The seasonal adjustment process itself may change the extent of transitory variations (and may change it differently in preliminary and in final

[50] On average, $100(1 - \alpha)$ per cent of the intervals computed in this fashion will contain the underlying systematic growth rate

[51] See "Numerical Specifications of Financial Variables and Their Role in Monetary Policy," *Federal Reserve Bulletin*, vol 60 (May 1974), pp 333–37

TABLE 10: Implied Variation in Monetary Growth Rates Due to Transitory Fluctuations

In percentage points

Growth-rate interval and method	One standard deviation		Confidence coefficient, per cent									
			50		80		90		95		99	
	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2	M_1	M_2
	A Estimates based on alternative over-all standard deviations											
Monthly												
ANOVA	2 29	1 15	1 5	8	3 0	1 5	3 8	1 9	4 5	2 3	5 9	3 0
SEW	1 69	83	1 1	6	2 2	1 1	2 8	1 4	3 3	1 6	4 4	2 1
SQW	1 27	62	8	4	1 6	8	2 1	1 0	2 5	1 2	3 3	1 6
Quarterly												
ANOVA	44	22	30	15	6	28	7	4	9	4	1 1	6
SEW	32	16	22	11	4	21	5	3	6	3	8	4
SQW	24	12	16	08	3	15	4	2	5	2	6	3
2 month—A												
ANOVA	81	41	5	27	1 0	5	1 3	7	1 6	8	2 1	1 0
SEW	60	29	4	20	8	4	1 0	5	1 2	6	1 5	8
SQW	45	22	3	15	6	3	7	4	9	4	1 2	6
2 month—B												
ANOVA	1 14	58	8	38	1 5	8	1 9	1 0	2 2	1 1	3 0	1 5
SEW	84	42	6	28	1 1	6	1 4	7	1 6	8	2 2	1 0
SQW	64	31	4	21	8	4	1 0	6	1 2	6	1 6	8
Semiannual												
ANOVA	16	08	10	05	20	10	26	13	30	15	40	20
SEW	11	06	08	04	15	07	19	11	22	11	30	15
SQW	09	04	06	03	11	05	14	08	17	08	22	11
Annual												
ANOVA	055	028	04	02	07	04	09	046	11	054	14	07
SEW	040	020	03	013	05	026	07	033	08	039	10	052
SQW	030	015	02	010	04	019	05	024	06	029	08	038
	B Estimates based on heteroskedastic model of intraweekly standard deviations											
Monthly												
ANOVA	2 1	1 0	1 4	7	2 6	1 3	3 4	1 7	4 0	2 0	5 3	2 7
SEW	1 5	8	1 0	5	2 0	1 0	2 5	1 3	3 0	1 5	4 0	2 0
SQW	1 3	6	8	4	1 6	8	2 1	1 0	2 5	1 2	3 3	1 6
Quarterly												
ANOVA	40	20	27	14	51	26	65	33	78	40	1 0	52
SEW	29	15	20	10	38	19	48	24	58	29	76	38
SQW	24	12	16	08	31	16	40	20	48	24	63	31
2-month—A												
ANOVA	73	37	49	25	93	47	1 2	61	1 4	73	1 9	96
SEW	54	27	36	18	69	35	89	45	1 1	53	1 4	70
SQW	45	22	30	15	57	29	74	37	9	44	1 2	58
2-month—B												
ANOVA	1 0	5	70	35	1 3	65	1 7	85	2 0	1 0	2 6	1 4
SEW	75	4	50	25	1 0	50	1 2	65	1 5	75	2 0	1 0
SQW	65	3	40	20	8	40	1 0	50	1 2	60	1 6	8
Semiannual												
ANOVA	14	07	09	05	18	09	23	12	27	14	36	18
SEW	10	05	07	04	13	07	17	08	20	10	27	13
SQW	08	04	06	03	11	06	14	07	17	08	22	11
Annual												
ANOVA	07	036	05	024	09	046	12	06	14	07	18	09
SEW	05	026	035	018	07	033	08	04	10	05	13	07
SQW	03	022	020	014	04	028	05	04	06	04	08	06

NOTE — Entries define the range, plus or minus, around the systematic growth rate within which the specified percentage (50, 80, 90, 95, or 99) of observed growth rates will (on average) fall

data) Seasonal adjustment is basically an averaging or smoothing process, and since necessarily both the transitory and the systematic components of the series are smoothed, it is generally true that seasonally adjusted data on the monetary aggregates exhibit fewer transitory variations than do not seasonally adjusted data

The magnitude of this effect depends heavily on the seasonal adjustment procedure employed In general, seasonal factors that are relatively "fixed" are determined from a relatively large amount of data, and the current observation carries relatively less weight, thus, the variance (whether transitory, nontransitory, or total) is reduced correspondingly less by the adjustment process By contrast, seasonal adjustment procedures such as X-11 allow for a rapidly changing seasonal that must be estimated from a smaller amount of data Thus, greater weight is given to the current observation and more of the variance (including transitory variance) is removed from this observation as a result of seasonal adjustment[52]

To illustrate, consider a "fixed" seasonal estimated from a moving m-year regression on seasonal dummies If y_{tj} is the observation from month j and year t (assumed for simplicity to have a zero mean), the estimated seasonal component for month j is

$$y_j = \frac{1}{m} \sum_{t=1}^{m} y_{tj}$$

and the seasonally adjusted value is

$$y_{tj}^{sa} = y_{tj} - y_j = \frac{m-1}{m} y_{tj} - \frac{1}{m} \sum_{s \neq j} y_{ts}$$

with transitory variance (assuming statistical independence)

$$\frac{(m-1)^2 + m - 1}{m^2} \sigma_\epsilon^2 = \left(1 - \frac{1}{m}\right) \sigma_\epsilon^2$$

where σ_ϵ^2 *is* the transitory variance of not seasonally adjusted y Thus, if $m =$ (allowing for a more rapidly changing seasonal), transitory variance is reduced through seasonal adjustment by 33 per cent, if $m = 9$, seasonal adjustment lowers the variance by 11 per cent

The effect of the X-11 procedure on transitory variance would be expected to fall between these two, as it is based on a 7-year average (though a weighted average, weighting most heavily the current observation), thus the transitory *standard deviation* is reduced by probably something like 10 per cent[53]

The foregoing discussion concerns the effects of final seasonal factors applied to final data A separate effect stems from the revision of preliminary seasonal factors as additional data become available The first-published seasonally adjusted series is subject to two sources of revision error—that discussed earlier for not seasonally adjusted data and, additionally, that due to revisions in seasonal factors However, even the first published seasonally adjusted data will generally have smaller transitory variance (as distinct from the variance of these revision errors) than the first published not seasonally adjusted data, as the averaging effect discussed above for final data is present whenever seasonal adjustment is undertaken

It will be argued in the following section that the data revisions that occur in not seasonally adjusted data can reasonably be assumed to be statistically independent of the transitory variations This independence assumption is equally valid for the seasonal factor revisions if the revision method (contrasted with the adjusted data produced by the method) is determined independently of the data being revised—for example, a fixed factor or regression method or X-11 with unchanging moving average weights This assumption could break down in situations where, for example, a sequence of large transitory or not seasonally adjusted revision errors produced seasonal-irregular ratios that would cause a different trend-cycle curve to be selected, or alternatively, where judgmental review is a part of the seasonal adjustment procedure[54]

Summary and conclusions

We have examined four statistical models to isolate the part of the variations in M_1 and M_2 and their components that arise from very short-run transitory fluctuations On the basis of these results, it appears that the standard deviation of the transitory component of daily not seasonally adjusted M_1 is in the neighbor-

[52] An opposite effect should also be noted The presence of transitory error can increase the error in the estimated seasonal factors, tending to produce a 'noisier' seasonally adjusted series When the seasonal pattern is relatively fixed, this effect can offset much of the smoothing effect discussed here

[53] The daily procedure developed by Pierce and others in "Seasonal Adjustment of the Monetary Aggregates," this volume, and recommended by the Advisory Committee in *Improving the Monetary Aggregates Report,* however, would have very little effect on transitory variance because a given daily observation contributes almost nothing to its own seasonal component

[54] "Seasonal irregular ratios" are defined as the ratio of the not seasonally adjusted series to the trend cycle component, which for the multiplicative seasonal adjustment procedures, is equal to the product of the seasonal and irregular components

hood of 1/2 of 1 per cent, for M_2 it is about 1/4 of a per cent The SEW and SQW models produced somewhat lower estimates, while the ANOVA estimates were slightly higher[55] For annualized monthly rates of growth, the 1/2 of a per cent figure for M_1 implies that the 95 per cent confidence-interval estimate of the growth rate of the systematic component of M_1 is equal to the measured growth rate plus or minus 4 percentage points, while for M_2 it is equal to the measured growth rate plus or minus 2 percentage points[56] Thus, on the average, about 95 per cent of all measured monthly growth rates of M_1 will lie within 4 percentage points of the systematic component of M_1, and about 5 per cent of all observed monthly growth rates of M_1 will deviate by more than 4 percentage points from the systematic component of M_1, due to day-to-day transitory fluctuations For quarterly rates of growth, the 95 per cent confidence interval includes the measured growth rate plus or minus 3/4 of a percentage point for M_1 and plus or minus 3/8 of a percentage point for M_2 Confidence-interval estimates for other aggregates or estimates can readily be determined from Equations 43 through 59

As indicated in the preceding section, the magnitude of the transitory variations in seasonally adjusted data depends on the method of seasonal adjustment The daily procedure of seasonal adjustment recommended by the Advisory Committee would leave essentially the same transitory effects in seasonally adjusted series that existed in the not seasonally adjusted series However, the effect of the X-11 seasonal adjustment procedure would be to reduce the standard deviation of the transitory component by about 10 per cent for seasonally adjusted data

In all likelihood, there are several sources of these transitory variations, but we have not tried to explain the transitory variations in terms of an explicit economic model We did, however, work out an empirical decomposition of the variation in M_1, M_2, and gross deposits less cash items For M_1 and M_2, the lion's share of the observed transitory variation stems from transitory variations in the demand deposit component of M_1 There are also some signs that variations in passbook savings accounts will account for more of the transitory variations in M_2 as these deposits become closer substitutes for demand deposits

Joint effects of data revisions and transitory variations in not seasonally adjusted data

This paper has dealt largely with transitory variations in the not seasonally adjusted monetary aggregates that are in final (revised) form For purposes of current analysis, there are additional sources of variation owing to revisions in the data from the time they are first published to their appearance in final form We examine here the revision in seasonally unadjusted data, having considered the effects of seasonal adjustment, including revisions in seasonal factors, in the preceding section

The "first-published" estimate of the aggregates for each month is released about 10 days after the end of the month More complete incoming weekly data from member banks will often modify this first-published number during the next month Additional revisions are made periodically when call report data for nonmember banks become available Irregular revisions are made either when reporting errors are uncovered or when a review of the construction of the money stock leads to specific repairs in the series—for example, the 1976 revision in the adjustment for cash-items bias[57] Given the nature of these revisions, it is plausible that the difference between the first-published not seasonally adjusted series and the final revised not seasonally adjusted series is statistically independent of

[55] These estimates are based on the 1968–74 sample period and are listed in Table 1

[56] For example, for M_1 the 4 per cent figure is obtained by substituting 1/2 for σ_ϵ into Equation 55 and then multiplying by a factor of 12 to annualize and a factor of 1 96 to make a 95 per cent confidence interval 3394 × 1/2 × 12 × 1 96 = 3 99

[57] See Edward R Fry, Darwin L Beck, and Mary F Weaver, "Revision of Money Stock Measures," *Federal Reserve Bulletin*, vol 62 (February 1976), pp 82–87

TABLE 11 Revision Errors in Monetary Aggregates, Not Seasonally Adjusted

In annual percentage rates of growth

Aggregate	Monthly			Quarterly		
	Standard error	RMSE	Mean error	Standard error	RMSE	Mean error
Currency	3 07	3 10	53	71	71	− 16
Demand deposits	2 98	3 03	63	1 19	1 66	1 18
M_1	2 26	2 33	60	91	1 25	87
M_2	85	86	21	42	51	40

NOTE —Error equals difference between annual percentage rate of growth of first-published estimate and final revised estimate (as of December 1977) for 1968–74 period RMSE denotes root mean square error

the transitory variations If this is so, we can combine the two parts—the variations caused by data revisions (other than seasonal-factor revisions) and the transitory variations in the revised series—to obtain an over-all estimate of the noise in the current (first-published not seasonally adjusted) series

The mean error, standard deviation, and root mean square error of the revision errors for M_1, M_2, and their components are shown in Table 11 [58] Table 12 combines the variations resulting from the revision errors reported in Table 11 with the variations resulting from movements in the transitory component to give an estimate of the over-all noise in the first-published series For example, for monthly rates of growth of M_1 the over-all standard deviation of about 3 per cent is determined from the equation $3\ 04 = \sqrt{2\ 26^2 + 2\ 03^2}$, based on a revision standard error of 2 26 per cent and a transitory standard error of 2 03 per cent [59] The implied 95 per cent confidence-interval estimate of the systematic component for first-published monthly growth rates of M_1 would, thus, be delimited by ±5 96 percentage points, the corresponding figure for monthly rates of growth of M_2 is 2 60 percentage points The comparable figures for the quarterly rates of growth are considerably reduced, the 95 per cent quarterly confidence interval covers ±1 94 percentage points for M_1 and ±0 90 percentage point for M_2

[58] These estimates are comparable to those in *Improving the Monetary Aggregates Report,* table 4, for seasonally adjusted data

[59] $2\ 03 = 12 \times \frac{1}{2} \times 3344$

TABLE 12. Over-All Estimate of Error in Rate of Growth Due to Both Revision and Transitory Errors

Standard deviations of annual percentage rates of growth, in percentage points

Aggregate	Monthly growth rate	Quarterly growth rate
Currency	3 36	1 06
Demand deposits	3 60	1 25
M_1	3 04	99
M_2	1 33	46

Concluding observations

Undoubtedly, users of monetary statistics should be aware of the transitory variations in the series, and the estimates that we have presented highlight the range of magnitudes involved However, these estimates represent first efforts, and there are several possible refinements

1 *Day-of-week effects* There is some evidence that the day-of-week effects are not invariant over time In particular, the Friday day-of-week effect for demand deposits generally fell over the sample period And, when the Friday residuals from the ANOVA method were regressed on a short-term interest rate (the Federal funds rate or commercial paper rate), the regression coefficient was negative and significant A similar regression for the residuals from other days indicated no relationship with interest rates It is possible that when interest rates are rising, the use of bank-managed demand accounts increases, and the process has its largest daily impact on Fridays because Friday deposit figures essentially count for 3 days in computing required reserves [60] The results were less clear-cut for the residuals from other methods, but it would be useful to examine this phenomenon in more depth

2 *Periodically correlated processes* It has been observed that the transitory variability is not constant across days of the week Yet, for the most part, the detrended data have

[60] See Stephen M Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity*, 3 1976, pp 683–730, and Raymond E Lombra and Herbert M Kaufman, "Commercial Banks and the Federal Funds Market Recent Development and Implications," *Economic Inquiry,* vol 16 (October 1978), pp 549–62

been modeled as stationary series A more appropriate technique may be to assume that the data are *periodically correlated* rather than stationary [61]

3 Width of the detrending interval For the ANOVA, SEW, and SQW models it is apparent that we have not selected the appropriate smoothing interval to determine the trend The residuals from each of these models were correlated at several lags, including fairly long ones If the true trend at time t is a function not only of the observations in the "week" including t but also of more distant observations, such as those a year apart from t, it is not surprising that a misspecification is introduced in the ANOVA, SEW, and SQW models that produces the large autocorrelations at annual lags, among others The results from the explicit time-series modeling exercises indicate that the appropriate smoothing span to determine the trend is much longer—more on the order of five quarters rather than a week Thus, fixed-weight detrending methods with a much wider smoothing interval—and with weights that largely follow an inverted V pattern—could be examined

4 Correlated transitory components The transitory variations have been defined to be independent from day to day However, it may not be desirable to impose strict serial independence for the first two or three lags A "blip" in the daily data, which takes a few days to dissipate, might with justification still be regarded as "transitory " Hence, an explicit times series model, in which there is a low-order moving average process for the transitory component combined with a mixed (ARMA) model for the trend component, may be a useful model to consider [62]

5 Estimated data sources The daily series on the monetary aggregates are based in part on daily data reported by various financial institutions and in part on estimates of components that are not reported daily [63] For example, in December 1974 the estimated portion of the daily series was nearly a third of the total for the demand deposit component of M_1 Accordingly, changes in the reporting frequency of data that are not available daily may have an impact on estimates of transitory variations in the aggregates The size of the impact would depend on the transitory variations of those data and their correlation with data that are now available daily [64] Also, there are alternative ways of estimating or interpolating data that are sampled only 1 day per week or more infrequently, and in further work it would be useful to examine the effects that alternative interpolation procedures have on estimates of transitory variations

[61] See, for example, William P Cleveland, "Analysis and Forecasting of Seasonal Time Series" (Ph D dissertation, University of Wisconsin, 1972), Harry L Hurd, "Survey on Periodically Correlated Processes" (paper presented at the Multiple Time Series and System Identification Conference, University of North Carolina at Chapel Hill, January 2-6, 1973), Richard D Porter and Paul N Rappaport, "Forecasting Net Basin Supplies on the Great Lakes" (paper presented at the TIMS Conference, Houston, Texas, April 1972), and Howard E Thompson and George C Tiao, "Analysis of Telephone Data A Case Study of Forecasting Seasonal Time Series," *Bell Journal of Economics and Management Science*, vol 2 (Autumn 1971), pp 515–41

[62] In general, the identification of such models is more difficult than that of models in which the transitory component is independent See the references in footnote 20

[63] For a breakdown of M_1 data sources and their reporting frequencies, see *Improving the Monetary Aggregates Report,* table 3

[64] The new sample of nonmember bank data that was started in July 1977 may have a significant impact on estimates of transitory variations in the aggregates

Appendix 1: The Relationship between ϵ_t and the Relative Transitory Error

Let

(A-1) $$f_t = \beta_t + \eta_t$$

be the systematic part ın logarıthms) of Equatıon 1 (page 3) and

(A-2) $$F_t = \exp(f_t)$$

be the systematıc part of the model ın levels The ımplıed transıtory error ın dollars ıs

(A-3) $$E_t = Y_t - F_t$$

where

(A-4) $$Y_t = \exp(y_t) = \exp(f_t + \epsilon_t)$$

ıs the level of the aggregate (ın dollars) Also, ın vıew of Equatıons A-4 and A-2

(A-5) $$Y_t = F_t \exp(\epsilon_t)$$

The relatıve transıtory error, E_t/Y_t, ıs

$$\frac{E_t}{Y_t} = \frac{F_t \exp(\epsilon_t) - F_t}{F_t \exp(\epsilon_t)} = 1 - \exp(-\epsilon_t)$$

so that

(A-6) $$\frac{E}{Y_t} = \epsilon_t$$

upon droppıng second- and hıgher order terms ın the Taylor-serıes expansıon of $\exp(-\epsilon_t)$ Table A-1 shows that the accuracy of the approxımatıon ın Equatıon A 6 for values of ϵ_t less than or equal to 0 01 ıs very good For example, for a 1 per cent value of ϵ_t, $\epsilon_t = 01$, the approxımatıon ıntroduces a dıscrepancy of only $15 mıllıon when ıt ıs ap pıed to a monetary aggregate of $300 bıllıon

TABLE A-1 Dıscrepancy between ϵ_t and E_t/Y_t

ϵ_t	Et/Yt	Dıscrepancy[1]
(1)	(2)	(3)
001	000999	$1\ 45 \times 10^5$
002	001998	$5\ 0 \times 10^5$
003	002995	$1\ 35 \times 10^6$
004	003992	$2\ 40 \times 10^6$
005	004987	$3\ 74 \times 10^6$
006	005982	$5\ 39 \times 10^6$
007	006976	$7\ 33 \times 10^6$
008	007968	$9\ 37 \times 10^6$
009	008960	$1\ 21 \times 10^7$
010	009950	$1\ 50 \times 10^7$

[1] Column 1 mınus column 2 multıplıed by $300 bıllıon

Appendix 2: Empirical Specification and Diagnosis of OSD Model

Model specification[1]

Consider first the plot of the autocorrelation function (ACF) for z_t, given in Chart 1 The first 10 autocorrelations (AC) decrease exponentially following the pattern of an AR(1) model with approximately $\hat{\varphi} = 0.85$ (the initial estimate of φ) Let ρ_j and r_j be the population and sample jth-lag autocorrelation Assuming that z_t follows an AR(1) process, the variance of r_j is approximated by

$$\text{(A-6)} \quad v(r_j) = \frac{1}{N}\left[\frac{(1+\varphi^2)(1-\varphi^{2j})}{1-\varphi^2} - 2j\varphi^{2j}\right]$$

For $j = 13$, the confidence region for the sample estimate is given by $(0.85)^{13} \pm 2[v(r_{13})]^{1/2} = 0.1209 \pm 0.39$ The sample estimate $r_{13} = -0.35$ falls outside this region, and the same is true for r_{12} and r_{14} Furthermore, the ACF displays high peaks at lags 39, 52, and 65 In particular, the large lag approximation

$$\text{(A-7)} \qquad \lim_{j\to\infty} v(r_j) = \frac{1}{N}\left(\frac{1+\varphi^2}{1-\varphi^2}\right)$$

implies that, after lag 67, all r_j can be assumed to be approximately zero

Now, consider the model consisting of Equations 24 to 26 In terms of the observable variable, z_t, it can be rewritten as

$$(1 - \varphi B)z_t = \epsilon'_t + (1 - \varphi B)(1 - B^{13})(1 - B^{52})\epsilon_t$$

which indicates that the variable

$$x_t = (1 - \varphi B)z_t$$

follows a moving-average process Chart 2 reproduces the time series $[x_t]$ for $\varphi = .85$ The theoretical ACF for x_t is given by

$$\gamma_x(0) = 4(1+\varphi^2)\sigma^2_\epsilon + \sigma^2_{\epsilon'}$$

$$\gamma_x(1) = -4\varphi\sigma^2_{\epsilon'}$$

$$\gamma_x(13) = \gamma_x(52) = -2(1+\varphi^2)\sigma^2_\epsilon = -2\gamma_x(39) = -2\gamma_x(65)$$

$$\gamma_x(12) = \gamma_x(14) = \gamma_x(51) = \gamma_x(53) = 2\varphi\sigma^2_\epsilon = -2\gamma_x(38) = -2\gamma_x(40) = -2\gamma_x(64) = -2\gamma_x(66)$$

with all other autocovariances equal to zero

For $j > 66$, the variance of the estimated r_j is approximately given by the expression

$$\text{(A-8)} \qquad v(r_j) = \frac{1}{N}\left\{1 + 2\sum_{i=1}^{66}\rho_i^2\right\}$$

Chart 3 contains a plot of the ACF of x_t The dotted lines represent the value $\pm 2[v(r_j)]^{1/2}$ for $j > 66$ It is seen that all ρ_j for $j > 66$ can be assumed to be 0 Furthermore, comparing the theoretical (nonzero) autocorrelations, corresponding to the initial values of the estimates with the sample autocorrelations, we have[2]

$\rho_1 = -.18$	$r_1 = -.19$
$\rho_{12} = .085$	$r_{12} = .03$
$\rho_{13} = -.18$	$r_{13} = -.28$
$\rho_{14} = .085$	$r_{14} = .08$
$\rho_{38} = -.042$	$r_{38} = -.06$
$\rho_{39} = .085$	$r_{39} = .08$
$\rho_{40} = -.042$	$r_{40} = -.04$
$\rho_{51} = .085$	$r_{51} = -.06$
$\rho_{52} = -.18$	$r_{52} = -.21$
$\rho_{53} = .085$	$r_{53} = .04$
$\rho_{64} = -.042$	$r_{64} = -.04$
$\rho_{65} = .085$	$r_{65} = .09$
$\rho_{66} = -.042$	$r_{66} = -.01$

The two sequences present a fairly similar pattern We conclude that, as a first approximation, x_t can be assumed to follow the MA process

$$x_t = \epsilon'_t + (1 - \varphi B)(1 - B^{13})(1 - B^{52})\epsilon_t$$

with φ, $\sigma^2_{\epsilon'}$ and σ_ϵ being approximately given by the initial estimates Recalling that $x_t = (1 - \varphi B)z_t$, Equations 24 to 26 are justified as a first approximation to the process generating $[z_t]$

[1] We shall use the following notation in this appendix for a variable x, $\{x_t\}$ will denote a stochastic process, $[x_t]$ will denote a time series realization of the process, and x_t will denote the value of the variable at time t, $AR(j)$ will denote an autoregressive model of order j, $MA(j)$ will denote a moving average model of order j

[2] The initial values—$\varphi = .85$, $\sigma^2_{\epsilon'} = (.4)10^{-4}$, $\sigma^2_\epsilon = (.3)10^{-5}$—are derived in Agustin Maravall, "Estimation of the Permanent and Transitory Component of an Economic Variable with an Application to M_1" Special Studies Paper 85, Board of Governors of the Federal Reserve System, 1976

Model diagnosis

Once the model has been specified and the final estimation has been performed, diagnostic checks should be applied to the fitted model The Box Pierce test cannot be applied to our calculated residuals $[\hat{e}_t]$, and the fact that the estimator $\hat{\delta}_t$ does not converge in probability to the true δ_t makes it difficult to derive appropriate tests Yet, a diagnostic check can be carried out in the following way

If our model is correct, the process $\{\delta_t\}$ is an AR(1) process, given by

(A-9) $$\delta_t = 89\delta_{t-1} + \epsilon_t'$$

and the process $[e_t]$ is an MA process given by

(A-10) $$e_t = \epsilon_t - \epsilon_{t-13} - \epsilon_{t-52} + \epsilon_{t-66}$$

We shall use the estimated series $[\hat{\delta}_t]$ and $[\hat{e}_t]$ to check whether both assumptions seem reasonable

Chart 4 plots the autocorrelations of $\hat{\delta}_t$ Under the assumption that $\hat{\delta}_t$ follows the AR(1) process given in Equation A 4, expressions A-1 and A-2 yield the variances of the sample autocorrelations of $\hat{\delta}_t$ Based on these variances, the implied correlogram of $[\hat{\delta}_t]$ seems to be in agreement with our model Chart 5 compares the autocorrelations of the two series $[z_t]$ and $[\hat{\delta}_t]$ Although the two plots follow the same general pattern, the autocorrelations for $[z_t]$ have bigger oscillations The pattern of the autocorrelations for $[\hat{\delta}_t]$ seems to follow an AR(1) model more closely than those for $[z_t]$ The higher order effects present in the ACF of $[\hat{\delta}_t]$ may arise because we are dealing with sample autocorrelations of an estimated time series [3]

Chart 6 displays a plot of the partial ACF for $\hat{\delta}_t$ Only the values corresponding to lags 2 and 14 fall outside the approximate 95 per cent confidence region, given by $\pm 2\sqrt{N}$

Thus, the estimated series $[\hat{\delta}_t]$ seems to be reasonably close to the theoretical model given by Equation A-4

Finally, Equation A-5 implies that the theoretical ACF for e_t is given by

$$\rho_{13} = -5 \qquad \rho_{52} = -5$$
$$\rho_{39} = 25 \qquad \rho_{65} = 25$$

and all other lagged correlations equal zero Using the estimated series $[\hat{e}_t]$, we obtain the values

$$r_{13} = -55 \qquad r_{52} = -38$$
$$r_{39} = 27 \qquad r_{65} = 21$$

which are in close agreement with the theoretical autocorrelations Also, by using Equation A-8, all correlation for lags greater than 66 can be assumed to be zero Chart 7 presents a plot of the autocorrelations for the series $[\hat{e}_t]$ Again, the estimated series are in reasonable accordance with the theoretical model given by Equation A-8, and we conclude that our fitted model offers an acceptable approximation to the stochastic process that generates the time series $[z_t]$

[3] Recall that the covariance between two sample correlations given approximately by

$$\text{cov}(r_k, r_{k+s}) = \frac{1}{N} \sum_{i=-\infty} \rho_i \rho_{i+s}$$

can distort the plot of the ACF, which may fail to damp out according to expectations see George E P Box and Gwilyn M Jenkins *Time Series Analysis Forecasting and Control* (Holden Day, 1970), p 35

CHART 1 Sample Autocorrelation Function for $[z_t]$

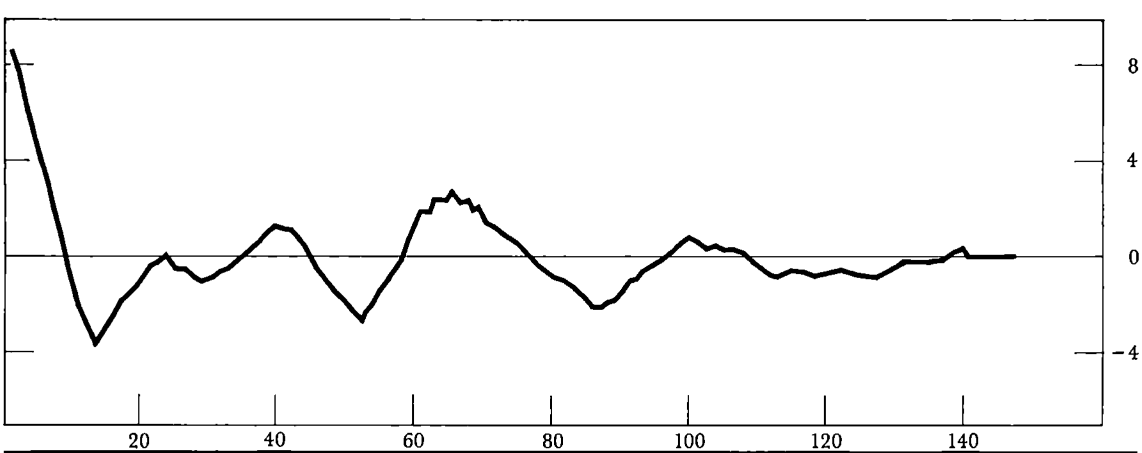


CHART 2 Time Series Plot of $[x_t]$

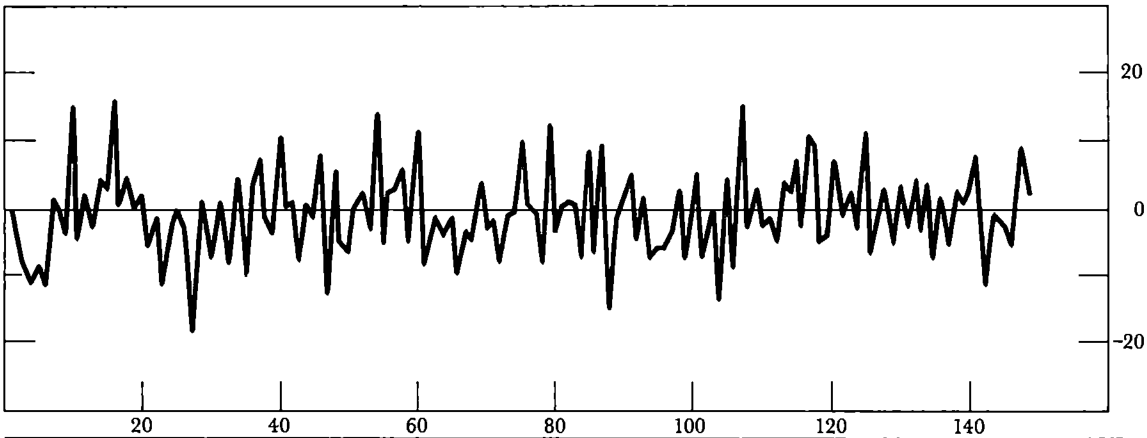


CHART 3 Sample Autocorrelation Function of x_t

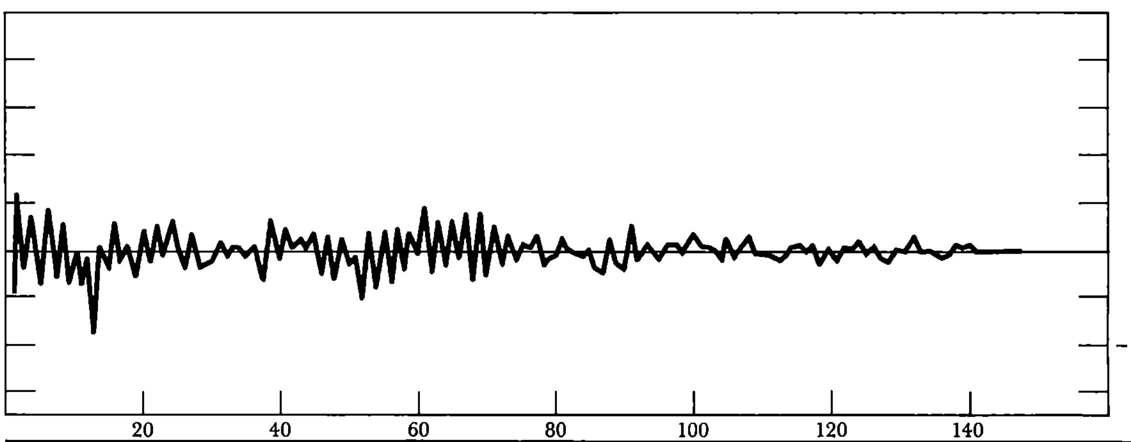


CHART 4 Autocorrelation Function for $[\hat{\delta}t]$

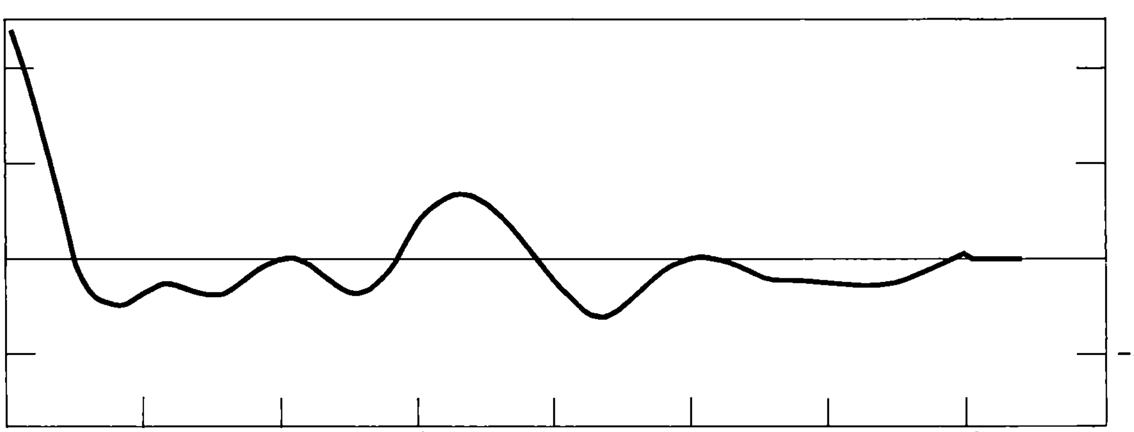


CHART 5 Autocorrelation Function for [z_t] and [$\hat{\delta}_t$]

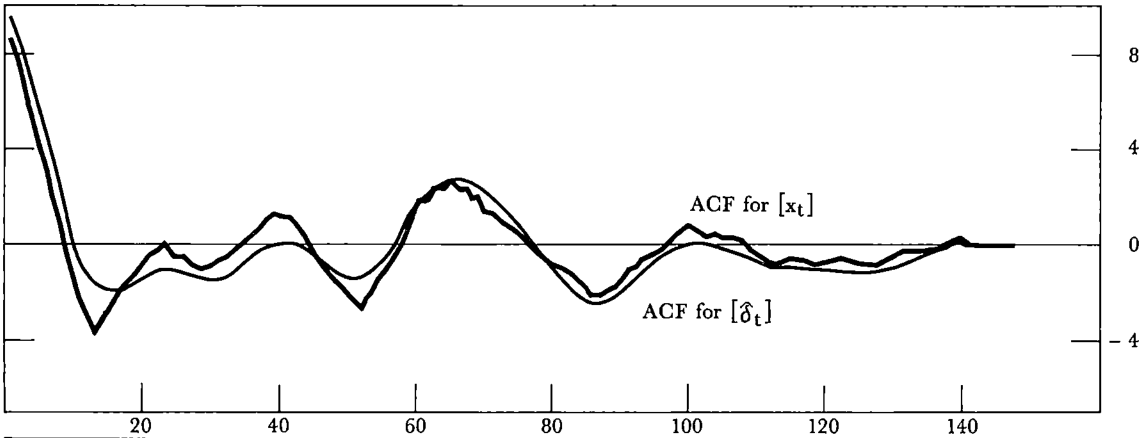


CHART 6 Partial Autocorrelation Function for [$\hat{\delta}_t$]

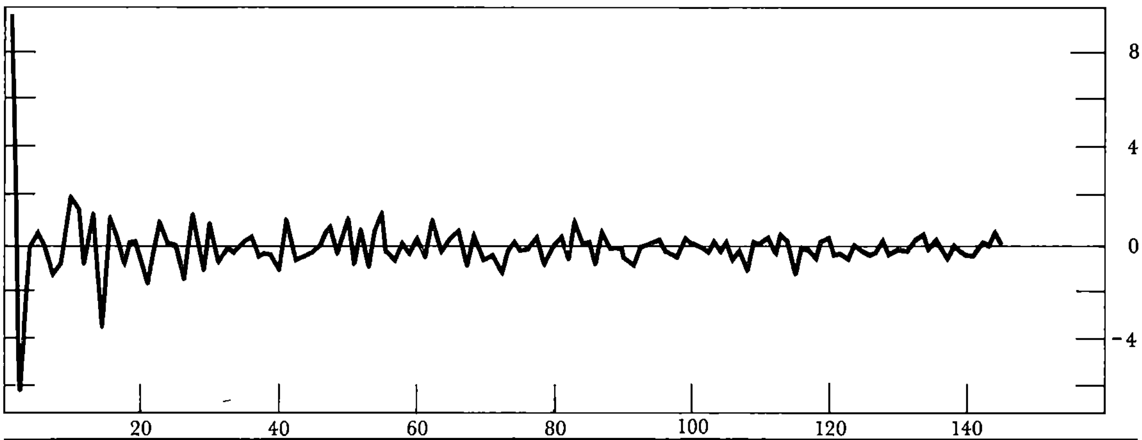
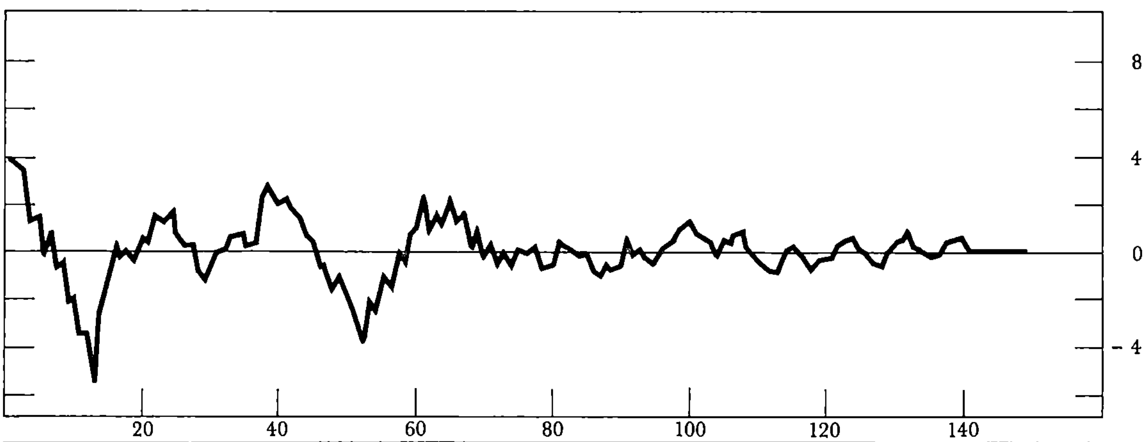


CHART 7 Autocorrelation Function for [e_t]



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Foreign Demand Deposits at Commercial Banks in the United States

Helen T Farr, Lance Girton, Henry S Terrell, and Thomas H Turner

This paper was completed in early 1976

Foreign depositors held about $13 billion in demand deposits at commercial banks in the United States at the end of 1975 Demand deposits that are held by foreign banks, nonbanks (individuals, partnerships, and corporations—IPC's), and official institutions are currently included in tabulations of the narrowly defined money supply (M_1) of the United States As of December 1975, foreign-owned demand deposits accounted for about 4 per cent of M_1

In this paper we discuss the general characteristics of these deposits and attempt to identify empirically the factors that determine the demand for them We also attempt to determine whether these deposits are closely related to U S macroeconomic variables and whether the relationship, if it exists, is sufficiently similar to that of the other components of U S monetary aggregates so that foreign deposits should continue to be included in these aggregates The evidence presented, although not conclusive, indicates that foreign demand deposits at U S banks in general, and demand deposits of foreign commercial banks and official institutions in particular, are not related to U S activity variables in the same manner as are other components of the narrowly defined money supply

Characteristics of foreign demand deposits at U S commercial banks

The following sections discuss in detail the characteristics of the various kinds of foreign demand deposits held at U S commercial banks those of foreign commercial banks, of foreign individuals, partnerships, and corporations, and of foreign official institutions

Deposits of foreign commercial banks at U.S. banks

Demand balances of foreign commercial banks at U S banks are the largest and most volatile of foreign deposits, having grown from $3 4 billion in December 1971 to $7 5 billion in December 1975 [1] At times, fluctuations in foreign bank demand deposits at U S commercial banks have had an appreciable impact on the growth of the narrowly defined money supply [2]

The largest U S banks currently maintain between 1,500 and 6,000 demand accounts for foreign commercial banks Of this total, 100 to 200 are usually characterized as active accounts belonging to the largest foreign banks that are heavily involved in international finance The remaining, smaller, accounts tend to be relatively inactive Most major foreign banks maintain demand balances at several U S money center banks

The accounts of major foreign banks are extremely active Daily turnover in an account can be several hundred times the average end-of-day balance A single transaction through one of these accounts is often several times as large as the average end-of-day balance, this is particularly true of Euro-dollar transactions,

NOTE —Helen T Farr is on the staff of the Division of Research and Statistics, Lance Girton and Henry S Terrell are on the staff of the Division of International Finance, and Thomas H Turner was formerly on that staff

[1] Information in this section has been enhanced by discussions with representatives of U S and foreign commercial banks

[2] These deposits do not include balances owed by U S banks to their foreign branches or those owed by U S agencies and branches of foreign banks to their head offices

in which often neither the delivering nor the receiving bank is a U S bank[3] Foreign banks use their accounts with domestic offices of U S banks to deliver and accept payment on their Euro-dollar transactions because U S banks require that the large credit judgments associated with these transactions be made at their head offices[4] A related reason for clearing dollar transactions in the United States is the proximity of the Federal funds market, in which market participants can acquire and place large sums of dollars on short notice

The second-largest type of transaction in these accounts results from the settlement of foreign exchange contracts, an unknown portion of which is directly related to the financing of exports or imports of the United States Some foreign exchange transactions reflect third-country trade and the special role of the dollar as a settlement currency in international trade Also, a proportion of the transactions reflects the attempts of foreign banks to achieve a desired position in foreign exchange markets, either for their own account or for their customers

Aside from the general purpose of clearing Euro-dollar and foreign exchange transactions, Japanese banks, which are usually large net borrowers of funds from banks in the United States, utilize their demand balances at U S banks for an additional purpose To obtain funds, Japanese banks have established numerous unsecured lines of credit with U S banks and often agree to maintain compensating demand balances of about 10 per cent of the lines of credit The compensating balances play the role of commitment fees When the lines of credit are drawn down, the Japanese banks often are required to maintain compensating balances of the same magnitude as those required of domestic nonbank borrowers This pattern of behavior appears to be limited to Japanese banks[5] As a general rule, a U S bank would not extend credit to a foreign bank that did not maintain a demand balance at the U S bank

An understanding of the institutional background is important in developing a model to explain the behavior of foreign demand deposits over time and to compare this behavior with that of other components of the money supply From discussions with market participants, it appears that demand for such deposits by foreign banks is positively related to their needs for transactions balances in the United States and negatively related to their costs of obtaining such funds in the market For U S banks, the costs of supplying these funds include the cost of servicing transactions through the accounts Servicing costs include the cost of U S banks' serving as standby lenders in case a foreign bank's demand balance is in deficit during the day or after the close of business An important way that the U S banks are compensated is through the value of the interest-free funds maintained on deposit by the foreign banks The value of these deposits to the U S banks is determined by an internal interest rate that reflects the cost savings from obtaining interest-free demand balances compared with the costs of obtaining funds in the market[6]

Deposits of foreign individuals, partnerships, and corporations

The second-largest category of foreigners holding demand balances at U S banks are

[3] An account with an average end of-day balance of $1 million may have transactions totaling several hundred million dollars on any business day

[4] For example, during the course of a business day the payment orders from an account may exceed the funds received in that account and the U S banks must decide whether or not to honor the orders, thus extending credit (sometimes in large amounts) to the foreign commercial bank These intrabusiness-day extensions of credit are often termed "daylight" overdrafts

[5] Canadian banks, which have important U S operations, do not maintain large demand balances at U S banks However, they do not borrow large amounts from U S banks because most of their Euro dollar and foreign exchange transactions are cleared through their New York agencies

[6] U S banks often maintain complex relationships with foreign commercial banks of which the demand deposit relationship is only one part Various interactions include, among other things, participation in joint ventures, correspondent relationships, introductions to clients, and the provision of various information and training services In some cases, a U S bank might reduce its demand balance requirements to a foreign bank as a "loss leader" to develop a more profitable relationship in other business areas

foreign IPC's At the end of 1975, foreign IPC's held about $3 2 billion in demand balances in the United States, or about 1 per cent of total M_1 Deposits of foreign IPC's do not show the same short-run volatility as deposits of foreign commercial banks The nature of the transactions through the IPC accounts is harder to describe than are transactions involving deposits of foreign commercial banks because of the larger number of depositors and the greater diversity among depositors [7]

The factors determining the demand for IPC deposits are varied, and it is difficult to assign a priori weights to particular reasons for holding these deposits First, some deposits are held to finance exports from and imports to the United States, while others may be held to finance third-country trade [8] Second, some deposits might be held to avoid confiscation of earnings of convertible currency by the governments of some developing countries, although in this case it is difficult to establish a preference for a demand balance rather than an interest-bearing account Third, some deposits serve to maintain lines of credit at U S banks for foreign commercial borrowers

Deposits of foreign official institutions

The term "foreign official institutions" covers a variety of institutions, including central banks, monetary authorities, government-owned development banks, government-owned institutions that conduct commercial banking operations in their home country, some international organizations, U S purchasing missions, and embassies and consular offices At the end of 1975, foreign official institutions maintained about $2 6 billion in demand balances in the United States, including about $350 million of demand balances in Federal Reserve Banks [9] These deposits constitute only a small fraction of the liquid assets held in the United States by foreign official institutions As of December 31, 1975, foreign official institutions had $60 billion in U S Treasury securities and $17 billion in earmarked gold in custody at Federal Reserve Banks [10]

As in the case of foreign nonbank depositors, the diversity of institutions and of nationalities in this category makes it quite difficult to identify any general motives for maintaining demand balances at banking institutions in the United States

Empirical analysis

In this section, we examine the issue of inclusion of foreign-owned demand deposits in the narrowly defined money supply [11] First, the degree of correlation between income and money, inclusive and exclusive of foreign-owned demand deposits, is reviewed by regressing changes in income on changes in alternative measures of the money supply Second, demand functions for alternative definitions of money are estimated, and the foreign deposit components are regressed separately on the same demand variables The estimated coefficients are then compared to see whether the factors that explain the demand for money also explain the demand for the foreign deposits Regressions are run from the middle of 1963, the first period for which data on foreign demand deposits are available, through the end of 1974 Both monthly- and quarterly-average data are used, and all data are seasonally adjusted [12]

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[7] As noted earlier, most of the transactions in the demand deposit accounts of foreign commercial banks are conducted by a small number of banks active in the Euro dollar market

[8] For example, a Brazilian company may pay for its imports from Japan by drawing on its demand balance at a banking office in the United States

[9] Foreign official demand deposits at Federal Reserve Banks are now included in the U S money supply

[10] Securities include marketable U S Treasury bills, certificates of indebtedness, notes, bonds, and nonmarketable Treasury securities payable in dollars and in foreign currencies The earmarked gold is valued at $42 22 per ounce, which understates its market value In addition, it should be noted that foreign official institutions hold about $20 billion in dollar-denominated assets at foreign branches of U S banks, an unknown portion of which is payable on short notice

[11] The empirical analysis of the next two sections refers solely to the question of inclusion or exclusion of various foreign owned demand deposits in the narrowly defined money supply (M_1)

[12] The data on foreign commercial bank deposits are derived primarily from averages of single day (Wednesday) observations for any month, whereas the

TABLE 1 Quarterly Changes in GNP as a Function of Changes in Alternative Definitions of Money[1]

Definition of money	Independent variables							Regression statistics	
	Constant	ΔM_t	ΔM_{t-1}	ΔM_{t-2}	ΔM_{t-3}	ΔM_{t-4}	Sum	$\bar{R}^2$	Standard error
M	1 445 (5)	1 941[2] (3 3)	1 644[2] (6 8)	1 301[2] (4 9)	913[2] (2 8)	479[3] (2 0)	6 279[2] (10 5)	488	6 747
MN	999 (3)	1 731[3] (2 6)	1 719[2] (5 9)	1 540[2] (4 9)	1 194[2] (3 2)	681[3] (2 4)	6 864[2] (10 2)	449	6 997
MN + FIPC	897 (3)	1 773[2] (2 7)	1 723[2] (6 1)	1 520[2] (5 0)	1 166[2] (3 2)	659[3] (2 4)	6 842[2] (10 4)	458	6 942
MN + FIPC + FCB	1 089 (4)	1 826[2] (2 9)	1 659[2] (6 5)	1 393[2] (5 0)	1 027[2] (3 0)	563[3] (2 2)	6 468[2] (10 4)	477	6 819
MN + FIPC + FOFF	1 074 (4)	1 920[2] (3 1)	1 725[2] (6 5)	1 435[2] (5 0)	1 052[2] (3 1)	573[3] (2 2)	6 704[2] (10 8)	475	6 705
FIPC	18 351[2] (7 4)	46 037 (1 7)	19 743 (1 6)	1 992 (1)	−7 215 (− 4)	−7 879 (− 5)	52 678 (1 9)	198	8 442
FCB	15 952[2] (6 9)	19 023 (1 7)	9 613[3] (2 6)	3 005 (6)	− 800 (− 1)	−1 801 (− 4)	29 040[3] (2 6)	226	8 294
FOFF	19 358[2] (9 4)	12 606 (1 7)	7 507 (1 6)	3 742 (7)	1 221 (2)	− 265 (− 7)	25 079[2] (3 4)	188	8 493

[1] *t*-statistics appear in parentheses
[2] Significant at 99 per cent confidence level
[3] Significant at 95 per cent confidence level

Income as a function of money

Table 1 presents the results of regressions run with quarterly data In each equation, the change in gross national product (GNP) is the dependent variable Each of the definitions of money used as the independent variable is one or a combination of the following $M = M_1$ as currently defined, $MN = M_1$ minus all foreign deposits, $FIPC =$ foreign IPC deposits, $FCB =$ foreign commercial bank deposits, and $FOFF =$ foreign official deposits A second-degree polynomial distributed lag is estimated on the first differences of alternative definitions of money and is constrained to zero at $t - 5$ All equations have a first-order correction for serial correlation of the residuals

Table 2 presents the results for the regressions run with monthly data In each equation, the change in personal income is the dependent variable and the definitions of money are the same as those used in the quarterly regressions A second-degree polynomial distributed lag is estimated on the change in the alternative definitions of money and is constrained to zero at $t - 16$ For compactness, only the sum of the distributed-lag coefficients is presented, all distributed-lag coefficients are positive

The quarterly and monthly regressions yield consistent results Including each of the foreign deposit components in the definition of

data for foreign official and foreign IPC deposits are derived from single day end of month observations In contrast, the data for demand deposits in M_1 are derived primarily from monthly averages of daily deposits Therefore, the three series on foreign demand deposits may show greater month to month variation than the deposit series in total M_1 For this reason, demand functions for the foreign components may have higher standard errors than those for monetary aggregates that include domestic deposits (See the appendix for a more complete treatment of the data sources used for foreign deposits)

TABLE 2 Monthly Changes in Personal Income as a Function of Changes in Alternative Definitions of Money[1]

Definition of money	Independent variables		Regression statistics	
	Constant	Sum of coefficients on Δmoney	$\bar{R}^2$	Standard error
M	759 (8)	5 136[2] (22 6)	180	4 093
MN	929 (9)	5 273[2] (21 4)	148	4 171
MN + FIPC	851 (8)	5 316[2] (21 9)	154	4 158
MN + FIPC + FCB	696 (1)	5 248[2] (22 6)	174	4 107
MN + FIPD + FOFF	857 (9)	5 260[2] (22 1)	162	4 137
FIPC	4 954[2] (11 1)	95 873[2] (13 9)	068	4 363
FCB	4 028[2] (8 4)	39 326[2] (13 8)	148	4 171
FOFF	5 465[2] (13 2)	29 023[2] (14 5)	027	4 458

[1] *t*-statistics appear in parentheses
[2] Significant at 99 per cent confidence level

TABLE 3 95 Per Cent Confidence Intervals for Regression Variances

Definition of money	Quarterly regressions		Monthly regressions	
	Variance	Confidence interval	Variance	Confidence interval
M	45 521	30 256–76 191	16 751	13 181–22 004
MN	48 965	32 545–81 955	17 396	13 690–22 853
MN + *FIPC*	48 193	32 032–80 663	17 289	13 650–22 712
MN + *FIPC* + *FCB*	46 494	30 902–77 819	16 868	13 274–22 159
MN + *FIPC* + *FOFF*	46 692	31 034–78 151	17 116	13 468–22 484

money results in a slight increase (decrease) in $\bar{R}^2$ (standard error of estimate) relative to the regressions on money excluding that component The improvements are small, however, and the question of their significance remains The 95 per cent confidence intervals for the variances of each regression are compared with the point estimates of these variances in Table 3 [13] (The degrees of freedom used in computing the confidence intervals are 37 and 118, respectively) It is apparent that the confidence interval for each equation's variance, monthly or quarterly, encompasses the variance of each of the other monthly or quarterly equations Although this is not a rigorous statistical test, the fact that the confidence intervals overlap to such a large degree suggests that the variances may not differ significantly [14]

Demand functions

Table 4 presents estimated demand functions for money and for the different foreign deposit components on a quarterly and on a monthly basis The first set of equations in panels A and B are all of the form

$$\ln M = \alpha_0 + \alpha_1 \ln R_{CP} + \alpha_2 \ln Y + \alpha_3 \ln M_{-1}$$

where R_{CP} is the 30- to 59-day commercial paper rate, and Y is GNP in the quarterly regressions and personal income in the monthly regressions The second set of equations in the panels drop the lagged dependent variable and estimate distributed lags on R_{CP} and Y The coefficients presented for R_{CP} and *GNP* (*PI*) are the sum of current and lagged coefficients on the respective variables The polynomials are second degree constrained to zero at $t-4$ for the quarterly equations and at $t-10$ for monthly equations

The results here are mixed In three of the four regressions for *FIPC*, the interest rate enters negatively, though not significantly In the fourth regression (monthly, distributed lag), the interest rate enters positively and significantly In all *FIPC* regressions, income enters positively but only in the quarterly distributed lag regression is it significant at the 95 per cent confidence level (At an 80 per cent confidence level, it is also significant in the monthly distributed lag regression) For *FCB*, the interest rate enters negatively and not significantly in the demand equations with a lagged dependent variable and positively and significantly in the distributed-lag regressions [15] In all but the monthly regression with a lagged dependent variable, *FCB* is positively and significantly related to income at the 90 per cent confidence level or better Finally, in all regressions, *FOFF* is positively related to the interest rate (significantly in the distributed-lag regressions) In no regression is *FOFF* significantly related to income, though the estimated relationship is positive

Turning to the demand functions for the alternative definitions of money, the income

[13] See, for example, Henri Theil, *Principles of Econometrics* (Wiley, 1971), pp 130–31

[14] Rigorous statistical tests are not possible, given the way the alternative definitions of money are constructed If, instead, the change in income is regressed on the changes in *MN, FCB, FOFF,* and *FIPC* as separate independent variables, the standard types of tests on the coefficients can be performed Since the foreign components do not enter the regressions separately but are summed with *MN,* such tests are not possible here

[15] An early memorandum presented to the Committee on Monetary Statistics did show *FCB* deposits negatively related to interest rates, see Stephen Thurman, "Preliminary Results of Tests on Inclusion of Foreign Deposits in the Money Supply" (Board of Governors of the Federal Reserve System, October 1974) The coefficients were significant at the 90 per cent confidence level The data used in these earlier regressions have been substantially revised, which may explain the difference in results

TABLE 4 Demand Functions for Foreign Deposits and Alternative Definitions of Money[1]

Independent variables and regression statistics	Dependent variables							
	ln *FIPC*	ln *FCB*	ln *FOFF*	ln *M*	ln *MN*	ln (*MN* + *FIPC*)	ln (*MN* + *FIPC* + *FCB*)	ln (*MN* + *FIPC* + *FOFF*)
	A Quarterly demand functions							
	Equations with lagged dependent variables							
Constant	– 848 (–2 5)	–2 331 (–1 8)	1 455 (8)	373 (1 7)	379 (1 8)	397 (1 8)	325 (1 7)	450 (1 9)
ln R_{CP}	– 010 (– 5)	– 003 (– 1)	100 (9)	– 013[2] (–3 2)	– 014[2] (–3 6)	– 014[2] (–3 5)	– 013[2] (–3 4)	– 013[2] (–3 3)
ln *GNP*	018 (5)	226 (1 7)	081 (7)	175[2] (2 9)	163[2] (2 8)	167[2] (2 9)	166[2] (2 9)	176[2] (2 9)
ln M_{-1}	1 085[2] (12 9)	906[2] (12 1)	631[2] (4 7)	776[2] (9 3)	788[2] (9 6)	783[2] (9 6)	790[2] (10 0)	768[2] (9 0)
$\bar{R}^2$	9695	9977	8068	9995	9994	9994	9995	9995
Standard error	0242	0226	0910	0040	0042	0042	0042	0040
	Equations with distributed lags							
Constant	–17 272 (–1 9)	–26 753[2] (–7 3)	4 289 (7)	1 763[2] (8 5)	2 003[2] (6 7)	2 012[2] (6 7)	1 710[2] (5 4)	2 069[2] (6 9)
ln R_{CP}	– 002 (– 7)	051 (1 9)	440[2] (4 2)	– 043[2] (–8 6)	– 050[2] (–9 9)	– 049[2] (–9 7)	– 046[2] (–9 1)	– 046[2] (–9 2)
ln *GNP*	1 726[2] (3 3)	2 502[2] (5 2)	158 (1)	768[2] (8 4)	750[2] (8 2)	750[2] (8 2)	772[2] (8 4)	746[2] (8 3)
$\bar{R}^2$	9623	9972	8038	9993	9993	9993	9993	9993
Standard error	0265	0241	0921	0044	0044	0044	0045	0044
	B Monthly demand functions							
	Equations with lagged dependent variables							
Constant	– 206 (–1 7)	– 250 (– 9)	201 (5)	172[3] (2 2)	240[2] (2 9)	240[2] (2 9)	200[3] (2 6)	212[3] (2 5)
ln R_{CP}	– 000 (– 0)	– 005 (– 8)	017 (6)	– 006[2] (–4 8)	– 008[2] (–5 3)	– 007[2] (–5 3)	– 007[2] (–5 0)	– 007[2] (–5 1)
ln *PI*	010 (8)	020 (6)	016 (6)	056[2] (3 3)	067[2] (3 9)	066[2] (3 9)	063[2] (3 7)	059[2] (3 4)
ln M_{-1}	1 010[2] (34 7)	1 000[2] (52 4)	941[2] (25 6)	926[2] (37 2)	908[2] (35 6)	909[2] (35 8)	915[2] (37 1)	919[2] (35 8)
$\bar{R}^2$	9631	9978	8535	9998	9997	9997	9997	9998
Standard error	0268	0221	0812	0028	0029	0029	0029	0027
	Equations with distributed lags							
Constant	– 485 (– 2)	–21 369[2] (–7 2)	3 257 (8)	2 581[2] (10 9)	2 831[2] (16 1)	2 851[2] (16 1)	2 588[2] (12 8)	2 871[2] (14 1)
ln R_{CP}	067[2] (2 9)	007 (4)	241[2] (3 8)	– 052[2] (–24 8)	– 055[2] (–25 8)	– 054[2] (–25 1)	– 052[2] (–23 9)	– 053[2] (–25 8)
ln *PI*	581 (1 3)	2 161[2] (6 5)	289 (2)	722[2] (17 9)	702[2] (16 9)	701[2] (16 7)	721[2] (17 0)	700[2] (17 6)
$\bar{R}^2$	9511	9976	8391	9998	9997	9997	9997	9997
Standard error	0304	0226	0850	0027	0028	0028	0029	0027

[1] *t*-statistics are in parentheses
[2] Significant at 99 per cent confidence level
[3] Significant at 95 per cent confidence level

and interest rate coefficients are all significant and have the expected signs the $\bar{R}^2$'s and standard errors are approximately the same across regressions In three cases the standard error of the equation for *MN* is slightly higher than that for the equation for *M*, suggesting that we may not wish to exclude *all* foreign components from the definition of money In three of four cases in which *FOFF* is included in the definition of money, the standard error is slightly lower than that for an equation excluding this foreign component In two regressions including *FCB* in the definition of money, the standard error is slightly higher than when *FCB* is excluded The remaining standard errors are indistinguishable

In summary, the differences among the standard errors for the demand functions for the alternative definitions of money are so small that little can be said, based on these regressions, about which foreign components should or should not be included in the definition of money More information is gained from the demand functions for the foreign components In no case does R_{CP} enter significantly into a demand function for a foreign component, except when the sign of the coefficient is positive[16] This result suggests that if the demand for any given foreign component is affected by movements in the commercial paper rate, it is affected in a manner that is very different from the way these movements affect the demand for the other components of the money supply There is some evidence of a relationship between *FCB* and income and less evidence of a relationship between *FIPC* and income Of course, the income variables may act as proxies for another transactions variable that is actually the determinant of the demand for these balances This conjecture will be investigated further in the next section Finally, while all the $\bar{R}$'s are quite high, the standard errors for the foreign components are very high relative to those for *M*, suggesting that although domestic income and interest rates do a good job of explaining the demand for *M*, other variables may be relevant in determining the demands for the foreign deposits

An alternative approach

In this section we attempt to develop a more complete model to explain the demand for demand deposits of foreign commercial banks (*FCB*) at U S banks For the demand deposits due to foreign official institutions and to foreign individuals, partnerships, and corporations, further efforts are made to establish the existence of meaningful correlations between the deposits and domestic macroeconomic variables Seasonally unadjusted quarterly and monthly data are used in these analyses, with quarterly and monthly dummy variables employed to remove the effects of any deterministic seasonal The limitations imposed by the available data are discussed more fully in the appendix

Demand deposits due to foreign commercial banks

Foreign commercial banks hold demand deposit balances at U S banks as part of broad commercial relationships These balances facilitate the clearing of their dollar transactions and serve to maintain lines of credit at U S banks U S bankers, as reported earlier, emphasized that the returns and costs associated with these demand deposits are monitored closely both by the U S banks that accept the deposits and by the foreign banks that make the deposits

In this section a simple transactions model is set out to explain the level of foreign commercial bank deposits held in U S banks Monthly data from 1971 through 1975 are used to test for the significance of the explanatory variables suggested by the transactions model

A simple model of foreign commercial bank deposits Foreign banks are assumed to attempt to minimize costs associated with clearing dollar transactions in the United States For a typical foreign bank the total cost of clearing transactions, per time period (*TC*), is given by[17]

$$(1) \qquad TC = A(T,D) + r_O D + S$$

where

$A(T,D)$ = the internal accounting and administrative costs incurred by the foreign bank in executing its dollar transactions

T = the dollar value of transactions through the account

D = the level of demand deposits held

r_O = the opportunity cost per dollar to the foreign bank of deposits held, in terms of interest forgone

S = the explicit service charges levied by the U S bank for clearing transac-

[16] In the alternative model specified in the next section, the estimated coefficient on R_{CP} is negative and significant when another short term rate is entered in the regressions

[17] In principle, Equation 1 and subsequent equations should be expressed in price deflated magnitudes This has not been done because of problems in choosing the appropriate deflators for the different nominal magnitudes Also, costs should probably be related separately to the number of transactions and the average value of a transaction Data limitations prevent this refinement In the empirical work we use a time trend in some of the regressions as a proxy for, among other things, secular changes in the average value of a transaction

tions minus charges for any nonclearing services provided by the U S bank and not charged for explicitly

Because data on the level of service charges (S) are not available, we need to derive an expression for S in terms of observable variables To do this, we look at the cost of servicing the foreign demand deposits at the U S bank Service charges, in terms of dollars per time period, are equal to the difference between the costs of servicing the foreign account, including profits, and the return the U S bank can earn on funds made available from the deposit[18]

(2) $S = C(T,D) + F(L) + \pi(D) - r_L L$

where

$C(T,D)$	=	the cost borne by the U S bank in clearing transactions through the foreign deposit account
L	=	the volume of loans (or other asset purchases) that can be made with the funds held on deposit by the foreign bank
$F(L)$	=	the cost of servicing the loans made with the deposit funds
$\pi(D)$	=	profits
r_L	=	the loan rate at the U S bank

We assume that the level of transactions costs—both for the foreign bank and the U S bank—increases with the volume of transactions, and that increases in deposit balances reduce clearing costs incurred by both the foreign bank and the U S bank Also, we assume that the costs of servicing loans increases with volume That is,

$$A_T, C_T > 0, \quad A_D, C_D < 0, \quad \text{and} \quad F_L > 0$$

where subscripts denote partial derivatives of the functions

The U S bank can use the deposited funds (D) to make loans of

(3) $$L = (1 - \rho)D$$

where ρ is the reserve ratio Using Equation 3 to eliminate L from Equation 2 and substituting the resulting expression for S in Equation 1, then

(4) $$TC = C(T,D) + A(T,D) + F[(1 - \rho)D] + \pi(D) + [r_O - (1 - \rho)r_L]D$$

The foreign bank is assumed to hold the level of deposits that minimizes the costs of clearing its dollar transactions The cost-minimizing condition obtained by taking the partial derivative of the cost function, Equation 4, with respect to D is[19]

(5) $$-(C_D + A_D) = r_O - (1 - \rho)(r_L - F_L) + \pi_D$$

The cost-minimizing level of deposits is given when the marginal cost savings per dollar of deposits $[-(C_D + A_D)]$ is equal to the difference between r_O, the opportunity cost of funds to the foreign bank, and r_D, the marginal value of funds to the U S bank, adjusted for the profits, where $r_D = (1 - \rho)(r_L - F_L) + \pi_D$

Solving Equation 5 for D yields the minimum-cost level of deposits

(6) $$D = H(T, r_O, r_D)$$

The demand for deposit balances (D) is a function of the volume of transactions (T), the opportunity cost of holding the deposits (r_O), and the rate of return on the deposits (r_D) From the assumptions made above, the partial derivatives of H with respect to the interest rates have signs as follows $H_{r_O} < 0$, $H_{r_D} > 0$ Following standard transactions models, we would expect that for a given level of deposits, the value of marginal deposits in reducing

[18] The level of service charges (S) may be positive or negative If the level of deposits is such as to provide abnormal profits with zero explicit charges, the U S bank is assumed to provide other banking services at less than full costs S is variable since we assume that the U S bank pays a competitive rate on the deposit even in the face of the prohibition on explicit interest payments

[19] We assume that T, ρ, r_O, and r_L do not depend on D The second order condition is that

$$C_{DD} + A_{DD} + (1 - \rho)^2 F_{LL} + \pi_{DD} > 0$$

where double subscripts denote second order partial derivatives

If the U S bank maximizes profits, then $\pi_D = 0$ The rest of this section is consistent with profit maximization by the U S bank, but only the slightly weaker assumption that π_D is constant is needed transaction costs increases with the level of transactions, that is, $(C_{DT} + A_{DT}) > 0$ This assumption implies that $H_T > 0$

Empirical estimation The exact form of the deposit demand function, $H(\ )$, will depend on the precise specification of the cost function Here, we do not set out a fully developed model of transactions costs, but rather assume for estimation purposes that the H function is log-linear [20] All variables—except the time trend—are in natural logarithms of levels

Because data on individual deposit accounts are not available, data on total demand deposits of foreign commercial banks and total foreign dollar transactions cleared through U S banks are used to estimate the relationship We continue to assume that T, r_O, and r_D do not depend on the level of foreign deposits

In the regressions reported below, the level of deposits (D) is primarily based on a monthly average of Wednesday figures The transactions variable is represented by the monthly average of daily dollar figures for the Clearing House Interbank Payments System (*CHIPS*) [21]

Several interest rates are used to represent r_O the 90-day Euro-dollar rate (RE_{90}), the 30- to 59-day commercial paper rate (R_{CP}), and the primary rate on 90-day U S certificates of deposit (R_{CD}) [22]

A major problem is the determination of a series to represent the implicit rate of return on deposits (r_D) As defined earlier,

$$r_D = (1 - \rho)(r_L - F_L) + \pi_D$$

For the banks accepting these foreign deposits, marginal reserve requirements (ρ) were essentially unchanged over the sample period Also, if F_L and π_D are constant, then r_D is a linear function of the loan rate (r_L) [23]

Several different rates could be used to represent r_L For three reasons, in the regressions to be reported the prime rate (R_P) is the loan rate used First, the prime lending market is a fairly competitive market with small administrative costs, this rate then should move closely with the true cost of funds to the U S banks [24] Second, it was reported and verified that overdrafts on the accounts of foreign commercial banks are frequently charged at the prime rate Assuming that U S banks perform their calculations carefully, the rate such banks charge on overdrafts in these accounts should reflect the marginal internal value of these deposits Third, although the Federal funds rate and the rate on repurchase agreements are also plausible candidates for the loan rate, the performance of these rates was dominated in our empirical work by the prime rate

Because deposits and transactions grew at a very rapid rate over most of the period, the equations were estimated with and without a time trend The time trend was used as a rough proxy for omitted variables to help explain this rapid growth

[20] The model indicates that the algebraic difference in the interest rates should enter the H function We estimated the function in various forms but the superiority of any one form could not be established The regressions that are reported use the logarithm of the interest rates entered separately

[21] CHIPS is an electronic system established in 1971 by the large New York banks to clear their international dollar transactions

[22] The market yield on 180-day Euro dollars and the 90 day U S Treasury bill rate were also used The findings were entirely consistent with those to be reported later

[23] Several U S banks indicated that they use an average of several rates to calculate a "treasurer's rate" for internal use in determining the profitability of customer relationships See Benjamin Klein, "Competitive Interest Payments on Bank Deposits and the Long Run Demand for Money," *American Economic Review*, vol 74 (December 1974), pp 931–49, and Robert J Barro and Anthony M Santomero, "Household Money Holdings and the Demand Deposit Rate," *Journal of Money, Credit and Banking*, vol 4 (May 1972), pp 397–413, for work that tries to measure r_D directly

[24] Borrowing at the prime rate normally carries a compensating balance requirement To the extent that the compensating balance requirement is a result of the implicit payment of interest on deposits by lending at a favorable rate, the prime rate will be less than the pure lending rate and may be less than or greater than the implicit deposit rate Assuming zero intermediation costs, the relationship between the prime rate and the implicit deposit rate depends on the reserve ratio and the compensating balance ratio For example, if the marginal reserve requirement is 17 per cent with a 20 per cent compensating balance requirement, the implicit deposit rate is 996 of the prime lending rate

TABLE 5 Estimates of the Demand Function for Demand Deposits Due to Foreign Commercial Banks[1]

$\ln FCB_t = \alpha \ln R_{Pt} + \beta \ln r_t + \sum_{i=0}^{6} \gamma_i \ln CHIPS_{t-i} + \delta t + \xi +$ (seasonal dummies)

r_t	Independent variables										
	α	β	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	γ_6	δ	ξ
	A Regressions including a trend term										
RE_{90}	559[4]	− 209[5]	013	− 043	− 040	079	− 004	068	− 009	007[4]	5 640[4]
	(5 74)	(−2 43)	(25)	(− 76)	(− 70)	(1 37)	(− 07)	(1 25)	(− 18)	(7 54)	(42 41)
R_{CP}	571[4]	− 237[5]	031	− 026	− 037	063	− 003	060	019	007[4]	5 604[4]
	(5 16)	(−2 19)	(55)	(− 45)	(− 63)	(1 05)	(− 06)	(1 06)	(34)	(5 00)	(23 95)
R_{CD}	574[4]	− 222[5]	031	− 034	− 036	080	002	052	007	007[4]	5 450[4]
	(4 99)	(−2 14)	(55)	(− 59)	(− 61)	(1 36)	(04)	(94)	(14)	(4 84)	(23 70)
	B Regressions without a trend term										
RE_{90}	928[4]	− 580[4]	081	− 053	− 104	021	− 012	137	107		3 933[4]
	(6 42)	(−5 12)	(96)	(− 62)	(−1 22)	(24)	(− 15)	(1 70)	(1 45)		(24 28)
R_{CP}	998[4]	− 689[4]	113	− 003	− 089	− 006	− 016	093	163[5]		4 227[4]
	(10 40)	(−8 90)	(1 58)	(− 03)	(−1 19)	(− 08)	(− 23)	(1 28)	(2 65)		(34 65)
R_{CD}	1 010[4]	− 647[4]	109	− 025	− 083	047	− 001	069	128[5]		4 243[4]
	(10 63)	(−9 07)	(1 55)	(− 34)	(−1 12)	(61)	(− 01)	(97)	(2 09)		(35 36)

[1] t-statistics appear in parentheses All data are monthly, not seasonally adjusted, for the period August 1971–November 1975

[2] F-statistic for test of ($\gamma_0 =$ $= \gamma_6 = 0$) $F(7,30)$ for regressions including a trend term, $F(7,31)$ for regression without a trend term

[3] F-statistic for all variables except seasonals, trend, and constant $F(9,30)$ for regressions with a trend term, $F(9,31)$ for regressions without a trend term

[4] Significant at 99 per cent confidence level

[5] Significant at 95 per cent confidence level

In addition, one set of regressions was run with only a single interest rate To the extent that funds are arbitraged between the U S bank loan market and the market that the foreign banks use for funds, r_L and r_O are directly related If arbitrage were perfect, the two rates would be equal, and only a single rate would appear in the demand deposit equation The single interest rate would enter with a negative sign in the deposit demand function with positive reserve requirements If, however, the regression with a single rate were actually a misspecification in the form of an omitted variable—that is, the other rate—then the estimated coefficient on the entered rate would be biased[25]

Estimated relationships, using R_P plus a second rate for r_O and an unconstrained lag distribution on current and six past values of *CHIPS* data, are summarized in Table 5 (with a time trend in panel A and without one in panel B) In all cases R_P has the expected positive sign and is significantly different from zero at least at the 99 per cent confidence level The F-statistic for joint significance of all coefficients except those on the constant, trend, and seasonal dummies is significant at well above the 99 per cent confidence level in all cases

Taking the regressions as a whole, there are several interesting results First, when R_P is used in conjunction with a second rate, each of the rates used for r_O enters with the expected negative sign and each is significant at least at the 95 per cent level[26] Second, in all cases the F-test for joint significance of the coefficients on the lag distribution for *CHIPS* indicates that these coefficients taken as a group are significantly different from zero at least at the 95 per cent confidence level Furthermore, in all cases the coefficient on current *CHIPS* has the expected positive sign, although none of these is significantly different from zero Few of the individual coefficients in the lag distribution are equal to or greater than their respective standard errors However, since it is not difficult to conceive of models in which the transactions variable would enter with a distributed lag and since collectively our estimated coefficients are significantly different from zero, rejection of the hypothesis that current and lagged values of the level of foreign transactions (as reflected by *CHIPS*)

[25] See, for example, Theil, *Principles*, pp 548–56

[26] This result is also obtained by using the rates mentioned in note 22

TABLE 5—Continued

Regression statistics						
F statistics		R^2	Standard error	D W	ρ	$\Sigma\gamma_i$
(2)	(3)					
2 653[5]	23 644[4]	979	034	2 10	188	0064
2 812[5]	24 534[4]	980	035	1 94	143	1062
2 634[5]	23 419[4]	979	035	1 99	168	1028
6 956[4]	58 497[4]	911	055	1 58	356	1778
29 568[4]	130 144[4]	959	047	1 88	202	2544
28 571[4]	133 655[4]	960	046	1 89	204	2426

are a significant determinant of FCB is not possible[27]

The exclusion of a time trend from the estimated relation alters the significance level, and on occasion the sign, of some of the estimated coefficients In all cases the coefficient on the rate used for r_0 remains negative, but it becomes significant at well above the 99 per cent level when the trend is omitted Additionally, the test for joint significance of the coefficients on current and lagged *CHIPS* indicates significance at well above the 99 per cent confidence level[28] The standard errors of the individual coefficients in the lag distribution are large, but in two cases coefficients on $CHIPS_{t-6}$ are significant at the 95 per cent level However, these results could be spurious The sensitivity of macroeconometric results to the inclusion or exclusion of a time trend is a well-known phenomenon, and it underscores some of the uncertainties and inadequacies inherent in current econometric work

A final note concerns the signs and significance of the coefficients on the two interest rates The results in panel B of Table 5 could reflect a trend in the spread between the rates However, the time series on R_p and on the other rates indicate that the spread between the rates narrows in the early part of the period considered and widens again over the final 15 to 16 months[29] Furthermore, as Panel A shows, the inclusion of a trend does not alter the roles of the two rates in the equation

Table 6 presents the results of regressions that parallel those reported in Table 5 but have only a single interest rate The positive sign on the rate—a negative sign is predicted by the model—and the rate's significance only in the presence of a trend constitute the most notable results of the regressions Use of a single interest rate appears to be inadequate and to result in specification error Given this likely specification error, it is not surprising that the coefficients on the *CHIPS* lag distribution are significant only in the absence of a trend[30]

[27] It should be noted that our theory does not provide a solid a priori foundation for the expected form of the lag distribution The regressions in Table 5 also have been carried out by employing a quadratic lag distribution over six periods, the sixth being constrained to equal zero In each case the coefficients on the two interest rates have the expected signs, and each of the rates used as r_0 is significant at approximately the 90 per cent level The exact shape of the lag distribution differs, of course, from the estimated unconstrained lag distribution (indeed, the constrained form always yields a coefficient on current *CHIPS* with a negative sign, although it is never significantly different from zero) But in each case the sum of the coefficients is significant at least at the 95 per cent confidence level Thus, while the exact form of the lag distribution may not be clear from the results, the *CHIPS* data do appear to be significant in explaining the level of these deposits

[28] Alternative forms of the estimates in Table 5 also have been obtained by using shorter lag distributions on *CHIPS* data In all cases the results are highly sensitive to inclusion or exclusion of the trend in terms of the significance of the coefficients on both *CHIPS* and interest rates

[29] The 90 day and 180 day Euro dollar rates do not follow this pattern with respect to R_P, although the regression results with these rates are very similar to those reported with domestic rates However, the problems of serial correlation are more severe in tests with these rates

[30] Regressions corresponding to the results reported in Table 6 for R_{CP} and RE_{90} also have been run by using a quadratic lag distribution on the *CHIPS* data The coefficients on the rates are significant at the 95 per cent confidence level and positive, but when the trend—significant at the 99 per cent level—is included, the sum of *CHIPS* coefficients is not significant

TABLE 6 Estimates of the Demand Function for Demand Deposits Due to Foreign Commercial Banks[1]

$$\ln FCB_t = \alpha \ln r_t + \sum_{i=0}^{6} \beta_i \ln CHIPS_{t-i} + \gamma t + \delta + \text{(seasonals)}$$

r_t	Independent variables									
	α	β_0	β_1	β_2	β_3	β_4	β_5	β_6	γ	δ
	A Regressions including a trend term									
RE_{90}	189[4] (2 88)	019 (30)	− 008 (− 14)	− 027 (− 47)	065 (1 13)	004 (07)	030 (55)	009 (17)	004[4] (5 67)	2 310[4] (16 74)
R_{CP}	247[4] (3 41)	003 (05)	− 084 (− 63)	− 030 (− 54)	070 (1 26)	− 001 (− 02)	040 (77)	− 019 (− 36)	004[4] (6 20)	2 472[4] (17 05)
R_{CD}	232[4] (3 44)	007 (11)	− 023 (− 41)	− 031 (− 55)	052 (94)	− 007 (− 13)	045 (87)	− 009 (− 16)	005[4] (6 34)	2 555[4] (17 62)
	B Regressions without a trend term									
RE_{90}	114 (1 35)	055 (79)	021 (32)	− 016 (− 25)	075 (1 27)	026 (44)	062 (1 05)	050 (87)		836[4] (7 31)
R_{CP}	127 (1 24)	053 (74)	005 (02)	− 024 (− 37)	071 (1 20)	023 (38)	075 (1 31)	047 (79)		917[4] (7 75)
R_{CD}	123 (1 26)	055 (77)	012 (19)	− 023 (− 36)	062 (1 05)	019 (32)	077 (1 34)	057 (98)		909[4] (7 77)

[1] t-statistics appear in parentheses All data are monthly, not seasonally adjusted, for the period August 1971–November 1975

[2] F statistic for test of ($\beta_0 = \quad = \beta_6 = 0$) $F(7,31)$ for regressions including a trend term, $F(7,32)$ for regressions without a trend term

[3] F-statistic for test of ($\alpha = \beta_0 = \quad = \beta_6 = 0$) $F(8,31)$ for regressions including a trend term, $F(8,32)$ for regressions without a trend term

[4] Significant at 99 per cent confidence level

[5] Significant at 95 per cent confidence level

In order to obtain consistent estimates, as well as to provide a basis for interpreting the estimated relations as representative of behavioral relations, T, r_O, and r_D must be statistically exogenous with respect to D[31] Utilizing C W J Granger's definition of causality and the equivalence of that definition with the econometrician's definition of statistical exogeneity established by Christopher A Sims, one attempt is made—the direct empirical implementation of Granger's definition—to determine if these conditions are met for the estimated relations reported here[32] The results of these tests, which are summarized in Table 7, suggest that while we are not justified in rejecting the hypotheses that each of our right-hand variables is exogenous with respect to these deposits, neither are we justified in rejecting the hypothesis of exogeneity of deposits with respect to each of the right-hand variables considered[33] Thus, while *CHIPS* and each of the rates pass this test for exogeneity with respect to *FCB*, the results suggest that we should interpret neither a regression of *FCB* on those variables nor regressions in the reverse direction as representative of behavioral relationships It should be noted that these tests are all bivariate tests To maintain consistency with the model, the data period should be extended and the tests reformulated in a four-variate representation reflecting the relationships in Table 6 Because of the limited size of the available data set, further tests have not been carried out Thus, these results imply that caution must be exercised in interpreting these regressions as representative of actual demand or behavioral relationships

Some final caveats regarding our results are in order The ρ indicated in Table 6 represents an estimated first-order autoregressive parameter for the disturbance in the equation No attempt is made to correct for higher than first-order serial correlation in the residuals

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[31] In estimating the demand function for deposits, it is assumed that the value of transactions (T) is determined by factors other than the rates included in the demand relation To the extent that T is correlated with these rates, the estimators are inefficient

[32] See Granger, "Investigating Causal Relations by Econometric Models and Cross Spectral Methods," *Econometrica*, vol 37 (July 1969), pp 424–38, and Sims, "Money, Income, and Causality," *American Economic Review*, vol 62 (September 1972), pp 540–52

[33] The 180-day Euro-dollar rate is the one exception to this, the rate appearing to be exogenous with respect to *FCB* but not the reverse

TABLE 6—Continued

Regression statistics						
F-statistics		$\bar{R}^2$	Standard error	D W	ρ	$\Sigma\beta_i$
(2)	(3)					
940	3 604[4]	838	0402	2 27	665	0922
466	4 221[4]	849	0386	2 36	667	0282
358	4 380[4]	858	0388	2 31	654	0343
3 319[4]	3 807[4]	350	0451	2 14	850	2726
2 588[5]	4 180[4]	371	0456	2 03	842	2503
2 568[5]	4 179[4]	371	0456	2 04	842	2541

In addition, any seasonal biases that remain after the deterministic seasonal effects represented by the dummy variables are accounted for are not considered[34] Many of these results are reported as *F*-tests on the joint significance of groups of coefficients Given the small number of observations, the relatively few degrees of freedom in many of our estimated relations, and the inconclusiveness of the results, the *F*-tests could be considered weak tests of the relevant hypotheses

In summary, given the limitations imposed by the data, inconclusiveness in certain results, and some incompleteness in the theory, the evidence supports the contention that demand deposits due to foreign commercial banks are determined in large part by the level of foreign transactions cleared through CHIPS These transactions are generated primarily by financial transfers in the Euro-dollar market and foreign exchange markets Since only a small proportion of these foreign transactions are related to sales of goods and services produced in the United States, our results suggest that proximate determinants of these deposits may be better represented by foreign transactions than by U S macroeconomic variables

TABLE 7 Tests Employing Granger's Definition of Causality[1]

$$Y_t = \sum_{i=1}^{9} \alpha_i Y_{t-i} + \sum_{j=1}^{6} \beta_j X_{t-j} + \gamma t + \delta + \text{(seasonals)}$$

Y	X	$F(6,22)$[2]	$F(9,22)$[3]
ln *FCB*	ln *CHIPS*	1 380	13 739[4]
	ln R_p	1 300	4 930[4]
	ln R_{CP}	1 098	5 541[4]
	ln RE_{90}	1 962	10 299[5]
	ln R_{CD}	1 469	5 312[4]
ln *CHIPS*	ln *FCB*	828	22 756[4]
ln R_p		819	30 126[4]
ln RE_{90}		1 305	19 844[4]
ln R_{CP}		764	22 638[4]
ln R_{CD}		982	25 066[4]

[1] All data are monthly, not seasonally adjusted, for the period October 1971–November 1975
[2] *F*-statistic for test of ($\beta_1 = \quad = \beta_6 = 0$)
[3] *F*-statistic for test of ($\alpha_1 = \quad = \alpha_9 = 0$)
[4] Significant at 99 per cent confidence level
[5] Significant at 95 per cent confidence level

[34] For a discussion of these types of problems, see Christopher A Sims, "Seasonality in Regression," *Journal of the American Statistical Association*, vol 69 (September 1974), pp 618–26, and Kenneth F Wallis, "Seasonal Adjustment and Relations between Variables," *Journal of the American Statistical Association*, vol 69 (March 1974), pp 18–31

Demand deposits due to foreign official institutions

An effort is made to supplement the results that employ seasonally adjusted data to examine demand deposits due to foreign official institutions (*FOFF*) Since no monthly figures comparable to *GNP* (but not seasonally adjusted) are available, the monthly index of industrial production (*IPI*), not seasonally adjusted, is used as a measure of U S economic activity to capture any relationship that may exist between these deposits and their use for purchase of U S goods and services These deposits are positively correlated with some short-term interest rates (Table 8), but they do not exhibit any significant correlations with U S economic activity as measured by the *IPI* Removal of the trend does not significantly alter the results, in most cases, the correlations are reduced to even lower levels

Table 9 shows the results of regressions of quarterly *GNP* on current and lagged values of various components of *M* with seasonally unadjusted data The coefficients on *FOFF*, whether taken as a group or singly, are not significantly different from zero regardless of

TABLE 8 Correlations of Demand Deposits Due to Foreign Official Institutions with Short-term Rates and Index of Industrial Production[1]

$$\ln FOFF_t = \alpha \ln r_t + \sum_{i=0}^{6} \beta_i \ln IPI_{t-i} + \gamma t + \delta + \text{(seasonals)}$$

r_t	Independent variables									
	α	β_0	β_1	β_2	β_3	β_4	β_5	β_6	γ	δ
R_P	522[4]	513	−1 609	1 770	−1 088	2 711	−3 662	1 107	007[5]	4 423
	(2 17)	(25)	(− 54)	(58)	(− 36)	(88)	(−1 21)	(50)	(4 72)	(1 88)
R_{FF}	526[5]	− 413	−1 668	1 012	348	2 151	−4 220	1 220	009[5]	8 844[5]
	(3 23)	(− 22)	(− 57)	(34)	(12)	(72)	(−1 42)	(59)	(7 91)	(3 01)
R_{CP}	575[4]	− 028	−1 841	1 709	−1 059	2 806	−3 862	977	007[5]	7 103[4]
	(2 73)	(− 01)	(− 65)	(59)	(− 37)	(95)	(−1 34)	(47)	(6 50)	(2 52)
RE_{90}	282	148	−1 316	1 583	− 740	2 538	−3 425	1 570	008[5]	2 726
	(1 73)	(07)	(− 45)	(52)	(− 25)	(83)	(−1 15)	(72)	(6 48)	(1 37)
R_{CD}	582[5]	− 343	−1 515	954	− 406	3 124	−4 529	1 232	008[5]	7 726[5]
	(2 98)	(− 18)	(− 54)	(33)	(− 14)	(1 07)	(−1 58)	(61)	(6 74)	(2 75)

[1] t-statistics appear in parentheses All data are monthly, not seasonally adjusted, for the period August 1971–November 1975
[2] F statistic for test of ($\beta_0 =$ $= \beta_6 = 0$)
[3] F-statistic for test of ($\alpha = \beta_0 =$ $= \beta_6 = 0$)
[4] Significant at 95 per cent confidence level
[5] Significant at 99 per cent confidence level

the presence or absence of a trend (However, considerable first-order autocorrelation obviously remains in the estimated relations) Table 10 further indicates that whether *GNP* is regressed on current and lagged *M* net of all foreign-owned items (*MN*) or *MN* plus foreign items due to individuals, partnerships, and corporations (*MN* + *FIPC*), the introduction of current and lagged values of *FOFF* results in coefficients on *FOFF* that, taken as a group, are not significantly different from zero in explaining *GNP*

TABLE 9 Regressions (Quarterly) of GNP on Various Money Measures[1]

$$\ln GNP_t = \sum_{i=0}^{6} \alpha_i \ln M_{t-i} + \beta t + \gamma + \text{(seasonals)}$$

M	Independent variables								
	α_0	α_1	α_2	α_3	α_4	α_5	α_6	β	γ
	A Regressions including a trend term								
M	1 049[3]	− 169	243	729	− 201	381	− 225	− 002	− 790
	(2 79)	(− 34)	(42)	(1 30)	(− 39)	(87)	(− 66)	(− 84)	(−1 24)
MN	973[3]	− 121	290	720	− 146	381	− 214	− 002	− 794
	(2 70)	(− 28)	(60)	(1 53)	(− 32)	(95)	(− 64)	(− 83)	(−1 18)
FCB	204[3]	023	− 062	050	012	− 056	− 014	005[4]	2 168[4]
	(2 17)	(20)	(− 54)	(42)	(11)	(− 46)	(− 12)	(3 90)	(176 04)
FOFF	021	026	− 010	004	009	− 033	− 021	007[4]	1 918[4]
	(94)	(1 04)	(− 38)	(15)	(36)	(−1 27)	(− 87)	(34 96)	(198 35)
FIPC	152	088	053	004	037	− 096	− 168	007[4]	1 925[4]
	(1 79)	(95)	(58)	(04)	(35)	(− 90)	(−1 60)	(13 16)	(59 30)
	B Regressions without a trend term								
M	894[3]	− 152	115	727	− 332	394	− 346		− 243[4]
	(2 74)	(− 31)	(21)	(1 31)	(− 67)	(91)	(−1 13)		(−4 17)
MN	824[3]	− 138	173	677	− 268	372	− 327		− 215[4]
	(2 67)	(− 32)	(37)	(1 47)	(− 63)	(94)	(−1 08)		(−3 65)
FCB	214	036	028	123	− 009	002	171		1 656[4]
	(1 94)	(27)	(22)	(93)	(− 07)	(01)	(1 49)		(204 64)
FOFF	017	023	− 009	002	005	− 037	− 018		359[4]
	(52)	(68)	(− 27)	(05)	(13)	(−1 06)	(− 53)		(52 78)
FIPC	385	386	417	465[3]	338	245	274		1 111[4]
	(1 94)	(1 87)	(2 05)	(2 14)	(1 42)	(1 02)	(1 15)		(28 73)

[1] t-statistics appear in parentheses All data are quarterly, not seasonally adjusted, for the period 1965 Q2–1973 Q4
[2] F-statistic for test of ($\alpha_0 =$ $= \alpha_6 = 0$) $F(7,23)$ for regressions including a trend term, $F(7,24)$ for regressions without a trend term
[3] Significant at 95 per cent confidence level
[4] Significant at 99 per cent confidence level

TABLE 8—Continued

Regression statistics						
$F(7,31)$[2]	$F(8,31)$[3]	R^2	Standard error	D W	ρ	$\Sigma\beta_i$
528	2 502[4]	734	099	1 90	412	− 2583
890	3 688[5]	790	094	1 93	355	−1 5696
779	2 954[4]	746	095	1 98	428	−1 2980
458	2 079	695	099	1 93	460	3583
896	3 240[4]	760	093	1 94	417	−1 4831

It might also be hypothesized that deposits like *FOFF* could be held for purchases such as military items As the last line of Table 10 shows, neither the coefficients on current and lagged *GNP* nor those on current and lagged U S military export sales are, taken as a group,

TABLE 9—Continued

Regression statistics					
F-statistic[2]	R^2	Standard error	D W	ρ	$\Sigma\alpha_i$
2 687[3]	982	009	2 17	793	1 8077
2 234	979	009	1 96	808	1 8843
2 065	987	011	1 76	582	1579
994	983	012	1 47	636	− 0003
1 507	984	011	1 84	632	0069
97 231[4]	981	009	2 03	801	1 3003
73 381[4]	979	009	1 85	822	1 3122
120 112[4]	975	013	1 42	677	5653
376	910	017	86	948	− 0019
14 560[4]	864	026	54	749	2 5120

significantly different from zero in explaining *FOFF*

The evidence, in short, does little to suggest that demand deposits due to foreign official institutions are related in any significant way to U S output or income

Demand deposits due to foreign individuals, partnerships, and corporations

Results of the efforts to supplement the earlier analysis of demand deposits due to foreign individuals, partnerships, and corporations (*FIPC*) are presented in Table 11 Coefficients on current and lagged *IPI* are, as a group, significantly different from zero at the 95 per cent level or above only when R_p or RE_{90} is included in the estimated relation Furthermore, when the trend is removed, even these results disappear As Table 9 shows, however, when the trend is removed from the quarterly regressions, the coefficients on *FIPC* are significant at well above the 99 per cent confidence level Unfortunately, the possibility of serious first-order autocorrelation in this estimated relation also exists Table 12 indicates that coefficients on *FIPC* are not, as a group, significant in explaining *GNP* when included in a regression of *GNP* on *M* net of all foreign items (*MN*) The same type of relationship, estimated monthly by using *IPI* for output, shows these coefficients to be significant at the 99 per cent level both when a trend is included and when it is excluded Again, however, in these cases there is strong evidence of serial correlation in the estimated relation (Indeed, tests using an estimated first-order autoregressive parameter resulted in no improvement, as indicated by the Durbin-Watson statistic)

In summary, these results do little to resolve the question of meaningful relationships between demand deposits due to foreign IPC's and U S macroeconomic variables

TABLE 10 Further Evidence on the Correlation of *FOFF* with *GNP*[1]

Independent variables									
α_0	α_1	α_2	α_3	β_0	β_1	β_2	β_3	γ	δ
A $\ln GNP_t = \sum_{i=0}^{3} \alpha_i \ln MN_{t-i} + \sum_{j=0}^{3} \beta_j \ln FOFF_{t-j} + \gamma t + \delta +$ (seasonals)									
883[5] (2 07)	− 068 (− 11)	070 (12)	607 (1 51)	022 (1 15)	010 (46)	0002 (001)	005 (24)	− 0009 (− 41)	− 909 (−1 21)
B $\ln GNP_t = \sum_{i=0}^{3} \alpha_i \ln (MN + FIPC)_{t-i} + \sum_{j=0}^{3} \beta_j \ln FOFF_{t-j} + \gamma t + \delta +$ (seasonals)									
895[6] (2 10)	− 083 (− 14)	088 (15)	595 (1 47)	021 (1 12)	010 (45)	0002 (01)	005 (22)	− 0009 (− 40)	− 919 (−1 23)
C $\ln FOFF_t = \sum_{i=0}^{3} \alpha_i \ln GNP_{t-i} + \sum_{j=0}^{3} \beta_j \ln MIL_{t-j} + \gamma t + \delta +$ (seasonals)									
766 (38)	3 061 (1 45)	− 745 (− 36)	1 126 (54)	097 (96)	108 (1 03)	022 (20)	− 016 (− 14)	− 031 (−1 56)	−7 320 (−1 37)

[1] t-statistics appear in parentheses *MIL* = U S military export sales All data are quarterly, not seasonally adjusted, for the period 1965Q2–1973Q4

[2] F-statistic for test of ($\alpha_0 =$ $= \beta_0$ $= 0$)

[3] F-statistic for test of ($\alpha_0 =$ $= \alpha_3 = 0$)

[4] F statistic for test of ($\beta_0 =$ $= \beta_3 = 0$)

[5] Significant at 95 per cent confidence level

TABLE 11 Correlations of Demand Deposits Due to Foreign Individuals, Partnerships, and Corporations with Short-term Rates and Index of Industrial Production[1]

$$\ln FIPC_t = \alpha \ln r_t + \sum_{i=0}^{6} \beta_i \ln IPI_{t-i} + \gamma t + \delta + \text{(seasonals)}$$

r_t	Independent variables									
	α	β_0	β_1	β_2	β_3	β_4	β_5	β_6	γ	δ
R_P	167[4] (2 09)	−1 538 (−1 75)	1 296 (92)	− 616 (− 43)	− 661 (− 47)	2 736 (1 90)	−2 784 (−1 94)	639 (66)	009[5] (14 96)	9 087[5] (8 69)
R_{FF}	043 (61)	−1 752 (−1 94)	1 360 (96)	− 531 (− 37)	− 392 (− 27)	2 503 (1 72)	−2 859 (−1 98)	1 049 (1 07)	009[5] (15 75)	7 262[5] (5 13)
R_{CP}	039 (45)	−1 680 (−1 86)	1 325 (95)	− 483 (− 34)	− 498 (− 35)	2 548 (1 77)	−2 811 (−1 98)	1 043 (1 06)	008[5] (15 17)	6 785[5] (4 97)
RE_{90}	035 (58)	−1 715 (−1 89)	1 399 (99)	− 521 (− 36)	− 478 (− 33)	2 563 (1 75)	−2 811 (−1 93)	1 049 (1 06)	009[5] (15 88)	7 021[5] (7 35)
R_{CD}	058 (73)	−1 736 (−1 93)	1 361 (97)	− 571 (− 40)	− 452 (− 32)	2 607 (1 79)	−2 897 (−2 02)	1 023 (1 05)	009[5] (15 61)	7 342[5] (5 34)

[1] t-statistics appear in parentheses All data are monthly, not seasonally adjusted for the period August 1971–November 1975

[2] F-statistic for test of ($\beta_0 =$ $= \beta_6 = 0$)

[3] F-statistic for test of ($\alpha = \beta_0 =$ $= \beta_6 = 0$)

[4] Significant at 95 per cent confidence level

[5] Significant at 99 per cent confidence level

TABLE 12. Further Evidence of Correlations between *FIPC* and U S Economic Activity[1]

Independent variables											
α_0	α_1	α_2	α_3	α_4	α_5	α_6	β_0	β_1	β_2	β_3	β_4
A Quarterly estimate $\ln GNP_t = \sum_{i=0}^{3} \alpha_i \ln MN_{t-i} + \sum_{j=0}^{3} \beta_j \ln FIPC_{t-j} + \gamma t + \delta +$ (seasonals)											
1 026[5] (2 53)	− 363 (− 71)	194 (40)	579 (1 71)				055 (72)	031 (36)	117 (1 23)	009 (09)	
B Monthly estimate, with trend $\ln IPI_t = \sum_{i=0}^{6} \alpha_i \ln MN_{t-i} + \sum_{j=0}^{6} \beta_j \ln FIPC_{t-j} + \gamma t + \delta +$ (seasonals)											
1 338 (1 96)	391 (37)	1 262 (1 05)	310 (24)	576 (43)	385 (30)	232 (31)	129[5] (2 10)	073 (1 16)	044 (67)	− 049 (− 73)	− 155[6] (−2 43)
C Monthly estimate, without trend Same as B, except $\gamma \equiv 0$											
− 370 (− 37)	1 056 (62)	525 (28)	318 (15)	− 110 (− 05)	1 441 (72)	−1 105 (− 98)	112 (1 14)	056 (56)	− 006 (− 06)	− 029 (− 27)	− 230[6] (−2 32)

[1] t-statistics appear in parentheses Quarterly data are for the period 1965 Q2–1973 Q4 monthly data are for the period August 1971–December 1975 All data are not seasonally adjusted

[2] F statistic for test of all $\alpha_i =$ all $\beta_i = 0$

[3] F statistic for test of all $\alpha_i = 0$

[4] F-statistic for test of all $\beta_i = 0$

[5] Significant at 95 per cent confidence level

[6] $F(8,22)$

TABLE 10—Continued

Regression statistics						
$F(8,22)$[2]	$F(4,22)$[3]	$F(4,22)$[4]	$\bar{R}^2$	Standard error	D W	ρ
2 643[5]	4 139[6]	0 741	988	00983	1 82	607
2 652[5]	4 156[5]	0 687	988	00982	1 83	608
0 895	0 850	0 551	− 092	11019	1 39	638

TABLE 11—Continued

Regression statistics						
$F(7,31)$[2]	$F(8,31)$[3]	$\bar{R}^2$	Standard error	D W	ρ	$\Sigma\beta_i$
3 720[5]	3 256[5]	930	042	2 02	208	− 9291
2 150	2 094	905	044	2 01	292	− 6211
2 044	1 956	897	044	2 03	319	− 5558
2 368[4]	2 135	907	044	2 00	281	− 5144
2 175	2 107	904	044	2 02	297	− 6650

TABLE 12—Continued

				Regression statistics						
				F-statistics						
β_5	β_6	γ	δ	(2)	(3)	(4)	$\bar{R}^2$	Standard error	D W	ρ
		− 0009 (− 45)	− 606 (− 85)	2 473[5,6]	3 220[5,7]	638[7]	985	00939	2 00	707
− 151[5] (−2 45)	−1 55[5] (−2 56)	− 016[8] (−6 51)	−48 676[8] (−8 60)	69 539[8,9]	17 855[8,10]	6 664[8,10]	961	0131	69	
− 258[5] (−2 72)	− 273[8] (−2 96)		−12 245[8] (−9 04)	29 611[8,11]	25 794[8,12]	45 856[8,12]	901	0208	49	

[7] $F(4,22)$
[8] Significant at 99 per cent confidence level
[9] $F(14,26)$
[10] $F(7,26)$
[11] $F(14,27)$
[12] $F(7\ 27)$

Appendix: Discussion of Data Used

In order to perform the empirical work requested by the Committee on Monetary Statistics, as well as to construct the body of supporting evidence presented in this study, it is important that each of the series used be constructed in a consistent manner over the entire period used in the study Unfortunately, this consistency is not easily obtained for the series on foreign demand deposits in the money stock, and some compromises have been necessary The particulars regarding the series on foreign-owned demand deposits in U S commercial banks are discussed here

Demand deposits due to foreign commercial banks

The principal sources of data on these deposits are the Treasury–Foreign Exchange Reports B-1 (TFEX) data and the deposits reported by weekly reporting banks that are members of the Federal Reserve System The TFEX data do not yield a consistent series because, prior to December 1971, liabilities of U S banks to their foreign branches were included as demand deposits due to foreign banks Since no separate series exists for these latter deposits prior to that date, it is impossible to remove them from the compiled series

The figures compiled from the reports of weekly reporting member banks do not yield a complete measure of the desired series In particular, data are not included for demand deposits due to foreign banks at (1) U S agencies and branches of foreign banks, (2) Edge Act corporations, (3) member banks not reporting weekly to the Federal Reserve, and (4) nonmember banks Accordingly, an estimated series has been constructed in an effort to overcome these omissions while maintaining as much consistency as possible in the resultant series Estimates for nonweekly reporting member banks and nonmember banks have been obtained by interpolation from call report data [1] Added to these figures are last Wednesday-of-the-month figures for (1) agencies of foreign banks in the United States and investment companies in the United States that are majority owned by one or more foreign banks, and (2) Edge Act corporations, compiled from Federal Reserve Reports 886a and 886b, respectively (For the period prior to November 1972 these figures are estimates based on a monthly compounded growth rate for the period over which data are available, November 1972 through November 1975) Finally, data have been obtained for branches of foreign banks in the United States from Federal Reserve Report 886a (For the period prior to January 1973 these figures are included in the estimates for nonweekly-reporting member banks and nonmember banks) These series are added then to the averages of Wednesday figures for weekly reporting member banks, and this resultant series is used in the empirical work Although this series does not measure the desired series exactly, it is as consistent as available data will permit and involves minimal extrapolations when data are not available

[1] Estimates were provided by the Board of Governors of the Federal Reserve System, Division of Research and Statistics

Demand deposits due to foreign official institutions and to foreign individuals, partnerships, and corporations

Single observation, end-of-month data for these series are taken from the *Federal Reserve Bulletin*, "Short-Term Liabilities to Foreigners Reported by Banks in the United States, by Type " These data were chosen in order to provide the longest consistent series possible and, in the case of foreign official institutions, to avoid the omissions inherent in the average data available for weekly reporting member banks The data used are revised as of January 1976

Other data series employed

The CHIPS data used are monthly averages of daily close of-business figures for the Clearing

House Interbank Payment System These averages are based upon the number of business days in a month, the daily figures being provided by the Federal Reserve Bank of New York The period for the monthly regressions employing the CHIPS data is determined by the period of available CHIPS data, that is, the daily data are not available prior to January 1971

All other monthly and quarterly data, with the exception of GNP and personal income figures, seasonally adjusted and not seasonally adjusted, are taken from various issues of the *Federal Reserve Bulletin* or provided by the Division of Research and Statistics, Board of Governors of the Federal Reserve System The seasonally adjusted data were prepared by using the version of the X-11 seasonal adjustment program available at the Board of Governors The quarterly unadjusted GNP figures are taken from publications of the Department of Commerce [2] (At the time this study was being conducted, these figures were being substantially revised, and consequently, data were available only through the fourth quarter of 1973) In addition, not seasonally adjusted GNP is not recorded in exactly the same way as are other not seasonally adjusted data, and the results obtained with those data should be interpreted with this in mind The supplemental work was done in response to a subsequent request by the Committee The initial period for the quarterly regressions with unadjusted data is determined by the earliest period for which the *FOFF* and *FIPC* series were available, that is, beginning in July 1963

[2] *National Income and Product Accounts of the United States, 1929–1965, Statistical Tables,* Supplement to the *Survey of Current Business* (August 1966), *U S National Income and Product Accounts, 1964–69* (July 1973), and *Survey of Current Business,* vol 54 (July 1974)

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Nonmember Banks and Estimation of the Monetary Aggregates

Darrel W. Parke

This paper, written in early 1976, presents a case for expanded collection of deposit data from banks that are not members of the Federal Reserve System. In June 1977 the Federal Deposit Insurance Corporation began collecting daily deposit data from a sample of about 600 nonmember banks. This survey will continue for the next 2 years, after which the issues discussed in this paper will be reassessed.

In June 1976 the Federal Reserve estimated the narrowly defined money stock (M_1) for January 1976 to be $301.3 billion. Of this amount, $161.9 billion was in demand deposits at commercial banks that are members of the Federal Reserve System—demand deposits adjusted (DDA) at member banks, $73.7 billion was in currency, and $62.5 billion was in DDA at nonmember banks.[1] The Federal Reserve constructs M_1 by adding these estimates to estimates of other components.[2] Thus, to obtain accurate current estimates of total M_1, it is imperative to have accurate current estimates of nonmember bank DDA because it constitutes more than 20 per cent of M_1.

Unfortunately, estimates of nonmember bank DDA have often been inaccurate. Deposit data are available from nonmember banks for only 4 days each year—the call report dates. The estimating procedure, which will be described in detail in the next section, is based on an extrapolation of the nonmember DDA series from previous call report dates to obtain a current or "initial" estimate. This estimate is successively revised as additional call reports are processed until the call reports for dates surrounding the period in question are available, at which time a "final" estimate is made. A list of initial and final estimates for the weeks of the call dates since 1970 is given in Table 1.

Examination of Table 1 reveals that the revisions have been as large as $2 billion, or about 4 per cent of aggregate nonmember bank DDA. The average of the absolute values of the revisions is $932 million, and the root mean square of the revisions is $1,116 million. To gain some perspective on these numbers, consider the computation of a quarter-to-quarter growth rate in M_1. Suppose the value of M_1 for the base quarter is known, but the

TABLE 1 Weekly-Average Estimates of Nonmember Bank DDA for Selected Weeks around Call Dates

In millions of dollars

Call date	Initial estimate	Final estimate	Total revision
1970—June	36,388	35,475	−913
Dec	40,406	40,476	70
1971—June	39,251	39,368	117
Dec	44,133	45,104	971
1972—June	43,874	45,490	1,616
Dec	51,761	52,489	728
1973—Mar	47,496	48,831	1,335
June	50,228	52,220	1,992
Oct	52,011	53,821	1 810
Dec	57,100	57,475	375
1974—Apr	56,491	55,349	−1,142
June	56,996	55,755	−1,241
Oct	57,460	57,236	−224
Dec	59,554	58,830	−724
1975—Apr	59,970	58,136	−1,834
June	59,109	58,638	−471
Sept	58,560	58,272	−288
Dec	63,111	62,729	−382

NOTE.—The author is on the staff of the Division of Research and Statistics. He wishes to thank Stephen Taubman and Lucy McCurdy for their programming assistance, staff members of the Federal Deposit Insurance Corporation for helpful comments on earlier drafts, Gerald Nickelsburg for assistance in the early stages of this study, and Richard Porter for many valuable discussions.

[1] *Federal Reserve Bulletin*, vol. 62 (May 1976), p. A12. All figures used in this report are not seasonally adjusted.

[2] See Darwin L. Beck, "Sources of Data and Methods of Construction of the Monetary Aggregates," this volume.

estimate for the current quarter is understated by $2 billion At the current level of M_1—about $300 billion—the annualized rate of growth would be understated by 2 7 percentage points

To aid the Federal Reserve in developing improved estimates of nonmember bank deposits, the Federal Deposit Insurance Corporation (FDIC) conducted an experimental survey in late 1974 and early 1975 The FDIC asked all of the 178 nonmember banks with more than $100 million in deposits and a sample of 395 smaller nonmember banks stratified by size to report their deposit balances on a weekly (daily-average) basis The FDIC then supplied the Federal Reserve with deposit data aggregated in various ways, although it retained the individual bank data in order to maintain confidentiality

This study aims to determine (1) whether information extracted from the FDIC survey can be used to modify and improve the present estimation procedure, and (2) whether estimates based on the sample data from the survey are substantially more accurate than the present estimates

This paper presents a description of the present method of estimating nonmember bank DDA by the Federal Reserve and some of the limitations of this method, a comparison of the present method with estimates based on the sample data, an assessment of the accuracy of the sample estimates, a discussion of alternative estimation procedures, and some concluding remarks

Present-method estimates

All member banks report their deposit balances for each day of the year Most of these banks report within a week after the close of the statement week, and the remainder report within 2 or 3 weeks All insured banks report deposit data as of the last day of each quarter on the call reports[3] These data generally become available 4 or 5 months after the call date

TABLE 2 Ratios of Nonmember DDA to Country Bank Data

Call date	R_t	Call date	R_t
1967—June	5471	1973—Mar	7230
Dec	5562	June	7357
1968—June	5614	Oct	7361
Dec	5730	Dec	7553
1969—June	5969	1974—Apr	7587
Dec.	6136	June	7709
1970—June	6178	Oct	7796
Dec	6307	Dec	7889
1971—June	6365	1975—Apr	7849
Dec	6585	June	8029
1972—June	6808	Sept	8057
Dec	6953	Dec	8174

To estimate nonmember DDA for a given statement week by the present method, the Federal Reserve staff first determines the ratios of nonmember DDA to the DDA of a subset of member banks, the "country banks,"[4] on the call dates that precede and follow the statement week A series of these ratios is displayed in Table 2 A linear interpolation of the call-date ratios with suitable adjustment for changes in bank structure yields the estimated ratio for the statement week The estimate of nonmember DDA is obtained by multiplying the estimated ratio by the reported country bank DDA for that week

Before the ratios of nonmember DDA to country bank DDA become available for the call dates, they are estimated by extrapolating the series of ratios obtained from the call reports that are available Suppose, for example, that the statement week is the first week in January The "initial estimate" of nonmember DDA is made during the fourth week in January even though the series of known ratios from the call reports extends only to June of the preceding year[5] Extrapolations are

[3] During the period under study, the spring and fall call dates varied from year to year

Data for noninsured banks are available only for the June and December call dates No significant problems appear to have been encountered in estimating the deposits of these banks

[4] "Country banks" is the classification of a group of member banks prior to November 9, 1972 Although the term is no longer officially used to describe these banks, the group still exists and will be referred to as country banks in this report

[5] In this report, we will be discussing revisions and errors in the estimates of nonmember DDA Since the discussion begins with the estimate made 3 weeks after the statement week, revisions and errors will be due solely to uncertainty about nonmember DDA and not to uncertainty about country bank DDA, which is known by this time Our "initial estimate" corresponds to the first revision discussed in *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* (Board of Governors of the Federal Reserve System, 1976), p 25

made from this known series to obtain ratios for December and March, which are interpolated to obtain the estimated ratio for the January statement week Multiplying this estimated ratio by reported country bank DDA for the statement week yields the initial estimate In February, the September ratio is calculated by using the September call report data, which have just become available New extrapolations are made to ratios for December and March, the interpolation procedure is repeated, and a revised estimate is obtained for the January statement week In May, when the December call report data are available, a new extrapolation is made to March, and the known December and extrapolated March ratios are interpolated as before to obtain a third estimate for the January statement week The March call report data then become available in July Interpolating the known December and March ratios yields the fourth and final estimate of nonmember DDA for the statement week

Each of the estimates was made by using the same value for country bank DDA, only the estimate of the ratio of nonmember bank DDA to country bank DDA is revised In the hypothetical example, four estimates were made, and the final one was made 6 months after the statement week In practice, three or four estimates (or, rarely, two) are made with the final estimate made 3 to 8 months after the statement week The number of estimates and the lag depend on the position of the statement week with respect to the call dates, the time between the call dates, and the time required to process the call report data

Throughout the procedure, the estimates and projections are modified to account for structural changes (banks dropping their membership, nonmember banks merging with member banks, and so on) For example, if a country bank resigns from the System, the estimated ratio for that week is revised upward, and ratios for succeeding weeks are obtained by interpolating between the revised ratio and a revised extrapolated ratio for the next call date

The process of extrapolating the series of ratios was exclusively a judgmental one prior to 1974 In early 1974 a regression model was developed that appeared to explain, in large part, the variation in the series[6] This model is now used to provide predictions, which are judgmentally modified, of the nonmember DDA and country bank DDA ratios The regression model is of the form

$$(1) \qquad \hat{R}_t = b_0 + b_1 t + b_2 t^2 + b_3 RTB_t$$

where R_t is the estimated ratio of nonmember bank DDA to country bank DDA at time t and RTB_t is the average 91-day Treasury bill rate for the half year preceding t The Treasury bill rate is a proxy for the constellation of short-term money market interest rates believed to influence the demand for demand deposits It enters the equation with a significantly positive coefficient presumably because the elasticity of the demand function for demand deposits at nonmember banks is lower than that at country banks The present procedure is to refit Equation 1 to the ratios each time a new ratio becomes available and then to extrapolate the resulting equation The extrapolations then undergo some judgmental adjustments, and the estimation proceeds as described earlier

Equation 2 is an example of how the regression model provides a good fit This equation was estimated on May 13, 1974, when the December 1973 call report data first became available The estimated equation and standard errors of the coefficients (in parentheses) are

$$(2) \qquad \hat{R}_t = \underset{(00817)}{52496} + \underset{(00163)}{00559t} + \underset{(00010)}{00064t^2} + \underset{(00121)}{00359RTB_t}$$

where $t = 1$ for June 1967 and increases one unit each 6 months The equation explains 99 4 per cent of the variation in R_t The standard error of the estimate is 0 0034 Country bank DDA was about $78 3 billion at the time, so the 0 0034 standard error for the

[6] See Darwin L Beck and Joseph Sedransk, "Revisions of the Money Stock Measures and Member Bank Reserves and Deposits," *Federal Reserve Bulletin,* vol 60 (February 1974), pp 81–95

ratios translates into a standard error of about $266 million for nonmember bank DDA estimates.

Unfortunately, Equation 1 does not fit as well outside the sample period as it does inside the period. For example, when Equation 1 was extrapolated after receipt of the December 1974 call report data, the estimated ratios for April and June 1975 were 0.7697 and 0.7845, respectively. As can be seen from Table 2, these estimates are in error by 0.0110 and 0.0136 or, in dollar terms, about $860 million and $1,060 million—far in excess of the standard error within the sample period. Why the equation breaks down outside the sample period is not known.

The present-method estimates over the period studied, from the week ending August 28, 1974, to April 16, 1975, are shown in Table 3. The first entry in each line of the table is the initial estimate for that statement week (made about 3 weeks later), followed by succeeding estimates as additional call reports are processed. The last entry in each line is the final estimate, and the differences between the final estimates and the early estimates are given in the columns labeled "Revision."

For example, the June 1974 call report was not available until October 30. The initial estimate for September 18 of $57,251 million was based on an extrapolation from the April 1974 call report. The series was revised on October 30, taking into account the June call report data. This revision yielded an interim estimate for September 18 of $56,774 million. This estimate was further revised on January 31, 1975, when the October 1974 call report data were processed. By this time, direct observations of the ratio of nonmember to country bank DDA were available for dates before and

TABLE 3 Estimates of Nonmember DDA Using the Present Method, 1974–75

In millions of dollars

End of week	Last call report available at time of estimate								
	Apr 1974		June 1974		Oct 1974		Dec 1974		Apr 1975
	Estimate	Revision	Estimate	Revision	Estimate	Revision	Estimate	Revision	Estimate
1974—Aug 28	55,204	−534	54,785	−115	54,670				
Sept 4	56,006	−571	55,566	−131	55,435				
11	57,390	−614	56,926	−150	56,776				
18	57,251	−641	56,774	−164	56,610				
25	55,620	−652	55,142	−174	54,968				
Oct 2	55,064	−679	55,113	−188	54,925				
9			56,228	−205	56,023				
16			57,460	−224	57,236				
23			56,852	−257	56,616	−21	56,595		
30			55,983	−290	55,749	−56	55,693		
Nov 6			56,859	−334	56,634	−109	56,525		
13			57,846	−406	57,627	−187	57,440		
20			57,514	−412	57,292	−190	57,102		
27			56,620	−442	56,392	−214	56,178		
Dec 4			57,711	−560	57,487	−336	57,151		
11			58,354	−602	58,134	−382	57,752		
18			58,685	−640	58,465	−420	58,045		
25			58,451	−674	58,229	−452	57,777		
1975—Jan 1			59,554	−724	59,338	−508	58,830		
8			60,389	−775	60,221	−607	59,676	−62	59,614
15					59,464	−682	58,912	−130	58,782
22					58,057	−732	57,510	−185	57,325
29					56,054	−772	55,525	−243	55,282
Feb 5					56,322	−857	55,767	−302	55,465
12					56,586	−940	56,006	−360	55,646
19					56,412	−1,020	55,816	−424	55,392
26					55,620	−1,074	55,020	−474	54,546
Mar 5					56,539	−1,185	55,900	−546	55,354
12					57,437	−1,290	56,759	−612	56,147
19					56,959	−1,351	56,271	−663	55,608
26					56,239	−1,410	55,547	−718	54,829
Apr 2					57,077	−1,500	56,364	−787	55,577
9					58,979	−1,687	58,169	−877	57,292
16					59,970	−1,834	59,087	−951	58,136

after September 18, and an interpolation yielded the final estimate of $56,610 million[7] Thus, the Federal Reserve's estimate of nonmember DDA for the week of September 18, 1974, was $57,251 million until October 30, from October 30 to January 31, it was $56,774 million, and after January 31, it was $56,610 million The total revision was $641 million, and the revision of the interim estimate was $164 million

During the study period, each successive estimate was closer to the final estimate than was its predecessor Typically, one would expect the revised estimate to be better than the initial one, but there is no guarantee of this A revision of an initial estimate is simply a new estimate that uses the additional information provided by new call report data There is no guarantee of the accuracy of the final series, which is just a set of estimates made after all data believed to be relevant are available Only nonmember deposits as of the single day call report dates are known with certainty

Insofar as revisions are concerned, the study period is typical of the general experience since 1970 The root mean square of the total revisions for the weeks of the three call dates (October 15, December 31, and April 16) covered by the study period is $1,146 million The root mean square of all such revisions from 1970 to September 30, 1975, is $1,116 million

A few of the weekly-average estimates could be improved if the call report data had been processed more quickly If, for example, the June 1974 call report data had been processed within 3 rather than 4 months—that is, by September 30—the initial estimate of $57,251 million for the week of September 18 would not have been made Instead, the initial estimate would have been the one in the June column of Table 3—$56,774 million—and the total benchmark revision for that week would have been $164 million, not $641 million On the other hand, the initial estimate for the week of September 4 would still have been based on call data only through April, so the total revision of $571 million for that week would be unaffected by the 1-month reduction in processing time In general, if processing time were reduced to 3 months, 11 of the 34 total revisions considered here would have been reduced

FDIC-sample estimates

The FDIC experimental sample was divided according to the banks' total deposits into seven strata, ranging from less than $5 million to more than $100 million Average nonmember bank DDA for week t, for example, was estimated by using the separate ratio estimator

$$(3) \quad \hat{Y}(t) = \sum_{h=1}^{7} [y_h(t)/y_h(c)] Y_h(c) = \sum_{h=1}^{7} [Y_h(c)/y_h(c)] y_h(t)$$

where $y_h(t)$ is the average aggregate DDA of the stratum h sample banks during week t, $y_h(c)$ is the aggregate DDA in the sample banks as reported on the most recent available call report, and $Y_h(c)$ is the aggregate DDA in all stratum h nonmember banks as reported on the most recent call report The first formula—the one most often found in textbooks—expresses the notion that the aggregate of all stratum h banks is estimated to have grown at the same rate as the aggregate of sample stratum h banks

The second formulation of the estimator in Equation 3 is presented in order to emphasize the similarity between the sample estimator and the present-method estimator In the present method, a projection of the ratio of nonmember bank DDA to country bank DDA is made and, in turn, is multiplied by the known weekly-average country bank DDA The sam-

[7] A misinterpretation of the October 1974 call report resulted in an overstatement of nonmember DDA for October 16 of $574 million The error was discovered and corrected in May 1975 during the December benchmarking In an effort to eliminate the effects of the misinterpretation, which is totally unrelated to the matters at hand, $574 million was subtracted from all estimates based on the October call data Thus, for example, the total revision for April 16, 1975, was actually $2,408 million but is given in Tables 1 and 3 as $1,834 million

ple estımate for stratum *h* banks ıs constructed by estımatıng the ratıo of nonmember bank DDA to sample bank DDA and then multıplyıng by the known weekly-average sample bank DDA Summıng all strata gıves the estımated aggregate The accuracy of eıther method depends on the accuracy of the estımates of the respectıve ratıos

The ınterım and final sample estımates are also analogous to those of the present method When a new call report becomes avaılable, an updated ratıo of nonmember bank DDA to sample bank DDA ıs obtaıned and applıed to the known sample bank DDA for week *t* When call reports for dates before and after week *t* are avaılable, a lınear ınterpolatıon of the two ratıos ıs applıed to the sample bank DDA foı week *t* ın order to obtaın the final estımates

The sample estımates of nonmember bank DDA are presented ın Table 4 The dıfference ın total revısıons between the sample and the present-method estımates ıs strıkıng Whıle total revısıons of the present-method estımates ranged from $205 mıllıon to $1,834 mıllıon over the study perıod, those of the sample estımates were much smaller, rangıng from $20 mıllıon to $410 mıllıon [8] Of the 65 ınıtıal and ınterım sample estımates ın Table 4, only 2 requıred larger revısıons than dıd the correspondıng present-method estımates

[8] The revısıons ın Table 3 for the present-method estımates are "smooth" functıons of tıme Thıs ıs due solely to the ınterpolatıon procedure In prıncıple, the revısıons of the sample estımates should also be smooth They were not because (1) structural changes occurred ınvolvıng the sample banks, (2) data from as many as 15 banks per week were screened out as "outlıers," and (3) dıfferıng numbers of banks reported each week Of the 573 banks asked to report, the number actually reportıng ranged from 439 to 550

TABLE 4 Sample Estımates of Nonmember DDA, 1974–75
In mıllıons of dollars

End of week	Last call report avaılable at tıme of estımate								
	Apr 1974		June 1974		Oct 1974		Dec 1974		Apr 1975
	Estımate	Revısıon	Estımate	Revısıon	Estımate	Revısıon	Estımate	Revısıon	Estımate
1974—Aug 28	53,618	410	53,778	290	54,028				
Sept 4	54,881	389	55,109	161	55,270				
11	56,064	287	56,408	−57	56,351				
18	56,094	204	56,374	−76	56,298				
25	54,078	363	54,392	−49	54,441				
Oct 2	54,250	408	54,676	−18	54,658				
9			55 958	−20	55,938				
16			56,959	28	56,987				
23			56,324	47	56,364	7	56,371		
30			54,924	191	55,124	−9	55,115		
Nov 6			56,603	284	56,867	20	56,887		
13			57,445	129	57,513	61	57,574		
20			56,992	34	57,041	−15	57,026		
27			55,842	23	55,941	−76	55,865		
Dec 4			56,817	162	57,049	−70	56,979		
11			57,331	51	57,422	−40	57,382		
18			57,862	71	57,870	63	57,933		
25			57,106	261	57,418	−51	57,367		
1975—Jan 1			58,081	133	58,430	−216	58,214		
8			59,820	296	59,963	153	60,135	−19	60,116
15					58,429	259	58,666	22	58,688
22					58,046	−59	57,953	34	57,987
29					54,858	145	54,906	97	55,003
Feb 5					n a		n a		n a
12					55,995	−67	55,905	23	55,928
19					55,935	−69	55,898	−32	55,866
26					54,709	53	54,693	69	54,762
Mar 5					56,396	−290	56,147	−41	56,106
12					57,001	−235	56,801	−35	56,766
19					56,765	−91	56,498	176	56,674
26					54,793	30	54,582	241	54,823
Apr 2					55,643	−133	55,619	−109	55,510
9					57,911	−213	57,888	−190	57,698
16					58,564	−179	58,531	−146	58,385

n a Not avaılable

In addition to requiring smaller benchmark revisions, the sample provides a somewhat different version of the historical series from that of the present method These estimates—the last columns of Tables 3 and 4—are repeated in Table 5 The sample estimates tended to be lower than the present-method estimates in 1974 and higher in 1975 In part, these differences may be due to the single-day call reports The accuracy of either method depends upon its ratio (nonmember to country bank or nonmember to sample bank) as determined from the call report data and how representative it is of the days and weeks surrounding the call report date To the extent that the ratios of weekly (or monthly) averages are subject to less random variation than single-day ratios, the accuracy of the estimates would be improved if all nonmember banks reported deposit data for a week (month) along with their call reports[9]

On the other hand, there is considerable week-to-week variability in the differences between the two series For example, the sample estimate was $1 billion higher than the corresponding present-method estimate for March 19, but a week later it was $6 million lower This variation in the differences would still remain if additional data were available on the call reports That is, even if, for example, deposit data for a week had been provided on the call reports, there would still have been large differences between the sample and the present-method estimates because of the different week-to-week movements in the deposits of the sample banks and the deposits of the country member banks

TABLE 5 Final Nonmember DDA Series Generated by Two Methods, 1974–75

In millions of dollars

End of week	Present method	Sample	Difference
1974—Aug 28	54,670	54,028	642
Sept 4	55,435	55,270	165
11	56,776	56,351	425
18	56,610	56,298	312
25	54,967	54,441	527
Oct 2	54,925	54,658	267
9	56,023	55,938	85
16	57,236	56,987	249
23	56,595	56,371	224
30	55,693	55,115	578
Nov 6	56,525	56,887	−362
13	57,440	57,574	−134
20	57,102	57,026	76
27	56,178	55,865	311
Dec 4	57,151	56,979	172
11	57,752	57,382	370
18	58,045	57,933	112
25	57,777	57,367	410
1975—Jan 1	58,830	58,214	616
8	59,614	60,116	−502
15	58,782	58,688	94
22	57,325	57,987	−662
29	55,282	55,003	279
Feb 5	55,465	n a	
12	55,646	55,928	−282
19	55,392	55,866	−474
26	54,546	54,762	−216
Mar 5	55,454	56,106	−752
12	56,147	56,766	−619
19	55,608	56,674	−1,066
26	54,829	54,823	6
Apr 2	55,577	55,510	67
9	57,292	57,698	−406
16	58,136	58,385	−249

n a Not available

Accuracy of the sample estimates

The usual formula for estimating the sampling variance of the separate ratio estimator (the estimator used to construct the sample estimates) is[10]

$$(4) \qquad s^2 = \sum_{h=1}^{L} N_h(N_h - n_h)s_h^2/n_h$$

where N_h is the number of banks in stratum h, n_h is the number of sample banks in stratum h, L is the number of strata, and s_h^2 is the sample variance around the stratum h regression line

$$(5) \qquad s_h^2 = \sum_{i=1}^{n_h} [y_{hi}(t) - r_h y_{hi}(c)]^2/(n_h - 1)$$

where $y_{hi}(t)$ is the DDA of the ith bank in stratum h at time t, $y_{hi}(c)$ is the corresponding value on a call report, and

$$(6) \qquad r_h = \sum_{i=1}^{n_h} y_{hi}(t) / \sum_{i=1}^{n_h} y_{hi}(c)$$

[9] Since March 1976 the FDIC has been collecting 7 days of deposit data from nonmember banks along with each call report

[10] See, for example, William G Cochran, *Sampling Techniques* (Wiley, 1963), p 158 The sampling variance refers to the variation among estimates based on the potential samples that could be selected, not to the variation of weekly estimates based on a given sample

is the estimated ratio of stratum h DDA for the statement week to its DDA given on the call report Equation 4 is appropriate when the sampling within a stratum is done on a purely random basis In the application discussed here, the sampling was not done on a purely random basis, rather, the sample was constrained so that its distribution (geographic, urban–rural, and so on) would reasonably reflect that of the population of nonmember banks Thus, Equation 4 would not seem to be an appropriate estimator of the variance of the sample estimates

However, it can be plausibly argued that Equation 4 should give an upper bound (possibly a crude one) for the variance of the sample estimates Let σ^2_{all} represent the variance of estimates based on any conceivable sample, including the ones that would have been rejected as unrepresentative Roughly half of the samples will yield s^2's smaller than σ^2_{all} and half will yield s^2's larger than σ^2_{all} Among the samples yielding smaller s^2's will be the geographically homogeneous ones, precisely the ones that would have been rejected as unrepresentative The samples yielding the larger s^2's are the ones that incorporate the geographic variation—the "representative" samples Thus, since representativeness is required, the value of s^2 yielded by the sample is likely to overestimate σ^2_{all}

Furthermore, σ^2_{all} itself is likely to overstate the actual sampling variance since it is the variance of a set of estimates that should have a larger dispersion than has the set of estimates based on representative samples

Equation 4 was applied to the sample data for the week of October 16, 1974, and the June 1974 call report data to obtain an estimated upper bound for the sampling standard error of the initial estimate of about $300 million Calculations for other weeks gave similar results Using the normal approximation, we may say that we are *at least* 68 per cent confident that a sample initial estimate is within $300 million of actual nonmember bank DDA, or *at least* 95 per cent confident that a sample initial estimate is within $588 million of actual nonmember bank DDA The sample final estimates, being equivalent to weighted averages of initial estimates, will have somewhat smaller sampling standard errors [11]

From Table 5, we note that the present-method final estimates differ from the corresponding sample final estimates by as much as 3 5s ($1,066 million for the week of March 19, 1975) We infer that the present-method final estimates depart substantially from "truth" as well as that movements of nonmember DDA between call dates differ from those of country banks

A more direct way of investigating the accuracy of these particular sample (and present-method) estimates is to consider estimates made for the call dates Aside from reporting errors—and the deposits of noninsured banks on the spring and autumn call dates—we know aggregate nonmember bank DDA on these dates We can construct estimates for these dates in exactly the same way as we constructed weekly-average estimates just substitute the call date DDA for the weekly-average DDA for the sample banks or for the country banks in the present-method estimates Then by comparing the initial estimate with the aggregate determined from the call report, we obtain the error resulting from the method for that single day In the case of the sample estimates, these single-day errors are likely to be *larger* than those for weekly-average estimates because of the additional day-to-day variation [12]

The results of these calculations are given in Table 6 The lines labeled "Estimate" give the actual estimates that were made, while the lines labeled "Estimate with call data" give the estimates that would have been made had the sample banks (or the country member banks for the present method) reported the same deposits in the survey as they did in the call report The differences between these two lines indicate the effects of reporting errors

[11] As shown in Appendix 1, the sampling standard error of a final estimate for a week about halfway between two call dates is at most about $240 million

[12] This point is elaborated in Appendix 2, where it is also shown that errors committed by the sample estimates of weekly averages are likely to be smaller than the revisions of those estimates

TABLE 6 Estimates of Nonmember DDA on Call Dates, Selected Methods, 1974–75
In millions of dollars

Method and data used	Last call report available at time of estimate					
	June 1974		Oct 1974		Dec 1974	
	Estimate	Error	Estimate	Error	Estimate	Error
	Estimate for October 15, 1974 (actual = 58 228)					
Present method						
Estimate	58,452	224				
Estimate with Oct call data	58,583	355				
Sample method						
Estimate	58,124	−104				
Estimate with Oct call data	58,192	−36				
	Estimate for December 31, 1974 (actual = 60,333)					
Present method						
Estimate	60,858	525	60,659	326		
Estimate with Dec call data	61,041	708	60,474	141		
Sample method						
Estimate	59,917	−416	60,290	−43		
Estimate with Dec call data	60,198	−135	60,579	246		
	Estimate for April 16, 1975 (actual = 58,658)					
Present method			60,413	1,755	59,558	900
Estimate with Apr call data			60,499	1,925	59,642	984
Sample method						
Estimate			58,799	141	58,776	118
Estimate with Apr call data			58,809	151	58,787	129

The actual present-method initial estimates differed from the three call report aggregates by $224 million, $525 million, and $1,755 million The sample initial estimates differed from the call report aggregates by $104 million, $416 million, and $141 million—a 74 per cent improvement on average If the sample banks and the country member banks had reported in their respective surveys the data they later reported in the call reports, the percentage improvement would have been even greater

The root mean square error of the five sample single-day initial and interim estimates was $210 million As shown in Appendix 3, this amount translates into a root mean square error for the final sample weekly-average estimates of, at most, $130 million to $167 million, with the size of the bound depending on the closeness of the statement week to the call date Thus, the final sample series appears to be considerably more accurate than the present historical series

Alternative estimation procedures

The increased accuracy of the FDIC sample estimates over the present-method estimates raises two questions Would estimates of nonmember bank DDA based on data from a group of member banks similar to the FDIC sample banks perform equally well? Can satisfactory estimates be obtained by using data from a subset of the sample—for example, the 178 large nonmember banks? The following discussion addresses these issues

The matched-banks method

For each of the 573 sample nonmember banks, the staff of the FDIC found a member bank that was similar with respect to size and location Daily deposit data are available for these matched banks as they are for all member banks Estimates of nonmember bank DDA were then constructed by using the matched banks as if they constituted the sample of nonmember banks, that is, Equation 2 was applied with the matched-banks DDA substituted for the sample-banks DDA

The results can be summarized in two ways First, the revisions of the matched-banks estimates are presented in Table 7[13] The re-

[13] At the time this portion of the experiment was conducted, sufficient data for making estimates were available only through January 1, 1975

TABLE 7. Estimates of Nonmember DDA Using Matched Member Banks, 1974–75
In millions of dollars

End of week	Last call report available at time of estimate						
	Apr 1974		June 1974		Oct 1974		Dec 1974
	Estimate	Revision	Estimate	Revision	Estimate	Revision	Estimate
1974—Aug 28	53,248	1,309	54,488	69	54,557		
Sept 4	53,969	1,342	55,237	74	55,311		
11	55,171	1,527	56,470	228	56,698		
18	55,037	1,534	56,332	239	56,571		
25	53,452	1,503	54,705	250	54,955		
Oct 2	53,514	1,567	54,770	311	55,081		
9			56,164	291	56,455		
16			57,263	338	57,601		
23			56,864	348	57,201	11	57,212
30			55,982	372	56,338	16	56,354
Nov 6			56,814	483	57,252	45	57,297
13			57,611	505	58,056	60	58,116
20			57,064	515	57,504	75	57,579
27			56,158	523	56,595	86	56,681
Dec 4			57,257	491	57,714	34	57,748
11			57,993	500	58,456	37	58,493
18			58,203	335	58,666	−128	58,538
25			57,656	310	58,117	−151	57,966
1975—Jan 1			58,912	290	59,377	−175	59,202

visions, ranging up to $1.5 billion, are considerably larger than the revisions of the sample estimates (Table 4) and are of the same order of magnitude as those of the present method (Table 3).

Second, a comparison of final estimates for the matched-bank and sample methods is given in Table 8. Since these estimates differ by as much as $1.2 billion, it appears that the matched banks do not track nonmember deposits very well between call dates.

TABLE 8. Nonmember DDA Series Generated by Two Methods, 1974–75
In millions of dollars

End of week	Sample method	Matched-banks method	Difference
1974—Aug 28	54,028	54,557	−529
Sept 4	55,270	55,311	−41
11	56,351	56,698	−347
18	56,298	56,571	−273
25	54,441	54,955	−514
Oct 2	54,658	55,081	−423
9	55,938	56,455	−517
16	56,987	57,601	−614
23	56,371	57,212	−841
30	55,115	56,354	−1,239
Nov 6	56,887	57,297	−410
13	57,574	58,116	−542
20	57,026	57,579	−553
27	55,865	56,681	−816
Dec 4	56,979	57,748	−769
11	57,382	58,493	−1,111
18	57,933	58,538	−605
25	57,367	57,966	−599
1975—Jan 1	58,214	59,202	−988

Large-banks method

To evaluate the usefulness of deposit data obtained only from the 178 large nonmember banks, an estimator was constructed that is essentially a mix of the present-method and sample estimators. The data for the 178 large nonmember banks were used to estimate the DDA of those nonmember banks reporting more than $100 million (the highest stratum) in total deposits in the call report, just as they were in the sample method. The DDA of the smaller nonmember banks was estimated by forming the ratio (small nonmember bank DDA)/(country member bank DDA), for each call date since 1967, fitting a regression—quadratic in time and linear in interest rates—to these ratios, and proceeding exactly as in the present method. We call this the large-banks method. The estimates and their revisions are given in Table 9. These estimates required larger revisions than did those of the sample but represented a considerable improvement over the present method. Experience with the present method indicates that care should be taken in extending the results of the large-banks method beyond the initial study period. The regressions for estimating small nonmember bank DDA may easily deteriorate as did the present-method regressions. The final estimates for large banks dif-

TABLE 9. Estimates of Nonmember DDA Using the Large-Banks Method, 1974–75
In millions of dollars

End of week	Last call report available at time of estimate								
	Apr 1974		June 1974		Oct 1974		Dec 1974		Apr 1975
	Estimate	Revision	Estimate	Revision	Estimate	Revision	Estimate	Revision	Estimate
1974—Aug 28	54,912	−475	54,589	−152	54,437				
Sept 4	55,994	−489	55,682	−177	55,505				
11	57,107	−373	56,952	−218	56,734				
18	57,185	−372	57,060	−247	56,813				
25	55,119	−483	54,896	−260	54,636				
Oct 2	55,163	−326	55,112	−275	54,837				
9			56,144	−301	55,843				
16			57,275	−328	56,947				
23			56,669	−347	56,359	−37	56,322		
30			55,667	−368	55,313	−14	55,299		
Nov 6			57,033	−336	56,734	−37	56,697		
13			57,814	−380	57,488	−54	57,434		
20			57,610	−368	57,302	−60	57,242		
27			56,506	−311	56,269	−74	56,195		
Dec 4			57,295	−339	57,083	−127	56,956		
11			57,785	−533	57,509	−257	57,252		
18			58,183	−503	57,936	−256	57,680		
25			57,833	−423	57,703	−293	57,410		
1975—Jan 1			59,151	−412	59,059	−320	58,739		
8			59,927	−307	59,609	11	59,681	−61	59,620
15					58,479	−222	58,348	−91	58,257
22					57,117	−344	56,888	−115	56,773
29					55,101	−333	54,919	−151	54,768
Feb 5					n a		n a		n a
12					55,574	−416	55,349	−191	55,158
19					55,538	−433	55,338	−233	55,105
26					54,562	−382	54,467	−287	54,180
Mar 5					55,827	−525	55,559	−257	55,302
12					56,551	−528	56,320	−297	56,023
19					56,270	−603	55,927	−260	55,667
26					55,432	−592	55,133	−293	54,840
Apr 2					56,244	−534	56,117	−407	55,710
9					57,961	−539	57,857	−435	57,422
16					58,820	−589	58,701	−470	58,231

n a Not available

fered from the corresponding sample final estimates by as much as $1 billion, indicating that the movements of nonmember deposits between call dates have still not been captured

TABLE 10 Series for the Estimation of Small Nonmember Bank DDA[1]

Call report date	*SNM/LNM*	*SNM/CB*	Treasury bill rate
June 1967	3 5612	4403	4 085
Dec 1967	3 4898	4499	4 185
June 1968	3 4701	4465	5 275
Dec 1968	3 4701	4570	5 39
June 1969	3 2417	4620	6 14
Dec 1969	3 1893	4715	7 18
June 1970	3 1286	4709	6 89
Dec 1970	3 1529	4811	5 84
June 1971	3 0354	4818	4 04
Dec 1971	3 0886	4973	4 615
June 1972	2 9816	5041	3 595
Dec 1972	2 9519	5123	4 535
Spring 1973	3 0428	5284	5 28
June 1973	2 9462	5354	6 15
Fall 1973	3 0733	5413	7 46
Dec 1973	2 9805	5521	7 91
Spring 1974	3 0861	5575	7 56
June 1974	3 0253	5582	7 885
Fall 1974	3 1380	5687	8 17

[1] *SNM* = small nonmember banks, *LNM* = large nonmember banks, *CB* = commercial banks

Another suggested approach is to use the large nonmember banks to estimate the DDA of the small banks directly We have been unable to find any relationship between the large and small banks that works as well as the method just outlined Call report data used to pursue this alternative are presented in Table 10

Conclusions

This study was initiated in response to increasing concern about the large revisions of the money stock brought about by the extensive revisions of the estimates of nonmember bank DDA These revisions, in turn, are caused by a lack of understanding of the forces that cause movements of nonmember bank deposits to differ from those of member bank deposits One approach to reducing the size of the revisions is to gain a better understanding of the forces governing nonmember bank deposits, but given the paucity of data on nonmember deposits—which are available for only 4 days per year—the prospects for this approach appear limited

A second approach is to estimate nonmember DDA directly by collecting daily deposit data from a subset of nonmember banks similar to the sample selected by the FDIC The estimates based on the sample required much smaller revisions than did the present-method estimates—the accuracy, as measured by the errors made on call dates, was improved by nearly 75 per cent While the study period was admittedly short, covering only three call dates, it is difficult to conceive of any results that could have been obtained from the FDIC experiment that would have more strongly justified the use of a sample [14]

[14] The FDIC plans to reinstitute the sample program beginning in late 1976 or early 1977

Another problem identified in this study is that even after all revisions have been made, the historical estimates of nonmember DDA may be wide of the mark except on call dates The sources of these errors are the different movements of member and nonmember deposits between call dates—for example, different seasonal patterns and the possibility that the ratio of nonmember DDA to country bank DDA on the call date may not be representative even of the period immediately surrounding the call date Reasonable measures of the relative contributions of these sources of error are not available because of the shortness of the study period Nevertheless, it is clear that some improvement in the present-method final estimates could be obtained if deposit data for more than 1 day were supplied by all nonmember banks in conjunction with the call reports Sample estimates would also benefit from the availability of such data

Appendix 1: Sampling Standard Error of a Final Estimate

The final estimate is a weighted average of two ratio estimates, one based on the call report just preceding, and the other based on the call report just following the statement week The weights reflect the relative lengths of the time intervals between the statement week and the two call dates For convenience, assume that the statement week is halfway between the two call dates, and suppose that the variances of the two estimates are equal (to σ^2) Then the sampling variance of the final estimate is

$$V(f) = \sigma^2(1 + \rho)/2$$

where ρ is the correlation coefficient between the two estimates A bound on σ ($300 million) was obtained in the text We now show that, under reasonable assumptions, ρ is no more than 0 2 and may be near -1, which implies that the standard error of the final estimate lies between zero and

$$(300)(1\ 2/2)^{1/2} = \$232 \text{ million}$$

We may think of aggregate nonmember DDA, say $Y(t)$, as having a trend component, $TR(t)$, and an error component, e_t, which is serially independent

$$Y(t) = TR(t) + e_t$$

Individual nonmember banks behave similarly

$$y(t) = tr(t) + u_t$$

To show that ρ can be equal to -1, we assume that $e_t = u_t = 0$, for all t Thus, when we draw a sample of banks to follow over time, we are really drawing a sample of trends Further assume that the trends are such that for any s

$$R_s(t) = Y(t)/y_s(t) = a_s + b_s t$$

where $y_s(t)$ is the aggregate DDA of the banks in sample s at time t Let t_1 and t_2 be two consecutive call dates, $t_1 < t < t_2$ The estimates of $Y(t)$ based on the call reports are

$$Y_1(t) = [Y(t_1)/y_s(t_1)]y_s(t)$$

and

$$Y_2(t) = [Y(t_2)/y_s(t_2)]y_s(t)$$

The final estimate is

$$\begin{aligned} Y(t) &= [(t_2 - t)R_s(t_1)y_s(t) \\ &\quad + (t - t_1)R_s(t_2)y_s(t)]/(t_2 - t_1) \\ &= [(t_2 - t)R_s(t_1) \\ &\quad + (t - t_1)R_s(t_2)]y_s(t)/(t_2 - t_1) \\ &= R_s(t)y_s(t) = Y(t) \end{aligned}$$

Thus, the final estimate is $Y(t)$ regardless of which sample is drawn, the variance of the final estimate is zero, and the correlation coefficient $\rho = -1$

As the error variances become large relative to the trend in $R_s(t)$, the correlation moves away from -1 To obtain an upper bound for ρ, we take the extreme case that $R_s(t)$ is a constant—that is, all banks follow the same trend and the only source of variation in the estimates is the random component

Specifically, we assume that the variance of an aggregate is proportional to its size, that $Y(t_1)$ and $Y(t_2)$ are known, and that the mean of a sample of banks varies independently over time A straightforward extension of the proof of Theorem 2 5 in Cochran's *Sampling Techniques* shows that the correlation between $Y_1(t)$ and $Y_2(t)$ is approximately the same as the correlation between

$$\bar{y}_s(t) - G_1\bar{y}_s(t_1)$$

and

$$\bar{y}_s(t) - G_2\bar{y}_s(t_2)$$

where $G_1 = Y(t)/Y(t_1)$, $G_2 = Y(t)/Y(t_2)$, and $\bar{y}_s(t)$ represents the mean of the sampled banks at time

t G_1 and G_2 are the unknown trends that all non-member banks are assumed to follow

Now the covariance matrix of $\bar{y}_s(t_1)$, $\bar{y}_s(t_2)$, and $\bar{y}_s(t)$ is

$$\sigma^2 \begin{pmatrix} 1/G_1 & 0 & 0 \\ 0 & 1/G_2 & 0 \\ 0 & 0 & 13/49 \end{pmatrix}$$

(The G's reflect proportionality to size and the 13/49 is the variance of a 7-day average) Hence the covariance matrix between $\bar{y}_s(t) - G_1\, \bar{y}_s(t_1)$ and $\bar{y}_s(t) - G_2\, \bar{y}_s(t_2)$ is

$$\sigma^2 \begin{pmatrix} 13/49 + G_1 & 13/49 \\ 13/49 & 13/49 + G_2 \end{pmatrix}$$

So the upper bound on the correlation between $Y_1(t)$ and $Y_2(t)$ is approximately

$$\rho = \frac{13}{49}\left[\left(\frac{13}{49} + G_1\right)\left(\frac{13}{49} + G_2\right)\right]^{-1/2}$$
$$= 0\ 2$$

when the trend is fairly uniform over (t_1, t_2) and G_1 and G_2 are close to 1

Appendix 2: On the Relationship between Errors and Revisions

Consider the sample estimates of nonmember DDA for some week t falling between the October and December 1974 call dates For convenience, we neglect stratification, nonreporters, structural changes, and so on The estimates are

Initial $(X_j/x_j)y_t = r_j y_t$

Interim $(X_o/x_o)y_t = r_o y_t$

Final $a_t(X_o/x_o)y_t + (1 - a_t)(X_d/x_d)y_t = [a_t r_o + (1 - a_t)r_d]y_t$

where X_j, X_o, X_d are the population aggregates and x_j, x_o, x_d are the sample aggregates on the June, October, and December call reports, y_t is the average aggregate of the sample banks for week t, and a_t is the proportion of days between the October and December call dates that remain after time t

The *revision* of the initial estimate (Table 4) can be written

$$\text{(A-1)} \quad r_j y_t - [a_t r_o + (1 - a_t)r_d]y_t = y_t\{r_j - [a_t r_o + (1 - a_t)r_d]\}$$

and the revision of the interim estimate can be written

$$\text{(A-2)} \quad r_o y_t - [a_t r_o + (1 - a_t)r_d]y_t = y_t(1 - a_t)(r_o - r_d)$$

From Equation A-1, we see that the revision of the initial estimate will be small if and only if the difference between the ratio r_j, determined from the June call report, and the weighted average of r_o and r_d, determined from the October and December call reports, is small From Equation A-2 we see that the revision of the interim estimate will be small if and only if the difference between r_o and r_d is small or a_t is large (a_t is large when week t is close to the October call date)

The *error* made by the initial estimate is

$$(X_j/x_j)y_t - Y_t = y_t(X_j/x_j - Y_t/y_t) = y_t(r_j - r_t)$$

where Y_t is the actual population aggregate for week t Similarly, the error made by the interim estimate is

$$y_t(r_o - r_t)$$

and the error made by the final estimate is

$$y_t[a_t r_o + (1 - a_t)r_d - r_t]$$

These errors will be small if r_t is close to r_j, r_o, and r_d

Is r_t close to r_j, r_o, and r_d? We cannot directly compare r_t with the other r factors because its numerator, Y_t, is unknown But consider the sequence r_1, r_2, of daily ratios of the population aggregate to the sample aggregate We have observed a sample of five of these ratios in this study r_j, r_o, r_d, and the April 1974 and April 1975 call report ratios The unobserved ratio r_t for week t can be regarded as an average of five of these daily ratios[1] Now the r's are subject to two sources of variation a trend, and random day-to day fluctuation If the trend effect is large, then the revisions will be large and perhaps only the final estimate will be reasonably accurate (since only the final estimate explicitly incorporates a trend effect) If the random fluctuations are large, the revisions will be large and none of the estimates is likely to be very accurate (although the final estimate is likely to be more accurate than the others) But we have evidence that neither the trend effect nor the random fluctuations are large That evidence is the sample of five ratios we obtained from the call reports That there was not much variability in these ratios is evidenced by the smallness of the benchmark revisions We therefore infer that since the sample of r's showed little variability, the population of r's also would show little variability Thus we can say that r_t is likely to be close to r_j, r_o, and r_d, and that the errors incurred by using r_j, r_o, or r_d in the estimate are small

We have shown that small revisions of the simple ratio estimate are associated with small errors of the estimate To see that the same conclusion applies to the separate ratio estimate, the argument is applied to the individual strata

[1] Actually, r_t is a ratio of weekly averages, not an average of daily ratios This distinction is not crucial to the argument, however

Appendix 3: Root Mean Square Error of the Final Estimates

It was shown in the text that the root mean square error (RMSE) of the five sample initial and interim estimates of nonmember DDA on call dates was $210 million Here we formulate a simple model in order to translate that RMSE into a bound on the RMSE of final weekly-average estimates As before, we neglect stratification, nonreporters, structural changes, and so forth

Let t_1 and t_2 be two call dates The ratio estimate of nonmember DDA for day t_2 based on the t_1 call report data is

$$\hat{Y}_{t_2} = r_{t_1} y_{t_2}$$

where $r_t = Y_t/y_t$, Y_t is nonmember DDA, and y_t is the sample-banks DDA on day t The estimate is in error by

$$e_{t_2} = \hat{Y}_{t_2} - Y_{t_2} = y_{t_2}(r_{t_2} - r_{t_1})$$

The use of the ratio estimate amounts to guessing that $r_{t_2} = r_{t_1}$ and the error, of course, is a function of the difference between the r's Suppose that, in fact, r_t is given by

$$r_t = \alpha + \beta t + \epsilon_t$$

where ϵ_t is serially independent with mean zero and variance σ_2 Approximating y_t by a constant y (in fact, y_t varies over short intervals of time by only a few percentage points), the expected squared error may be calculated

$$\text{(A-3)} \qquad Ee_{t_2}^2 = y^2[\beta^2(t_2 - t_1)^2 + 2\sigma^2]$$

By inserting the appropriate values for t_1 and t_2 in Equation A-3, we can calculate the expected squared error for any call date estimate

For our ultimate purpose of obtaining an upper bound for the root mean square error of a final weekly-average estimate, we will see that we need an upper bound for $2\sigma^2 y^2$ Now, given an empirical estimate of $Ee_{t_2}^2$, it is clear from Equation A-3 that an estimated upper bound for $2\sigma^2 y^2$ can be obtained by setting $\beta = 0$ But then,

$$Ee_{t_2}^2 = 2\sigma^2 y^2$$

is not a function of time and can be estimated by the mean square error of the five call date estimates ($210 million)^2

Let w be the average value of t for the statement week and r_w be the average of the r_t's for that week We regard r_w as approximately equal to the ratio of the weekly averages of Y_t and y_t The final estimate for the statement week is

$$[(1 - a)r_{t_1} + ar_{t_2}]y_w$$

where t_1 and t_2 are the call dates preceding and following the statement week The error committed by the final estimate is

$$e_w = [(1 - a)r_{t_1} + ar_{t_2}]y_w - r_w y_w$$
$$= y[(1 - a)r_{t_1} + ar_{t_2} - r_w]$$

where again we have approximated y_w by y After some algebraic manipulation, we have

$$e_w = y[(1 - a)\epsilon_{t_1} + a\epsilon_{t_2} - \epsilon_w]$$

where ϵ_w is the average of the ϵ_t's for the statement week and thus has variance 13 $\sigma^2/49$ The mean square error of the final estimates is

$$Ee_w^2 = y^2\sigma^2[(1 - a)^2 + a^2 + 13/49]$$

Setting $2\sigma^2 y^2$ to our empirical bound ($210 million)^2, we obtain the estimated bound on the mean square eror of the final estimate —call it $M^2(a)$

$$M^2(a) = 210^2[(1 - a)^2 + a^2 + 13/49]/2$$

$M(a)$ reaches its maximum value when $a = 0$ or 1, when the statement week is the week of a call date

$$M(0) = M(1) = \$167 \text{ million}$$

$M(a)$ reaches its minimum value when $a = 1/2$, halfway between two call dates

$$M(1/2) = \$130 \text{ million}$$

Seasonal Adjustment of the Monetary Aggregates

David A. Pierce, Neva Van Peski, and Edward R. Fry

Research for this paper was completed in 1975 and early 1976 Consequently, the applications of seasonal adjustment procedures and statistical tests discussed in the paper do not take account of data after 1974 or 1975

Seasonal adjustments for the published monetary aggregates series were revised in February 1977 and March 1978 in accordance with procedures described in the discussion of "Seasonal adjustment of published M_1 series" There was some evidence in monthly data for 1976 and 1977 that a new quarterly seasonal pattern was developing in the demand deposit component of M_1 Based on Census X-11 seasonal adjustments, the quarterly pattern of fluctuation was partially eliminated in the 1978 revision

The Board's staff has continued to develop and experiment with the daily seasonal factor method, as described later The basic program has been improved by including an optional log transformation and by improving the method of selecting harmonic terms to include in the regression In addition, work is in progress to take account of changes in the seasonal pattern, by using a ratio-to-moving-average technique to remove seasonality remaining in the irregular component from the series adjusted by the method described here This is analogous to X-11 except that the weights of the moving average are designed to match the statistical characteristics of the particular series

Seasonality is a widespread phenomenon in economic time series, and much has been and continues to be written regarding its nature and its treatment The monetary aggregates are no exception Particularly with the increasing attention directed toward the monetary aggregates as an indicator and a target of monetary policy, it is important to have available reliable means for seasonally adjusting the monetary aggregates in order to disentangle purely periodic, calendar-linked movements in the narrow measure of the money supply (M_1) and related series from others, perhaps economically more meaningful Procedures for accomplishing a reliable seasonal adjustment, including particularly the development and application of a new method, are reviewed and compared in this paper

The adjustment of a series for "seasonal variation" presupposes a notion or concept of what the term means For the monetary aggregates there are at least three meanings The seasonal (factor or component) in the money stock that actually occurs in the data is referred to as the *descriptive* seasonal In general, it is the combined result of two conceptually distinct elements, referred to as the *natural* seasonal and the *policy* seasonal The former arises not only from natural phenomena such as the weather but also from social phenomena such as holidays or tax-payment dates The latter is the result explicitly or implicitly of policy decisions of the Federal Reserve—for example, whether to accommodate an increase in the natural seasonal in money at Christmas or to allow interest rates to rise

These distinctions are described in more detail in another Board publication,[1] they are

NOTE—The authors are on the staff of the Division of Research and Statistics

[1] *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* (Board of Governors of the Federal Reserve System, 1976)

made here primarily to focus this paper Except for the section on the published seasonally adjusted series, which discusses how the policy seasonal is now estimated, this paper is concerned largely with the descriptive seasonal and with alternative ways to estimate it

The first section discusses briefly the nature of seasonality and seasonal adjustment procedures, including regression and moving-average approaches This is followed by a description of the Board's current seasonal adjustment procedure

Another section presents an alternative procedure to the Census Bureau X-11 method, suggested by Friedman and developed by one of the authors (Van Peski), for adjusting any monetary aggregate or other time series for which daily data are available This procedure has the feature that, once daily seasonally adjusted data are determined, then weekly, monthly, or quarterly seasonal adjustments can immediately be calculated and will be consistent with each other Included also in this section are several tests for stable versus moving seasonality, concentrating on the period from 1968–74 (prior to which seasonal shifts such as tax-date changes were known to have occurred)

The last section compares three seasonal adjustment procedures, the ordinary and "fixed-factor" X-11 procedures and the daily procedure developed earlier It is found that, for demand deposits and currency during the time period studied, the daily seasonal method gives results quite close to both the ordinary and the fixed-factor X-11 seasonal adjustment (which are fairly close to each other)

This paper is confined largely to an analysis of currency and demand deposits—the two components of M_1—although the procedures developed or described are equally applicable to M_2 as well as to reserve aggregates, including, with minor modifications, those series for which weekly but not daily data are available [2]

[2] See David A Pierce, "Relationships—and the Lack Thereof—Between Economic Time Series, with Special Reference to Money and Interest Rates," *Journal of the American Statistical Association*, vol 72 (March 1972), pp 11–26

Nature of seasonality and seasonal adjustment

The primary problem in seasonally adjusting a monetary aggregate or other time series is the determination of the part of the series that is purely "seasonal" This determination is often facilitated by simultaneously determining a "trend cycle" as well, with the remainder of the series then referred to as "irregular" There are two basic schemes for representing this decomposition The *multiplicative* seasonal model for a time series $\{Y_t\}$ is

$$(1) \qquad Y_t = P_t S_t E_t$$

where P_t, S_t, and E_t are, respectively, the trend-cycle, seasonal, and irregular *factors* of Y_t, all at time t Ordinarily the trend factor is the dominant part of the series and retains the units (dollars, in the case of monetary aggregates) associated with the series The seasonal and irregular factors, expressed as ratios to trend cycle, are unity when there are no seasonal or irregular effects, and are above or below 1, respectively, when the effect of seasonal or irregular influences is to increase or decrease the level of the series

Many economic series exhibit exponential growth and for these the multiplicative model is most appropriate For other series, however, an *additive* model may be more suitable In fact, the additive model may be derived from the multiplicative model by taking logarithms If $y_t = \log Y_t$, $p_t = \log P_t$, and so forth, then Equation 1 becomes

$$(2) \qquad y_t = p_t + s_t + e_t$$

which is the additive seasonal model The term s_t is the seasonal *component* of y_t Of course, in many cases $\{y_t\}$ will be actual series rather than the logarithm of a multiplicatively generated series

The *seasonally adjusted* series Y_t^a and y_t^a are then

$$(3) \qquad Y_t^a = Y_t / \hat{S}_t$$

and

(4) $$y_t^a = y_t - \hat{s}_t$$

where the circumflex denotes that the "true" seasonal is never known but instead must be estimated in a suitable manner The problem of (descriptive) seasonal adjustment is thus the problem of obtaining estimates of the seasonal components or factors To accomplish this, some restrictive assumptions regarding the nature of the series must be made, particularly concerning the nature of the seasonal component s_t (or factor S_t) The remainder of this section briefly describes the assumptions underlying the X-11 and regression procedures for seasonal adjustment

Methods now in use for seasonal adjustment generally fall into one of two broad categories, depending on whether the series' seasonality is assumed to be "deterministic" (capable of representation by such deterministic functions of time as sines and cosines, dummy variables, and interaction of these with powers of time), or "stochastic" (representable by a seasonal autoregressive moving-average—ARMA—model, or as a component of such a model) A deterministic seasonal has the feature that it can be predicted without error from seasonals of previous years For example, if in Equation 2 the data are monthly and the seasonal component is

(5) $$s_t = \sum_{j=1}^{12} \delta_j d_{jt}$$

where d_{1t}, , d_{12t} are seasonal dummy variables and $\Sigma\delta_j = 0$, then year after year the January seasonal is δ_1, February's is δ_2, and so forth In general, regression methods for seasonal adjustment are appropriate for deterministic seasonality, and the simplest of these would be a regression on the seasonal dummies in Equation 5 A flexible regression method, which allows for changing trend and seasonality, is that of Stephenson and Farr [3]

For stochastic seasonality it is known that the optimal (minimum mean square error) procedure consists of the application of a symmetric moving average to estimate the seasonal,[4] that is,

(6) $$\hat{s}_t = \sum_{i=-n}^{n} \delta_i y_{t-i}$$

where $\delta_{-i} = \delta_i$ Insofar as y_t is stochastic and only partially predictable from its past, s_t will also exhibit these features Moreover, s_t and s_{t+12} (for monthly series) will rarely be identical, a point to which we return shortly The Census X-11 program is essentially of this form,[5] and in fact Cleveland and Tiao have found a particular ARMA model for which X-11 is nearly optimal [6]

The distinction between deterministic and stochastic seasonality is conceptually a fundamental one, however, in practice it is not always obvious whether the seasonality in a series is deterministic, stochastic, or both The money supply is a prime example it is generally adjusted by using the X-11 program, yet in a subsequent subsection it will be seen that its seasonality can sometimes be adequately captured with monthly dummy variables And the daily method to be presented uses features of both the regression and the moving-average approaches

A related distinction in seasonal adjustment concerns the issue of fixed versus moving seasonality A series displays fixed or stable

[3] "Seasonal Adjustment of Economic Data by Application of the General Linear Statistical Model," *Journal of the American Statistical Association*, vol 67 (March 1972), pp 37–45

[4] William P Cleveland and George C Tiao, "A Model for the Census X 11 Seasonal Adjustment Program," Technical Report 312 (University of Wisconsin, 1974), and Peter Whittle, *Prediction and Regulation by Linear Least Square Methods* (English Universities Press, 1963)

[5] See "The X-11 Variant of the Census Method II Seasonal Adjustment Program," Bureau of the Census Technical Paper 15, revised (Government Printing Office, 1967) Additional features of X 11 that are outside the symmetric filter framework include provisions for outliers and trading day variation See Kenneth F Wallis, "Seasonal Adjustment and Relations Between Variables," *Journal of the American Statistical Association*, vol 69 (March 1974), pp 18–31, as well as "X-11 Variant"

[6] See Cleveland and Tiao, "Model for the Census X-11"

seasonality if its seasonal factor for each month remains unchanged from year to year, otherwise, it possesses moving seasonality A fixed seasonal is necessarily a deterministic seasonal, as, given knowledge of the true model, it can be predicted from year to year without error However, methods such as X-11 can produce estimates of a fixed seasonal if constrained to do so, and regression methods can incorporate a moving deterministic seasonal

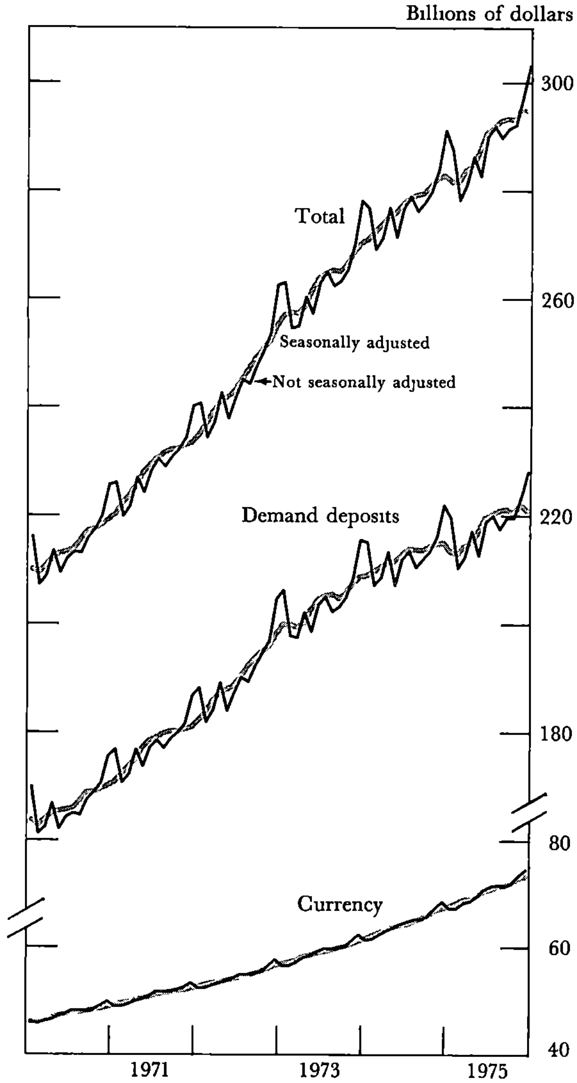
In investigating alternative ways to seasonally adjust the monetary aggregates, it is important to ascertain whether the evidence is in favor of a fixed or a moving seasonal pattern This question is addressed in several ways in the third section, as the method presented there assumes a constant monthly seasonal pattern (apart from trading-day effects)

Seasonal adjustment of published M_1 series

On a continuing basis the Federal Reserve publishes a seasonally adjusted monthly money supply (M_1), and revises the monthly seasonal factors periodically (in general every year)[7] The procedure employed consists essentially of (1) applying the X-11 program and then (2) judgmentally modifying the X-11 seasonal factors to take account of elements of both natural and policy seasonals felt to be inadequately captured by X-11 (a descriptive method) In this section both aspects of this procedure are discussed

The published seasonally adjusted M_1 series is derived by summing separately adjusted currency and demand deposit components This procedure has been followed over the years since initial publication of the money supply data because of analytical interest in the two component series[8] Chart 1 shows total

CHART 1 M_1 Total and Major Components



M_1 and the currency and demand deposit components, both seasonally adjusted and unadjusted, as published in January 1976 It is evident from the chart that most of the fluctuation in total M_1, not seasonally adjusted, reflects seasonal changes in deposit balances The seasonal pattern of currency is well defined but relatively small in dollar terms Currency growth makes a substantial contribution to the longer-run trend of M_1, while demand deposits not only contribute to growth but also account

[7] The data and seasonal factors are published in the *Federal Reserve Bulletin* For example, the revision published in April 1978 reflected both revisions in seasonal factors and other technical adjustments See "Money Stock Revisions," *Federal Reserve Bulletin*, vol 64 (April 1978), pp 338–39

[8] Comparisons of direct adjustment of total M_1 with sums of separately adjusted components indicate that the resulting differences in movement are relatively minor

for most of the irregular fluctuations and longer-run shifts in growth rates

The X-11 computation

As mentioned earlier the X-11 program is a ratio-to-moving-average procedure that in some respects provides considerable flexibility for identifying seasonal characteristics and for tailoring seasonal adjustment to individual series [9] The X-11 options employed in adjusting M_1 include computation of multiplicative seasonal factors and use of moderately flexible moving averages to take account of moving seasonality

For M_1, a multiplicative relationship of the seasonal component to trend appears to be appropriate for most months since, under the assumption of an additive relationship, the seasonal and trend-cycle components appear often to be strongly related, by contrast, the factors or components in Equations 1 or 2 are generally assumed to be independent This relationship of seasonal to trend-cycle components is seen in Chart 2 (pages 76–77), which displays relationships of seasonal-irregular differences to trend cycle as computed by an X-11 additive adjustment for the period 1965–75 As may be noted, the correlation coefficients inserted on the scatter diagrams are relatively high for 9 of the 12 months Similar correlations for the currency and demand deposit components (not shown in the chart) also are relatively high for 8 of the 12 months, suggesting that strong relationships exist between the dollar amounts of the seasonal component and the level of M_1 Proportional changes in the dollar amount of the seasonal and the trend cycle represent multiplicative relationships While a multiplicative relationship is not perfect, it appears more representative of the seasonal characteristics of M_1 than is the additive seasonal alternative, and multiplicative adjustments are used for the published M_1 series [10]

Another X-11 option employed in M_1 seasonal adjustments is the use of moderately flexible moving averages to allow for moving seasonality The X-11 program provides tests for moving seasonality for individual months, offering the possibility of controlling the flexibility of the process by which average seasonal factors are derived for each month from the seasonal-irregular (*SI*) ratios [11] These tests suggest that moving seasonality was a significant characteristic of both the currency and the demand deposit components during the 1965–75 period [12] Final X-11 seasonal factors were derived by smoothing the *SI* ratios by a 3-term average of a 5-term average of the ratios

Judgmental modifications

For several reasons the seasonal factors produced by X-11 may not adequately incorporate

[9] See "X-11 Variant"

[10] Correlations for January, April, and August are relatively weak for total M_1, reflecting either greater relative fluctuations in the irregular component or little relationship between the size of the seasonal component and the level of M_1 in these 3 months It is likely that the M_1 seasonal reflects a combination of multiplicative and additive relationships The multiplicative option is used because it appears to be most consistent with the observed relationship of M_1 seasonals to trend cycle It may be noted that an additive adjustment of a series that displays multiplicative relationships will also give reasonable results if the additive dollar seasonal factors shift from year to year by amounts consistent with the multiplicative seasonal ratios For series in which the seasonal component is changing in proportion to an expanding trend cycle, this relationship can be expressed either as a stable ratio (multiplicative) or as a changing dollar amount (additive) It seems preferable to apply a multiplicative procedure in this case, especially if judgmental modifications are to be made historically and in projected factors for a year ahead To the extent that multiplicative relationships can be represented in stable ratio factors, it may be easier to identify changing seasonality resulting from other influences

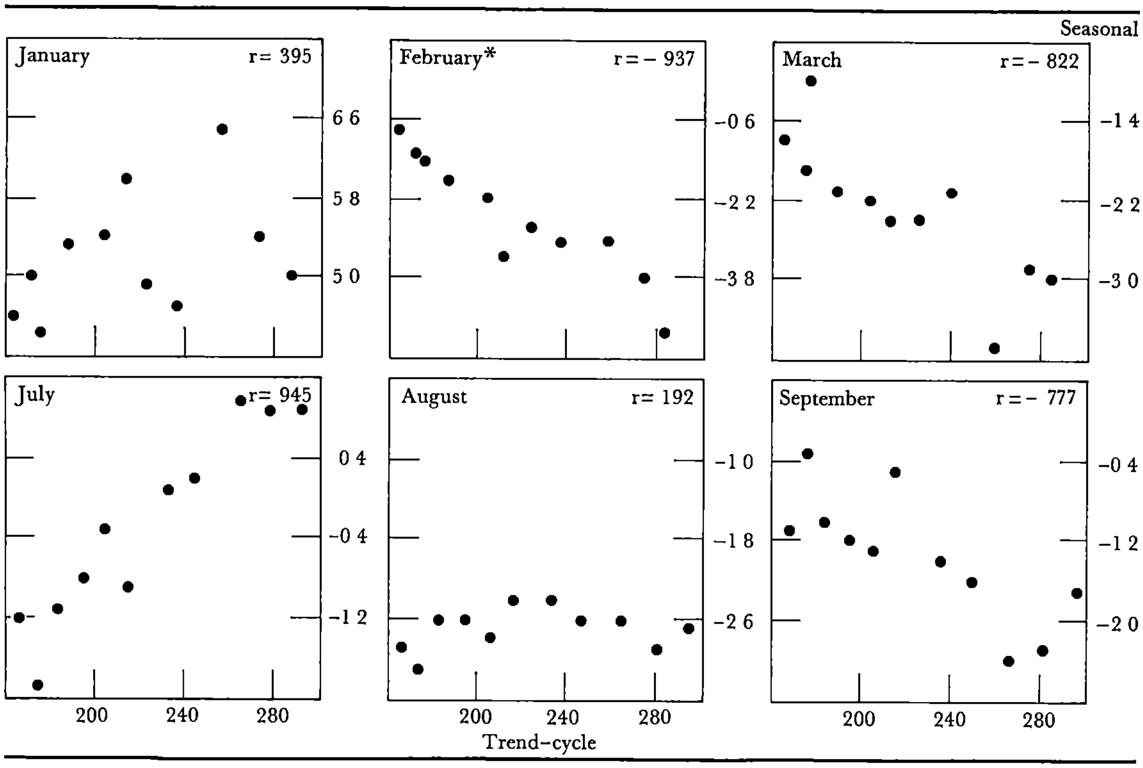
[11] *SI* ratios represent the seasonal irregular component of the series—that is, the ratio of the not seasonally adjusted data to the trend cycle component as computed by X 11

[12] Moving seasonality ratios (*MSR*'s) computed by X 11 relate average year to year changes of the irregular and seasonal components, indicating the importance of average year to year changes in the seasonal for a given month relative to changes in the irregular This ratio can be used as a guide for controlling the flexibility allowed in X 11 computations of seasonal factors for any month *MSR*'s computed for M_1 suggest that moderately flexible moving averages are appropriate for 11 of the 12 calendar months in the case of currency and for 10 months in the case of demand deposits

the seasonalıty present ın the money supply Fırst, whıle the smoothed movıng averages are moderately flexıble ın allowıng for movıng seasonalıty, judgmental modıficatıon of the X-11 results has been desırable to stabılıze the computed seasonal factors ın some perıods and to make them somewhat more flexıble ın others Such modıficatıons are based on analysıs of the computed *SI* ratıos for each month at varıous stages of the X-11 computatıonal process Factors causıng a change ın seasonal patterns are taken ınto account when known, and ımpacts of nonseasonal ınfluences on the *SI* ratıos also are weıghed ın modıfyıng the computed factors If an abrupt shıft occurs ın *SI* ratıos for a gıven month, the X-11 averagıng process would take account of thıs shıft only gradually ın the seasonal factors for surroundıng years, but the tımıng of the change can be sharpened by judgmental modıficatıon when approprıate, as for example ın the case of a modıficatıon ın tax remıttance schedules that results ın a change ın seasonal needs for money

In addıtıon, the computed seasonal factors are sometımes changed judgmentally to reduce the weıght of *SI* ratıos that are thought to reflect nonseasonal ınfluences ın partıcular years Seasonal factors computed for the latest years get specıal scrutıny, because X-11 movıng seasonals sometımes are more responsıve to fluctuatıons ın *SI* ratıos ın termınal years of a serıes than seems justıfied by contemporary ınformatıon on seasonal ınfluences In such cases, judgmental modıficatıons often are made to stabılıze the seasonal factors for the last few years of the serıes, unless a trend ın *SI* ratıos has been well establıshed or unless there ıs a known ınfluence causıng a shıft ın the seasonal pattern Judgmental modıficatıons of the computed seasonal factors are constraıned by the requırement that monthly factors must average approxımately 100 per cent over the year (or total 1,200) whıle lımıtıng tendencıes

CHART 2 Relatıonshıp Between Seasonal Component and Trend-Cycle Component, 1965-75



* Scales dıffer for February and December

toward repetitive movements in the seasonally adjusted data in successive years On balance, these modified X-11 (3 × 5) seasonal adjustments have produced movements in M_1 that tend to be between X-11 (3 × 5) and X-11 (3 × 9) adjustments, movements that have tended more toward a stable seasonal than the X-11 (3 × 5) seasonal adjustments

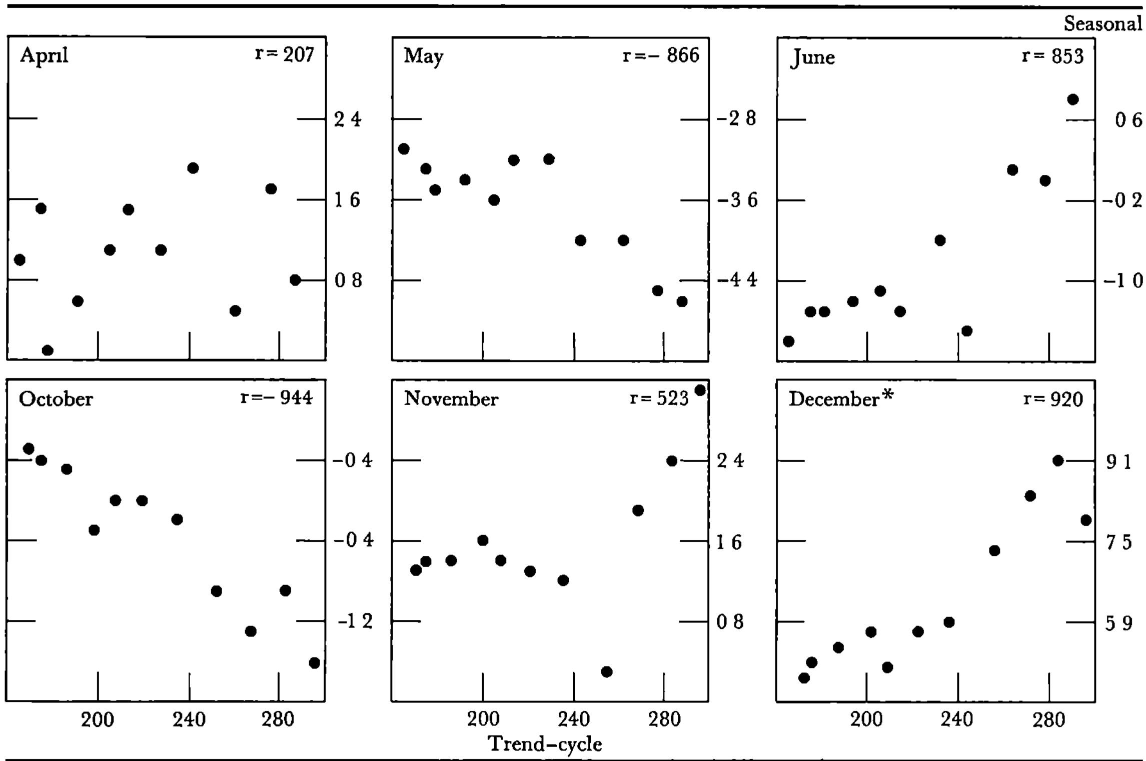
In recent years, a major concern in reviewing the X-11 M_1 seasonal adjustments has been the tendency toward rapid expansion of this series in the first half of the year, followed by slower growth in the second half This pattern is evident in the half-year growth rates for the most recent years, as shown in Table 1 In fact, the timing of all six of the major shifts in expansion rates in the 11 years was such that first-half growth rates exceeded second-half rates substantially However, in each instance these major shifts in growth rates appeared to be trend-cycle in nature rather than seasonal From a technical viewpoint, some of the shifts did not occur in successive years and the timing of turning points in monthly growth rates varied from February to August Moreover, the duration of fast and slow growth differed somewhat in these periods Most important, the second-half slowing and the rapid expansions that followed in each of

TABLE 1 Half-Year Changes in M_1

Seasonally adjusted annual rates in per cent

Year	Change	
	H1	H2
1965	3 4	5 8
1966	5 0	0 1
1967	6 5	6 5
1968	7 7	7 9
1969	4 5	1 9
1970	4 6	5 6
1971	9 3	3 5
1972	8 1	9 9
1973	6 9	4 8
1974	5 3	3 9
1975	5 6	2 7

NOTE —Data are derived from seasonally adjusted levels for June and December Growth rates based on half-year or quarterly averages show similar patterns, except in 1975, in which second-half expansion exceeded that in the first half by these alternative computations



NOTE —Amounts are in billions of dollars Variables derived from X-11 additive seasonal adjustment of M_1

the six periods were associated with monetary or other national economic policy actions that are considered nonseasonal influences

As a further check on the nature of these movements, several alternative seasonal adjustment procedures were compared in conjunction with the M_1 revision published in January 1976[13] In general, the alternative procedures also reflected these shifts in M_1 growth as trend cycle, rather than seasonal, in nature

Behavior of M_1 adjusted series and seasonal factors

The extent of change in the published M_1 seasonal factors over the past two decades is shown in Table 2 The largest net changes in M_1 seasonal factors over the past 20 years have been in February, April, and July, with shifts in demand deposit seasonals most important Since 1965 the largest changes in M_1 seasonal factors have included reductions of nearly 1 percentage point in the January and February factors and increases exceeding 1 percentage point in the June and July factors Significant portions of the latter shifts were recognized in the revision published in January 1976, based on trends in *SI* ratios that appeared to be developing in the last several years However, additional data will be needed to determine whether or not these shifts are still in process

As has been noted, the seasonal adjustments computed for M_1 components are based on monthly levels However, observers of current monetary conditions tend to focus on monthly changes in the seasonally adjusted levels expressed at annual rates Chart 3 shows monthly changes in dollars in the upper panels and percentage changes at the bottom It may be seen that much of the monthly fluctuation in the not seasonally adjusted M_1 levels (top curve) is removed as seasonal change (second curve), leaving relatively small and usually positive residual changes in the seasonally adjusted series (third curve) The tendency for monthly seasonally adjusted changes to be positive, of course, reflects underlying growth in the money stock However, monthly fluctuations in the irregular component, positive and negative, are large enough relative to short-run growth to obscure shifts in underlying rates of growth This is especially evident in the bottom panel of Chart 3, which shows the seasonally adjusted monthly changes in per cent and also in per cent at annual rates While it is common to express monthly seasonally adjusted money stock changes at annual rates, this practice unavoidably gives equal weight to the irregular and trend-cycle

[13] See Edward R Fry, "Seasonal Adjustment of M_1—Currently Published and Alternative Methods," Staff Economic Studies 87 (Board of Governors of the Federal Reserve System, 1976)

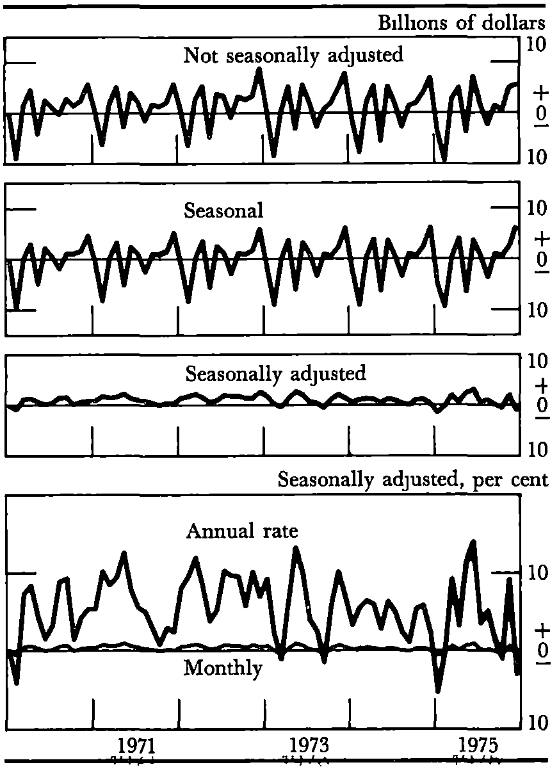
TABLE 2 Changes in Seasonal Factors for Money Stock, 1955–75

In percentage points

Month	Total M_1[1]			Demand deposits			Currency		
	Level of seasonal factor	Change		Level of seasonal factor	Change		Level of seasonal factor	Change	
	1975	1965–75	1955–65	1975	1965–75	1955–65	1975	1965–75	1955–65
Jan	102 04	– 91	35	102 9	– 9	5	99 35	– 42	– 15
Feb	98 78	– 92	– 78	98 8	–1 1	9	98 70	– 23	– 29
Mar	99 05	– 05	– 58	99 0	– 1	– 7	99 20	08	– 12
Apr	100 55	02	1 35	100 9		1 7	99 45	31	04
May	98 35	40	– 70	97 9	3	9	99 75	48	03
June	99 76	1 14	– 72	99 6	1 3	–1 0	100 25	45	30
July	100 07	1 08	08	99 9	1 25		100 75	32	30
Aug	98 92	53	– 33	98 5	55	– 5	100 35	12	29
Sept	99 36	– 08	03	99 2	– 1	1	99 85	– 13	– 22
Oct	99 65	– 61	32	99 6	– 7	5	99 80	– 33	– 36
Nov	100 62	– 32	26	100 6	– 3	3	100 70	– 39	09
Dec	102 86	– 17	55	102 3	– 1	7	101 85	– 18	03

[1] Total M_1 is derived by summing separately adjusted demand deposits and currency Implied seasonal factors shown were derived by dividing the not seasonally adjusted total M_1 by the seasonally adjusted total

CHART 3 M_1 Total, Month-to-Month Change



components However, irregular fluctuations seldom cumulate in one direction over a span as long as a year, in contrast to the trend-cycle component Consequently, in assessing the underlying growth rate, it is necessary to view average fluctuations in the money stock over a long enough span to reduce the importance of irregular changes or to consider the seasonally adjusted level of the money stock in relation to a longer-run trend level [14]

A daily seasonal adjustment procedure

A seasonal adjustment method for series such as the money supply, for which daily data are available, was suggested to the Federal Reserve staff by Professor Milton Friedman As thus far developed, it computes stable daily seasonal factors, making no allowance for moving seasonality However, monthly factors calculated from the daily factors vary from year to year because the daily factors include an adjustment for intraweekly movements and the weekdays included in a given month vary from year to year In addition, the introduction of dummy variables to adjust for holidays and other special events also provides flexibility

Description of the method

In the daily seasonal method, the first step is to compute day of-the-week factors and use them to remove intraweekly movements, then trend is removed from this adjusted series to arrive at seasonal-irregular ratios A Fourier transform of these ratios is made and the sine and cosine terms having the largest amplitudes are selected to form an estimate of the seasonal In order to incorporate dummy variables, the coefficients of the terms selected are determined not from the Fourier transform, but from a regression using the seasonal-irregular ratios as the dependent variable and both the sine and cosine terms and the dummy variables as independent variables Daily seasonal factors computed from the regression coefficients are combined with intraweekly factors to seasonally adjust daily observations

A detailed description of the method follows

1 Removal of intraweekly movements

a The ratio of each day's observations to a 7-day centered moving average is computed

b The ratios for each day are averaged by quarters, and analyses of variance tests are made for changes in the ratios between years and between the quarters within a year

c If the tests in (b) show no significant change, seven day-of-the-week factors are computed by averaging ratios for all Mondays, all Tuesdays, and so forth If there is significant between- or within-year change, day-of-the-

[14] Alternative methods for measuring the contribution of the irregular component, or at least that part of the irregular component that arises from very short run day to day variations in M_1, are proposed in Richard D Porter, Agustin Maravall, Darrel Parke, and David A Pierce, "Transitory Variations in the Monetary Aggregates," this volume

week factors must be computed that allow for the change (So far, this has not been done)

d Observations in the original series are divided by appropriate day-of-the-week factors to get an adjusted series used in subsequent calculations

2 Calculation of seasonal factors

a A trend-cycle component is estimated by calculating for each observation a 365-day centered moving average of the adjusted series

b The trend-cycle curve is divided into the series derived in 1(d) to obtain seasonal-irregular ratios In leap years, the February 28 ratio is calculated by averaging the February 28 and 29 ratios, and February 29 is omitted

c A Fourier transform is made of the seasonal-irregular ratios, calculating the A and B coefficients in the equation

$$(7)\quad y_t = \frac{1}{2} A_0 + \sum_{k=1}^{182} A_K \cos\left(\frac{2k\pi t}{365}\right) + \sum_{k=1}^{182} B_k \sin\left(\frac{2k\pi t}{365}\right)$$

d A regression is run with the seasonal-irregular ratios as the dependent variable and the N largest sine or cosine terms, plus dummy variables for holidays, tax dates, and other such effects as independent variables[15] Dummy variables are used for holidays or other events that fall on a different date each year or that cause the series to "spike" too sharply to be represented adequately by sine and cosine terms The coefficients estimated by the regression are used to construct a final daily seasonal factor series

3 Final adjustment and calculation of weekly and monthly averages

a An adjustment factor for each day is constructed as the product of the daily seasonal factor and the appropriate day-of-the-week factor (For February 29, the February 28 daily seasonal factor is used) Future daily adjustment factors may be projected using the regression coefficients and day-of-the-week factors The original series is divided by the daily adjustment factor to get a final seasonally adjusted series

b Weekly and monthly seasonally adjusted series are calculated as the appropriate averages of the daily seasonally adjusted data

c Implied monthly (and weekly) seasonal factors may be calculated for periods for which original data are available by dividing the monthly average of the original data by the monthly average of the seasonally adjusted data For projecting future monthly seasonal factors, the projected daily adjustment factors may be averaged, these factors (for most series) will differ only slightly from the implied monthly factors, which can be calculated only after original data become available

[15] Thus far, no single criterion has been selected for determining N For the money supply components, 30 terms were used, see note 16

Application of the daily seasonal method to M_1

This section presents the results of applying the daily seasonal adjustment to the demand deposit and currency components of M_1 for the years 1969–74, and compares them with an X-11 adjustment

The computation of day-of-the-week factors (see item 1 above) yielded the factors shown in Table 3

The original series was adjusted for the intraweekly pattern, the estimated trend was divided into this adjusted series to yield seasonal irregular ratios, and a Fourier transform of this ratio series was made The 30 sine or cosine terms having the largest amplitude were selected as independent variables in the regression used to compute the seasonal factors[16] The independent variables in the regres-

[16] The number of terms used was determined experimentally by computing three seasonal factor series having, respectively, 18, 30, and 50 sine–cosine terms and

TABLE 3 Day-of-the-week Factors for Money Supply Components

Day	Demand deposits	Currency
Monday	1 00614	99625
Tuesday	1 00578	98959
Wednesday	1 00227	98936
Thursday	1 00322	99405
Friday	99326	1 00995
Saturday	99472	1 01050
Sunday	99458	1 01031

TABLE 4 Summary Measures, Demand Deposit and Currency Regressions, 1969–74

Measure	Demand deposits	Currency
R^2	886	887
Standard error of estimate	0068	0039
F statistic	420 8	421 5

sion included, in addition to the sine and cosine terms, 11 dummy variables These dummy variables were for Washington's Birthday, the April 15 tax date, Easter Monday, Memorial Day, July 4, Labor Day, Columbus Day, Veterans Day, and the days before Thanksgiving, Christmas, and New Year's The treatment varied when holidays fell on Saturday and Sunday, some holidays are commonly observed by making an adjoining weekday a nonworking day when the holiday falls on a weekend In such cases the position of the dummy variable was shifted accordingly, otherwise, the dummy was omitted for the year in which the holiday fell on a weekend Some results of the two regressions are given in Table 4

The coefficients of the 41 variables were used to compute 365 daily seasonal factors[17] Seasonal adjustment of the daily series was then made by dividing the original daily observations by a factor consisting of the product of the day-of-the-week factor and the daily seasonal factor

Tests for changing seasonal pattern

Several tests were performed in an attempt to determine whether, at least over the 1969–74 period, the evidence is in favor of fixed or changing seasonal factors We present here the results of tests for stability in the day-of-the-week effect and several tests for stability of the monthly factors The tests do not always yield identical conclusions, however, they are all consistent with the assertion that any changes occurring in the descriptive seasonal over this period have been mild

We consider first a test of stability in the intraweekly patterns, that is, in the day-of-the-week factors Analysis of variance was used in order to test for shifts both between years and between quarters within a year The data used were the ratio of each daily observation to a centered 7-day average of daily observations Seven tests were made, one for each day of the week In each test, all the data for 1 day (say, Monday) were divided into 24 cells—6 years and 4 quarters—and the variances of the quarterly means and the yearly means were compared with the within-cell variance Table 5 shows, in the columns headed "Quarters," the ratio of the variance of quarterly means to the within-cell variance, and in the columns headed "Years," the ratio of the variance of yearly means to within-cell variance Under the hypothesis of unchanging intraweekly factors these ratios possess F-distributions with degrees of freedom as indicated in Table 5

comparing the variance of the differences between the actual seasonal irregular ratios and the computed seasonal factors For the demand deposit component, the variance was significantly smaller when 30 rather than 18 variables were used, but using 50 rather than 30 variables did not make a further significant reduction For currency, there was a statistically significant smaller standard deviation when 50 variables were used, however, as the dollar magnitude of the currency series (and thus of the reduction in standard deviation) is much smaller than that of the demand deposit series, it was decided to use 30 terms here also

[17] Actually 40 variables plus the constant term The latter is equivalent to the expression $(\frac{1}{2})A_0$ in Equation 7

TABLE 5 F-tests for Change in Intraweekly Factors

Day	Demand deposits		Currency	
	Quarters $F(3,289)$	Years $F(5,289)$	Quarters $F(3,289)$	Years $F(5,289)$
Monday	1 0993	1 0585	4244	1 8134
Tuesday	5304	3080	1 6845	2 7409[1]
Wednesday	2 7629[1]	1 0163	1 6868	3181
Thursday	2158	1 8763	1281	2 1411
Friday	1 8424	3893	1 9050	3704
Saturday	6069	5 0206[1]	1 4876	6185
Sunday	3 0661[1]	3 4713[1]	6442	5025

[1] Significant at 5 per cent level

Those ratios that indicate statistically significant between-quarter or between-year differences are indicated in a footnote While there are significant differences for some days, either in years or in quarters, most days show no significant differences, and hence stable rather than moving intraweekly factors were used in the daily seasonal adjustment of the M_1 components

Three tests were conducted to examine the possibility of a change in the monthly seasonal factors The first test is based on the monthly averages of the residuals from the regression Each monthly average is assumed to be an estimate of the residual mean, and a test is made (assuming a normal distribution for the residuals) of whether this estimate of the mean differs significantly from the "true" mean [18] In fact, the test was made by using two different estimates of the "true" mean residual In one test the true mean residual was assumed to be the average residual for that month, in the other, the true mean residual was assumed to be zero The variance of the mean was estimated for each month separately, using data for that month for all 6 years in the series If average residuals are significant in a given month, a shift in seasonal patterns could be indicated

Table A-1 in the appendix shows the results of this test It contains two groups of five columns, one group for demand deposits and the other for currency The first two columns in each group show the deviation of the mean residuals from the true mean, adjusted for the estimated variance of the mean, in the first column, the "true" mean is assumed zero, while in the second column, the true mean was estimated for each month as the average of the residuals in that month over the entire series On the assumption that these statistics are normally distributed, those that exceed 90 per cent confidence limits (5 per cent in each tail) are marked with an asterisk, those that exceed 95 per cent limits, with a dagger The table shows a suspiciously large number of months with high residuals However, the fact that they generally cluster together suggests a defect in the estimation of trend rather than a significant change in seasonal

The second test for moving seasonality is based on the idea that if seasonality remains in the residuals from the regression (thus indicating moving seasonality), it will be reflected in the autocorrelations of the residuals at the "seasonal" lags—that is, in the correlations of observations in successive years or quarters Thus, with daily data, large residual autocorrelation at or near lag 365 would indicate an annual seasonal pattern unaccounted for by the daily seasonal adjustment method, and significant autocorrelation at or near lags 91, 182, or 273 would point to a remaining quarterly pattern

However, when the autocorrelations of the daily residuals are examined, any possible existence of seasonality is masked by the dominant first-order autocorrelation Tables A-2 and A-3 show these autocorrelations, from the demand and currency regressions, respectively, for the first 370 lags These autocorrelation coefficients are in both cases largest at the lowest lags In fact, this low-order autocorrelation reinforces the conclusion that it is trend more than seasonality that is inadequately treated

A common approach in the presence of such serial correlation patterns is to compute first differences (daily changes) of the series [19] In

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[18] The variance of the mean was computed as

$$S_m^2 = \frac{S^2}{n}\left[\sum_{k=0}^{n-1}\left(1 - \frac{k}{n}\right)\rho_k\right]$$

where

$$\rho_k = \frac{\sum_{t=k+1}^{N} x_t' x_{t-k}'}{\sum_{t=1}^{N} (x_t')^2}$$

S^2 = variance of observations for the given month over the whole series

S_m^2 = variance of mean for the given month

n = sample size (number of days in the given month)

ρ_k = correlation coefficient for observations k days apart calculated from the set of $N = 2190$ regression residuals

x' = deviation of observations (that is, the residuals) from their mean

N = number of observations in entire series

[19] See George E P Box and Gwilyn M Jenkins, *Time Series Analysis Forecasting and Control* (Holden-Day, 1970)

TABLE 6 Quarterly and Annual Autocorrelation in First-Differenced Residual Series

Interval	Lag in days	Value for demand deposits	Value for currency
3 months	91	153	208
	92	039	− 003
6 months	182	149	195
	183	025	044
9 months	273	133	148
	274	038	023
1 year	364	155	269
	365	125	154
	366	− 064	− 129
4 weeks	28	*	157
5 weeks	35	*	122
9 weeks	63	*	139

* Negligible

the present context we would expect at least that the presence or absence of seasonality would be more clearly revealed after detrending the residuals in this way This was found to be true, and in fact the highest autocorrelation coefficients in the series of daily residual changes occur at the quarterly and annual lags Table 6 shows these coefficients While they are never higher than 0 27 and are usually below 0 20, they are in several instances very highly significant statistically owing to the large sample size, the standard error of a sample autocorrelation coefficient is about 0 03

To examine the possible impact of this, consider a simple case in which the annual autocorrelation coefficient has a value of 0 155 (the sample value for demand deposits) and other coefficients are essentially zero This would imply that the residuals (first-differenced), say e_t, had an annual autoregressive model of the form

$$(8) \qquad e_t = 155\, e_{t-365} + u_t$$

For the demand deposit component the standard deviation of e_t was 0 0052, thus the standard deviation of $(0\,155 e_{t-365})$, which is the change in the ratio at time t resulting from taking this autocorrelation into account, is 0 0008 This could affect the seasonally adjusted (daily) demand component figures (if their level is \$200 billion) by ±\$160 million With currency the comparable effect would be about ±\$50 million While occasionally a cumulative effect of several such occurrences could be substantial, this effect on the whole would appear to be rather mild

The third test of stable seasonality is similar to the one just described except that it is based entirely on monthly data As indicated earlier, the log of the seasonal factor is the seasonal component of the log of the series We therefore estimated the regression equation

$$(9) \qquad \Delta \log M_{1t} = \sum_{j=1}^{12} \alpha_j d_{jt} + e_t$$

First differences of the logarithms are used in order to obtain serially uncorrelated regression residuals, however, it can be shown that seasonal components for levels are all unchanging if and only if this is true for the differences As in Equation 5, d_{1t}, , d_{12t} are seasonal dummy variables [20]

Since the seasonal dummies in Equation 9 capture all the fixed seasonality, any seasonality in the regression residuals e_t indicates moving seasonality in $\Delta \log M_{1t}$ (hence in M_{1t}) To test for seasonality in e_t the autocorrelations of this series were computed, they are displayed in Table 7, for lags 1–30 (an autocorrelation of lag k is the sample correlation coefficient between residuals k months apart) Seasonality in this series would ordinarily induce serial correlation at the annual lags of 12, 24, , and perhaps also at the quarterly lags 3, 6, The standard errors of these autocorrelation coefficients, under the null hypothesis that there is little actual serial correlation in the residual series, are about 0 12, so that sample values above 0 24 could be regarded as statistically significant (at the 5 per cent level) In Table 7 it is seen that no autocorrelation coefficients are significantly nonzero, in particular, those at the seasonal lags give no evidence whatever of any seasonality remaining in this series We conclude from this test that the fixed seasonal model (Equa-

[20] The term $\Sigma\alpha_j d_{jt}$ in Equation 9 also incorporates a constant term (which is the average rate of growth of M_1 over this period), so that $\Sigma\alpha_j \neq 0$, contrasted with the case in Equation 5 If $\bar{\alpha} = \Sigma\alpha_j/12$ denotes this constant, then the α's in Equation 9 and the δ's in Equation 5 are related by $\alpha_j = \bar{\alpha} + \delta_j$ The seasonal component for the jth month is $\delta_j = \alpha_j - \bar{\alpha}$

TABLE 7. Autocorrelations of Residuals from Fixed Seasonal M_1 Regression

Lags	1	2	3	4	5	6	7	8	9	10
1–10	13	− 08	− 14	05	16	09	− 02	− 07	− 00	08
11–20	03	− 07	− 20	01	− 04	08	01	− 01	06	− 02
21–30	− 04	− 03	03	− 06	− 03	− 05	06	11	− 08	− 05

tion 9) adequately captures seasonality in the money supply over this period (1969–74)

However, the fact that a fixed-seasonal model appears adequately to capture seasonality in a series does not necessarily imply that the series does not contain moving seasonality There is rather limited information in only a few years' data—six in this investigation of M_1—concerning various seasonal patterns possible, and so the tests employed are likely to have low power Indeed, the previous two tests do find evidence for changes in the seasonal factors over this period, with no more—though also no less—evidence than in Table 7 that any seasonality remains after applying these procedures

Even the regression on seasonal dummies, however, revealed moving seasonality in prior sample periods A very different seasonal structure was found for M_1 for the periods 1959–68 and 1965–75 [21] Also for the former sample period, application of the Stephenson and Farr method found significant seasonal-trend interactions, a clear indication of moving seasonality [22] On the other hand, for the 1969–74 period, the technique described and applied to M_1 above has also failed to find moving seasonality for M_2 as well as for the currency, demand, and time deposit components of these aggregates separately One possible conclusion is that over shorter periods seasonality is generally best described by fixed-factor procedures

An alternative detrending method

Both the tests on monthly residual means and the daily autocorrelation analysis just described have indicated an inadequate trend removal in the daily procedure In order to get a more flexible trend line than is provided by a 365-day moving average, the basic daily seasonal adjustment method was altered by making a preliminary seasonal adjustment of the original series by using daily seasonal factors constructed from the 30 sine and cosine terms having the largest coefficients as well as the day-of-the-week factors A quadratic was then fitted to N days centered on each date in this seasonally adjusted series (Values of N of 181 and 365 were tried) For each day the ratio of the original data (adjusted for day of the week) to the middle term of the quadratic centered on that day was computed, and these ratios were then used in exactly the same way as the ratios of daily data to 365-day averages were used in the basic adjustment method—a Fourier transform was made and the 30 sine and cosine terms having the largest amplitudes were used with 11 holiday dummies in a regression

There are a variety of comparisons that can be made between the basic method and the quadratic-trend variant Comparing the residuals from the regression shows that a quadratic fitted to 365 terms reduces the mean square deviation significantly, and that using a 181-term quadratic reduces it even further It is necessary to be cautious in interpreting this result, however A quadratic does not eliminate seasonal movements, hence, a seasonal remaining in the seasonally adjusted series from which the trend was computed with the quadratic could be incorporated into the trend component In addition, a sufficiently flexible trend could incorporate some of the irregular movement in the series For both of these reasons the over-all variance of the seasonal-irregular ratios would be reduced, and the smaller size of the deviations from the regression would not necessarily indicate a superior trend computation

[21] David A Pierce and Richard D Porter, "Linear Models and Linear Filters in the Analysis of Seasonal Time Series," *American Statistical Association, 1973 Proceedings of the Business and Economic Statistics Section*, pp 537–42

[22] "Seasonal Adjustment of Economic Data "

Running the residual-means test for a changing seasonal for the two variants also shows interesting comparisons Estimating trend with a 365-term quadratic yielded results quite similar to the basic method in that there were nearly as many "significant" deviations of monthly-average residuals from the "actual" mean deviation However, using a 181-term quadratic reduced the number of months in which a changing seasonal was triggered for demand deposits to 11, it was 19 under the basic method In addition, the pattern of seasonal-change signals with the 181-term quadratic trend is quite different from that with the basic method With the basic method, spurious signals come in clusters, all bearing the same sign and thus seeming to come from defects in the estimate of trend, but with the 181-term quadratic, signals, when they occur close together, have opposite signs

These results indicate that further work is needed to improve the detrending procedure in the daily seasonal method

Comparison of daily and X-11 seasonal adjustment procedures

Table A-4 in the appendix shows the money supply, M_1, adjusted by three different methods —a stable-seasonal variant of X-11, the standard (moving-seasonal) X-11 adjustment, and the daily seasonal adjustment [23] In all cases the demand deposit and currency components were adjusted separately, and the results summed Table A-4 also shows the differences between the daily seasonal method and these two versions of the X-11 method Table 8 shows summary measures of the differences

The results of the X-11 moving adjustment shown here are not those that would be obtained were the same method used on a longer time span A 6-year period may contain too few observations to identify meaningful moving-seasonal factors, given the problem of separating seasonal from irregular and the fact that a large proportion of the factors in a 6-year series are estimated by special procedures for terminal years at both ends of the series Given a longer time span, the X-11 moving-seasonal method could give results either closer to or further from those shown in Table 8

TABLE 8 Alternative Adjustments of M_1, 1969–74 Data
In millions of dollars

Comparison	Absolute average difference	Range of difference
Daily seasonal versus X-11 moving seasonal	218	−1,151 to 414
Daily seasonal versus X-11 stable seasonal	153	−652 to 256

One would expect that the daily seasonal method, which computes stable seasonal factors, would give results closer to the X-11 stable-seasonal adjustment than to the X-11 moving-seasonal adjustment, and Table 8 shows this to be true However, when the seasonally adjusted components of the money supply are examined separately, it is seen that the daily seasonal adjustment of the demand deposit component is closer to an X-11 stable-seasonal adjustment, while the daily seasonal adjustment of the currency component is (slightly) closer to an X-11 moving-seasonal adjustment (see Table 9) Evidently, the intraweekly pattern in the currency component (the "trading-day" variation) is strong enough to account for a substantial part of the year-to-year movement in the seasonal factors generated by the X-11 moving-seasonal program The stable-seasonal X-11 is constrained to compute a constant seasonal factor for each month and thus cannot allow for the effect of intraweekly movements

To summarize, a daily seasonal adjustment method has been presented that, at least for the money supply components, produces seasonally adjusted series not greatly different from those produced by X-11 over the past several years The method produces stable daily seasonal factors and thus monthly factors that are stable except for "trading-day" variation

[23] The series shown here does not include the latest revisions and hence differs from current published figures In addition, in a few months there are small differences between these figures (which come from the daily file) and published figures (which come from the monthly file) that result from differences in the averaging methods used for Edge Act deposits

TABLE 9 Alternative Adjustments of M_1 Components, 1959–74 Data

In millions of dollars

Comparison	Demand deposits		Currency	
	Average absolute difference	Range of difference	Average absolute difference	Range of difference
Daily seasonal versus X 11 moving seasonal	206	−1,111 to 400	52	−93 to 155
Daily seasonal versus X-11 stable seasonal	128	−645 to 196	53	−132 to 162

Several refinements and further work with this method are still needed The effects of using logarithms have not yet been investigated, no method has yet been developed for dealing with a changing intraweekly pattern, and further work is needed concerning the number of sine–cosine terms to include as independent variables in the regression But perhaps the most basic issue is the question of whether to adjust the money supply with stable or moving seasonals If it is decided to use stable seasonals, the daily method has the advantage of allowing for the introduction of dummy variables to adjust for holidays and other special events It also gives consistent weekly and monthly seasonal adjustments, which present a problem when X-11 is used On the other hand, application of the daily method to M_1 adjustment would require determination of which segments of the series can be appropriately adjusted by a constant seasonal procedure and how such segments can be linked together during periods when seasonal factors are known to be changing

If it is decided to use a moving-seasonal method, X-11 is an obvious choice, though there is still the question, in estimating the descriptive seasonal, of whether to use the results "raw" or to adjust for known special events and policy changes Judgmental review is used, at present, to eliminate effects on the X-11 factors considered to be induced by nonseasonal movements While this adjustment is based largely on judgment, such effects can be quantified by using artificial series constructed with a known seasonal pattern [24]

[24] Results of a preliminary study of this nature argue against using an X 11 adjustment without judgmental review

Appendix Tables

TABLE A-1 Test for Change in Seasonal

Monthly averages of residuals from the regression, basic daily seasonal adjustment

Month	Demand deposits					Currency				
	X/SD	*(X M)/SD*	*X*	*M*	*SD*	*X/SD*	*(X M)/SD*	*X*	*M*	*SD*
1969—Jan	2 450527†	2 144221†	0088	0011	0036	2 391307†	2 527953†	0035	− 0002	0015
Feb	2 349611†	2 517440†	0070	− 0005	0030	1 993044†	2 214493†	0027	− 0003	0014
Mar	1 961078†	1 961078†	0054	0	0028	1 026415	1 111950	0012	− 0001	0012
Apr	1 148012	1 418132	0034	− 0008	0030	−1 769279*	−1 300941	− 0034	− 0009	0019
May	531941	461016	0015	0002	0028	−2 583534†	−2 422062†	− 0048	− 0003	0019
June	− 206847	− 088649	− 0007	− 0004	0034	−1 364684	−1 516315	− 0018	0002	0013
July	− 948509	− 569106	− 0030	− 0012	0032	− 228294	−1 027322	− 0004	0014	0018
Aug	−1 849700*	−1 723583*	− 0044	− 0003	0024	843187	389163	0013	0007	0015
Sept	− 974997	− 934372	− 0024	− 0001	0025	769371	349714	0011	0006	0014
Oct	0	0	0	0	0025	2 174907†	2 174907†	0032	0	0015
Nov	− 387205	043023	− 0009	− 0010	0023	1 570616	1 903775*	0033	− 0007	0021
Dec	−1 580070	−1 333185	− 0064	− 0010	0041	050072	751079	0001	− 0014	0020
1970—Jan	1 420191	1 113875	0051	0011	0036	− 341615	− 204969	− 0005	− 0002	0015
Feb	−1 846124*	−1 678293*	− 0055	− 0005	0030	−1 845411*	−1 623961	− 0025	− 0003	0014
Mar	− 690009	− 690009	− 0019	0	0028	−1 710692*	−1 625158	− 0020	− 0001	0012
Apr	0	270121	0	− 0008	0030	−1 873355*	−1 405016	− 0036	− 0009	0019
May	− 780180	− 851106	− 0022	0002	0028	1 022649	1 184119	0019	− 0003	0019
June	−2 068474†	−1 950275*	− 0070	− 0004	0034	1 213053	1 061420	0016	0002	0013
July	−3 035229†	−2 655825†	− 0096	− 0012	0032	1 712202*	913175	0030	0014	0018
Aug	− 756696	− 630579	− 0018	− 0003	0024	1 037767	582745	0016	0007	0015
Sept	1 665619*	1 706243*	0041	− 0001	0025	839314	419657	0012	0006	0014
Oct	1 289507	1 289507	0032	0	0025	− 679659	− 679659	− 0010	0	0015
Nov	172091	602319	0006	− 0010	0023	−1 094671	− 761511	− 0023	− 0007	0021
Dec	−1 061610	− 814725	− 0043	− 0010	0041	− 951367	− 250360	− 0019	− 0014	0020
1971—Jan	−1 448038	−1 754354*	− 0052	0011	0036	−1 229815	−1 093168	− 0018	− 0002	0015
Feb	−1 208371	−1 040542	− 0036	− 0005	0030	− 442899	− 221449	− 0006	− 0003	0014
Mar	− 435795	− 435795	− 0012	0	0028	−1 026415	− 940881	− 0012	− 0001	0012
Apr	− 337651	− 067530	− 0010	− 0008	0030	− 312226	156113	− 0006	− 0009	0019
May	1 914988*	1 844062*	0054	0002	0028	− 538236	− 376765	− 0010	− 0003	0019
June	1 802527*	1 920726*	0061	− 0004	0034	227447	075816	0003	0002	0013
July	1 517614	1 897017*	0048	− 0012	0032	3 196111†	2 397082†	0056	0014	0018
Aug	1 975815†	2 101932†	0047	− 0003	0024	2 918721†	2 464699†	0045	0007	0015
Sept	934372	974997	0023	− 0001	0025	3 077483†	2 657826†	0044	0006	0014
Oct	564159	564159	0014	0	0025	1 631180	1 631180	0024	0	0015
Nov	−2 022070†	−1 591843	− 0047	− 0010	0023	− 380755	− 047594	− 0008	− 0007	0021
Dec	−1 802268*	−1 555383	− 0073	− 0010	0041	−1 552230	− 851223	− 0031	− 0014	0020
1972—Jan	−2 366986†	−2 673302†	− 0085	0011	0036	−1 844723*	−1 708076*	− 0027	− 0002	0015
Feb	−1 077699	− 909308	− 0032	− 0005	0030	− 222082	0	− 0002	− 0003	0014
Mar	544744	544744	0015	0	0028	1 283019	1 368554	0015	− 0001	0012
Apr	303886	574006	0009	− 0008	0030	− 468339	0	− 0009	− 0009	0019
May	−1 205733	−1 276658	− 0034	0002	0028	− 322942	− 161471	− 0006	− 0003	0019
June	−1 950275*	−1 832076*	− 0066	− 0004	0034	−1 516315	−1 667948*	− 0020	0002	0013
July	−1 169827	− 790424	− 0037	− 0012	0032	−1 198542	−1 997570†	− 0021	0014	0018
Aug	− 882811	− 756696	− 0021	− 0003	0024	−2 010675†	−2 464699†	− 0031	0007	0015
Sept	243749	284374	0006	− 0001	0025	−1 538741	−1 958398*	− 0022	0006	0014
Oct	886536	886536	0022	0	0025	543727	− 543727	− 0008	0	0015
Nov	0	430228	0	− 0010	0023	285566	618727	0006	− 0007	0021
Dec	2 049155†	2 296041†	0083	− 0010	0041	650935	1 351942	0013	− 0014	0020
1973—Jan	1 531579	1 225264	0055	0011	0036	068323	204969	0001	− 0002	0015
Feb	939845	1 107674	0028	− 0005	0030	− 811981	− 590532	− 0011	− 0003	0014
Mar	−1 380017	−1 380017	− 0038	0	0028	− 342138	− 256604	− 0004	− 0001	0012
Apr	−2 464849†	−2 194730†	− 0073	− 0008	0030	1 873355*	2 341693†	0036	− 0009	0019
May	0	− 070925	0	0002	0028	1 560885	1 722356*	0029	− 0003	0019
June	1 713878*	1 832076*	0058	− 0004	0034	2 426105†	2 274474†	0032	0002	0013
July	1 612464	1 991869†	0051	− 0012	0032	570734	− 228294	0010	0014	0018
Aug	798734	924850	0019	− 0003	0024	− 518884	− 972908	− 0008	0007	0015
Sept	−2 153116†	−2 112493†	− 0053	− 0001	0025	−1 049142	−1 468779	− 0015	0006	0014
Oct	−2 619309†	−2 619309†	− 0065	0	0025	−2 310839†	−2 310839†	− 0034	0	0015
Nov	− 043023	387205	− 0001	− 0010	0023	−2 094154†	−1 760993*	− 0044	− 0007	0021
Dec	1 061610	1 308496	0043	− 0010	0041	−1 852662*	−1 151654	− 0037	− 0014	0020
1974—Jan	− 863254	−1 169569	− 0031	0011	0036	−1 708076*	−1 571430	− 0025	− 0002	0015
Feb	167829	335659	0005	− 0005	0030	− 147633	073816	− 0002	− 0003	0014
Mar	907907	907907	0025	0	0028	1 881763*	1 967297†	0022	− 0001	0012
Apr	337651	607771	0010	− 0008	0030	2 603882†	3 070221†	0050	− 0009	0019
May	0	− 070925	0	0002	0028	1 991474†	2 152944†	0037	− 0003	0019
June	1 241083	1 359282	0042	− 0004	0034	227447	075816	0003	0002	0013
July	1 391147	1 770550*	0044	− 0012	0032	−1 598056	−2 397082†	− 0028	0014	0018
Aug	966889	1 093004	0023	− 0003	0024	−1 491791	−1 945815*	− 0023	0007	0015
Sept	0	040625	0	− 0001	0025	−1 328913	−1 748569*	− 0019	0006	0014
Oct	523862	523862	0013	0	0025	0	0	0	0	0015
Nov	1 548820	1 979048†	0036	− 0010	0023	1 285048	1 618210	0027	− 0007	0021
Dec	962856	1 209742	0039	− 0010	0041	1 151654	1 852662*	0023	− 0014	0020

NOTE —The symbols have the following definitions

X = average of residuals for that month

M = average of residuals for the given month over the entire series, that is, all January's have the same value

SD = estimated standard deviation of the mean for the given month, estimated over the entire series, that is, all January's have the same value

X/SD = monthly average of daily residuals, adjusted for standard deviation of the mean

$(X-M)/SD$ = monthly average of difference between daily residuals and monthly average of residuals for that month, adjusted for standard deviation of the mean

* Significant at 90 per cent confidence level

† Significant at 95 per cent confidence level

TABLE A-2 Autocorrelations of Residuals from Demand Deposit Regression

Lags	1	2	3	4	5	6	7	8	9	0
1– 10	704	534	457	436	410	381	375	367	362	347
11– 20	347	343	366	394	372	327	299	293	276	286
21– 30	289	291	300	298	311	278	274	295	297	263
31– 40	226	217	216	215	226	226	243	260	262	241
41– 50	217	190	173	138	111	111	116	117	126	125
51– 60	145	162	165	150	129	109	078	062	047	056
61– 70	084	081	058	026	024	036	034	032	011	– 009
71– 80	– 031	– 030	– 037	– 015	– 002	008	014	– 000	– 010	– 021
81– 90	– 034	– 050	– 068	– 094	– 096	– 074	– 064	– 074	– 049	007
91–100	061	024	– 037	– 071	– 076	– 092	– 110	– 116	– 096	– 082
101–110	– 076	– 072	– 083	– 081	– 070	– 086	– 093	– 108	– 125	– 123
111–120	– 109	– 086	– 087	– 069	– 060	– 062	– 082	– 090	– 062	– 057
121–130	– 093	– 123	– 123	– 112	– 104	– 092	– 083	– 068	– 044	– 042
131–140	– 056	– 069	– 067	– 066	– 067	– 078	– 069	– 062	– 044	– 039
141–150	– 039	– 021	– 012	– 002	– 007	– 038	– 050	– 053	– 051	– 057
151–160	– 057	– 033	000	009	– 014	– 037	– 020	– 018	– 020	– 030
161–170	– 017	– 035	– 029	– 027	– 011	003	031	045	033	029
171–180	033	032	022	– 000	– 026	– 032	– 023	– 033	– 026	– 015
181–190	032	078	037	– 021	– 052	– 047	– 042	– 049	– 061	– 047
191–200	– 016	– 011	– 007	– 001	– 002	007	– 008	– 022	– 036	– 043
201–210	– 036	– 025	– 016	– 015	– 006	– 002	– 024	– 046	– 052	– 037
211–220	– 033	– 038	– 072	– 073	– 065	– 059	– 055	– 053	– 028	– 001
221–230	– 005	– 020	– 042	– 058	– 065	– 061	– 071	– 075	– 080	– 071
231–240	– 071	– 055	– 056	– 047	– 041	– 065	– 083	– 095	– 097	– 088
241–250	– 081	– 096	– 089	– 061	– 035	– 056	– 068	– 047	– 045	– 058
251–260	– 086	– 075	– 076	– 091	– 092	– 072	– 052	– 042	– 016	– 029
261–270	– 040	– 053	– 048	– 057	– 067	– 086	– 108	– 101	– 097	– 092
271–280	– 080	– 040	012	– 014	– 063	– 092	– 083	– 081	– 095	– 087
281–290	– 081	– 069	– 063	– 056	– 076	– 059	– 043	– 036	– 060	– 077
291–300	– 087	– 081	– 073	– 067	– 052	– 032	– 026	– 038	– 075	– 091
301–310	– 076	– 061	– 064	– 094	– 097	– 075	– 057	– 051	– 031	– 000
311–320	015	022	007	– 012	– 030	– 037	– 039	– 055	– 064	– 064
321–330	– 063	– 060	– 086	– 049	– 034	– 029	– 034	– 062	– 074	– 083
331–340	– 080	– 084	– 089	– 075	– 035	– 031	– 073	– 098	– 082	– 084
341–350	– 097	– 105	– 118	– 112	– 123	– 122	– 106	– 096	– 066	– 055
351–360	– 072	– 076	– 092	– 111	– 119	– 127	– 132	– 149	– 146	– 136
361–370	– 136	– 117	– 065	028	029	– 044	– 079	– 101	– 109	– 132

TABLE A-3 Autocorrelations of Residuals from Currency Regression

Lags	1	2	3	4	5	6	7	8	9	0
1– 10	683	534	464	414	375	327	293	277	308	318
11– 20	317	311	305	329	327	313	307	309	306	290
21– 30	283	285	299	300	294	268	290	359	332	287
31– 40	272	283	287	284	294	225	206	222	226	223
41– 50	207	210	216	190	184	180	180	176	164	155
51– 60	155	152	151	143	135	147	155	146	123	105
61– 70	108	134	147	072	044	080	101	112	103	093
71– 80	097	102	089	056	030	011	001	– 022	– 033	– 023
81– 90	– 011	– 014	– 034	– 042	– 005	013	006	– 015	– 028	019
91–100	085	022	– 037	– 038	– 033	– 030	– 043	– 055	– 068	– 065
101–110	– 055	– 076	– 111	– 131	– 123	– 121	– 117	– 109	– 108	– 099
111–120	– 097	– 098	– 101	– 099	– 102	– 102	– 118	– 111	– 066	– 058
121–130	– 084	– 114	– 129	– 132	– 134	– 158	– 197	– 204	– 187	– 179
131–140	– 191	– 203	– 204	– 198	– 194	– 186	– 197	– 203	– 197	– 191
141–150	– 175	– 161	– 154	– 160	– 171	– 168	– 160	– 131	– 136	– 156
151–160	– 158	– 147	– 098	– 059	– 116	– 162	– 138	– 150	– 149	– 173
161–170	– 201	– 196	– 183	– 182	– 184	– 203	– 199	– 193	– 204	– 198
171–180	– 182	– 164	– 153	– 174	– 148	– 150	– 141	– 147	– 155	– 155
181–190	– 091	– 019	– 068	– 144	– 164	– 157	– 136	– 142	– 138	– 137
191–200	– 129	– 098	– 113	– 141	– 160	– 159	– 149	– 148	– 136	– 129
201–210	– 130	– 134	– 147	– 128	– 101	– 097	– 080	– 070	– 063	– 008
211–220	– 023	– 057	– 075	– 083	– 072	– 061	– 067	– 094	– 102	– 079
221–230	– 067	– 060	– 068	– 074	– 090	– 090	– 084	– 075	– 076	– 081
231–240	– 090	– 093	– 083	– 063	– 062	– 070	– 076	– 066	– 038	– 022
241–250	– 022	– 027	– 009	034	045	– 015	– 045	– 023	– 011	013
251–260	– 000	– 020	– 017	– 009	– 016	– 024	– 055	– 059	– 055	– 073
261–270	– 067	– 037	– 017	– 017	– 020	– 013	– 011	006	– 004	– 004
271–280	– 025	015	077	046	002	– 000	018	030	019	– 007
281–290	– 032	– 010	– 003	– 007	– 038	– 056	– 058	– 046	– 016	– 001
291–300	020	038	041	025	021	018	007	– 010	– 042	– 055
301–310	– 026	– 022	– 035	– 035	– 018	– 005	016	010	– 014	– 025
311–320	– 014	– 003	– 004	– 019	– 020	– 006	004	– 008	– 014	– 024
321–330	– 016	– 005	– 014	– 010	– 009	– 012	– 023	– 025	– 014	016
331–340	023	011	– 007	– 004	049	068	– 002	– 036	– 019	008
341–350	016	– 014	– 034	– 025	– 008	– 010	– 017	– 024	– 014	– 002
351–360	– 015	– 028	– 026	– 021	– 020	– 044	– 066	– 058	– 031	– 025
361–370	– 018	003	094	239	215	092	048	019	– 008	– 027

TABLE A-4 Alternative Seasonal Adjustments of M_1

In millions of dollars

Month	Stable X-11	Moving X 11	Daily seasonal	Col 3 less col 1	Col 3 less col 2	Month	Stable X-11	Moving X 11	Daily seasonal	Col 3 less col 1	Col 3 less col 2
	(1)	(2)	(3)	(4)	(5)		(1)	(2)	(3)	(4)	(5)
1969—Jan	204138	204340	203688	−450	−652	1972—Jan	236850	237131	236336	−514	−795
Feb	204603	204657	204343	−260	−314	Feb	238678	238654	238482	−196	−172
Mar	204930	204893	204890	−40	−3	Mar	240724	240769	240701	−23	−68
Apr	205125	205158	205169	44	11	Apr	241663	241763	241765	102	2
May	205527	205384	205592	65	208	May	242333	242334	242334	1	0
June	205861	205988	205990	129	2	June	243034	242957	243229	195	272
July	206129	206362	206320	191	−42	July	245383	245410	245639	256	229
Aug	206616	206602	206714	98	112	Aug	247564	247504	247602	38	98
Sept	207616	207325	207566	−50	241	Sept	249722	249605	249756	34	151
Oct	208667	208363	208711	44	348	Oct	251511	251426	251578	67	152
Nov	209132	209256	209212	80	−44	Nov	252776	252670	252758	−18	88
Dec	209183	209531	208873	−310	−658	Dec	256366	255905	256078	−288	173
1970—Jan	211835	211952	211375	−460	−577	1973—Jan	257897	258351	257245	−652	−1106
Feb	210472	210415	210285	−187	−130	Feb	258465	258527	258228	−237	−299
Mar	211902	211819	211803	−99	−16	Mar	258268	258384	258264	−4	−120
Apr	212915	212899	213018	103	119	Apr	259058	259236	259128	70	−108
May	213851	213695	213877	26	182	May	261877	262013	261892	15	−121
June	213992	214067	214098	106	31	June	264295	264157	264515	220	358
July	214522	214725	214761	239	36	July	265303	265235	265523	220	288
Aug	217001	216992	217050	49	58	Aug	265869	265817	265946	77	129
Sept	219280	219027	219257	−23	230	Sept	265669	265692	265701	32	9
Oct	220148	219912	220202	54	290	Oct	266741	266808	266813	72	5
Nov	220880	221000	220916	36	−84	Nov	269388	269239	269400	12	161
Dec	221822	222059	221516	−306	−543	Dec	271977	271251	271604	−373	353
1971—Jan	223279	223419	222838	−441	−581	1974—Jan	272019	272525	271374	−645	−1151
Feb	224732	224652	224538	−194	−114	Feb	273681	273734	273443	−238	−291
Mar	226258	226197	226187	−71	−10	Mar	275189	275304	275200	11	−104
Apr	227384	227375	227471	87	96	Apr	276279	276486	276300	21	−186
May	229854	229749	229887	33	138	May	277151	277372	277216	65	−156
June	231115	231138	231254	139	116	June	278904	278712	279126	222	414
July	232237	232375	232491	254	116	July	279724	279608	279951	227	343
Aug	233566	233531	233571	5	40	Aug	280287	280297	280379	92	82
Sept	234313	234105	234299	−14	194	Sept	280724	280905	280702	−22	−203
Oct	235082	234912	235237	155	325	Oct	281863	282116	281957	94	−159
Nov	235084	235096	235028	−56	−68	Nov	283410	283349	283436	26	87
Dec	235766	235680	235488	−278	−192	Dec	284935	284181	284496	−439	315

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Demand Deposit Ownership Survey

Helen T Farr, Richard D Porter, and Eleanor M Pruitt

This paper was initially completed in the summer of 1976 It has been updated (see particularly pages 103–06) to make reference to additional work that has made use of the Demand Deposit Ownership Survey

Theoretically, the determinants of the demand for money differ among various classes of holders of demand deposits However, until 1970, when the Federal Reserve began to collect sample data on demand deposit holdings by ownership category, there were no regularly available monthly data that could be used to test hypotheses about sectoral money demands About 5½ years of data now exist that appear to be reliable in the sense that they accurately report ownership of deposits by individuals, partnerships, and corporations (IPC's)

Even with severe data limitations, reasonable sectoral demand functions have been successfully estimated The results suggest quite strongly that estimates of aggregate money demand can be improved by using the information in disaggregated, sectoral demand functions The sectoral demand functions can be used directly, and the information on elasticities and speeds of adjustment that are derived from the estimated sectoral demand equations can also be used in constraining estimated coefficients in aggregate demand functions

The first two sections describe the nature of the demand deposit ownership survey (DDOS) and the tests of the reliability of the reported data[1] The next sections detail the results of estimating sectoral demand functions and examine several other current uses of the DDOS data evaluations of short-run movements in the aggregates, analysis of the short-run impact of tax rebates and refunds on deposit holdings, estimation of the Board's monthly money market model, studies of sectoral velocities and deposit turnover rates, and the usefulness of the DDOS data as a data source for other series A brief survey of potential longer-term studies is followed by two appendixes

History and outline of the survey

Since June 1970 a Federal Reserve System survey has provided data on the ownership of demand deposit balances of IPC's[2] The DDOS classifies total IPC balances into five mutually exclusive categories financial business, nonfinancial business, household, foreign, and a residual category termed all other IPC deposits, which includes deposits of nonprofit institutions and trust departments of reporting banks Monthly sample data are used to prepare estimates on a daily-average basis for each category at weekly reporting banks, and an expanded sample provides estimates for all commercial banks for the last month of each quarter

In the original survey, 413 banks were chosen to supply reports for the end-month-of-quarter estimate, and 225 of these were also to supply monthly reports Because of mergers

NOTE—Helen T Farr and Richard D Porter are members of the staff of the Division of Research and Statistics Eleanor M Pruitt, who has since died, was also a member of that staff

[1] These sections and Appendix I are based on earlier unpublished Federal Reserve staff work of James L Pierce and Martha S Scanlon

[2] For a more detailed description of the survey, see "Survey of Demand Deposit Ownership," *Federal Reserve Bulletin*, vol 57 (June 1971), pp 456–67

and other problems, the numbei of reporting banks has declined and it actually fluctuates somewhat from month to month At present, about 380 banks report in the quarterly sample and about 215 report monthly

The sample is divided into strata based on size classification All banks with IPC deposits of more than $1 billion were included in the first stratum, and a stratified random-sampling technique was used to select banks in the other five size classes During the initial 6 months of operation of the survey—in the latter half of 1970—there were a number of problems associated with procedures for reporting and editing the data Staff at the reporting banks, the Reserve Banks, and the Board attempted to solve these difficulties, and except for occasional problems, they have made substantial progress in establishing procedures that produce timely and accurate reporting of data Results are tabulated within 5 to 6 weeks of the close of the survey month and are published in the *Federal Reserve Bulletin* with a 2-month lag

Reliability of the DDOS data

No benchmark data on ownership of demand deposits by category are available to edit sample data or to test the validity of the published estimates directly An indirect test of data quality, which involves comparing the DDOS total for IPC demand deposits with a measure of gross IPC demand deposits derived from money stock data, suggests that the total IPC estimates from the DDOS are reliable Table 1 shows the dollar amount of the difference between the quarterly estimates from the DDOS and from the money supply series Appendix 1 provides an explanation of the relationship between the two

The DDOS figures have differed from the derived money stock balances by amounts ranging from less than $50 million to as much as $3 5 billion, with the average absolute difference over the survey period amounting to approximately $600 million, about 0 4 per cent of gross demand deposits In most periods the absolute difference was less than 1 per

TABLE 1 Comparison of the Estimate of Gross IPC Demand Deposits Derived from M_1 with the Estimate from DDOS

In billions of dollars, not seasonally adjusted

Quarter	M_1 estimate	DDOS estimate	Difference in estimates	Difference as percentage of M_1 estimate
1970—Q3	167 2	167 9	− 7	4
Q4	174 6	175 1	− 5	3
1971—Q1	169 8	170 9	−1 1	6
Q2	175 8	175 8		
Q3	178 1	177 9	2	1
Q4	186 0	187 5	−1 6	− 8
1972—Q1	182 6	181 2	1 4	8
Q2	188 0	188 4	− 4	2
Q3	195 6	195 4	2	1
Q4	207 9	208 0	− 1	0
1973—Q1	200 4	200 0	4	2
Q2	206 7	206 3	4	2
Q3	209 2	210 3	−1 1	5
Q4	220 1	220 1		
1974—Q1	211 4	211 2	2	0
Q2	218 5	215 0	3 5	1 6
Q3	218 6	216 8	1 8	8
Q4	226 7	225 4	1 3	6
1975—Q1	215 4	216 3	9	4
Q2	223 8	222 2	1 6	7
Q3	227 5	227 0	5	2
Q4	236 9	236 9		
1976—Q1	228 4	227 9	5	2

cent of gross IPC demand deposits In 1974 the DDOS estimates of gross IPC deposits began to diverge significantly from the preliminary estimate derived from M_1 However, subsequent revisions in the M_1 data brought the money stock-derived estimates back in line with the DDOS figures, suggesting that the survey does provide a reasonably reliable independent estimate of gross IPC deposits

The DDOS was designed primarily not to estimate total IPC demand deposits but rather to estimate the distribution of deposits among the various ownership categories The appropriate test of the quality of the data would be a comparison between movements in the DDOS estimates of the various ownership categories and the true values Unfortunately, no such benchmark data exist

DDOS estimates are subject to both reporting and sampling errors Some concern has been expressed from time to time about the quality of the reported data However, a recent analysis of the variance of percentage shares reported quarterly by each of the individual banks on the panel indicated that seriously inaccurate data appeared to be a problem at only about 2 per cent of the banks As for sampling error, the standard errors of

TABLE 2 IPC Demand Deposit Ownership, by Type of Holder, All Commercial Banks[1]
In billions of dollars, not seasonally adjusted

Month	Type of holder					
	Financial	Nonfinancial	Household	Foreign	All other	Total
1970—June	17 1	85 3	49 0	1 6	9 6	162 5
	(1 1)	(1 4)	(1 7)	(1)	(1 3)	(1 9)
December	17 3	92 7	53 6	1 3	10 3	175 1
	(9)	(1 8)	(1 9)	(1)	(1 0)	(1 3)
1971—June	18 1	89 6	56 2	1 3	10 5	175 8
	(9)	(2 0)	(1 7)	(1)	(1 4)	(1 2)
December	18 5	98 4	58 6	1 3	10 7	187 5
	(8)	(1 2)	(2 3)	(2)	(1 2)	(2 0)
1972—June	17 9	97 6	60 5	1 4	11 0	188 4
	(9)	(2 4)	(2 2)	(1)	(1 7)	(1 6)
December	18 9	109 9	65 4	1 5	12 3	208 0
	(7)	(3 5)	(2 3)	(2)	(1 5)	(2 2)
1973—June	18 5	106 6	67 2	2 0	11 7	206 1
	(7)	(3 5)	(3 0)	(2)	(1 6)	(2 3)
December	19 0	116 4	70 2	2 4	11 7	219 8
	(7)	(3 2)	(2 8)	(2)	(8)	(1 4)
1974—June	18 2	111 9	71 2	2 1	11 1	214 6
	(8)	(3 0)	(2 2)	(2)	(1 2)	(2 0)
December	18 9	118 2	73 1	2 3	11 7	224 1
	(1 0)	(4 0)	(2 0)	(2)	(1 1)	(1 4)
1975—June	19 4	115 1	74 8	2 3	10 6	222 2
	(8)	(3 2)	(1 2)	(2)	(8)	(2 4)
December	20 1	125 1	78 0	2 4	11 3	236 9
	(1 0)	(3 0)	(2 4)	(2)	(6)	(1 6)

[1] Figures in parentheses are two standard errors of the estimate Figures may not sum to total because of rounding

estimate have been small relative to the estimated deposit levels for all ownership categories throughout the survey period, especially for the largest ownership categories—nonfinancial businesses and households (See Table 2)

Money demand studies

Motivation for disaggregated studies

Several considerations suggest that disaggregating the demand for demand deposit balances by sector will improve our knowledge of the *aggregate* demand for such deposits

First, each of the elasticities in the aggregate demand function is a weighted average of the corresponding disaggregated sectoral elasticities with the weights equal to the share of deposits held by each sector [3] For example, the aggregate interest rate elasticity is a weighted average of the rate elasticities for households, nonfinancial businesses, financial businesses, and so forth This averaging implies that were the shares held by each sector to change, the aggregate rate elasticity would change even if the disaggregated elasticities were unchanged Though the sectoral shares appear to have been relatively constant to date, they are likely to change in response to particular changes in the payments mechanism that are currently developing But more important, given disaggregated estimates, it is possible to test

[3] To demonstrate this point, first let the deposit demand function for the ith sector be written as

$$D_i = D_i(x)$$

where x is a vector of explanatory variables If elements of x do not belong in a particular sector, the associated coefficients in the function $D_i(x)$ will be zero Hence, it can be assumed that x is common to all sectors Aggregate deposits, D, are the sum of deposits in the individual sectors

$$D = \sum_{i=1}^{p} D_i$$

where p is the number of sectors It follows that the aggregate elasticity of D with respect to the rth component of x, x_r, is

$$\left(\frac{\partial D}{\partial x_r}\right)\left(\frac{x_r}{D}\right) = \sum_{i=1}^{p}\left(\frac{\partial D}{\partial D_i}\right)\left(\frac{\partial D_i}{\partial x_r}\right)\left(\frac{x_r}{D}\right)$$

$$= \sum_{i=1}^{p}\left(\frac{\partial D_i}{\partial x_r}\right)\left(\frac{x_r}{D}\right)\left(\frac{D_i}{D_i}\right) = \sum_{i=1}^{p}\left(\frac{\partial D_i}{\partial x_r}\right)\left(\frac{x_r}{D_i}\right)(f_i)$$

where f_i is the share of aggregate deposits held by ith sector whether the elasticities that are estimated by using aggregate data alone are "correct" or are statistical artifacts In addition, the disaggregated coefficients suggest plausible values for the aggregate coefficients that can, if it is warranted, be imposed (with any level of precision desired) on the aggregate estimates themselves using Bayesian or mixed estimation techniques

For example, it is worthwhile to consider a significant puzzle in the standard aggregate equation for demand for demand deposits Estimates of the long-run elasticities for the short-term rate, the commercial paper rate or the Treasury bill rate, generally range from about −0 04 to −0 25, while the elasticity for the savings deposit rate—however measured—is generally two to three times larger in absolute value Since over sample periods before November 1974 only consumers would be affected by the savings deposit rate and since consumers hold only about a third of deposits, it is unclear why the savings deposit elasticity should be so large relative to that of the commercial paper rate (or the Treasury bill rate) The disaggregated equations shed some light on this puzzle

Next, the basic determinants of money demand presumably differ somewhat across sectors Until recently, corporations could not hold savings accounts at commercial banks, and so the savings rate was an alternative yield for consumers but not for firms Similarly, since consumers hold less than 1 per cent of commercial paper outstanding, the commercial paper rate is presumably not a particularly relevant alternative rate for most consumers Also, the relevant scale (transactions) variable will also differ across sectors For example, consumer demand for money probably depends on a consumer transactions measure (personal income or consumption), and nonfinancial business demand may depend on business sales [4] At the aggregate level, such transactions variables are quite collinear, and it is difficult to obtain reliable estimates of their separate impacts Finally, sectors are also distinguished by how quickly the money holders in each adjust to changes in transactions measures and interest rates—the relative speeds of adjustment Financial firms appear to adjust very quickly, much more quickly than nonfinancial firms, which, in turn, appear to adjust more quickly than households

Because none of the individual sectors represents more than about half of the total demand for demand deposits, the demand equations for individual sectors may each exhibit less simultaneous-equations bias than the equation for aggregate demand for demand deposits

Besides the primary determinants of the demand for demand deposits (interest rates and transactions), there are secondary variables that affect only particular sectors Undoubtedly, one of the most important of these is the compensating-balance requirement that banks impose on commercial and industrial loans Deposit holdings of nonfinancial businesses may well depend on the level of commercial and industrial loans in addition to the transactions and interest rate variables [5]

[4] Intuitively, business sales appear to be a reasonable measure of transactions volume for nonfinancial firms Goldfeld used this variable in his work, see Stephen M Goldfeld, "The Demand for Money Revisited," *Brookings Papers on Economic Activity*, 3 1973, pp 577–643 Miller and Orr have developed a model of the demand for money in which the "scale" variable is the variance of the change in the daily deposits of a firm having stochastic inflows and outflows Although there is a positive relationship between this variance and sales, Miller and Orr indicate that the relationship is loose, see Merton H Miller and Daniel Orr, "A Model of the Demand for Money by Firms," *Quarterly Journal of Economics*, vol 80 (August 1966), especially pp 425–26 See also Daniel Orr, *Cash Management and the Demand for Money* (Praeger, 1971)

[5] To be sure, the relationship between the demand for demand deposits and compensating balances is complex The rationale for a loan variable (or compensating balances) in the demand function is not well established Desired transactions balances for some firms may match, on average, their compensating balances, and, accordingly, the loan coefficient for those firms is zero See Jared Enzler, Lewis Johnson, and John Paulus, "Some Problems of Money Demand," *Brookings Papers on Economic Activity*, 1 1976, p 274, and Orr, *Cash Management*, pp 98–100, for further discussions of this point Moreover, there are other reasons for holding compensating balances, such as payment for lines of credit and payment for other services that cannot be economically priced directly, see, for instance, Richard Homonoff and David Wiley Mullins, Jr, *Cash Management* (Lexington Books, 1975)

In an aggregate demand deposit regression, the effect of compensating balances as represented by commercial and industrial loans can be lost in the welter of other variables and influences, but it shows up significantly in the disaggregated regression explaining deposits of nonfinancial businesses

Another secondary variable is the change in government deposits This variable probably has a transitory impact on all of the sectors, but the impact disappears in a matter of days or weeks for most The only sector in which the impact of the monthly change in government deposits could be measured is the household sector Finally, speculative motives for holding deposits appear largely in the financial sector, accordingly, "speculative" variables, such as the expected change in short-term interest rates, appear to have a decisive influence there but not elsewhere In summary, one advantage of disaggregating deposit demand is that this procedure permits us to obtain reliable estimates of the elasticities of some secondary variables that are quite difficult, if not impossible, to estimate directly at the aggregate level

Sectoral money demands

In Appendix 2, we analyze a standard money demand function and show that significant differences exist among sectors in their responses to changes in interest rates and income Given this evidence that the major holders of deposits react differently to some "standard" set of determinants of deposit holdings, demand equations were estimated for each sector with explanatory variables that differed across sectors The series containing "reliable" DDOS data begin in December 1970, thus, the periods of fit of most of the equations begin in January 1971 The second half of 1974 and all of 1975 were excluded from the period of fit because a number of studies have indicated that standard aggregate money demand functions do very poorly in explaining this period[6] Such exclusion from the period of fit permitted us to simulate over this period and test the gain from using disaggregated demand functions

All equations were estimated in natural logarithms, only the equation for financial businesses is not in real terms The variables (listed below) are not seasonally adjusted except personal income, which is available only on an adjusted basis Data are monthly and thus deposit data are for the weekly reporting banks only All equations were estimated by using a two-stage least-squares technique[7] with a "rho" term Polynomial distributed lags were second degree constrained to zero at the right-hand tail

The following list provides the symbols and abbreviations used in the equations and tables below

HOUSR	=	balances of households deflated by the consumer price index (CPI), not seasonally adjusted
GOVR	=	government deposits deflated by the CPI, not seasonally adjusted
PIR	=	personal income, deflated by the CPI
RPQ	=	Regulation Q ceiling on savings
*R*90	=	90-day Treasury bill rate
U_{t-1}	=	lagged error term
$\bar{R}^2$	=	squared coefficient of correlation, adjusted for degrees of freedom
S E	=	standard error of estimate, adjusted for degrees of freedom
D W	=	Durbin-Watson statistic
D F	=	degrees of freedom
P	=	superscript denoting that a polynomial distributed lag was estimated

[6] See, for example, Enzler and others, "Some Problems," pp 261–80, and Charles Lieberman, "The Transactions Demand for Money and Technological Change," *Review of Economics and Statistics*, vol 59 (August 1977), pp 301–17

[7] The reduced form was

$$\Delta \ln R_t = \alpha_0 + \alpha_1 \Delta \ln PI_t^P + \alpha_2 \Delta \ln M_{1_{t-1}}^P + \alpha_3 \Delta \ln RFF_{t-1}^P$$

where *R* is the commercial paper rate (*RCP*) or the 90 day Treasury bill rate (*R*90), *PI* is personal income, and *RFF* is the Federal funds rate This reduced form is consistent with the money demand functions in the monthly money market model and an assumed "reaction function" that relates changes in the Federal funds rate to deviations of the lagged rate of growth of money from some desired rate

S_i = seasonal dummy variables
NFBR = balances of nonfinancial businesses deflated by wholesale price index net of farm products (*WPIN*), not seasonally adjusted
CILR = commercial and industrial loans deflated by *WPIN*, not seasonally adjusted
BSR = manufacturing and trade sales deflated by *WPIN*, not seasonally adjusted
RCP = rate on 30- to 59-day prime commercial paper
FIN = balances of financial businesses, not seasonally adjusted
DEBF = debits at seven financial centers, not seasonally adjusted
NYSE = New York Stock Exchange index
TOTR = sum of *HOUSR* and *NFBR*
SUM = projection of *TOTR* from disaggregated equations

Demand of households. The explanatory variables chosen for the household equation are the change in government deposits, the level of personal income, the Regulation Q ceiling on the savings rate,[8] and the 90-day Treasury bill rate The price index used to deflate household demand deposits, personal income, and government deposits was the consumer price index, not seasonally adjusted Among households, nonfinancial businesses, and financial businesses, the change in government deposits —at least over a period as long as a month— seems to be related only to household holdings of money, when tried in the other two equations, it did not enter significantly Personal income is obviously a transactions proxy that is relevant only to households Until recently, savings accounts were an alternative asset holding only for individuals, and thus the savings deposit rate belongs in the household equation but not in the equations for nonfinancial and financial businesses[9] Finally, the 90-day Treasury bill rate was also included

[8] Savings rates offered were essentially at the ceiling rate in the period under study

[9] State and local governments and corporations became eligible to hold such accounts in the fall of 1974 and 1975, respectively, after our estimation period ended

Goldfeld used the commercial paper rate in his household demand equation, he also used flow of funds data on holdings of M_1[10] However, individuals have greater access to the bill market than to the commercial paper market, and so we prefer the specification that uses the bill rate

The results of estimating the equation and information on the lag characteristics are given in Table 3[11] Note first that all variables have the correct sign and only the savings rate is not statistically significant at the 90 per cent confidence level The lack of significance for the savings rate is not surprising given the very short sample period and the single change in the rate during the relevant time span Also, the elasticity for the savings rate (−0 152) is only slightly larger than that for the Treasury bill rate (−0 110) This result suggests that estimates of the elasticity for the savings deposit rate two to three times larger than that for the Treasury bill rate (or the commercial paper rate) in aggregate equations are statistical artifacts and do not possess an empirical basis in the microeconomic relations that underpin the aggregate equation

Demand of nonfinancial businesses Commercial and industrial loans, business sales, and the commercial paper rate appear as explanatory variables in this equation, shown in Table 4 The loan variable, as expected, appears to affect only the demand of nonfinancial businesses,[12] when tried in the other

[10] Goldfeld, "Demand for Money"

[11] In all tables presenting estimated equations, the numbers in parentheses are *t*-statistics The long run coefficients of the distributed-lag variables are presented in the exposition of the equation, and individual monthly coefficients are presented below Mean lag is the average length of lag (in months), length of lag is the total number of lagged months in the distribution

[12] The magnitude of the loan coefficient may provide a rough estimate of the fraction of firms that, on average, hold more in compensating balances than is required to carry out transactions Alternatively, a pure transactions model may be appropriate, but our scale variable (business sales) is the wrong measure If both the level of loans and the level of sales are functionally related to the true scale variable, say, the aggregate variance of daily cash flows, the sum of the coefficients on loans and sales may represent a mixture of the underlying Miller and Orr transaction elasticity and the coefficients relating loans and sales to the true scale variable

TABLE 3 Balances of Households, Equation with *R*90

$$\ln HOUSR_t = -\ 021\ \Delta \ln GOVR_t^p + 602 \ln PIR_t^p - 152 \ln RPQ_t^p - 110 \ln R90_t^p + \sum_{i=1}^{12} \beta_i S_{it} + 589\ U_{t-1}$$
$$(-1\ 75) \quad (4\ 62) \quad (-0\ 91) \quad (-4\ 30) \quad (4\ 38)$$

Period of fit July 1971–June 1974

$R^2 =\ 9671$, S E = 0060, D W = 2 17, D F = 16

Item	Δ ln $GOVR_t$	ln PIR_t	ln RPQ_t	ln $R90_t$
	Polynomial distributed lag weights			
Lag				
t	− 010	239	− 033	− 004
$t-1$	− 012	168	− 037	− 010
$t-2$		109	− 036	− 014
$t-3$		061	− 029	− 016
$t-4$		025	− 017	− 017
$t-5$				− 017
$t-6$				− 015
$t-7$				− 011
$t-8$				− 006
Distributed lag characteristics				
Mean lag	550	1 117	1 741	4 171
Length of lag	1	4	4	8

two equations, it was not significant and often entered the equation with the wrong sign [13] The deflator used is the wholesale price index net of farm products A certificate of deposit rate was included along with the commercial paper rate, but these rates did not enter simultaneously and *RCP* performed better

Our results for nonfinancial businesses are in sharp contrast to those of Goldfeld [14] His transactions variable did not enter significantly, his long-run interest rate elasticity was only −0 018, and his speed of adjustment only 0 1 per quarter, while our longest lag is only 6 months Given these results, the DDOS data appear to yield more reasonable results than the flow of funds data

Demand of financial businesses. Financial businesses represent a hodgepodge of deposits held by (1) trust departments of other banks, (2) sales, commercial, and personal finance companies, (3) security brokers, dealers, and exchanges, (4) commodity contracts brokers, dealers, and exchanges, (5) other nonbank financial institutions (including holding and other investment companies, clearing house associations, insurance carriers, mortgage companies, savings and loan associations, agricultural credit associations, and so forth), and (6) mutual savings banks Goldfeld treated this sector as if it represented exclusively money holdings by savings and loan associa-

[13] Unconstrained estimation with aggregate data has failed to produce a significant positive loan variable, see, for instance, Enzler and others, "Some Problems," p 274

[14] Goldfeld, in "Demand for Money," p 629, considered the results for this sector to be unsatisfactory

TABLE 4 Balances of Nonfinancial Businesses

$$\ln NFBR_t = 583 \ln CILR_t + 731 \ln BSR_t^p - 241 \ln RCP_t^p + \sum_{i=1}^{12} \beta_i S_{it} + 915\ U_{t-1}$$
$$(2\ 98) \quad (2\ 17) \quad (-6\ 98) \quad (14\ 74)$$

Period of fit January 1971–June 1974

$R^2 =\ 9796$, S E = 0086, D W = 1 94, D F = 26

Item	ln BSR_t	ln RCP_t
	Polynomial distributed lag weights	
Lag		
t	074	− 064
$t-1$	110	− 056
$t-2$	131	− 046
$t-3$	136	− 036
$t-4$	125	− 025
$t-5$	099	− 013
$t-6$	057	
Distributed lag characteristics		
Mean lag	2 895	1 756
Length of lag	6	5

tions and mutual savings banks[15] Though money holdings of these thrift institutions are sizable, they represent slightly less than a quarter of money held by financial businesses[16] Thus, it is not too surprising that the scale variable of total deposits at savings and loans and mutual savings banks did not perform satisfactorily the sum of deposits at these institutions had a negative coefficient When these variables were entered separately, deposits at savings and loans had a negative sign, while deposits at mutual savings banks had the anticipated sign and were significant

It appears that the motives of other financial business deposit holders are not well represented by these transactions proxies Instead of trying to develop separate proxies for each holder, one composite variable was constructed—a proxy for financial debits, defined as total demand deposit debits at New York City and six other large financial centers[17] This transaction measure enters significantly in the estimated equation for balances of financial businesses

$$\ln FIN_t = \underset{(5\ 86)}{086} \ln DEBF_t + \underset{(3\ 12)}{075}\ \Delta \ln RCP_t$$

$$+ \underset{(2\ 64)}{142}\ \Delta \ln NYSE_t + \sum_{i=1}^{12} \beta_i S_{it} + \underset{(3\ 14)}{436}\ U_{t-1}$$

Period of fit January 1971–June 1974

$\bar{R}^2$ = 8731, S E = 0109, D W = 1 50, D F = 27

The equation also contains the change in the commercial paper rate—a speculative money demand variable indicating extrapolative expectations—and the change in the New York Stock Exchange index (*NYSE*) *NYSE* may be viewed as a close proxy for changes in wealth Alternatively, because changes in stock market indexes and stock market volume are positively correlated, the stock market variable may be viewed as an additional transactions proxy Other than the speculative interest rate variable, no interest rate was significant[18] Furthermore, as expected, all explanatory variables entered without lags, reflecting the very high speed of adjustment in this sector

A priori, one might expect that demand by financial businesses for money balances would be in real terms, as are the demands of households and nonfinancial businesses Efforts to estimate a real demand equation for financial businesses were not too successful The best equation was

$$\ln FINR_t = \underset{(1\ 58)}{063} \ln DEBFR_t + \underset{(1\ 96)}{065}\ \Delta \ln RCP_t$$

$$+ \underset{(2\ 16)}{171}\ \Delta \ln NYSER_t + \sum_{i=1}^{12} \beta_i S_{it} + \underset{(10\ 03)}{84}\ U_{t-1}$$

Period of fit Januaiy 1971–June 1974

$\bar{R}^2$ = 8573, S E = 0189, D W = 90, D F = 33

where *R* appended to the mnemonic indicates that real values were used In terms of R^2 and standard error, this equation is similar to the one in nominal terms However, when the equation is simulated over the last half of 1974 and all of 1975, it exhibits severe deterioration In dynamic simulation, the root mean square error is nearly 12½ times the standard error On the other hand, when the equation for financial businesses in nominal terms is simulated, the root mean square error in dynamic simulation over the same period is only a little more than twice the standard error (See the next subsection for further details)

Implicit in estimating a money demand equation in real terms is the assumption that the coefficient on prices is 1 We tested this homogeneity restriction in the case of the equation for financial businesses by regressing nominal deposits on prices, on the other real variables, and on interest rate terms (all in natural logarithms) In fact, the estimated coefficient on prices is significantly different from

[15] Recall that Goldfeld, in "Demand for Money," used flow of funds data for M_1

[16] See *Flow of Funds, Assets and Liabilities Outstanding, 1974* (Board of Governors of the Federal Reserve System, 1975), pp 1, 2

[17] The six other centers are Boston, Philadelphia, Chicago, Detroit, San Francisco–Oakland, and Los Angeles–Long Beach

[18] This includes Goldfeld's proxy variable for the outflow of deposits at thrift institutions (the Treasury bill rate divided by the saving deposit rate) See Goldfeld, "Demand for Money"

TABLE 5 Total Balances of Households and Nonfinancial Businesses

$$\ln TOTR_t = \underset{(3\ 15)}{516} \ln CILR_t - \underset{(-2\ 38)}{012}\, \Delta \ln GOVR_t + \underset{(1\ 62)}{369} \ln PIR_t^p - \underset{(-7\ 39)}{179} \ln RCP_t^p - \underset{(-2\ 68)}{303} \ln RPQ_t^p + \sum_{i=1}^{12} \beta_i S_{it} + \underset{(12\ 01)}{880}\, U_{t-1}$$

Period of fit January 1971–June 1974

$\bar{R}^2 = 9838$, S E = 0062 D W = 1 49, D F = 22

Item	ln PIR_t	ln RCP_t	ln RPQ_t
	Polynomial distributed lag weights		
Lag			
t	159	− 042	− 213
$t-1$	210	− 040	− 081
$t-2$		− 035	− 010
$t-3$		− 029	
$t-4$		− 022	
$t-5$		− 012	
Distributed lag characteristics			
Mean lag	569	1 918	329
Length of lag	1	5	2

1, suggesting that a real demand equation may not be appropriate for financial businesses[19] Nevertheless, much more work on the specification of this sector is undoubtedly necessary before one can accept the test result at face value and drop the requirement of homogeneity with respect to prices

A comparison with an "aggregate" equation for households and nonfinancial businesses To illustrate what is lost or hidden by aggregation, a simple aggregate equation for the total of deposits of households and nonfinancial businesses, *TOTR,* was also considered A limitation in the distributed lag estimation program prevented inclusion of all of the variables appearing in the sectoral equations, therefore, the Treasury bill rate was dropped since it is, in general, highly correlated with the commercial paper rate However, even without this rate, the aggregate equation was not sensible In particular, significant coefficient estimates for both transactions variables, real personal income and real business sales, could not be obtained Since income worked better in terms of the $\bar{R}^2$ and standard error of the equation, it was used alone with the results reported in Table 5 Except for income, all the variables are significant at least at the 98 per cent significance level The equation displays the curiosity, noted earlier, that the long-run savings deposit elasticity is more than 1½ times the commercial paper rate elasticity This result contradicts our disaggregated estimates

Table 6 compares the direct aggregate estimates with two sets of aggregate estimates made by using the disaggregated coefficients and weighting them by the average share of deposits held by consumers (0 308) and nonfinancial businesses (0 692) The first estimate is based on the assumption that the Treasury bill rate elasticity is the same as the commercial paper rate elasticity for households, while the second estimate uses an alternative equation for households, which contains the commercial paper rate explicitly (see Table 7) The two sets of derived estimates are very similar but differ significantly from the direct aggregate estimates Thus, the disaggregated equations do not support the aggregate finding Because consumers hold an average of only 30 8 per cent of the total deposits held by nonfinancial businesses and households, a disaggregated elasticity for household demand with respect to the savings deposit rate of −0 984 would be required to yield this aggregate elasticity This implausibly large value (in absolute terms) is nearly 6½ times the disaggregated elasticity estimated directly,

TABLE 6 Alternative Elasticity Estimates

Type of estimate	Savings deposit rate	Commercial paper rate
Direct aggregate estimate	− 303	− 179
Derived aggregate estimates		
Disaggregated model 1	− 047	− 201
Disaggregated model 2	− 053	− 200

[19] Goldfeld, in "Demand for Money," also estimated his financial business equation in nominal terms

TABLE 7 Balances of Households, Equatıon wıth RCP

$$\ln HOUSR_t = -\ 019\ \Delta \ln GOVR_t^p + 680 \ln PIR_t^p - 172 \ln RPQ_t^p - 107 \ln RCP_t^p + \sum_{i=1}^{12} \beta_i S_{it} + 634\ U_{t-1}$$

(−1 76) (4 80) (−0 99) (−4 35) (4 92)

Perıod of fit July 1971–June 1974

$\bar{R}^2 = 9693$, S E = 0058, D W = 2 34, D F = 16

Item	ln $GOVR_t$	ln PIR_t	ln RPQ_t	ln RCP_t
	Polynomıal dıstrıbuted lag weıghts			
Lag				
t	− 008	123	− 048	− 014
$t-1$	− 011	161	− 044	− 015
$t-2$		166	− 037	− 015
$t-3$		142	− 028	− 015
$t-4$		086	− 015	− 014
$t-5$				− 012
$t-6$				− 010
$t-7$				− 007
$t-8$				− 004
Dıstrıbuted lag characterıstıcs				
Mean lag	561	1 862	1 534	3 311
Length of lag	1	4	4	8

−0 152 It appears, then, that the dısaggregated equatıons provıde more reasonable estımates of the aggregate elastıcıtıes Thıs result exemplıfies the sıgnıficant payoff to dısaggregatıng the money demand functıon or, at least, ıncorporatıng ınformatıon derıved from the dısaggregated estımates ınto aggregate estımates [20]

Sımulatıons It ıs ınstructıve to examıne the post-sample predıctıons from each of the equatıons These sımulatıons are reported ın Table 8, for the perıod from July 1974 through December 1975, for consumers (*HOUSR*), nonfinancıal busınesses wıth the loan varıable (*NFBR*) and wıthout the loan varıable (*NFBR* —no *CILR*),[21] financıal busıness (*FIN*), and the sum of *HOUSR* and *NFBR* (*TOTR*) wıth and wıthout loans and government deposıts [22] It was poınted out earlıer that ın a true aggregate equatıon the ımpact of loans or government deposıts could not be ıdentıfied Sınce *TOTR* ıncludes the deposıts of only the ownershıp classes that these varıables affect, the equatıon ıs ın some sense bıased toward beıng able to ıdentıfy these ımpacts Thus, the *TOTR* equatıon ıncludıng these varıables provıdes more ınformatıon than an equatıon for a broader aggregate probably would Therefore, a more accurate ıllustratıon of what can be lost ın aggregatıon may be provıded by sımulatıng an aggregate equatıon wıthout these varıables Fınally, an alternatıve estımate of *TOTR*, denoted *SUM*, was also constructed by addıng predıctıons of the separate equatıons for consumers and nonfinancıal busınesses

Overall, most of the equatıons tended to overpredıct money demand startıng ın the second half of 1974 Thıs perıod coıncıdes wıth a sımılar breakdown ın the aggregate equatıon for demand deposıts of both of the Board's econometrıc models—the monthly money market model and the quarterly Massachusetts Instıtute of Technology–Unıversıty of Pennsylvanıa–Socıal Scıence Research Councıl (MPS) model Only the financıal busıness equatıon does not eventually overpredıct by a sızable percentage Though the percentage errors and the root mean square errors are large for consumers and nonfinancıal busınesses, the dısaggregated equatıons, when summed (*SUM*), do better ın sımulatıon than eıther equatıon for the aggregate (*TOTR*)

[20] The aggregate equatıon presented here probably understates the gaıns from dısaggregatıon because only household and nonfinancıal busıness deposıts are aggregated When a sımılar equatıon ıs estımated wıth the demand deposıt component of the money supply as the dependent varıable, the results poınt up even more strongly the ınformatıon lost ın aggregatıon In the demand deposıt equatıon, neıther loans nor government deposıts enter sıgnıficantly Thus, the dısaggregated equatıons yıeld ınformatıon about the ımpact of these varıables that we would not have otherwıse An even more strıkıng result ıs that the estımated savıngs rate elastıcıty ın thıs aggregate equatıon ıs eıght tımes the estımated commercıal paper rate elastıcıty

[21] See Table 9 for the specıficatıon of thıs equatıon

[22] See Table 10 for the specıficatıon of thıs last equatıon

TABLE 8 Post-Sample Simulations, July 1974–December 1975

Not seasonally adjusted

Equation	Correlation squared of actual and predicted	Root mean square error		Standard error of estimated equation (per cent)	Mean absolute error (billions of dollars)	Mean error (billions of dollars)
		Billions of dollars	Per cent			
	Dynamic simulation					
HOUSR	0072	1 452	7 65	60	1 304	−1 304
NFBR	4977	3 452	8 17	86	3 257	−3 257
NFBR (no *CILR*)	2994	4 447	10 97	98	4 123	−4 123
FIN	4698	346	2 35	1 09	289	− 043
TOTR	0035	6 797	11 35	62	6 390	−6 390
TOTR (no *CILR*, *GOVR*)	0004	8 228	13 53	76	7 659	−7 659
SUM	1863	4 870	8 24	n a	4 561	−4 561
	Nondynamic simulation					
HOUSR	5302	672	3 63	60	598	− 598
NFBR	8304	802	2 06	86	655	− 544
NFBR (no *CILR*)	6893	1 125	2 88	98	928	− 840
FIN	5056	341	2 33	1 09	277	− 018
TOTR	8088	1 409	2 44	62	1 203	−1 203
TOTR (no *CILR*, *GOVR*)	7619	1 855	3 22	76	1 717	−1 717
SUM	8155	1 315	2 29	n a	1 159	−1 143

n a Not available

The aggregate equation including the loan and government deposit variables has approximately a 40 per cent higher root mean square error and mean absolute error in dynamic simulation than does the total based on the disaggregated equations (*SUM*) When loans and government deposits are excluded from the equation, these errors are almost 70 per cent higher than the errors for *SUM* Similarly, error statistics increase when compensating balances are excluded from the equation for nonfinancial businesses (*NFBR*—no *CILR*) as compared with the equation including these balances (*NFBR*) Since it is difficult to measure the effects of compensating-balance requirements at the aggregate level, the ability to do so by using disaggregated data is significant

Conclusions regarding money demand functions

The DDOS data appear to yield reasonable disaggregated equations for the demand for money The results of the estimated demand equations suggest that different factors influence the demands of different sectors Although many interest rates—and transactions variables—are collinear and could probably be substituted for one another in regression analysis, theoretically the rates and transactions variables included in the demand equa-

TABLE 9 Balances of Nonfinancial Businesses, Equation Excluding *CILR*

$$\ln NFBR_t = \underset{(2\,90)}{871} \ln BSR_t^P - \underset{(-6\,35)}{204} \ln RCP_t^P + \sum_{i=1}^{12} \beta_i S_{it} + \underset{(11\,58)}{873}\, U_{t-1}$$

Period of fit January 1971–June 1974

$R^2 = 9732$, S E $= 0098$, D W $= 2\,23$ D F $= 26$

Item	ln BSR_t	ln RCP_t
	Distributed lag weights	
Lag		
t	185	− 050
$t-1$	173	− 046
$t-2$	155	− 040
$t-3$	134	− 032
$t-4$	107	− 023
$t-5$	076	− 013
$t-6$	040	
Distributed lag characteristics		
Mean lag	2 225	1 860
Length of lag	6	5

tions for each sector are the most appropriate for that sector Further, such variables as the change in government deposits (in the household equation) and the level of commercial and industrial loans (in the equation for nonfinancial businesses), when tested in other demand equations, proved to be insignificant and often of the wrong sign

The large variety of determinants of money demand disclosed by the sectoral demand equations provides a great deal of information about what may be happening to the aggregate demand for deposits Much of this information could be lost when analysis is confined to an aggregate demand function First, to the extent that common variables affect different sectoral demands, an aggregate equation will estimate only an average impact, if the sectoral impacts differ and the sectoral shares change, information will be lost even if the sectoral demand functions are linear Second, as seen from our "aggregate" equation, which attempted to combine only two sectors, all relevant variables cannot be included in the aggregated equation Multicollinearity, among other problems, produces insignificant coefficients and often wrong signs—the equation presented was the best in terms of *t*-statistics, expected signs, and standard error If all interest rates and all transactions variables were perfectly correlated, the loss of variables in the aggregate equation would be unimportant, no information would have been lost However, such perfect correlation is not the case, and divergent movements could give us considerable information, assuming we were dealing with sectoral demand equations rather than an aggregate one

The DDOS also permitted us to check whether the elasticity of the aggregate demand for demand deposits with respect to the rate paid on short-term interest-bearing accounts at commercial banks[23] was too large The estimated aggregate elasticity does appear to be larger than the disaggregated data would warrant This result casts some doubt on the large, expansionary GNP multiplier associated with changes in Regulation Q ceilings that has been adduced by some economists, who rely on more traditional estimates of aggregate demand deposit elasticities [24]

Our simulation results confirm the loss of information in aggregation Summary statistics are presented for *TOTR* (the aggregate equation for the sum of deposits of households and nonfinancial businesses) and for *SUM*, the sum of the simulation solutions for the sectoral demand equations for households and nonfinancial businesses In dynamic simulation, all error statistics are higher when the aggregate equation is simulated than when the two sectoral equations are simulated and the errors summed, the increase in the root mean square error is better than 15 per cent Furthermore, when loans and government deposits are excluded from the *TOTR* equation,

[23] Specifically, the passbook rate ceiling, or an average of the passbook rate and the rate paid on consumer type certificates of deposit, weighted by quantity

[24] See Myron B Slovin and Marie E Sushka, *Interest Rates on Savings Deposits* (Lexington Books, 1975), especially chap 10

TABLE 10 Total Balances of Households and Nonfinancial Businesses, Equation Excluding *CILR* and *GOVR*

$$\ln TOTR_t = \underset{(2\ 96)}{615} \ln PIR_t^p - \underset{(-5\ 47)}{138} \ln RCP_t^p - \underset{(-2\ 37)}{324} \ln RPQ_t^p + \sum_{i=1}^{12} \beta_i S_{it} + \underset{(9\ 90)}{837}\ U_{t-1}$$

Period of fit January 1971–June 1974

$\bar{R}^2 = 9752$, S E = 0076, D W = 1 85, D F = 24

Item	ln PIR_t	ln RCP_t	ln RPQ_t
	Distributed lag weights		
Lag			
t	439	− 024	− 080
$t-1$	177	− 028	− 135
$t-2$		− 028	− 108
$t-3$		− 026	
$t-4$		− 020	
$t-5$		− 012	
Distributed lag characteristics			
Mean lag	287	2 197	1 087
Length of lag	1	5	2

as would be likely in a more aggregated equation, the increase in the root mean square error is 40 per cent While even sectoral demand equations did poorly in terms of the standard errors of the estimated equations, they still suggest that better results would have been obtained by using all the information available from sectoral equations than by using the more limited information included in an aggregate demand equation

Finally, recent predictions of the aggregate demand for demand deposits relative to GNP and short-term interest rates have been considerably off the mark, actual deposit growth (at least through the first quarter of 1976) in the current recovery has been unusually slow compared with the predictions of many standard money demand equations Apart from financial businesses, the disaggregated equations have also tended to overpredict deposit growth The deterioration appears to be worse for nonfinancial businesses (see Table 8) Since disaggregated ownership data help to identify the sectors performing least well, they may also be useful in isolating the factors causing the deterioration—factors that it may not be possible to isolate at the aggregate level

Preliminary results for an aggregate demand equation using constraints derived from the DDOS equations

After most of the work reported so far in this paper was completed, a program became available that enabled us to estimate a demand equation for the demand deposit component of M_1 and to make use of the information gained from our disaggregated equations to constrain sums of current and lagged coefficients Table 11 presents the results

We estimated distributed lags using the Shiller technique with soft (inexact) constraints applied just to the sums of distributed lag

TABLE 11 Demand Deposit Component of M_1, Constrained Estimation[1]

$$\ln DDR = 223 \ln PIR^S_t + 269 \ln BSR^S_t - 012\,\Delta \ln GOVR^S_t - 128 \ln RCP^S_t - 055 \ln RPQ^S_t + \underset{(24\ 04)}{310 \ln CILR_t}$$

$$+ \underset{(2\ 32)}{015 \ln DEBFR_t} + \underset{(1\ 31)}{014\,\Delta \ln NYSER_t} + \underset{(1\ 32)}{008\,\Delta \ln RCP_t} + 0\ 0 \ln WPIN^S_t + 998\, U_{t-1}$$

Period of fit January 1968–June 1974

$R^2 = 9676$ S E = 0067, D W = 5225, D F = 73

Item	ln PIR_t	ln BSR_t	Δ ln $GOVR_t$	ln RCP_t	ln RPQ_t	ln $WPIN_t$
	Shiller distributed lag weights					
Lag						
t	093 (4 43)	073 (6 26)	− 004 (−1 16)	− 021 (−3 27)	− 019 −(1 01)	− 670
$t-1$	070 (7 61)	062 (10 05)	− 005 (−1 38)	− 018 (−4 68)	− 015 (−1 70)	− 111
$t-2$	047 (5 06)	051 (12 60)	− 002 (− 58)	− 016 (−4 47)	− 011 (−1 23)	034
$t-3$	024 (2 09)	040 (7 79)	− 000 (− 05)	− 015 (−4 13)	− 007 (− 71)	142
$t-4$	001 (05)	028 (4 76)		− 015 (−4 31)	− 003 (− 27)	212
$t-5$		014 (2 85)		− 015 (−4 37)		244
$t-6$		001 (17)		− 103 (−3 85)		238
$t-7$				− 010 (−2 99)		191
$t-8$				− 004 (−1 12)		105
$t-9$						− 021
$t-10$						− 186
$t-11$						− 177
Distributed lag characteristics						
Mean lag	1 012	1 291	846	3 230	1 293	
Length of lag	4	6	3	8	4	
Sum constraints[2]	22	26	− 01	− 15	− 06	0 0

[1] *DDR* is demand deposits deflated by *WPIN* superscript *S* denotes a Shiller distributed lag

[2] ln *CILR* = 0 30, ln *DEBFR* = 0 01, Δ ln *NYSER* = 0 02, Δ ln *RCP* = 0 01

coefficients,[25] individual lag coefficients were free to assume any value within the constraints on the degree of the estimated polynomial The values of the sum constraints were derived by multiplying sums estimated with the disaggregated DDOS data by the average share of the relevant component of total gross IPC deposits, and adding We did not estimate demand equations for the "foreign" and "other" components in the DDOS, and variables affecting the components for which we did estimate equations could affect these other components While the "foreign" and "other" shares of the total DDOS deposits are small, which would lead to a minimal impact on coefficient sums, tightness priors on sums were such that the sums could deviate somewhat from those implied by the estimated component equations Thus, the estimates may allow for the effects of the other sectors as well as for the fact that the demand deposits used here are "net" and DDOS deposits are "gross" (see Appendix 1 for the differences between the two concepts)

Program size constraints were such that we could not include all relevant variables and seasonal dummy variables as well, therefore, the equation was estimated in seasonally adjusted terms We also deviated somewhat from the disaggregated DDOS equations by putting financial business demands in real terms using *WPIN* as the deflator Finally, an 11-period distributed lag in *WPIN* with weights summing to zero was included Without this distributed lag in prices, money holders are assumed to adjust immediately to the current price level Including the distributed lag in prices permits lagged adjustment to price changes, with the sum of the lag coefficients constrained to zero, however, long-run homogeneity with respect to prices is preserved The distributed lag on prices affected the estimated coefficients on the other independent variables very little, but it did result in a

[25] See Robert J Shiller, "A Distributed Lag Estimator Derived from Smoothness Priors," *Econometrica*, vol 41 (July 1973), pp 775–88

TABLE 12 Demand Deposit Component of M_1, Unconstrained Estimation[1]

$\ln DDR = 851 \ln PIR^S_t - 093 \ln BSR^S_t - 019\, \Delta \ln GOVR^S_t - 057 \ln RCP^S_t - 134 \ln RPQ^S_t + 072 \ln CILR_t$ (0 66)

$+ 010 \ln DEBFR_t + 006\, \Delta \ln NYSER_t + 005\, \Delta \ln RCP_t + 0\,0 \ln WPIN^S_t + 998\, U_{t-1}$

(0 52) (0 49) (0 70)

Period of fit January 1968–June 1974

$R^2 = 9876$, S E = 0041, D W = 1 3031, D F = 64

Item	ln PIR_t	ln BSR_t	Δ ln $GOVR_t$	ln RCP_t	ln RPQ_t	ln $WPIN_t$
	Shiller distributed lag weights					
Lag						
t	338 (5 51)	− 28 (− 54)	− 005 (−1 42)	− 004 (−' 77)	− 046 (−1 68)	− 934
$t-1$	254 (5 57)	− 023 (− 53)	− 007 (−1 93)	− 004 (−1 30)	− 038 (−1 84)	− 119
$t-2$	170 (5 50)	− 018 (− 51)	− 004 (−1 24)	− 005 (−1 69)	− 029 (−1 85)	− 042
$t-3$	086 (5 09)	− 013 (− 48)	− 003 (− 86)	− 006 (−2 17)	− 018 (−1 65)	023
$t-4$	001 (16)	− 008 (− 44)		− 008 (−3 01)	− 004 (− 56)	075
$t-5$		− 004 (− 38)		− 010 (−3 68)		115
$t-6$		000 (12)		− 009 (−3 62)		143
$t-7$				− 007 (−3 00)		157
$t-8$				− 003 (−1 14)		158
$t-9$						145
$t-10$						120
$t-11$						159
Distributed lag characteristics						
Mean lag	1 009	1 559	1 270	4 261	1 236	
Length of lag	4	6	3	8	4	

[1] *DDR* is demand deposits deflated by *WPIN*, superscript *S* denotes a Shiller distributed lag

somewhat more satisfactory lag pattern in the estimated coefficients on the commercial paper rate

Table 12 presents the results of estimating the same equation without constraints except that on the distributed lag in prices Only the estimated elasticity with respect to the change in government deposits, debits, and the change in the paper rate approximate those implied by the disaggregated equations Among other things, the estimated elasticity with respect to the commercial paper rate is less than half what is implied by the disaggregated equations, and we again observe the phenomenon of the estimated savings rate elasticity being almost 2½ times the estimated paper rate elasticity Further, without constraints, the business sales variable has the wrong sign and is not significant Finally, it is no longer possible to identify the influence of such variables as loans and debits since their estimated coefficients are not significantly different from zero

Table 13 presents the results of simulating the constrained and unconstrained equations Although the standard error of estimate of the unconstrained equation is almost 40 per cent less than the constrained equation, the results of the dynamic simulations point up dramatically the gains from making use of the disaggregated elasticity estimates to place constraints on the estimated aggregate elasticities For example, the root mean square error of the unconstrained equation is almost 2½ times as large as that of the constrained equation Further, in percentage terms, the constrained equation does better than our simple aggregate equation (*TOTR*) in which we attempted to estimate determinants for only two classes of money holders The potential for making use of information derived from disaggregated equations is obviously sizable

Other current uses of the DDOS

Current analysis

The DDOS data are used in current analysis to evaluate unusual movements in the aggregate demand deposit component of M_1 If, for example, a strong surge in M_1 growth in a a particular month or quarter is accompanied by an unusual change in the deposit shares, the source of the increased demand for balances can be more accurately pinpointed

The DDOS data have been particularly helpful in evaluating the impact of tax rebates and tax refunds on short-term movements in demand deposits The results from this analysis indicate that, under current operating procedures of the Desk, about a quarter of rebates distributed uniformly over a given month will be held in demand deposits in that month and about half of that (or about one-eighth of the original dollar flow) will be present in the following month Direct estimates of such impacts using only aggregate deposit data tend to produce much more implausible short-term impacts of rebates on aggregate demand deposits

As a source of data, the DDOS survey is being used regularly by the Flow of Funds Section of the Board's Division of Research and Statistics to separate demand deposits from cash holdings and to estimate deposit

TABLE 13 Summary Statistics of Post-Sample Simulations, July 1974–December 1975

Equation	Correlation squared of actual and predicted	Root mean square errors		Standard error of estimated equation (per cent)	Mean absolute error (billions of dollars)	Mean error (billions of dollars)
		Billions of dollars	Per cent			
	Dynamic simulation					
Constrained	1540	6 860	5 29	67	6 056	−6 056
Unconstrained	0917	17 09	12 64	41	14 94	−14 94
	Nondynamic simulation					
Constrained	6503	1 644	1 30	67	1 332	− 370
Unconstrained	9052	1 619	1 28	41	1 451	−1 397

holdings by sector, and also by the Department of Commerce for use in the national income and product accounts to estimate services rendered without fee by financial intermediaries other than life insurance carriers Several large commercial banks in New York City are known to use DDOS data in analysis of money stock movements, and it is believed that these and other banks make use of the data in their marketing research

Monthly model

The elasticity estimates derived from the DDOS demand equations have been used in constraining estimated coefficients in a simplified aggregate demand deposit equation (versus the equation presented in the last part of the previous section) In particular, we constrained the commercial paper rate elasticity to be in the neighborhood of the disaggregated elasticities (weighted by deposit shares) In an unconstrained estimation, the elasticity of the rate on other time and savings deposits ends up being over five times that of the commercial paper rate When the paper rate elasticity is constrained, the ratio is less than two to one While our experience is limited, the constrained equation appears to produce more reasonable responses of money growth to changes in the paper rate It has also been very helpful in evaluating the impacts of alternative monetary policies

Studies of velocity by ownership class

The DDOS will also help in velocity studies and, thus, in the prediction of income Table 14 presents the end-of-quarter-transaction velocities (computed with the quarterly DDOS data) consistent with the different sectoral money demand functions presented in the second section, *VFIN* is financial debits divided by deposits of financial businesses, *VNF* is business sales divided by deposits of nonfinancial businesses, and *VCON* is personal income (not at an annual rate) divided by deposits of households Chart 1 plots these numbers

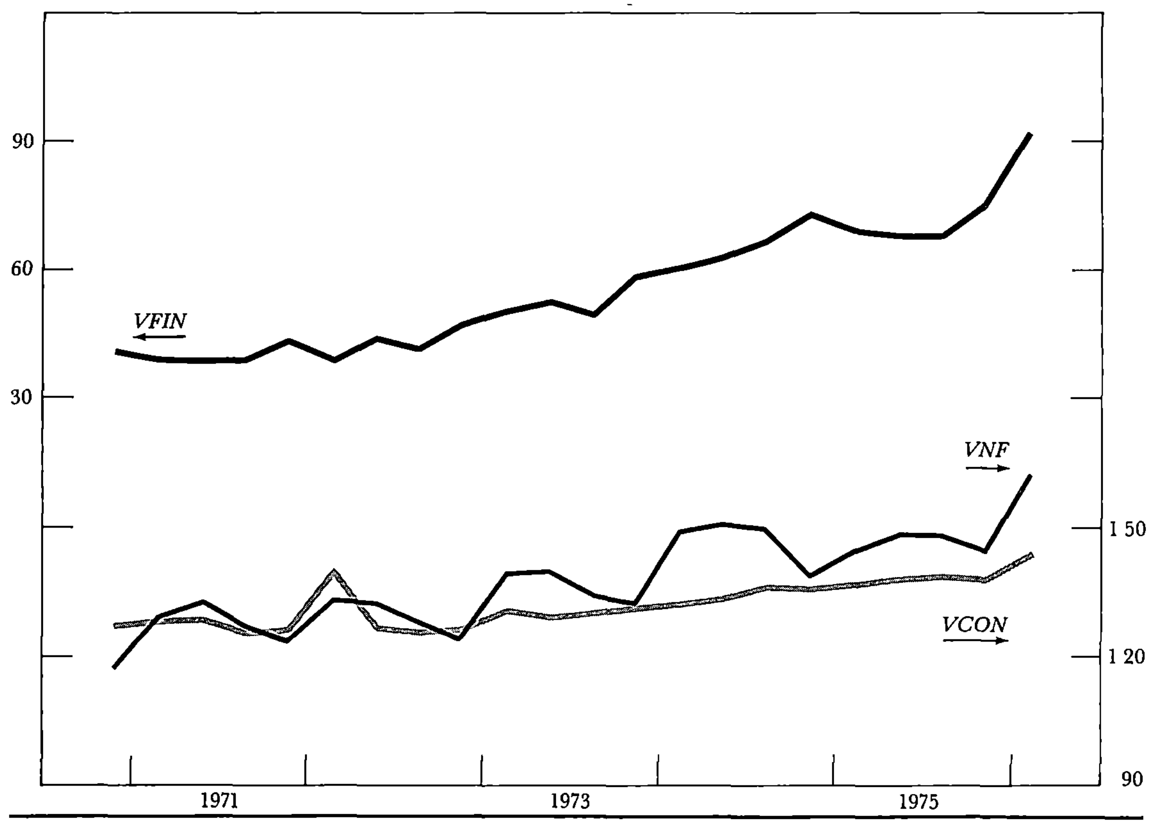
It can be seen that the sectoral velocities move quite differently from one another For example, from the cyclical trough in the fourth quarter of 1970 to the peak in the fourth quarter of 1973, the velocity associated with financial businesses increased about 43 per cent, or about 3½ per cent per quarter, while those associated with nonfinancial businesses and households rose 10 per cent and 3 per cent, respectively, for average quarterly increases of about 0 8 per cent and 0 3 per cent For the period from the cyclical peak in the fourth quarter of 1973 to the trough in the second quarter of 1975, the average quarterly increases in velocity were 2 7 per cent, 2 per cent, and 0 9 per cent, respectively Such differing behavior is not likely to be captured in an aggregate relationship, thus, the use of disaggregated information may eventually lead to better predictions of aggregate income

TABLE 14 Quarterly Transactions Velocities

Quarter	*VFIN*	*VNF*	*VCON*	Quarter	*VFIN*	*VNF*	*VCON*
1970—Q4	40 931	1 1977	1 2761	1973—Q3	49 314	1 3421	1 3019
				Q4	58 429	1 3197	1 3161
1971—Q1	39 060	1 2953	1 2878				
Q2	38 425	1 3268	1 2887	1974—Q1	60 085	1 4917	1 3240
Q3	38 520	1 2678	1 2588	Q2	62 275	1 5091	1 3357
Q4	43 314	1 2346	1 2675	Q3	66 894	1 5000	1 3675
				Q4	72 721	1 3886	1 3647
1972—Q1	38 446	1 3309	1 4017				
Q2	44 117	1 3223	1 2713	1975—Q1	68 763	1 4479	1 3718
Q3	41 272	1 2790	1 2599	Q2	67 964	1 4858	1 3873
Q4	47 190	1 2378	1 2640	Q3	67 653	1 4844	1 3929
				Q4	75 239	1 4485	1 3891
1973—Q1	50 344	1 3942	1 3088				
Q2	52 435	1 3997	1 2977	1976—Q1	91 413	1 6206	1 4421

NOTE —Velocities are not at an annual rate None of the data are seasonally adjusted except for personal income, which is available only in seasonally adjusted form Sufficient quarterly DDOS data do not yet exist to seasonally adjust these series

CHART 1 Velocities



Ownership data have also been used by James Pugash in estimating sectoral turnover rates[26] Pugash reported the following results

1 Estimated demand deposit turnover rates differed significantly across ownership categories

2 Estimated turnover rates by ownership categories also differed across three bank sizes

3 The estimated sectoral turnover rates, comparing the two cross-sectional estimates made for June 1970 and June 1972, were significantly different in most cases, suggesting that, especially for consumers, the use of demand deposits changes over time

Most of Pugash's results are quite plausible It is important, however, to try to go further and explain the movements of turnover rates over time as indexed by ownership category and bank size Advances in cash management techniques that lower the average level of money balances relative to some transactions measure are difficult to measure at the aggregate level These disaggregated turnover measures should provide independent evidence of such shifts For example, consider those banks that offer large corporate customers a bank-managed account from which the banks automatically invest in an overnight money market instrument all funds in excess of an agreed-upon balance If managed accounts become significant, there should be a once-and-for-all spurt in estimated corporate turnover at these banks

[26] See James Z Pugash, "The Demand for Money in Six Sectors," Unpublished manuscript (Board of Governors of the Federal Reserve System, January 1974)

Potential studies

Innovations in the payments mechanism

A variety of financial and technical innovations have increased the turnover rate of demand deposits in the United States bank-managed demand accounts, payable through drafts, money market mutual funds with check features, lines of credit, telephonic transfers between savings and demand accounts, and other cash management techniques The DDOS data may help to predict the aggregate impact of such innovations in the payments mechanism If the innovations result in shifts in deposit shares, we may, without being able to predict the shifts, recognize earlier what is occurring

Several innovations that appear to have quite specific sectoral impacts are developing The following illustrate these developments

1 The spread of automatic clearinghouses (ACH) The increase in ACH's will tend to reduce bank float Since ACH's facilitate almost instantaneous transfers of funds, corporations may well reduce their balances to some minimum except for times when payments are to be made Since the funds for payments would be deposited and almost immediately withdrawn, lower average balances would be observed

2 Use of ACH's to facilitate the direct deposit of payrolls through preauthorized payments, again reducing float

3 Point-of-sale terminals If these permit retail customers to make direct transfers from interest-bearing accounts, they may dramatically reduce the levels of demand deposits that consumers will wish to hold for transaction purposes

4 Continuous real-time monitoring of individual bank accounts (including credits and debits) Time-sharing computer systems that permit direct, continuous readout of individual account information are likely to be offered to and to be used by corporations Such systems clearly offer timely information about current cash flows, thus reducing uncertainty and therefore probably lowering average cash balances

Bank portfolio models

The DDOS data may also be used to study bank portfolio behavior It has been shown that asset preferences of banks are related to the composition of their liabilities This result reflects the different probabilities of withdrawal associated with each type of deposit The probability of withdrawal will likely differ not only between time and demand deposits but also among different classes of demand deposit holders The differences in turnover rates across sectors, noted earlier, are undoubtedly related to these probabilities Thus, the disaggregated data from the DDOS can aid in analysis of bank portfolio decisions

Expanding the linkages between real and financial markets

Recent study has provided some empirical evidence that the state of balance sheets is important in determining expenditures [27] The usefulness of this idea has been limited by an inability to explain the state of the balance sheets However, it appears that we will now be able to model the flow of funds accounts because of a nearly completed project funded by the National Science Foundation [28] The project has already developed specifications and estimates to explain the portfolio holdings of almost all of the major sectors in the accounts The plan is to incorporate this flow of funds model into the Board's quarterly MPS model Several new linkages between financial markets and real activity (such as

[27] See, for example, James R Kearl and Frederic S Mishkin, "Illiquidity, the Demand for Residential Housing and Monetary Policy," forthcoming in *Journal of Finance*, Frederic S Mishkin, "Illiquidity, Con sumer Durable Expenditure, and Monetary Policy," *American Economic Review*, vol 66 (September 1976), pp 642–54, and Edward Yardeni, "A Portfolio Balance Approach to Corporate Finance" (Ph D dissertation, Yale University, 1976)

[28] The work has been carried out largely at Yale University (by James Tobin, William M Brainard, Gary Smith, and Gary Fromm) and at the University of Pennsylvania (by Lawrence R Klein and Albert Ando)

housing, inventory investment, plant and equipment expenditures, and consumption) can then be entertained Thus, the DDOS will be used indirectly because it provides a basis for constructing more accurate estimates of the M_1 balances in the flow of funds accounts

In addition, some recent work by Tinsley[29] and by Kalchbrenner and Tinsley[30] suggests that quarterly real forecasts can be substantially improved by taking into account the correlations between the innovations in quarterly real variables and those in monthly financial variables The DDOS data can be of help in such filtering exercises by expanding the set of monthly financial data included in the analysis

[29] Peter A Tinsley, "On Proximate Exploitation of Intermediate Information in Macroeconomic Forecasting," Special Studies Paper 59 (Board of Governors of the Federal Reserve System, 1975)

[30] John H Kalchbrenner and Peter A Tinsley, "On the Use of Feedback Control in the Design of Aggregate Monetary Policy," *American Economic Review*, vol 66 (May 1976), pp 349–55

Summary

The preceding discussions of potential uses of the DDOS data suggest the sizable amount of research that this body of data may facilitate or enhance To date, many of these projects have not been undertaken because of the relatively small number of observations available in the DDOS data base, the number of monthly observations may now be sufficient for some relatively limited studies, but the quarterly base is still very small—about 22 observations The potential return from monthly and quarterly ownership data appears large The ability to be able to identify special factors accounting for shifts in sectoral money demands, and hence in aggregate money demand, alone has great potential for improving predictions of money demand and income

Appendix 1: Relationship of Gross IPC Demand Deposits to the Money Supply

Gross IPC demand deposits differ from the demand deposit component of the money supply in that the money supply deposit figure is net of cash items in process of collection (CIPC) and Federal Reserve float and includes several types of deposits besides IPC deposits (for example, deposits of State and local governments, foreign governments, foreign official institutions and foreign commercial banks,[1] and certified and officers' checks) These differences are expressed in Table A-1 in terms of adjustments necessary to go from the demand deposit component of the money supply to gross IPC demand deposits by using data for the fourth quarter of 1975

The figures for Federal Reserve float are, of course, supplied by Federal Reserve Banks and are the true daily-average values for this item for each month All other data are partly estimated Currency figures are as reported in money supply data for these months They were derived by first obtaining from the Federal Reserve Banks data reflecting the total volume of currency outstanding in each month The volume of currency held by banks in their vaults was then deducted from this total, data on the actual volume of currency held by Federal Reserve member banks were combined with an estimate of currency holdings at nonmember banks The figures for CIPC are also based on data reflecting the actual volume of these items at Federal Reserve member banks and estimates for this item at nonmember banks

The values for all of the various deposit categories were estimated by using data from weekly reporting banks and call reports Estimates of daily-average balances in these deposit categories maintained at weekly reporting banks were obtained by averaging balances reported on each Wednesday of the reference month, straight-line interpolations were used in those instances in which the week preceding a Wednesday report date spanned the end of a calendar month Estimates for nonweekly reporting banks were obtained by using a ratio estimating technique Ratios reflecting the relationship between the various deposit categories at nonweekly reporting banks and at weekly reporting banks outside New York on call report dates were first calculated These ratios were then used, together with data reflecting esti-

[1] Including deposit balances maintained by foreign official institutions and international institutions at Federal Reserve Banks

TABLE A-1 Reconciliation of the Money Stock with the DDOS, Fourth Quarter, 1975

In millions of dollars, not seasonally adjusted

Demand deposit component of M_1	228,095
Plus CIPC all commercial banks	
Federal Reserve float	
Less Edge Act and Agency adjustment	
CIPC plus Federal Reserve float, adjusted	42,849
Gross deposits in M_1	270,944
Less M_1-type balances at agencies and branches	
Foreign official deposits with the Federal Reserve	
Foreign commercial bank deposits, all commercial banks	
Foreign government deposits, all commercial banks	
Foreign adjustment—Total	9,213
All other deposits—Total	261,731
Less Certified and officers' checks, all commercial banks	
State and local deposits, all commercial banks	
Total certified and officers' checks plus State and local deposits	24,855
Derived estimate of IPC demand deposits	236,876
DDOS estimate of IPC demand deposits	236,910
Difference	−34

mates of daily-average balances in the various deposit categories at weekly reporting banks outside of New York—calculated in the same way as were the estimates for all weekly reporting banks—to obtain estimates for nonweekly reporting banks

An estimate of gross IPC demand deposits based on data received on reports from DDOS sample banks is presented in Table A-1 for comparison with the gross IPC figures derived by making the various adjustments to the money supply The estimates are reasonably similar to each other

It is not clear which of the two approaches yields estimates that most closely approximate the true daily-average values for gross IPC deposits Both are subject to error—the DDOS estimate because of sampling variation and the estimate derived from the money supply because proxy estimates were utilized at various stages of the calculation The weakest estimates in the adjustment of the money supply figure are the figures for "certified and officers' checks" and for "State and local demand deposits"

Appendix 2: Tests of the Equality of Coefficients across Ownership Classes Using "Standard" Money Demand Equations

One assumption underlying the discussion of potential uses of the DDOS is that different ownership categories have different demand functions for money, to assess the validity of this assumption, sets of tests were undertaken Both deal with the three main ownership categories in the DDOS financial businesses, nonfinancial businesses, and households These categories accounted for 92 8 per cent of total IPC deposits as of December 1975 Demand functions were also estimated for total DDOS deposits

NOTE —Helen T Farr and Arthur M Havenner prepared this appendix

Monthly, not seasonally adjusted data for the sample subset of weekly reporting banks were used in estimating the equations Data for the first 6 months of the survey were excluded because survey start-up problems made those data less reliable Data for the second half of 1974 and for all of 1975 were also excluded A number of staff studies indicate that standard money demand equations, for some reason as yet not fully explained, do very poorly in explaining this period Including these data in the demand equations discussed below led to severe deterioration in the estimated relationships

TABLE A-2 Demand Function Interest Rate Coefficients and Summary Statistics

Interest rate	Households		Financial businesses		Nonfinancial businesses		Total	
	Coefficient (t-statistic)	$\bar{R}^2$ SE	Coefficient (t-statistic)	$\bar{R}^2$ SE	Coefficient (t statistic)	$\bar{R}^2$ SE	Coefficient (t statistic)	$\bar{R}^2$ SE
*R*30	− 0122 (−1 682)	9833 0073	0257 (1 473)	7965 0138	− 0193 (−2 192)	9874 0070	− 0120 (−1 454)	9884 0061
*R*90	− 0143 (−1 839)	9836 0075	0254 (1 324)	7934 0139	− 0220 (−2 384)	9876 0069	− 0149 (−1 723)	9887 0061
RCP	− 0157 (−2 242)	9844 0073	0278 (1 451)	7960 0138	− 0262 (−3 188)	9892 0065	− 0178 (−2 294)	9895 0058
CD_1 (30–59 day)	− 0163 (−2 374)	9847 0072	0286 (1 527)	7975 0138	− 0258 (−3 070)	9891 0065	− 0168 (−2 237)	9894 0059
CD_2 (60–89 day)	− 0159 (−2 229)	9844 0073	0302 (1 550)	7980 0138	− 0258 (−2 983)	9889 0066	− 0164 (−2 089)	9892 0059
CD_3 (90–119 day)	− 0176 (−2 310)	9846 0072	0346 (1 686)	8011 0137	− 0268 (−2 913)	9887 0066	− 0178 (−2 104)	9892 0059
RCDS	− 0162 (−2 146)	9842 0073	0305 (1 530)	7976 0138	− 0255 (−2 791)	9885 0067	− 0162 (−1 948)	9890 0060
RFF	0005 (414)	9817 0079	0049 (1 913)	8067 0135	0015 (658)	9860 0074	0039 (2 013)	9896 0058
ROTS	− 1317 (−2 039)	9841 0074	0752 (656)	7831 0143	− 1463 (−1 658)	9870 0071	− 1239 (−1 929)	9893 0059

TABLE A-3 Coefficients and *t*-Statistics for Bill Rate and Income

Deposit category	*R*90 coefficients						
	α	α_1	α_2	α_3	α_4	α_5	α_6
1 Sum of all DDOS deposits	012 (2 24)	− 001 (− 30)	− 010 (−7 48)	− 016 (−7 75)	− 018 (−6 75)	− 016 (−6 22)	− 010 (−5 92)
2 Financial business	008 (58)	006 (82)	003 (98)	002 (34)	001 (85)	− 000 (− 02)	− 000 (− 07)
3 Nonfinancial business	012 (1 61)	− 004 (−1 24)	− 016 (−8 71)	− 022 (−8 24)	− 024 (−6 94)	− 021 (−6 29)	− 013 (−5 93)
4 Households	018 (3 41)	001 (40)	− 011 (−8 62)	− 019 (−9 57)	− 021 (−8 53)	− 019 (−7 97)	− 012 (−7 00)

First tests

In the first tests, all demand functions estimated were of the form

$$\ln D = \alpha_o + \alpha_1 \ln R + \alpha_2 \ln PI + \alpha_3 \ln D_{-1} + \sum_{i=1}^{11} \beta_i S_i$$

where D is the deposit category, R is an interest rate, PI is personal income, and S_i are seasonal dummies For each demand equation, nine different interest rates were tried separately the 30-day Treasury bill rate, the 90 day Treasury bill rate, the 30- to 59-day commercial paper rate, the 30- to 59-primary CD rate, the 60- to 89 day primary CD rate, the 90- to 119-day primary CD rate, the 90-day secondary CD rate, the Federal funds rate, and a composite time and savings deposit rate

The interest rate that gave the "best" equation in terms of $\bar{R}^2$ and standard error varied according to ownership category For total DDOS deposits and for nonfinancial businesses, it was the commercial paper rate, for households, it was the 30- to 59 day primary CD rate [1] For financial businesses, neither personal income nor any interest rate was significant Table A 2 gives the estimated interest rate coefficients and their t statistics (in parentheses), the $\bar{R}^2$, and the standard error for the estimated equations The results provide evidence that different interest rates are relevant for different holders of money

Second tests

In the second tests, demand functions were estimated for the three main ownership categories and for aggregate deposits All equations were of the form

$$\ln D_t = \sum_{i=0}^{6} \alpha_i \ln R90_{t-i} + \sum_{i=0}^{6} \beta_i \ln PI_{t-i} + \sum_{i=1}^{11} \gamma_i S_{it} + \gamma_o$$

where D is the deposit category, $R90$ is the 90 day Treasury bill rate, PI is personal income, and the S_i are seasonal dummies The coefficients and t statistics for the two main independent variables of the total and component equations are presented in Table A-3 The equations were estimated by a stacked regression technique that took account of the fact that the contemporaneous errors in each regression are probably correlated but that all errors are uncorrelated over time The coefficients of the polynomial distributed lags were assumed to lie along a second degree polynomial constrained to zero at the tail, with a total length of 7 months

Tests were made of the significance of the differences between the α_i's, β_i's, and γ_i's of the component equations The evidence indicates that the coefficients of the component equations differ significantly from each other In evaluating these results, it should be noted that only 37 observations were used, that is, each equation had only 21 degrees of freedom, which may be too few observations to estimate adequately all of the differences among the various ownership categories However, even with the limited degrees of freedom, the tests strongly indicated differences If the object of the tests had been simply to estimate the best equation for each ownership category, different variables would have been used for each category [2] By using separate polynomial distributed lags on income and the interest rate, however, it was possible to allow different time response patterns between the two variables, unlike models that constrain the re-

[1] As noted in the paper, most aggregate money demand equations show a large and significant impact of the time deposit rate Theory suggests that such an impact would arise predominantly in the consumer sector (only since November 10, 1975, have corporations been permitted to hold savings deposits) These results indicate that the household category is the only ownership category in which the time deposit rate has a significant impact

[2] See the section of this paper on "Money demand studies"

TABLE A-3—Continued

PI coefficients						
β_0	β_1	β_2	β_3	β_4	β_5	β_6
364 (4 15)	227 (6 13)	119 (26 9)	038 (1 43)	014 (– 35)	– 037 (– 96)	– 033 (–1 27)
578 (2 55)	263 (2 75)	257 (2 26)	– 134 (–1 94)	– 217 (–2 14)	– 222 (–2 21)	– 150 (–2 25)
120 (1 04)	133 (2 74)	136 (23 6)	129 (3 68)	112 (2 18)	085 (1 66)	047 (1 40)
264 (3 16)	185 (5 25)	120 (28 6)	068 (2 68)	031 (82)	007 (18)	– 004 (– 14)

TABLE A-4 Test Results

Test	Statistic[1]	Type I error
1 Equality of coefficients in all equations $\alpha_{1i} - \alpha_{2i} = 0$ and $\alpha_{2i} - \alpha_{3i} = 0$ and $\beta_{1i} - \beta_{2i} = 0$ and $\beta_{2i} - \beta_{3i} = 0$ and $\gamma_{1j} - \gamma_{2j} = 0$ and $\gamma_{2j} - \gamma_{3j} = 0$, $i = 0,6$, $j = 0,11$	$F_{32\ 63} = 8766$	$2\ 4 \times 10^{-16}$
2 Equality of nonseasonal coefficients in all equations $\alpha_{1i} - \alpha_{2i} = 0$ and $\alpha_{2i} - \alpha_{3i} = 0$ and $\beta_{1i} - \beta_{2i} = 0$ and $\beta_{2i} - \beta_{3i} = 0$, $i = 0,6$	$F_{8\ 99} = 17\ 869$	$7\ 1 \times 10^{-16}$
3 Equality of seasonal coefficients in all equations $\gamma_{1i} - \gamma_{2i} = 0$ and $\gamma_{2i} - \gamma_{3i} = 0$, $i = 0,11$	$F_{24\ 75} = 13\ 381$	$1\ 3 \times 10^{-15}$
4 Equality of rate coefficients in all equations $\alpha_{1i} - \alpha_{2i} = 0$ and $\alpha_{2i} - \alpha_{3i} = 0$, $i = 0,6$	$F_{4\ 105} = 5\ 987$	0002
5 Equality of income coefficients in all equations $\beta_{1i} - \beta_{2i} = 0$ and $\beta_{2i} - \beta_{3i} = 0$, $i = 0,6$	$F_{4\ 105} = 18\ 045$	$2\ 6 \times 10^{-11}$
6 Equality of nonseasonal coefficients, financial and nonfinancial equations $\alpha_{1i} - \alpha_{2i} = 0$ and $\beta_{1i} - \beta_{2i} = 0$, $i = 0,6$	$F_{4\ 103} = 34\ 538$	$1\ 4 \times 10^{-16}$
7 Equality of nonseasonal coefficients, nonfinancial and household equations $\alpha_{2i} - \alpha_{3i} = 0$ and $\beta_{2i} - \beta_{3i} = 0$, $i = 0,6$	$F_{4\ 103} = 1\ 326$	265
8 Equality of nonseasonal coefficients, financial and household equations $\alpha_{1i} - \alpha_{3i} = 0$ and $\beta_{1i} - \beta_{3i} = 0$, $i = 0,6$	$F_{4\ 103} = 32\ 507$	$1\ 4 \times 10^{-16}$

[1] At the 99 per cent confidence level, $F_{30\ 60} = 2\ 03$, $F_{8\ 100} = 2\ 69$, $F_{24\ 70} = 2\ 07$, $F_{4\ 100} = 3\ 51$

sponse pattern by specifying a lagged dependent variable

The statistic used to test equality of the coefficients is attributable to Zellner and is best described in his paper, "An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias"[3] Table A-4 presents the values of the test statistics for the different comparisons made when, for example, the α_{1i} are the coefficients on the bill rate in the financial business equation, the β_{2i} are the coefficients on personal income in the nonfinancial business equation, and the γ_{3i} are the seasonal coefficients and intercept in the household equation

In order to argue that no additional information is gained by disaggregating into ownership classes, all respective coefficients in all equations must be equal (test 1) One can be 99 99999999999998 per cent certain that this is not the case (1 minus the type I error times 100) Test 2 indicates that this result is not due to the (nuisance) seasonal coefficients, because the nonseasonal coefficients are also significantly different The seasonal coefficients are significantly different also, however, as test 3 demonstrates

Breaking the coefficients into subcategories, it can be seen that while the responses to interest rate changes are significantly different (test 4), the differences are not nearly so great as in the case of income responses (test 5) Disaggregating over ownership categories, tests 6 through 8 show that whereas financial and nonfinancial holders respond to interest and income changes in a substantially different manner (test 6), households are not significantly different from nonfinancial institutions (test 7) Since households are not significantly different from nonfinancial businesses, it is not surprising that they are significantly different from financial businesses (test 8) Tests run with the 30- to 59 day commercial paper rate instead of the 90 day bill rate gave essentially the same results

[3] Arnold Zellner, *Journal of the American Statistical Association,* vol 57 (June 1962), especially pp 354–56

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Sources of Data and Methods of Construction of the Monetary Aggregates

Darwin L Beck

This paper is a somewhat more detailed version of the study originally prepared for the Advisory Committee on Monetary Statistics in 1976

The first series on the money stock published by the Federal Reserve was based on data for demand and time deposits of banks and currency in circulation for June call dates for the period 1892 to 1922, and for June and December call dates for 1923 to 1941 [1] In February 1944, the Board first began to publish single-day monthly data (for the last Wednesday of the month) similar to that based on call report data In October 1960 a revised and improved measure became available for the period beginning with 1947,[2] it was a daily-average, rather than a single-day, series and was available twice each month

While the money stock series has been revised many times since 1960, the narrow measure, M_1, currently published by the Board is consistent with that first published, on a semimonthly basis, in 1960 In August 1962, in a minor revision, foreign demand balances with Federal Reserve Banks and demand deposits of banks in U S territories and possessions held at U S commercial banks were added to the demand deposit component of the money supply At the same time weekly estimates of the money stock back to 1959 were published for the first time [3]

From 1963 to 1968 the money stock was adjusted five times to incorporate new benchmark data for nonmember banks and revised seasonal factors based on additional data Furthermore, in 1969 and again in 1970, the money stock was adjusted to correct for downward bias in the level and trend of the series that had developed in association with expansion of check-clearing operations of foreign-related institutions in New York City [4] In early 1973, another statistical revision arose from changes in Federal Reserve regulations that caused a discontinuity in the reported data from which money stock measures are constructed [5]

In the early years, the narrow money stock measure, M_1, was given the greatest emphasis Time deposits adjusted were also published, but no effort was made to construct broader monetary measures by adding such deposits, and deposits of nonbank institutions, to M_1 [6] However, in April 1971, the Board also began regularly to publish broader monetary aggregate measures, M_2 and M_3 More recently, beginning in April 1975, the Board added M_4 and M_5 to the published data

The tabulation below describes the public's financial assets included in each of the measures of monetary aggregates regularly published by the Board of Governors of the Federal Reserve System In general, the public is defined as all individuals and institutions, do-

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NOTE—Darwin L Beck is a member of the staff of the Board's Division of Research and Statistics

[1] *Banking and Monetary Statistics* (Board of Governors of the Federal Reserve System, 1943)

[2] "A New Measure of the Money Supply," *Federal Reserve Bulletin*, vol 46 (October 1960), pp 1102–23

[3] "Revision of Money Supply Series," *Federal Reserve Bulletin*, vol 48 (August 1962), pp 941–51

[4] See "Revision of Money Supply Series," *Federal Reserve Bulletin*, vol 55 (October 1969), pp 787–803, and "Revision of the Money Stock," *Federal Reserve Bulletin*, vol 56 (December 1970), pp 887–909

[5] "Revision of the Money Stock Measures and Member Bank Reserves and Deposits," *Federal Reserve Bulletin*, vol 59 (February 1973), pp 61–79

[6] Time deposits adjusted are defined as total time and savings deposits at commercial banks less U S Government and interbank time deposits

mestic and foreign, other than the U S Goverment and domestic commercial banks

Money stock measure	*Assets included*
Currency in circulation	All currency and coin outside the U S Treasury and Federal Reserve Banks less currency and coin held in the vaults of U S commercial banks or in transit to or from Federal Reserve Banks
M_1	Currency in circulation plus demand deposits adjusted at all U S commercial banks (gross demand deposits less demand deposits due to the U S Government, demand deposits due to domestic commercial banks, cash items in the process of collection, and Federal Reserve Reserve float), M_1 type deposits at Edge Act corporations, branches and agencies of foreign banks, and foreign investment corporations, and foreign official deposits at Federal Reserve Banks
M_2	M_1 plus total time and savings deposits at all commercial banks less (a) negotiable time certificates of deposit issued in denominations of $100,000 or more by large weekly reporting banks, (b) time deposits due to domestic commercial banks, and (c) time deposits due to the U S Government
M_3	M_2 plus deposits at mutual savings banks, savings and loan shares, and credit union shares
M_4	M_2 plus negotiable time certificates of deposit issued in denominations of $100,000 or more by large weekly reporting banks
M_5	M_3 plus negotiable time certificates of deposit issued in denominations of $100,000 or more by large weekly reporting banks

Economists and financial analysts generally agree that money stock series should be constructed by measuring the various financial assets that have been categorized as money—currency, demand deposits, savings deposits, time deposits, and so on—from the records of the actual money holders This is the "holder record" concept of the money stock However, universe reporting of actual money stock on such a basis is not possible, and a sample survey also appears to be impractical Even if an adequate sample could be drawn or reporting arranged for the universe of domestic holders of money stock assets, a large segment—foreign holders—could not be readily accounted for

A rough equivalent of the holder-record measure of the money stock can be derived from the records of the Treasury, Federal Reserve Banks, and other financial institutions if proper adjustment is made for the recording of some items on the books of two banks at the same time With that adjustment, such a measure would differ from one based on holder records only because of "mail float"—checks issued and deducted from holders' records but not yet received and deposited in payees' accounts

The mail-float discrepancy between holder records and bank records may be offset, so far as economic motivation is concerned, by the expectation of an inflow of funds by the drawer of the check before the check is presented for payment To the extent that such an offset exists, measures based on unduplicated bank records and holder records are very similar

All of the measures of the money stock published by the Board are derived from the records of the Treasury, Federal Reserve Banks, domestic commercial banks, and other financial institutions The basic adjustments that must be made to these data include adjustments for double counting and estimation of weekly- and monthly-average levels of deposits at banking institutions that do not report on so frequent a basis In addition, deposits of some holders, such as foreign commercial banks, must be estimated using supplementary data because the basic data do not provide a sufficient breakdown to permit direct measurement

Inasmuch as currency in circulation is a building block common to all of the broader money stock measures, the description of the construction of the monetary aggregates begins with it A discussion of the demand deposit component of the money stock is next, followed by a description of the broader money stock measures, M_2 through M_5

Currency in circulation

The currency component of the money stock is defined as all U S currency and coin outside the Treasury, Federal Reserve Banks, and commercial banks This component accounts for roughly 25 per cent of the narrow money stock measure, M_1 Daily data on currency in circulation outside the Treasury and the Federal Reserve System are reported to the Board on a regular basis

Table 1 shows for the last day of 1975 the various items that make up the total of currency and coin in circulation outside the U S Treasury and Federal Reserve Banks The bulk of currency and coin in circulation consists of Federal Reserve notes, followed by the fractional coin (quarters, dimes, nickels, and so on) issued by the Treasury Other relatively large components are silver dollars currently issued by the Treasury and U S notes issued by the Treasury in earlier years A minor component, about $285 million, of assorted currency still outstanding but in the process of retirement consists of silver certificates, Federal Reserve Bank notes, National Bank notes, Federal Reserve notes prior to the 1923 series, and gold certificates

TABLE 1 Currency in Circulation Outside the U S Treasury and Federal Reserve Banks, Year-End 1975[1]

In millions of dollars

Type of currency	Amount
F R notes outstanding	78 769
Fractional coin	8,610
Silver dollars	1,001
Silver certificates	210
U S notes	323
F R Bank notes	50
National Bank notes	20
Gold certificates	3
F R notes prior to 1923 series	1
Total currency and coin	88,987
Less F R notes of other F R Banks and Treasury coin held by F R Banks	
F R notes	1,612
Coin	345
Held by the Treasury	
F R notes	175
Coin	308
Total	86,547

[1] For a more detailed description of the components that make up total currency in circulation, see *Banking and Monetary Statistics, 1941–1970* (Board of Governors of the Federal Reserve System, 1976), pp 615–16

The currency component of the money stock measures excludes the vault cash (currency and coin) held by commercial banks Since vault cash of member banks can be used to meet reserve requirements, these holdings are included on reports submitted to the Federal Reserve for the determination of required reserves, and are thus available on a daily basis Vault cash at nonmember banks must be estimated from quarterly or semiannual reports of condition of all commercial banks Lines 2 and 3 in Table 2 show the estimated vault cash held at member and nonmember banks on average in December 1975 [7]

Estimates of vault cash held at nonmember banks are based on the ratio of vault cash of nonmember banks to vault cash of member banks on call report dates Currently, these benchmark relationships are available for weekly averages surrounding call dates four times each year Prior to March 1976, they were available for four single days each year, prior to March 1973 they were generally available only for June 30 and December 31 [8]

Estimates of the ratio of vault cash for each week between call report dates are based on a straight-line interpolation Weekly estimates of nonmember vault cash are then derived by multiplying the estimated weekly ratio of vault cash by the reported weekly-average vault cash of member banks Monthly-average vault cash is derived from a proration of the weekly estimates The ratio for the latest call report

[7] Note that Table 1 shows currency and coin components for the last day of December 1975, while Table 2 shows the monthly average for December 1975 of currency in circulation and vault cash at member and nonmember banks

[8] Data for *all* commercial banks are available from call reports for June 30 and December 31 The other two calls provide data for all *insured* banks (Uninsured banks are a relatively small component of the total U S banking system)

TABLE 2. Construction of M_1

Monthly averages in millions of dollars, not seasonally adjusted

Line		Item	Contribution December 1975	Source of data
1	Currency in circulation		85,847	Daily data reported by Federal Reserve Banks and Treasury Department
2	*Less*	Member bank vault cash	8,097	Daily data reported by all member banks
3		Nonmember bank vault cash	2,649	Estimated, based on data reported by member banks and call report data
4	*Equals*	Currency component of M_1	75,101	
5	Demand deposits at member banks[1]		155,722	Daily data reported by all member banks
6	*Less*	F R float	3,096	Daily data reported by Federal Reserve Banks
7	*Plus*	Demand deposits at nonmember banks	62,082	Estimated, based on daily data reported by small member banks and call report data
8		Demand deposits due to foreign commercial banks	5,408	Estimated based on single day (Wednesday) data for large banks and call report data for other banks
9		Demand deposits due to mutual savings banks	1,132	Estimated, based on single day (Wednesday) data for large banks and call report data for other banks
10		Demand deposits due to banks in territories and possessions	110	Estimated, based on call report data
11		Cash items in process of collection associated with foreign agency and branch transfers[2]	3,319	Daily data reported by foreign-related institutions in New York City
12		M_1-type balances at foreign related institutions in New York City	3,025	Estimated, based on daily reporting for large institutions and on reports for the last Wednesday of month for smaller institutions
13		Deposits due to foreign official institutions at Federal Reserve Banks	391	Daily data reported by Federal Reserve Banks
14	*Equals*	Demand deposits component of M_1	228,093	
15	Money stock (M_1)—currency plus demand deposits adjusted		303,194	

[1] Gross demand deposits less demand deposits due to U S Government and interbank deposits and cash items in process of collection

[2] Includes M_1 type deposits at Edge Act corporations

period is held constant until another call report is available

Even though the currency component, defined as currency in circulation outside the Treasury and the Federal Reserve Banks less vault cash held at commercial banks, can be measured quite accurately, the definition deviates by some unknown amount from a holder-record concept because it makes no allowance for currency lost or destroyed In addition, some of the currency may be held in safe-deposit boxes or sent out of the country Thus the published measure overstates the amount of currency in circulation in the United States No effort has ever been made to measure the currency "not in circulation," and any adjustment for it would be nothing more than a guess

Demand deposits component of money stock

Data on the demand deposits component of the money stock are not so readily available as are those for the currency component and thus must be constructed from a number of sources These include data available each day and single-day data available weekly, monthly, and from quarterly call reports

Nearly two-thirds of total demand deposits are accounted for by member banks, and data on these deposits are readily available on a daily basis from the Report of Deposits submitted by member banks for determination of reserve requirements Because the purpose of this report is to measure deposits subject to reserve requirements, and not deposits to be included in the money stock, a number of adjustments must be made in the basic data reported by member banks The demand deposits component of domestic nonmember banks is derived from call report data and estimates based on daily deposits data reported by small member banks Deposits of other financial institutions, and other adjustments to the deposits component of M_1, are derived from a number of sources Each component is discussed in detail below

Member bank demand deposits

From the Report of Deposits, filed weekly by member banks, four items are used to construct the demand deposits component of the narrow money stock, M_1. Three of these items aggregate to gross demand deposits: U.S. Government deposits, demand deposits due to other commercial banks, and "all other" demand deposits (that is, demand deposits due to individuals, partnerships, and corporations—domestic and foreign, State and local governments, nonprofit organizations, and so on). The fourth item, cash items in the process of collection (CIPC), is deducted from gross demand deposits in the construction of the money stock.

All U.S. Government demand deposits are excluded from the money stock and "all other" demand deposits are included. A problem arises in connection with demand deposits due to banks. At the present time, demand deposits due to foreign commercial and mutual savings banks are included in the money stock, and demand deposits due to domestic commercial banks are excluded. Because these items are not listed separately on the Report of Deposits but are included in the "due to banks" component, alternative sources of data must be used to estimate the demand deposits due to foreign commercial banks and mutual savings banks included in the money stock. The bulk of these deposits are held at large banks that report on them each week (Wednesday) as part of a detailed balance sheet. These single-day weekly data, along with call report data for all commercial banks, are used to adjust the demand deposits data.

The calculation of the demand deposits at member banks included in the money stock begins with gross demand deposits. From this figure total demand deposits of the U.S. Government and those due to banks are deducted. In order to avoid double counting of demand deposits that are shown simultaneously on the books of two banks, CIPC are also deducted from gross demand deposits to derive the component of M_1 accounted for by the member bank demand deposits (see line 5 of Table 2).

Since CIPC can be deducted in computing deposits subject to reserve requirements, it is also available on a daily basis from the Report of Deposits. CIPC shown on this report, however, is not broken down for items associated with private demand deposits and those associated with all other operations of the bank.

It is known that gross CIPC overstates those items that should be deducted from the money stock deposits. For example, cash items associated with deposits due to banks, with U.S. Government deposits, with redeemed coupons of U.S. Government securities, and with bank credit cards are included in the gross cash items data. Past investigations and contacts with bank accountants suggest that the distortions noted above are not large for domestic transactions and that they remain fairly constant relative to total deposits. A much more serious problem, discussed in some detail below, concerns the significant proportion of the CIPC related to interbank transfers of funds, associated largely with the clearing of Eurodollar transactions in the New York City money market between large member banks and more specialized institutions engaged in international banking. Such CIPC is added back via data collected directly from international banking institutions.

Federal Reserve float

Federal Reserve float, which is very similar to CIPC, is also deducted from private demand deposits in calculating M_1 (line 6 of Table 2). This float is deducted because on some items that are cleared through Federal Reserve Banks credit is passed to the sending bank before the paying bank has received the item and reduced deposits. When the sending bank receives credit, the CIPC account is reduced on that bank's books even though deposit liabilities on the books of the paying bank have not been reduced. The amount of double counting in such instances is reflected in the float created by Federal Reserve Banks rather than CIPC. Deductions for both Federal Reserve and CIPC float serve to offset this double-counting effect.

Nonmember bank deposits

Domestic nonmember banks account for the second largest deposit component of the money stock (line 7 of Table 2) Data for nonmember banks are available four times a year from call reports In order to estimate their deposits for other periods, the ratio of the demand deposits of nonmember banks in M_1 to those of the smaller member banks is computed for each call report date A straight-line interpolation of this ratio adjusted for changes in bank structure is made between call report dates [9] These estimated weekly ratios are then applied to weekly data on average deposits reported by smaller member banks in order to obtain weekly and monthly estimates of the demand deposits component of the money stock at nonmember banks Monthly-average estimates are derived from a weighted average of the weekly estimates Beyond the current call report date, ratios are estimated based on a regression equation and judgment [10] As new call report data become available, these estimates are revised and benchmarked to the universe data available from the call report

While demand deposits of member and nonmember banks account for the bulk of the demand deposits component of M_1, a number of additional adjustments must be made to complete construction of M_1

Demand deposits due to foreign commercial banks

As indicated in the discussion of the demand deposits of member banks, demand deposits due to foreign commercial banks are included in interbank deposits on the Report of Deposits Since total demand deposits due to banks were deducted from gross deposits, further adjustments must be made to include deposits due to banks in foreign countries in the demand deposits component of M_1 Estimates of these foreign demand deposits are based on weekly single-day (Wednesday) data for large banks and on call report data As part of a detailed balance sheet, on Wednesday of each week about 320 large commercial banks report the breakdown of their deposits, from which the demand deposits due to foreign commercial banks can be derived For nonweekly reporting banks, which account for about 20 per cent of demand deposits due to foreign banks, estimates are based on call report data

Estimates of the demand deposits due to foreign commercial banks included in M_1 are constructed as follows For each call report the amount of demand deposits due to foreign commercial banks at nonweekly reporting banks is calculated Between call report observations, weekly estimates are derived from a straight-line interpolation After the most current call report date, the latest level of deposits at nonweekly reporting banks is carried forward as a constant The total of weekly estimates for nonweekly reporting banks and Wednesday data reported by weekly reporting banks is then used as a proxy for the weekly-average level of deposits due to foreign commercial banks at all domestic commercial banks Monthly averages are prorations of the weekly data

Deposits due to foreign commercial banks are a relatively small part of M_1 (line 8 of Table 2) However, because these deposits, particularly as derived from Wednesday data for weekly reporting banks, can be quite volatile, they can have a significant impact on the changes in M_1 both from week to week and from month to month Since weekly reporting banks account for roughly 80 per cent of these deposits, measurement error should be relatively small, except to the extent that the single-day Wednesday data are a poor estimator of the weekly-average level

Demand deposits due to mutual savings banks

Demand deposits due to mutual savings banks are also included in the interbank ac-

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[9] Changes in bank structure reflect shifts in bank reporting status due to changes in Federal Reserve membership, mergers, and the like that affect the ratio of nonmember banks to small member banks

[10] For a description of this process, see "Revision of the Money Stock Measures and Member Bank Deposits and Reserves," *Federal Reserve Bulletin*, vol 60 (February 1974), pp 81–95

count on the Report of Deposits and thus deducted from gross deposits Estimates of deposits due to mutual savings banks, to be added back to the component of M_1 consisting of demand deposits adjusted, are derived from the same sources as estimates of deposits due to foreign banks—that is, weekly reporting banks and call reports Weekly estimates of mutual savings bank deposits at nonweekly reporting banks are based on a straight-line interpolation between call report dates These estimates plus Wednesday data for weekly reporting banks are used as a proxy for the weekly-average level, and monthly data are weighted averages of the weekly observations

The component comprising deposits due to mutual savings banks is small and relatively stable (see line 9 of Table 2) In addition, weekly reporting banks account for the bulk of such deposits, about two-thirds in late 1975 Thus any errors in estimation of data from nonweekly reporting banks are small and have little impact on the total M_1 measure

Demand deposits due to banks in territories and possessions

Demand deposits due to banks in territories and possessions are also derived from call reports However, these deposits must be estimated somewhat differently—from a special tabulation of the call report showing balance sheet data for banks located outside the United States, sometimes referred to as banks in "other areas" Included in this tabulation is an asset item, demand deposits *due from* U S banks This item is assumed to be equivalent to demand deposits *due to* banks in territories and possessions included in demand deposits due to banks on the books of U S commercial banks, and it is used as a proxy for such deposits

Weekly estimates of demand deposits due to banks in U S territories and possessions (line 10 of Table 2) are derived from a straight-line interpolation between call report dates Estimates between call report dates are carried forward as constants, and monthy-average estimates are derived from prorations of the weekly figures Since these deposits generally are less than $100 million on call report dates, there is little measurement error in this component

Adjustments for cash-items bias

CIPC, as reported by member banks on the Report of Deposits, excludes some items that should be deducted from demand deposits to avoid double counting of money stock deposits, and it includes some items that should not be deducted because they do not reflect double counting An example of the understatement of CIPC is the "due from banks" bias Some banks, when forwarding checks to a correspondent bank for collection, immediately increase their due-from-banks account rather than their CIPC account During part of the collection process, such accounting entries result in an overstatement of the money stock because CIPC is understated and deductions for double counting are too small Due-from-banks deposits are not deducted from gross deposits in calculation of the money stock Due-to-banks deposits, from the liability side of the balance sheet, are deducted from gross demand deposits If both due-to and due-from deposits were deducted, the money stock measure would be grossly understated

No data exist to measure the amount of the overstatement of the money stock related to this bias, but it is generally thought to be relatively small and to grow proportionally with the money stock Thus, while the level of the series is biased upward, month-to-month and year-to-year changes should not be seriously affected

The *overstatement* of CIPC and the associated *understatement* of the money stock have been a much more serious matter, particularly in the late 1960's and early 1970's In the spring of 1969, it was discovered that an increasing volume of Euro-dollar transactions of large banks with their foreign branches had sharply expanded the dollar amount of items in the process of collection While drafts issued for the payment of such transfers ("London drafts" and "bills-payable checks") increased CIPC, they were not classified as deposits and the associated expansion in CIPC resulted in unwarranted deductions from reported demand deposits in the estimates of the money supply[11]

The deduction of CIPC associated with these Euro-dollar transfers also had the effect of reducing required reserves To prevent such reductions, the Board changed Regulation D, effective July 31, 1969, to require that member banks include checks originating from transactions with foreign branches as deposits subject to reserve requirements To avoid a significant break in the money stock series associated with this change in Regulation D and to correct for the understatement of the money stock series in previous periods, back data were revised The revisions to correct for Euro-dollar float were carried back to May 1967 Revisions for the first 7 months of 1969 were based on weekly data obtained from large banks covering bills-payable checks and London drafts originating from transactions with foreign branches According to these reports, the total amount of such instruments increased from $1 8 billion in January 1969 to $3 3 billion in July, largely in the May–June period, when Euro-dollar borrowings rose sharply Revisions prior to 1969 were interpolated on the basis of the reported growth rate of CIPC relative to gross demand deposits These data indicated that growth in cash items relative to demand deposits accelerated significantly about mid-1967 and again about mid-1968[12]

In the spring of 1970, additional problems with CIPC arising from international transactions were uncovered Checks issued by Edge Act corporations and agencies and branches of foreign banks were recorded as CIPC on the books of domestic banks However, these checks were not picked up in the gross deposit figures used in the construction of the money stock since at that time liabilities of these institutions were not included in the money stock The generation of CIPC without recording a counterpart liability for money stock deposits on the books of large New York City banks resulted in a downward bias of the level of the money stock This bias was even larger than the one corrected in the 1969 revision And because the issuance of such checks had grown rapidly during this period, the measured growth in the money stock was also understated

In order to correct for this downward bias in the money stock, data were collected from Edge Act corporations and U S agencies and branches of foreign banks, which served as a proxy for the amount of CIPC improperly deducted[13] On October 1, 1970, institutions began to report daily data that reflect the amount of inappropriate cash items included in the total figure deducted from demand deposits (line 11 of Table 2) Since that date, money stock measures have been adjusted for the CIPC bias by adding back the amounts reported by foreign-related institutions (Subsequently, in early 1973, the money stock was also adjusted for CIPC bias generated by foreign investment corporations located in New York City)

With reported data available from October 1, 1970, in order to avoid a break in the money stock series, a method was needed to estimate the size of the bias prior to that date To make corresponding revisions in the back data, it was necessary to estimate the amount of total cash-items bias indirectly The sharp fluctuations in cash items and in interbank deposits that occurred on the books of the major New York City banks around certain

[11] "London drafts" and "bills-payable checks" were checks drawn by or on behalf of a foreign branch of a member bank on an account maintained by such a branch with a domestic office of the parent bank Until the change in Regulation D, effective July 31, 1969, such checks were not included in officers' checks by the issuing bank

[12] "Revision of Money Supply Series," *Federal Reserve Bulletin* (October 1969), p 788

[13] Since Edge Act corporations are required to hold reserves against deposits, these institutions submit a weekly report similar to the report of deposits submitted by member banks The data from these reports not only reflected the cash items bias generated by Edge Act corporations but also a small amount of M_1-type deposits held at these institutions Since the cash-items bias and the M_1 type deposits could not be separated, all of the Edge Act corporation adjustment was included in the adjustment for cash items bias

holidays—such as Easter and Christmas—when European and U S banking practices with respect to working days diverge, provided a basis for estimating the magnitude of the cash-items bias

In those holiday periods when New York City banks were open and European banks were closed, the decline in cash items typically exceeded the decline in money stock deposits by several billion dollars The difference reflected a drop in interbank deposits attributable to the collection of checks issued the day before the European bank holiday by agencies, branches, and Edge Act corporations This difference is a rough measure of the amount of bias associated with the international operations of such institutions The Euro-dollar market was closed on the holiday abroad and the flow of overnight transfers was interrupted, but banks in New York City remained open and collected outstanding checks When these checks were collected, cash items declined sharply At the same time, New York City banks debited "due to banks"—that is, due to agencies, branches, and Edge Act corporations—for an equivalent amount of check clearings against their balances The balances due to banks declined by an amount approximately equal to the residual decline in cash items Thus the holiday decline in balances due to banks was about equal to the volume of cash items generated by these institutions in their normal daily transactions Cash items and balances due to banks returned to normal quickly following the holiday Over the holiday, the elimination of Euro-dollar cash items resulted in an "unbiased" measure of net deposits, as derived from bank records

The decline in balances due to banks was measured on each Good Friday back to 1959, and on Boxing Day (observed as a holiday in Britain on the day after Christmas) back to 1966, to provide benchmarks for adjusting the back data for cash-items bias Ratios of the total bias to known Edge Act deposits were interpolated between the holiday benchmarks, and the estimates of bias for intervening weeks and months were derived by multiplying these estimated ratios by figures on Edge Act deposits

The adjustment for cash-items bias remains a component of the construction of the money stock However, the advent of new methods of transferring funds in New York City—the Clearing House Interbank Payments System (CHIPS) in April 1970 and the Paper Exchange Payment System (PEPS) in early 1972—eliminated much of the cash-items bias Banks and other institutions using these facilities were required to record all of their transactions in interbank accounts, either as due to banks or due from banks, thus eliminating any cash-items bias from transactions related to CHIPS or PEPS

For a short time after the introduction of CHIPS, a few banks in New York City failed to account properly for the transfers through that system This problem was soon resolved, however, and back data were collected to correct for errors it had caused Currently, the bulk of Euro-dollar transfers that originally generated cash-items bias are handled through CHIPS Transfers outside CHIPS continue to create a bias, however Generally, this bias is small and relatively stable While rare, the cash-items bias can increase to a very significant factor when there is a failure of the CHIPS facility

Adjustment for Regulation J

In late 1972, a change in the Board's regulations governing check collection procedures (Regulation J) required a one-time adjustment to the data on the money stock to avoid a break in the series Prior to that change, many banks were on a "deferred payment" basis in remitting to the Federal Reserve for checks presented to them for payment That is, when the Federal Reserve presented checks to a payee bank for payment, remittance in immediately available funds was not due until the following business day Payee banks, nonetheless, were able to reduce their customers' demand deposit accounts on the day the check was presented by the Federal Reserve For one day the bank would carry the liability in a nondeposit account ("other liabilities"), remittance due to the Federal Reserve Because the demand deposit account at the payee bank was reduced before the corresponding cash item or Federal Reserve float was reduced, the level of the money stock was understated by the amount of these remittance payments

The change in Regulation J, implemented in November 1972, required former deferred-payment banks to remit for checks presented by the Federal Reserve for payment on the day of presentation The earlier remittance by the affected banks resulted in the disappearance of this source of bias, and a one-time increase in the money stock on the day the change was implemented To avoid this break in the series, the remittance-payments bias was estimated using data collected from Federal Reserve Banks and regression analysis For the period 1966–72, the adjustment to the money stock was based on the reported credits to member and nonmember transit accounts at Federal Reserve Banks For the period 1959–65, the adjustment was derived from an estimated and simulated regression equation for transit-account credits based on reported data for 1966–72 [14] The effect of these estimates was to raise the level of the money stock about $300 million in January 1959 and about $4 5 billion in December 1972

Other M_1 components

The net of the components discussed above —currency, demand deposits of member and domestic nonmember banks, Federal Reserve float, and the cash-items bias adjustment—account for 98 per cent of the total money stock, M_1 The remainder of the money stock deposits are distributed among a number of financial institutions, primarily foreign related, and nearly all of them are in New York City (see lines 12 and 13 of Table 2) While each institution accounts for a relatively small portion of the total money stock, their deposit-type liabilities are indistinguishable from demand deposit liabilities of commercial banks and therefore rightly belong in an aggregate U S money stock measure [15] The deposit-type liabilities of several of the remaining institutions have been folded into the money stock measures since 1970 As each institution was folded in, estimates of money stock deposits back to 1959 were derived

Deposits of U.S. branches of foreign banks

Deposits of U S branches of foreign banks have always been considered part of the U S money stock Prior to 1973 these deposits were included in the nonmember bank estimates derived from the call report Like domestic commercial banks, U S branches of foreign banks are required to file call reports, but only twice a year In late 1972, the Board began to collect single-day data from branches each month In most months, these observations were as of the last Wednesday of the month In June and December these reports were for the last day of the month and coincided with the call report date

Beginning in January 1973, single-day monthly data were used to estimate deposits at U S branches of foreign banks Weekly estimates were derived from straight-line interpolations between the single-day monthly data In April 1975, the Board began to collect daily data on deposits from branches of foreign banks located in New York City Since then these daily data have been used to measure the contribution to M_1 of demand deposits at U S branches of foreign banks

[14] For a complete description of the adjustment process, see the appendix to "Revision of Money Stock Measures," *Federal Reserve Bulletin* (February 1973), pp 66–69

[15] Demand deposits of mutual savings banks, which are not included in any of the measures of the money stock, should also be included in M_1 when they are clearly subject to withdrawal on demand In total, all mutual savings banks reported demand deposit liabilities of about $1 billion at the end of 1975 The bulk of these deposits was in escrow accounts, however, and was not generally subject to withdrawal on demand

M_1-type balances of agencies of foreign banks in New York City

By State law, agencies of foreign banks located in New York City are not permitted to hold demand deposits However, these institutions have credit liabilities to customers' accounts, which serve the same function as demand deposits The 1970 revision of the money stock measures incorporated credit liabilities reported by these institutions into the money stock

Agencies of foreign banks are required to file monthly reports with the New York State Commissioner of Banking From early 1970 to April 1973 these monthly reports were used to estimate the amount of liabilities akin to the money stock held at U S agencies of foreign banks Prior to 1970, estimates of such deposits were derived from end of-year summary tabulations published by the New York State Commissioner of Banking Again, weekly observations were derived from straight-line interpolations between end-of-year or monthly single-day data Since M_1-type deposits at these institutions were relatively small prior to 1970, estimating errors for this component must also be small, despite the limited information available for estimating back data

Since April 1975, agencies of foreign banks in New York City, like branches of foreign banks, have reported data on M_1-type deposits on a daily basis These data are currently used in the construction of the money stock measures

M_1-type balances of international investment corporations in New York City

International investment corporations chartered by the State of New York, and located in New York City, also hold M_1-type balances to the account of customers that are included in the money stock measures Such balances at these institutions, only about $800 million at the end of 1975, can be used in the same manner as demand deposits at other institutions and thus belong in an aggregate money stock measure Balances at these institutions were first included in the money stock in February 1973 Historical data were estimated based on data derived from reports of the New York State Commissioner of Banking From November 1972 to April 1975, M_1-type deposits of foreign investment corporations were estimated based on monthly single-day data similar to those reported by agencies and branches of foreign banks Since April 1975, foreign investment corporations have reported daily data to the New York Federal Reserve Bank, which are currently used in the construction of the money stock series

Deposits due to foreign official accounts at Federal Reserve Banks

Since 1962, deposits due to foreign official accounts at Federal Reserve Banks (that is, due to foreign governments, central banks, and international institutions) have been included in M_1 The reason for the inclusion was that these deposits "may be used for investment or other expenditures in much the same way as foreign demand balances with commercial banks" Data for these accounts are reported daily by Federal Reserve Banks Their inclusion has little effect on the change or the level of the money stock series

Broader money stock measures— M_2 through M_5

In the October 1960 description of the construction of the money stock, the discussion centered entirely on the narrow money stock, M_1 There was an oblique reference to the fact that "other financial instruments perform in varying degrees some of the functions of money, particularly the store-of-value function, but no other instrument performs all of [the functions]" As our financial system changes, new instruments such as NOW (negotiable orders of withdrawal) accounts, telephonic transfer of funds, overdraft arrangements, and negotiable certificates of deposit

TABLE 3 Construction of M_2 through M_5

Monthly averages in millions of dollars, not seasonally adjusted

Line		Item	Contribution, December 1975	Source of data
1	Money stock, M_1		303,194	See Table 2
2	*Plus*	Time and savings deposits at member banks	337,186	Daily data reported by all member banks
3		Time and savings deposits at nonmember banks	122,302	Estimated, based on daily data reported by small member banks and call report data
4	*Less*	Time deposits due to banks	9,300	Estimated, based on single day (Wednesday) data for large banks and call report data for other banks
5		Time deposits due to U S Government	575	Estimated, based on single day (Wednesday) data for large banks and call report data for other banks
6		Large denomination ($100,000 or more) negotiable CD's	83,462	Single day (Wednesday) data reported by large banks
7	*Equals*	Money stock, M_2	669,345	
8	*Plus*	Thrift institution deposits	424,936	Single day data for last day of month for mutual savings banks, savings and loan associations, and credit unions
9	*Equals*	Money stock, M_3	1,094,281	
10		Money stock, M_4	752,807	M_2 plus large denomination negotiable CD's at large banks
11		Money stock, M_5	1,177,743	M_3 plus large denomination negotiable CD's at large banks

(CD's) have blurred the distinction between demand deposits and other liquid assets Consequently, the Board has periodically reviewed and broadened the money stock concepts it publishes on a regular basis The first such broader concept was M_2—M_1 plus time and savings deposits at commercial banks other than negotiable CD's in denominations of $100,000 or more issued by large weekly reporting banks Later, M_3, M_4, and M_5 were added Table 3 shows the construction of these broader money stock measures

Money stock, M_2

The construction of M_2 parallels very closely the construction of M_1 so far as the member and nonmember bank components are concerned (see Table 3) In addition to the currency and demand deposit components of M_1, M_2 includes time and savings deposits at all commercial banks other than large negotiable certificates of deposit and all deposits due to the U S Government and domestic commercial banks The measure includes time deposit liabilities of branches of foreign banks but not time deposits of Edge Act corporations and other foreign-related institutions (There is no theoretical reason for including the demand deposits of these latter institutions in M_1 and excluding them from M_2 Importance and data availability have been the criteria Historically, these latter institutions held a relatively small amount of time deposits)

Figures for total time and savings deposits of member banks are available from the Report of Deposits submitted by these banks for purposes of setting reserve requirements, but time and savings deposits of nonmember banks must be estimated on the basis of call reports The method used is similar to that for estimating demand deposits at nonmember banks, that is, the ratio of nonmember time and savings deposits to the time and savings deposits of smaller member banks is derived from the call report data, weekly ratios are estimated by straight-line interpolation between call report dates, adjusted for changes in bank structure, and these estimated ratios are applied to the weekly time and savings deposits reported by smaller member banks Adjustments to eliminate time and savings deposits due to the U S Government and to domestic commercial banks are derived from data for weekly reporting banks and the call report

Negotiable CD's in denominations of $100,000 or more issued by large weekly reporting banks are deducted from total time and savings deposits in computing M_2 [16] For

[16] Since all large negotiable CD's and all time deposits due to the U S Government and to domestic

this purpose monthly-average estimates are based on a weighted average of the Wednesday figures as reported by large weekly reporting banks A detailed description of the construction of the historical CD series is presented below

Money stock, M_3

The M_3 money stock is defined as M_2 plus deposits at mutual savings banks, savings and loan shares, and credit union shares Because of the limited data available for these institutions, the M_3 series is published only monthly

Time and savings deposits at mutual savings banks are reported as part of the balance sheet data accompanying the monthly "Research Analysis" of the National Association of Mutual Savings Banks (NAMSB) [17] These data are based on a sample of 338 institutions of a total of 470 for the entire industry According to the NAMSB, the institutions in the sample hold more than 90 per cent of all savings bank deposits The sample estimates generally are available 6 to 7 weeks following the end of the month Twice a year, in June and December, the NAMSB collects data from all savings banks and revises the preliminary numbers for those months accordingly Unless June and December revisions are large, the first published numbers for other months are not changed

Total savings capital at savings and loans is taken from a monthly release of the Federal Home Loan Bank Board (FHLBB), "Selected Balance Sheet Data, All Operating Savings and Loan Associations" These data are estimated by the FHLBB staff on the basis of single-day, end-of-month reports from all savings and loan associations insured by the Federal Savings and Loan Insurance Corporation Such associations hold about 97 per cent of all industry deposits Usually, preliminary data are received with a 4-week lag, and final data become available 1 month later

"Credit Union Statistics," a monthly release by the National Credit Union Administration (NCUA), is the source of data on credit union shares These data are estimated from an end-of-month sample of about 6 per cent of all credit unions, holding approximately 30 per cent of the deposits of these institutions Figures are generally available with a 1-month lag and are revised annually to incorporate benchmark data derived from end-of-year reports filed by all operating Federal credit unions

Data on mutual savings banks, savings and loan associations, and credit unions are reported for a single day each month, usually the last Since the M_1 and M_2 numbers are essentially monthly averages, two successive month-end figures for thrift institutions are averaged in an effort to obtain consistent series For example, the published figure for the month of June for the thrift deposits component of M_3 would be the average of the end-of-May and end-of-June data reported by these institutions These "monthly average" data are then added to M_2 to construct M_3

A technical problem arises as the money stock measures are expanded to include the liabilities of mutual savings banks, savings and loans, and credit unions Ideally, one would like to consolidate the liabilities of these institutions with those of commercial banks For example, when the deposit liabilities of savings and loan associations are added to M_2, the deposit liabilities of banks due to savings and loans should be deducted to net out interinstitution deposits The same is true for mutual savings banks and credit unions Such consolidation already exists with the netting of interbank demand deposits in the construction of M_1 Unfortunately, because of the way the data on thrift institution deposits are collected and reported, such consolidation is, in most cases, quite difficult and requires additional data and a great deal of estimation

commercial banks are subtracted from time and savings deposits, some time deposits—large negotiable CD's issued to the U S Government or other banks—are deducted twice No estimates of this double deduction are available, but it is thought to be quite small

[17] This total excludes checking, club, and school accounts Mutual savings banks held a total of about $600 million in such accounts in late 1975

Thus the M_3 measure is essentially a *combination* of the liabilities of banks and thrift institutions rather than a consolidation

Negotiable certificates of deposit

Negotiable time certificates of deposit became important as a money market instrument in early 1961 At that time several large money market banks in New York City began to offer CD's in readily marketable form to their corporate depositors At about the same time, securities firms announced that they stood ready to buy and sell CD's in open trading The practice was soon taken up by other banks and other dealers

In early 1964 the Federal Reserve System began to gather weekly data on the volume of negotiable CD's in denominations of $100,000 or more outstanding at large weekly reporting banks The panel of weekly reporting banks has been revised once, at the beginning of July 1965

The resulting break in the series was relatively large The old panel of banks reported outstanding CD's of $15,203 million while the new panel of banks reported outstanding CD's of $15,587 million, a difference of about 2½ per cent To avoid a break in series, and to make the previous data comparable with the new, the reported weekly data for the period January 1964 through June 1965 were increased by 2½ per cent

Data on negotiable CD's prior to January 1964 were estimated based on a survey conducted in late 1962 and early 1963 The survey showed that at the end of 1960 large-denomination CD's ($100,000 or more) issued by banks totaled about $800 million By the end of 1961 the total had risen to $2 9 billion, and by late 1962 it had reached $5 6 billion, a sixfold increase in just 2 years These totals included all large CD's, negotiable and nonnegotiable

Several assumptions were made in the process of estimating large negotiable CD's outstanding for the period 1961 to 1963 The first was that no negotiable CD's were outstanding at the end of 1960 Second, the $830 million of large nonnegotiable CD's outstanding at the end of 1960 were replaced by negotiable CD's during 1961 on a straight-line path Third, the growth in total CD's, negotiable and nonnegotiable, from $800 million to $2 9 billion in 1961 was estimated by straight-line interpolation of the log of the beginning and ending values Thus the week-to-week dollar increases were greater at the end of the period than at the beginning The difference between the estimated total series and the estimated nonnegotiable CD series was used as the estimate of large negotiable CD's for the year 1961 For 1962 and 1963, estimates were made using straight-line interpolation between the logs of the 1961, 1962, and 1963 year-end values, $2 9 billion, $5 6 billion, and $9 8 billion, respectively Weekly observations were derived, and monthly estimates were based on the prorations of the weekly data

Since 1963, when Wednesday observations became available, they have been averaged to obtain a rough proxy for the weekly-average level of CD's consistent with the weekly-average measurement of M_1 and M_2 Estimates of the monthly-average level of large negotiable CD's are derived from proration of estimated weekly-average levels [18]

Money stock, M_4 and M_5

The broader money stock measure, M_4, is derived by adding CD's, derived as described above, to M_2 This measure corresponds roughly to all private deposits at commercial banks plus currency in circulation It excludes U S Government deposits and net interbank deposits The M_4 measure is published on both a monthly-average and weekly-average basis

[18] It should be noted that large denomination non negotiable CD's serve the same purpose as negotiable CD's In addition, it is not difficult for large banks to convert a nonnegotiable CD to a negotiable instrument Thus M_2 might logically be computed by deducting all large time deposits from total time and savings deposits if historical data were available It is only recently, however, that the Board has collected any data on total large time deposits In December 1975 large time deposits at commercial banks totaled about $158 1 billion and large negotiable CD's totaled about $83 5 billion

The M_5 measure, the broadest one published by the Board, is derived by adding CD's to the M_3 measure It includes not only the private deposits of all commercial banks but also the deposits of thrift institutions (mutual savings banks, savings and loan associations, and credit unions) Like M_3, M_5 is published only as a monthly average

Seasonal adjustment of the monetary aggregates

The measurement of the seasonal component in any economic time series is difficult, and this is especially true of the money stock The money stock is influenced not only by normal seasonal swings but by other economic factors The irregular component of the series is large and highly volatile Moreover, changes in the financial system, such as shifts in tax collection schedules, in disbursement dates for large government transfer payments, and in the form in which the public holds its liquid assets affect the seasonal pattern over time Some of these changes are abrupt and new seasonal patterns develop quickly, but a few years of data are required to establish the new seasonal pattern for most changes Some of the changes evolve over a considerable period, resulting in continuously shifting seasonal factors that also are measured only with a lag In some instances, several factors may be working simultaneously to change the seasonal pattern, some having cumulative effects and others offsetting one another with unpredictable net impacts The existence of these changing influences makes measurement of seasonal patterns in the money stock imprecise and subject to revision, especially for the most recent years

The various components of the money stock —currency, demand deposits, time and savings deposits other than large negotiable CD's, large negotiable CD's, mutual savings bank deposits, savings and loan shares, and credit union shares—are all seasonally adjusted separately The published adjusted measures are aggregates of these seasonally adjusted components Most of the components are published along with the aggregate

All of the monthly seasonally adjusted series are derived using the Census Bureau's X-11 seasonal adjustment method [19] A multiplicative moving-seasonal variant of this program is used to update seasonal factors each year, and the results are reviewed and in some instances modified judgmentally in an effort to take account of known factors affecting seasonals, random disturbances, or policy-induced changes in the series Usually the published series is close to the X-11 results

For all series the monthly seasonal pattern is derived first and the weekly seasonal factors are forced to agree with the monthly seasonal factors In other words, the weighted averages of the weekly seasonal factors for any month must equal the monthly seasonal factor, within a small range of tolerance Experience suggests that the monthly seasonal patterns are more stable than the weekly ones, because they are influenced less by irregular movements in the data and because factors causing shifts in intramonthly patterns tend to average out over the month While there is always considerable uncertainty about the validity of current weekly seasonal factors, they are anchored to the more stable monthly seasonal factors, and the seasonally adjusted weekly and monthly data will average about the same levels over a period of several weeks

The Board's weekly seasonal adjustment program is essentially a ratio method Seasonally adjusted monthly data are centered at midmonth, and estimates of seasonally adjusted weekly values are generated by a straight-line interpolation between these values The unadjusted weekly data are divided by these estimated adjusted values to obtain an estimate of the seasonal irregular component of the series The intramonthly pattern of these ratios is smoothed, first by a 3×3 moving average of the seasonal-irregular ratios calculated for all the weekly obser-

[19] For a description of this program, see "The X-11 Variant of the Census Method II Seasonal Adjustment Program," Bureau of the Census Technical Paper 15 (Government Printing Office, 1965)

vations over recent years, and then by a judgmental modification to take account of any apparent shifts in the intramonthly pattern Differences between the predetermined monthly factors and the average of weekly factors are distributed to the weekly seasonal factors so that the latter agree on average with the former

After deriving unadjusted aggregates for the currency and demand deposits component of M_1, each component series is seasonally adjusted separately Seasonal factors for currency and demand deposits are computed and reviewed as described above The adjusted series are then aggregated to derive adjusted M_1 All of the raw data, whether or not adjusted, are estimated to millions of dollars, and the aggregation of seasonally adjusted data is also done at this level However, these estimates are not considered accurate to the nearest million so, for publication, all series are rounded to the nearest tenth of a billion dollars Thus rounding differences frequently appear between the published series on components and on aggregates

Derivation of seasonally adjusted time and savings deposits in M_2 is more complex First, large negotiable CD's are subtracted from total time and savings deposits at all member banks and the residual series on member bank time and savings deposits is seasonally adjusted Second, seasonal factors are derived for adjusting total time and savings deposits at small member banks A seasonally adjusted series on total time and savings deposits for nonmember banks is derived by applying the expansion factors described above to total time and savings deposits at small member banks, seasonally adjusted Next, the seasonally adjusted series on total time and savings deposits less negotiable CD's at member banks is aggregated with the seasonally adjusted total time and savings deposits of nonmember banks From this aggregate, time and savings deposits due to the U S Government and domestic commercial banks, not seasonally adjusted, are subtracted (There is no measurable seasonal in these deposits) The result is an adjusted time and savings deposits component of M_2 that parallels the adjusted demand deposits component of M_1 in excluding deposits due to the U S Government and other commercial banks Seasonally adjusted M_2 is the aggregate of seasonally adjusted currency, demand deposits, and time and savings deposits other than large negotiable CD's

Mutual savings bank deposits, savings and loan association shares, and credit union shares—components of M_3—are also seasonally adjusted by the Board First, the reported end-of-month data for each series are seasonally adjusted These numbers are then averaged, as explained above, to approximate a monthly-average series, which is added to seasonally adjusted M_2 to derive M_3 Because weekly data are not available for thrift deposits, only a monthly-average series on M_3 can be constructed

Large negotiable CD's are also seasonally adjusted, both monthly and weekly Seasonal factors are especially difficult to derive for this series, however, because of the large trend and cyclical components During the early and mid-1960's, when CD's first became an important financial asset, the series was highly dominated by trend In the late 1960's and early 1970's, CD's—because of Regulation Q ceilings on interest rates—were heavily influenced by monetary policy and the level of market interest rates These two factors are extremely difficult to untangle in deriving seasonal factors for the series The seasonal factors from the basic X-11 program are used with only minor judgmental review Seasonally adjusted, monthly-average CD's are aggregated with adjusted M_2 and M_3 to derive adjusted monthly-average M_4 and M_5, respectively Seasonally adjusted weekly-average CD's are aggregated with adjusted M_2 to derive adjusted weekly-average M_4 Weekly-average M_5 is not available

Conclusion

The measures of monetary aggregates currently constructed and published by the Board are derived from a wide variety of data sources The data have been revised and refined several times over the years, as new data sources developed or as measurement problems required the collection of additional data. Nevertheless, all of the series on the money stock are still only approximations of the conceptual, holder-record measures intended. Problems of double counting, inconsistency in accounting entries, and single-day versus daily-average data all have an impact on the accuracy of the series. The longer the time span, the less serious are such data problems. However, those who use the money stock measures for short-run analysis should be aware of the extent of estimation required in the construction of the series and of the short-run volatility inherent in the data.

An Alternative Method for Calculating M_1

Anton S Nissen and Darwin L Beck

This paper revises and updates the study originally prepared for the Advisory Committee and contains information not available to the Committee when it made its report

The Advisory Committee on Monetary Statistics included as one of its recommendations " a new, simpler process of handling interbank deposits and cash items in the process of collection when consolidating data from different financial institutions, in order to eliminate certain biases and to obtain a more accurate measure of M_1 and other aggregates "[1] The Committee made this a tentative recommendation because of large statistical differences between a preliminary construct of the new series and the money stock then being published by the Federal Reserve The Committee also recommended that the Board staff investigate the new series further and resolve the differences between the two measures The Committee assumed that these differences would be resolved and that the new method, while still not perfect, would be a more accurate measure of the actual money stock

Since the Committee report, the staff of the Federal Reserve has made an intensive effort to reconcile the differences between the two series This paper presents the information available to the Committee at the time of its report and incorporates additional information collected by the staff since the report was published First, minor biases in the published money stock measure have been uncovered These biases were corrected in 1976, and at the same time, the staff improved the initial estimates of the alternative money stock measure [2]

For continuity, data on the current and alternative money stock measures and interbank deposits as they were originally made available to the Committee are presented in Tables 1 and 2 These tables also show sources of subsequent revisions to the series, the final alternative series, and the money stock series now being published The differences between the two series are described in this paper

Information available at the time of the Committee report indicated that, despite the large discrepancy between the two series, the alternative method of constructing the money stock was an improvement over the current method [3] Assumptions were that further research would explain the differences and that the alternative measure would prove to be superior Further research has not resolved the differences, however, nor is it clear which method of constructing the money stock is superior, both measures can be affected by changes in banking regulations, and both can be affected by changes in accounting procedures

The problem is one that is inherent in many economic time series Often, economic series derived from different data sources provide different measures of the same variable There

NOTE—Anton S Nissen is a member of the staff of the Federal Reserve Bank of New York and Darwin L Beck is on the staff of the Board's Division of Research and Statistics

[1] *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* (Board of Governors of the Federal Reserve System, 1976), p 3

[2] "Revision of Money Stock Measures," *Federal Reserve Bulletin*, vol 62 (February 1976), pp 82–87 For a detailed description of these revisions, see the appendix

[3] In December 1974 the level of the current money stock measure was $8 0 billion higher than the level of the alternative measure on a monthly average basis, and about $5 5 billion on an end of month basis

TABLE 1. Comparison of Alternative and Current M_1 Measures

In millions of dollars, not seasonally adjusted

Year-end	Available to the Advisory Committee on Monetary Statistics			Adjustment		Adjusted alternative M_1	Adjusted current M_1[1]	Adjusted alternative M_1 less current M_1
	Alternative M_1	Current M_1	Alternative M_1 less current M_1	To alternative M_1 for inappropriate Regulation J adjustment	To current M_1 for reestimation of cash items bias			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1959	148,787	147,771	1,016	−500		148,287	147,771	516
1960	149,733	148,767	966	−600		149,133	148,767	366
1961	155,896	154,553	1,343	−700		155,196	154,553	643
1962	157,772	156,984	788	−800		156,972	156,984	−12
1963	162,298	161,241	1,057	−900		161,398	161,241	157
1964	172,345	172,218	127	−1,000		171,345	172,218	−873
1965	180,901	180,581	320	−1,100		179,801	180,581	−780
1966	186,474	185,756	718	−1,200		185,274	185,756	−482
1967	199,572	198,545	1,027	−1,300		198,272	198,545	−273
1968	215,481	214,929	552	−1,400	800	214,081	215,729	−1,648
1969	223,377	222,869	508	−1,500	900	221,877	223,769	−1,892
1970	229,488	234,067	−4,579	−1,600	−2,600	227,888	231,467	−3,579
1971	244,768	248,164	−3,396	−1,700	−2,600	243,068	245,564	−2,496
1972	266,600	272,492	−5,892		−1,600	266,600	270,892	−4,292
1973	283,584	289,834	−6,250		−500	283,584	289,334	−5,750
1974	294,817	301,321	−6,504		−1,000	294,817	300,321	−5,504
1975[2]						309,349	313,913	−4,564
1976[2]						326,520	332,660	−6,140

[1] As revised and published in early 1976

[2] See footnote 8 on p 138

are, for example, statistical discrepancies between gross national product and national income accounts, between household and man-hour employment surveys, and between different measures of the balance of payments A similar unresolved statistical discrepancy appears to exist between the current and alternative money stock series

The currently published money stock series has been adjusted for breaks associated with regulatory changes and for major biases associated with conventional bank accounting The alternative money stock has also been adjusted for regulatory changes, and it is not distorted by accounting procedures as is the current money stock Further investigation suggests, however, that the alternative money stock measure is affected by other data prob-

TABLE 2 Interbank Demand Deposits and Cash-Items Bias Adjustment

In millions of dollars, not seasonally adjusted

Year end	Available to the Advisory Committee on Monetary Statistics					Adjustments		After adjustment for Regulation J and reestimation of cash items bias				
	Deposits			Adjustment for cash items bias	Net interbank less cash-items bias	To due from to remove Regulation J discontinuity	To cash-items bias for re estimation	Deposits			Adjustment for cash-items bias	Net interbank less cash items bias
	Due to banks	Due from banks	Due to less due from					Due to banks	Due from banks	Due to less due from		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1959	13,445	12,429	1,016		1,016	500		13,445	12 929	516		516
1960	14,882	13,916	966		966	600		14,882	14,516	366		366
1961	15,900	14,473	1,427	84	1,343	700		15,900	15,173	727	84	643
1962	14,058	13 230	828	40	788	800		14,058	14,030	28	40	−12
1963	13,460	12,403	1,057		1,057	900		13,460	13,303	157		157
1964	15,718	15,153	565	438	127	1,000		15,718	16,153	−435	438	−873
1965	16,016	15,519	497	177	320	1,100		16,016	16,619	−603	177	−780
1966	17,195	16,416	779	61	718	1,200		17,195	17,616	−421	61	−482
1967	19,029	18,002	1,027		1,027	1 300		19,029	19,302	−273		−273
1968	21,566	20,208	1,358	806	552	1,400	800	21,566	21,608	−42	1,606	−1,648
1969	23,651	21,675	1,976	1,468	508	1,500	900	23,651	23,175	476	2,368	−1,892
1970	26,713	24,932	1,781	6,360	−4,579	1,600	−2,600	26,713	26,532	181	3,760	−3,579
1971	28,357	26,048	2,309	5,705	−3,396	1,700	−2,600	28,357	27,748	609	3,105	−2,496
1972	30,616	33,424	−2,808	3,084	−5,892		−1,600	30,616	33,424	−2,808	1,484	−4,292
1973	32,630	35,932	−3,302	2,948	−6,250		−500	32,630	35,932	−3,302	2,448	−5,750
1974	41,089	43,915	−2,826	3,678	−6,504		−1,000	41 089	43,915	−2,826	2,678	−5,504
1975[1]								38,625	39,433	−808	3,756	−4,564
1976[1]								41,033	42,350	−1,317	4,823	−6,140

[1] See footnote 8 on p 138

lems The lack of uniformity among banks in accounting for interbank deposits causes distortions in the accounts that reflect demand deposits due to and due from banks, data series that are important in the construction of the alternative money stock For example, changes in accounting practice associated with the implementation of the Paper Exchange Payments System (PEPS) in 1972 are believed to have caused a serious distortion in the alternative money stock measure

Construction of the alternative series

The narrowly defined money stock, M_1, has two major components—demand deposits adjusted and currency in circulation outside the Treasury, the Federal Reserve, and commercial banks[4] The first component is intended to measure primarily the net demand deposit liabilities of commercial banks in the United States to both domestic private nonbank customers and to all foreign customers, bank and nonbank At present, this component is calculated by subtracting cash items in the process of collection, as shown on the books of commercial banks, from so-called "other demand deposits," which consist of demand deposit liabilities due to depositors other than the U S Government and banks[5] However, a number of statistical problems in this basic procedure cause biases in the series When possible, adjustments have been made to correct for such bias, but for the purposes of this paper, three data problems are important First, cash items in the process of collection include items drawn against accounts outside of other demand deposits Second, some checks drawn against accounts recorded in other demand deposits and still in the process of collection are not reported in cash items in the process of collection And third, other demand deposits, as used in the money stock calculations, do not include all deposits due to money stock holders

The first problem—cash items drawn against deposits that are not included in the money stock—arises in connection with a large volume of checks drawn against due-to-banks accounts by agencies and branches of foreign banks, foreign bank-owned investment companies engaged in banking, and Edge Act corporations in New York City[6] Most checks are drawn in the course of transferring funds related to international financial transactions and typically are deposited in New York City commercial banks on the day they are drawn The New York City banks carry the checks deposited as cash items in the process of collection, a procedure that results in an overstatement of cash items for money stock purposes and a consequent understatement of M_1 This distortion was first discovered early in 1970 Since late that year, data have been collected on the amounts of outstanding checks drawn by the agencies and branches of foreign banks, foreign bank-owned investment companies engaged in banking, and Edge Act corporations in New York and have been used to correct for this so-called "cash-items bias"[7]

The second problem is that many banks forward checks to correspondent banks for collection and immediately post them as demand deposits due from banks rather than as cash items Thus, other things being constant, the amount of cash items deducted in calculating

[4] Since the currency component is common to the two money stock measures, it is not discussed in this paper

[5] In addition to cash items in the process of collection, Federal Reserve float also is subtracted Cash items in the process of collection represent primarily checks in the process of collection for which the collecting agent has not yet granted credit Federal Reserve float also represents checks still in the process of collection, but for which the Federal Reserve *has* passed credit even though it has not yet collected from the banks on which the checks were drawn

[6] Other items included in cash items—such as checks drawn on U S Government accounts, food stamps, redeemed savings bonds, credit card slips—also violate the assumption Studies conducted by the Federal Reserve indicate that the problem of checks drawn on U S Government accounts is small, but no data are available on the size of the other problems Discussions with banks indicate that it would be virtually impossible to have these items recorded in separate accounts

[7] While discovered in 1970, the cash-items bias first developed on a much smaller basis around the mid-1960's Since actual data on outstanding checks were not available until the late 1960's, adjustments to account for the earlier bias were estimated as described in the *Federal Reserve Bulletin*, vol 56 (December 1970), pp 892–93

demand deposits adjusted is smaller than it should be (and the amount of demand deposits adjusted is larger) until the checks are received and either charged directly against a deposit account by the correspondent or entered on its balance sheet as cash items and forwarded for collection The resulting overstatement of M_1—referred to as the "due-from-banks bias"—was recognized by the Federal Reserve System committee that had developed the money stock measure in the late 1950's However, since the overstatement was assumed to be relatively small on average and to change relatively slowly over time, the basic money stock calculation has not been adjusted to correct for this bias

As indicated, the third problem is that other demand deposits do not include all relevant money stock deposits In particular, this deposit category does not include demand deposits due to foreign commercial banks or domestic mutual savings banks, so an adjustment has to be made to "other deposits" to include the deposits due to these institutions The only data available upon which to base such adjustments are single-day, Wednesday—as opposed to daily-average—data reported by weekly reporting banks and call report data available four times a year These estimated data are incorporated into the money stock calculations

The three problems were considered at an early meeting of the Advisory Committee on Monetary Statistics, and an alternative method for calculating the money stock was suggested Briefly, the alternative was to include, along with other demand deposits, all demand deposits due to banks (foreign and domestic) and to deduct, along with cash items in the process of collection, demand deposits due from domestic banks in computing the demand deposits adjusted component of M_1 The alternative method was believed to have three advantages First, it would eliminate the cash items bias and the consequent need for correction of data to adjust for that bias In this instance, the deposits due to banks against which the currently inappropriate cash items are drawn would be included in the deposits total from which the cash items would be deducted Second, the alternative method would eliminate the due-from-banks bias because, by deducting both cash items and demand deposits due from banks, the use of the due-from account by banks forwarding checks to correspondents for collection no longer would result in the bias Finally, Wednesday and call report data would no longer have to be used to estimate demand deposits due to mutual savings banks and foreign commercial banks, since such deposits would be included on a daily-average basis as a part of demand deposits due to banks A priori the level of the money stock series constructed by the alternative method was expected to be slightly lower than the present series, reflecting elimination of the due-from-banks bias, but changes in the two series over any period of time—except perhaps short ones—would be essentially the same

In response to the Committee's suggestion, an alternative money stock series was constructed on a monthly-average basis for the 1968–74 period, and on a single-day basis, December 31, for the 1959–74 period (Table 1)[8] Comparison of the two revised series for December 31 (columns 6 and 7) indicated that a priori expectations were not borne out[9] As can be seen in column 8 of Table 1, the differences between the currently published and the alternative money stock were contrary to expectations in the early years and much larger than expected in the later years Moreover, large discontinuities appear in 1968, 1970, and 1972

A further effort was made to explain these differences Essentially, the procedure used to calculate the alternative money stock series was to add demand deposits due to domestic banks to the current money stock series, and to subtract both demand deposits due from banks and the adjustment for cash-items bias from it

[8] Call report data for December 31, 1975 and 1976, available since the Committee completed its report, are also shown

[9] The focus was on the December 31 series since the monthly-average series contain large estimated components for nonmember banks

This procedure is equivalent to adding net interbank deposits and subtracting the adjustment for cash-items bias In attempting to explain the unexpected differences between the two series, therefore, attention was concentrated on the behavior of net interbank deposits and the adjustment for cash-items bias Data on net interbank deposits and the adjustment, as originally presented to the Committee and as later revised, are shown in Table 2

The 1959–67 period

The 1959–67 period presents a mixed picture, but if allowance is made for the vagaries of single-day data and the uncertainty of historical adjustment for the alternative measure, the currently published and the revised alternative money stock series track about as expected (column 8, Table 1) During this period, the levels of the two series differ by less than $1 0 billion and annual growth rates differ, on average, by less than ¼ of a percentage point Nevertheless, there are some unexpected differences between the two series Since the adjustment for cash-items bias was negligible during most of this period, the interbank deposits must be responsible for the difference

The alternative money stock exceeded the current money stock early in the 1959–67 period (Table 1), reflecting an excess of deposits due to banks over those due from banks and contradicting the expectation of a bias in the current money stock measure arising in deposits due from banks

As noted earlier, the possibility of a due-from-banks bias in the current money stock series had been suggested by a System committee in the late 1950's [10] The committee noted that, at least since the mid-1950's, deposits due to banks had exceeded deposits due from banks by almost $1 billion The committee report hypothesized that some banks did not post checks forwarded to correspondents for collection immediately to a due-from-banks account as had been assumed in adjusting for the due-from-banks bias Rather, the committee suggested, the checks were posted to the cash-items account and held there until notification was received from the correspondent that they had been collected, then the cash-items account was reduced and the due-from-banks account was increased Since the checks being collected by correspondent banks appeared on the correspondent's books during the collection period as deposits due to banks, this phenomenon was believed to explain the excess, on balance, of due-to accounts over due-from accounts While this explanation appears plausible, there is no practical way to check its historical validity

If this explanation is correct for the early period, the data indicate that around 1964 either a shift in accounting practices or some other structural change caused deposits due from banks to grow more rapidly than deposits due to banks From 1964 to 1968, deposits due from banks consistently exceeded those due to banks, but generally by ever-smaller amounts (column 10, Table 2) During this period there were no known changes in accounting practices or in structure that would explain the shift in the relationship between deposits due to and deposits due from banks Thus the data do not establish the superiority of either series over this period

The 1968–71 period

The 1968–71 period was a time of rapid expansion in transfers of funds through the New York Clearing House by agencies and branches of foreign banks, foreign bank-owned investment companies engaged in banking, and Edge Act corporations located in New York City These transfers of funds were related primarily to expanding Euro-dollar transac-

[10] The due-from banks bias, it will be recalled, was hypothesized to arise because some banks forwarded checks to correspondents for collection and wrote up immediately their deposits due from banks Because of unavoidable lags in transporting such checks to correspondents and in posting by the correspondent banks to cash items in the process of collection and deposits due to banks, the cash items deduction from money stock deposits was thought to be understated, the money stock to be overstated, and deposits due from banks to exceed deposits due to banks

tions As column 11 of Table 2 shows, the adjustment for cash-items bias, a proxy measure for the volume of these transfers, is estimated to have increased rapidly during this period In making transfers of funds through the Clearing House, the various institutions involved typically would make deposits in New York City correspondent banks, thus leading to increases in cash items in the process of collection and demand deposits due to banks on the books of those correspondents Other things constant, one would expect an increase in the excess of deposits due from banks over deposits due to banks that would roughly equal the increase in the adjustment for cash-items bias However, according to the data available, this did not happen

Over the 1968–71 period, the adjustment for cash-items bias increased nearly $3 2 billion, while net interbank deposits (deposits due to banks less those due from banks) increased less than $1 0 billion This discrepancy accounts for the sharp rise in the difference between the current and the alternative series

From 1959 to 1967, deposits due to banks and those due from banks increased, on average, $700 million and $800 million, respectively, per year From 1968 to 1971, these yearly increases rose to $2 4 billion and $2 1 billion, respectively The increased growth in the deposits due to banks is explained in part by the increases in transfers of funds through the Clearing House by foreign-related institutions in New York City What is unexplained, and what ultimately causes the differences in the money stock series, is the acceleration in the growth of deposits due from banks Could this growth reflect an increase in the so-called due-from-banks bias? That is, were more banks using a due-from-banks account rather than a cash-items account when forwarding checks for collection? If so, the alternative series might be a better measure of the money stock Since banks had no known reason to shift their accounting practices at this particular time, it is assumed that some other, unknown, factor accounted for the change Whatever the cause, there appears to be a break in the alternative money stock measure, and given the size of the change, it most probably reflects bias in the series either before or after the change

During the 1968–71 period the alternative money stock measure would not have been so susceptible to the problem of cash-items bias as was the current money stock The cash-items bias in the current money stock was, however, identified and corrected, albeit with a lag It is not certain that the alternative series was affected over this period by a bias from deposits due from banks, but because of the peculiar and unexplained movement in the deposits due from banks, that possibility cannot be dismissed At this point in time, if there is a bias in the alternative measure, it can be neither identified nor corrected Thus, for the 1968–71 period, as for the 1959–67 period, neither money stock measure is clearly superior to the other

The 1972–74 period

In 1972 the relationship between demand deposits due to banks and demand deposits due from banks shifted sharply, by nearly $3 5 billion, and then remained roughly constant through the end of 1974 (Table 2, column 10) Whereas prior to 1972 demand deposits due to banks had exceeded demand deposits due from banks, at the end of 1972 deposits due from banks exceeded those due to banks by about $2 8 billion Of that amount, about $1 7 billion (−$2 0 billion in due to, and −$0 3 billion in due from) reflected the change in the Federal Reserve's Regulation J in November 1972[11] When Regulation J was changed, banks had to remit funds to the Federal Reserve on the day checks presented by the Federal Reserve were received (Prior to the change, banks did not remit funds until one business day after receipt of the checks from the Federal Reserve) Member banks acting as correspondents for nonmember banks that did not have a deposit account with the Federal Reserve also were required to remit

[11] For a more detailed discussion of the impact of the change in Regulation J on the current and alternative money stock, see the appendix

funds one day earlier for checks presented for collection by the Federal Reserve to nonmember banks Because the nonmember banks for the most part had already been accounting for deposits due from banks one day before actual remittance to the Federal Reserve by their correspondents, when payment was speeded up a day the due-from accounts at these banks were mostly unaffected, whereas the due-to accounts at the correspondent banks declined

The source of the remaining part of the shift in the differential between due-to and due-from accounts in 1972 is not certain However, it seems to stem from the introduction by the New York Clearing House in February of that year of the Paper Exchange Payments System (PEPS) PEPS was an arrangement under which a large number of agencies and branches of foreign banks, foreign bank-owned investment companies engaged in banking, and Edge Act corporations located in New York City met at the New York Clearing House each day to exchange debit and credit advices arising from transfers of international-transaction funds The purpose of PEPS was to obviate the need to receive and deposit each day large volumes of checks drawn on (or payable through) member correspondents of the New York Clearing House Although the accounts reflecting deposits due from and due to banks at the Clearing House banks were affected by PEPS, any specific accounting conventions that would have led to the change in the due-to–due-from relationship have not been identified Thus, the initiation of PEPS does not necessarily account for the remainder of the 1972 shift The similar timing of these events, however, is difficult to ignore and gives credence to the suspicion that the explanation lies in PEPS

Both the current and alternative series were adjusted to avoid a break in series when Regulation J was changed in late 1972 Thus, assuming that the adjustments were reasonably accurate, there is no reason to expect that—with respect to the effects of the change in Regulation J—one series is any better than the other However, the current series has required a larger adjustment than the alternative because it was subject to bias from two types of accounting practices associated with remittances to the Federal Reserve, whereas the alternative series was subject to a smaller bias from only one of these practices

To the extent that the 1972 shift in the due-to–due-from relationship was caused by factors other than the change in Regulation J, the Federal Reserve staff is unable to make any judgments as to the relative quality of the current and alternative M_1 series over the 1972–74 period The staff has not been able to identify with any degree of certainty those factors and how they affected the various accounts on banks' books that bear on the calculations of the two money stock measures Even if the shift were related to the advent of PEPS, there is still the question of what were its effects on deposits due to and due from banks, and hence which of the two money stock series was affected Without firm evidence, however, more definitive statements cannot be made at this time

Summary

The difference between the current and alternative money stock measures continued to grow in the 1975–76 period (Table 1, column 8) This growth, however, did not accelerate significantly, and the relationship between the two measures did not shift noticeably after the apparent break between 1971 and 1972 Thus, the later data provide no additional information that might help to explain the large differences between the two series

A review of the construction of the two series indicates that both measures can be distorted by regulatory changes and by changes in accounting practices The alternative measure appears to be particularly susceptible to changes in accounting procedures associated with interbank deposits

While attempting to reconcile the differences between the two series, the Board staff became more acutely aware of instances when timing or interbank accounting variations could lead to discrepancies between deposits due to and due from banks for the commercial banking system as a whole Of course, what is important to an individual bank is *not* that the book balances show its deposits due to and due from other banks to be equal at any point in time, but rather that they can be reconciled These interbank accounting variations can, however, inject serious bias into the alternative money stock measure At this point it is not known if the alternative money stock contains such biases or not The coincidence of some of the sharp changes in the differences between the two series and of known changes in interbank accounting suggests that such biases exist

On the other hand, except for the bias arising from deposits due from banks, which is still believed to be small, the current money stock measure has no known or suspected biases The differences in levels created by this form of bias is not important for policy purposes, and the initial presumption that this bias evolved rather slowly on average with little attendant effect on monetary growth rates, which are more important than levels for policy purposes, appears to be valid When biases have developed in the past, they have been found and quickly corrected

In conclusion, neither method of constructing the money stock discussed in this paper is clearly superior As with other economic data series, analysts should be aware that these statistical discrepancies exist and that any construction of the money stock is only a near approximation of the "true" money stock Data on the money stock, regardless of the method of construction, require careful and constant monitoring to avoid serious distortions in the series

Appendix: Adjustments to Money Stock Measures

In constructing the alternative money stock measure and comparing it with the current measure, two data problems were uncovered The first related to a misestimation of the cash-items bias associated with the transfer of funds by foreign-related institutions in New York (primarily Euro dollar transfers), and the second related to an inappropriate adjustment to the alternative measure associated with the change in Regulation J in 1972 After discovery of the problem of cash-items bias, additional data were collected as necessary and new estimates of the cash-items bias associated with foreign related funds transfers were derived The revised estimates of cash-items bias were folded into the published money stock data in 1976 The reasons for this revision are described below

The impact on interbank deposits and the current money stock of transfers of funds at the New York Clearing House for foreign-related institutions in New York City was first discovered in the spring of 1970, when there was a huge unexplained bulge in the money stock Investigation showed that this bulge was caused by a large decline in cash items in the process of collection at New York City banks on Good Friday, which continued unchanged over the weekend This decline in cash items was matched not by a decline in other demand deposits, however, but by a decline in deposits due to banks Further investigation revealed that London banks were closed on Good Friday, while U S banks were open [1] With London banks closed, there was thought to be little or no activity in the Euro-dollar market—which gave rise to most of the transfers discussed above—so that few, if any, new borrowings were initiated or outstanding ones repaid With New York City banks open, however, all the transfers associated with Euro-dollar borrowings and repayments that had been initiated on the preceding day cleared out of the pipeline As a result, deposits due to banks at New York City banks (specifically due to agencies, branches, and Edge Act corporations making the transfers) declined sharply, along with cash items in the process of collection If usual accounting procedures had been followed by the agencies, branches, and so forth, the problem with the money stock could have been corrected by folding in balance-sheet data reported by these institutions However, conventional accounting practices had not been followed at most of these institutions, so their balance-sheet data were not adequate to correct the current money stock Instead, some proxy measure was needed Thus, beginning in late 1970, daily data on officers' checks outstanding of these institutions were collected for this purpose

For the period before actual data are available, a method for estimating the impact of the transfers of funds at the New York Clearing House on the current money stock had to be devised Given the explanation for the declines in deposits due to banks and cash items around Good Friday and Boxing Day, the size of these declines was determined to be a good measure of the cash-items bias Thus, estimates of the cash-items bias for earlier periods were based on interpolations between "benchmark" data derived from earlier holiday declines in deposits due to banks A similar interpolation was made for the period between Good Friday 1970 and early October 1970, when the initial "hard" numbers reported by agencies, branches, and so forth became available

As suggested by the behavior of the cash-items adjustment, the total of the first actual numbers received in October 1970 was much larger than the estimate for Good Friday, and it remained much larger, with some modest further growth into 1971 The difference between the Good Friday estimate and the actual numbers was not suspect, however, since there were other indications that activity in the Euro dollar market was expanding rapidly Because of the interpolation between the estimate for Good Friday and the first actual numbers in

[1] On December 26, Boxing Day, London banks are also closed and U S banks are open, which leads to the same phenomenon that occurs on Good Friday In those years when December 26 falls on a weekend, there is, of course, no impact on domestic money stock data

October, however, the adjustment for cash items bias grew rapidly in 1970

In 1970 Boxing Day was on a Saturday, so the decline in the deposits due to banks could not be checked against the adjustment for cash-items bias until Good Friday 1971 When the check was made, the reported decline in the adjustment exceeded the decline in deposits due to banks by perhaps $3 billion to $3 5 billion As will be discussed later, about $2 billion to $2 5 billion of the difference appeared to reflect an overstatement of the actual adjustment, while $1 0 billion was the amount by which the decline in deposits due to banks underestimated the cash-items bias

One part of the overstatement in the reported data on cash-items bias derives from the fact that, in some instances, contrary to assumptions, checks received by agencies, branches, and so forth were not being deposited in New York City banks on the day of receipt In particular, the checks were not being deposited until early the following day Given these delayed deposits, the checks did not appear as cash items on the books of New York City banks on the day of receipt by the agencies or branches Nonetheless, the checks were reported by the agencies, branches, and so forth that had written the checks as a part of the bias-adjustment numbers, and so they were included in the adjustment Data collected on the amounts of delayed deposits suggest that the daily flow of "missing" cash items and the consequent overstatement of the adjustment for cash-items bias was about $2 0 billion in 1971

Another part of the overstatement of the adjustment for cash-items bias may be caused by the fact that some checks drawn by agencies, branches, and so forth were deposited in the same New York City banks on which they were drawn In these circumstances, the offset to the credit of the depositor's account was an immediate debit to the account of the institution that drew the check At the same time, however, the amount was reported by the agencies, branches, and so forth drawing the checks as part of the statistics for the adjustment for cash-items bias, and it was included in the adjustment No data are available on the extent of this particular problem, although the agencies, branches, and so forth have suggested that the percentage of their total checks outstanding that were deposited in the banks on which they were drawn was "small"—perhaps $500 million in 1970

The estimates of the cash items for Good Friday and Boxing Day are understated because not all foreign banking offices active in the Euro-dollar market are closed on those days Since data on the cash-items bias were first collected, a residual amount of checks—about $1 0 billion—never disappears in the reported adjustment for cash-items bias, even when European banks are closed for holidays Presumably these checks give rise to a need for a continued adjustment Since the checks are still in the pipeline, however, there is no decline in deposits due to banks to match these checks, and the estimating procedure, using Good Friday and Boxing Day declines in deposits due to banks, understates the true level of the necessary adjustment

After consideration of all the foregoing details, new estimates of the cash-items bias were derived in 1976 and folded into the historical money stock series For the period 1968–74, the magnitude of these revisions for the last day of each year ranged from —$2 6 billion to $900 million For earlier periods the adjustment was negligible

The second data problem was an inappropriate adjustment to the original alternative series associated with a change in Regulation J in late 1972 This inappropriate adjustment, which raised the level of the series for 1959–71, resulted from the method used to construct the original alternative series The alternative M_1 was calculated by using current M_1 as a base That is, alternative M_1 was constructed by adding demand deposits due to domestic banks to the current M_1 series and subtracting demand deposits due from banks and also the original adjustment for cash items bias This calculation is the same as adding net interbank deposits and subtracting the cash-items bias from current M_1 In late 1972, current M_1 was adjusted upward for the period extending back to 1959 [2] That adjustment compensated for what was termed the "remittance payment bias" that persisted until November 1972, when the Federal Reserve's Regulation J was changed For the current money stock, the entire adjustment made at that time was appropriate For the alternative M_1, however, *part* of that adjustment was *not* appropriate, but it was inadvertently included in the original estimate because the estimate used the current money stock measure as a base The reason for the different treatment is described below

Prior to November 9, 1972, payments for checks presented by the Federal Reserve to banks outside Federal Reserve cities were not due to the Federal

[2] *Federal Reserve Bulletin*, vol 59 (February 1973), pp 61–77

Reserve until the business day after presentation Even so, banks reduced their customers' demand deposit accounts on the day the checks were presented, and as an offsetting entry banks increased an other-liabilities account, "remittance due to Federal Reserve" In addition to following general accounting conventions, banks wanted to reduce their deposit liabilities as soon as possible in order to minimize reserve requirements other liabilities are not subject to such requirements Reductions in demand deposit accounts generally occurred before the reduction of the corresponding cash items or Federal Reserve float Because the liability for remittance payment was not carried in a money stock deposit account, the amount deducted for these items was too large for money stock purposes and the level of the series was understated

When Regulation J was changed, the total amount of checks for which remittance was speeded up by one business day was estimated at around $4 0 billion The acceleration in remittance eliminated the write-up of other liabilities Thus, the contraseasonal decline in other liabilities at member banks that immediately followed the change provided a measure of the part of the $4 0 billion that was concentrated at member banks—roughly $2 0 billion The remainder reflected faster remittance from nonmember banks through correspondents

Banks that do not have accounts at the Federal Reserve remit through correspondent banks that do have such accounts Prior to November 1972, these banks could follow either of two accounting procedures First, they could, upon receipt of a cash letter from the Federal Reserve, reduce their customer accounts and the deposits due from domestic banks The next day, when the correspondent remitted to the Federal Reserve, it would reduce an account reflecting deposits due to banks Given these transactions and other things being unchanged, deposits due to banks would always exceed deposits due from banks

In the alternative procedure, nonmember banks could use essentially the same procedure as member banks, writing down customer demand deposits and increasing other liabilities for 1 day On the following day, when the correspondent bank remitted to the Federal Reserve and reduced deposits due to banks, the nonmember banks would write down deposits due from banks and other liabilities Under this accounting procedure, deposits due to and due from banks remained in balance each day To the extent that the second accounting method was used, the contraseasonal decline in other liabilities at nonmember banks after the change in Regulation J should provide a measure of its magnitude Other liabilities at nonmember banks showed a contraseasonal decline of only about $300 million Subtracting this $300 million from the $2 0 billion remittances through correspondents by nonmember banks leaves $1 7 billion This is a rough estimate of the amount by which deposits due from banks were reduced 1 day prior to the reduction in deposits due to banks [3]

Since neither other liabilities nor deposits due from banks are used in calculating the current money stock, adjustment for both transactions was appropriate in order to avoid a break in series after the change in Regulation J For the alternative measure, however, in whose construction net interbank deposits were used, adjustment was appropriate only for the other liabilities related to member banks' remittances for their own accounts and to nonmember remittances through correspondents when similar accounting procedures were followed No adjustment is necessary in the alternative series for the remittances associated with the early reduction of deposits due from banks In fact, because the alternative money stock measure used the current measure as a base, the Regulation J adjustment was included in both series The result was that alternative M_1 as originally calculated was overstated by the amount of the inappropriate adjustment for remittance-payment bias

A new estimate of the overstatement of the alternative M_1 was derived by using the late-1972 estimate of $1 7 billion as a benchmark and reducing this level by $100 million each year back to 1959 This is not a satisfactory procedure, but unfortunately, there is no better way to make this adjustment Regardless of how the adjustment is made, it is sufficiently small and would be spread over a sufficiently long period of time that year-to-year distortion should be minor

The adjustments for the current and alternative money stock for the last day of each year from 1959 to 1974 are shown in Table 1 in the text As indicated, the adjustments for cash-items bias were folded into the published money stock series in 1976

[3] The practice of writing down amounts due from banks before remittance by correspondents might have been unnecessarily costly for nonmember banks because of lower deposits that could be used to meet nonmember State reserve requirements, and there is no economic explanation for its use

Developing Money Substitutes: Current Trends and Their Implications for Redefining the Monetary Aggregates

Steven M Roberts

This paper was completed in January 1977 It has not been revised to include any deposit or other data available since late 1976 Nor has any attempt been made to incorporate any regulatory or legal changes affecting the monetary aggregates that have been made since late 1976

In recent years the distinction between demand deposits and savings deposits at both banks and nonbank depositary institutions has become increasingly blurred The driving force behind the regulatory and institutional innovations leading to this development has been greater competition for funds among financial institutions, which in turn has resulted in expanded payments services and higher interest returns to deposit owners For example, depositary innovations that have emerged within the last few years include negotiable orders of withdrawal (NOW) accounts in New England, telephonic and third-party transfers from savings accounts, credit union share drafts, and electronic transfers of funds by means of customer bank communication terminals (CBCT's)

As a result of these and other innovations—which suggest evolving savings-based transfer systems—the traditional meaning of the narrow money stock (M_1), defined as private demand deposits at commercial banks plus currency in the hands of the public, as being representative of the economy's media of exchange or cash balances, has been somewhat eroded While the usage is thus far relatively small, it can be expected that an increasing volume of fund transfers may be made from interest-bearing accounts, and M_1 as currently defined may account for a smaller proportion of total transactions in the years ahead Consequently, monetary policy formulation might appropriately consider and evaluate movements in a broader array of monetary aggregates that explicitly recognize the development of savings-based transfers and other recent developments

The Board of Governors of the Federal Reserve System and the Federal Open Market Committee, through Chairman Burns' recent series of congressional testimonies on monetary policy, are already on record as having targets for the growth of several monetary aggregates, including M_1, M_2, and M_3 [1] However, it should be recognized that the time deposit components of M_2 and M_3 have specific maturities and strict regulations regarding redemption prior to maturity that make them both relatively illiquid compared with savings deposits and M_1 and not really representative of transactions balances, although they may be considered near-money reposi-

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He would like to thank Paul Boltz, Edward Ettin, David Lindsey, Raymond Lombra, Darrel Parke, John Paulus, and John Williams for comments on early drafts of this paper

[1] These testimonies are published in the *Federal Reserve Bulletin* on a regular basis and also appear in the *Annual Report*

M_2 is defined as averages of daily figures for M_1 plus time and savings deposits at all commercial banks other than negotiable certificates of deposit (CD's) of $100,000 or more at large weekly reporting banks M_3 is defined as M_2 plus the average of the deposits at the beginning and the end of the month at mutual savings banks, savings and loan associations, and credit unions tories for precautionary or speculative funds [2] Also, in recent years there has been a tendency for small-denomination time deposit funds to become increasingly concentrated in the longer maturities because interest ceilings and rates paid on such maturities make them relatively more attractive, vis-a-vis market instruments, than the shorter-maturity time deposits Thus, the inclusion of longer-maturity time deposits in M_2 and M_3 has resulted in monetary aggregates that include, in addition to M_1, both liquid (savings) and illiquid deposits

In addition, the meaning of M_2 and M_3 as currently defined may also be distorted by the current treatment of large-denomination (over $100,000) time deposits The current definition of "other time and savings deposits" —which are added to M_1 to obtain M_2—is total time and savings deposits less negotiable certificates of deposit (CD's) in denominations of $100,000 or more at weekly reporting banks [3] This definition of other time and savings deposits means that M_2 includes not only those large-denomination time deposits at weekly reporting banks that are not in the form of negotiable CD's but also all large-denomination time deposits, whether negotiable or not, at all other banks Recently available data suggest that movements of other time and savings deposits, as currently defined, may be significantly influenced by large-denomination deposits that tend to move like negotiable CD's at weekly reporting banks and do not parallel the behavior of consumer-type (small-denomination) deposits Thus, not only do M_2 and M_3 contain long-term maturity deposits, which are unlikely to be used as part of the payments mechanism, but M_2 also contains both small- and large-denomination deposits, with the latter behaving differently from the former over the business cycle

It should also be noted that nonbank thrift institutions—that is, mutual savings banks (MSB's), savings and loan associations (S&L's), and credit unions—have been relatively more active than commercial banks in developing and marketing savings-based transfer services for their customers [4] These services include not only telephonic and third-party transfers but also direct transfers between consumer and business savings deposits as payment for goods and services by means of remote terminals Commercial banks have been able to offer similar services only since 1975 The development of savings-based transfers at nonbank thrift institutions suggests that the Federal Reserve will need more extensive and more timely data on deposits at such institutions in order to monitor developments in the more broadly defined stock of "money" used for payments [5]

The remainder of this paper reviews these developments in more detail and considers their implications for redefining the monetary aggregates One section focuses on the recent regulatory changes and financial innovations that have led to the development of money substitutes Some of the new money substitutes will be described and, whenever possible, data on the dollar amounts outstanding and on rate of growth will be presented The analysis will indicate the causes for the recent changes Another section discusses two problems re-

[2] The penalty for early withdrawal of a time deposit under Regulation Q (Section 217 4 as amended July 5, 1973, applicable to all time deposit contracts entered into after that date) is that interest paid on the amount withdrawn may not exceed the savings deposit ceiling rate and that 3 months' interest is forfeited The Federal Deposit Insurance Corporation (FDIC) and the Federal Home Loan Bank Board (FHLBB) have similar regulations for the depositary institutions under their jurisdiction

[3] Weekly reporting banks are the approximately 320 large commercial banks that report detailed balance sheets to the Federal Reserve System each week

[4] The term nonbank thrift institutions will be used in the remainder of this paper to denote MSB's, S&L's, and credit unions taken as a group

[5] More timely and extensive data from the FDIC pertaining to demand deposits at nonmember banks have been recommended as necessary to the Federal Reserve's central monetary policy function in *Improving the Monetary Aggregates Report of the Advisory Committee on Monetary Statistics* (Board of Governors, 1976) Beginning with the March 1976 call report, the FDIC agreed to collect 7 days of deposit data from nonmember banks in order to provide weekly average benchmark data rather than single-day data In addition, the FDIC has agreed to reinstitute the collection of weekly data from a sample of about 575 nonmember banks Data from a similar sample of nonmember banks was collected on an experimental basis from the summer of 1974 to the spring of 1975

lating to the current definition of "other" time deposits that are included in M_2 The creation of longer-maturity, small-denomination time deposit categories under Regulation Q has changed the maturity structure of these time deposits significantly This is true of time deposits at S&L's and MSB's and thus affects the current definition of M_3 also In addition, this section discusses the inclusion of large-denomination time deposits in the definition of M_2 and M_3 The final section draws on the initial portions of the paper and suggests several ways in which current definitions of the monetary aggregates might be modified at some future date

Recent regulatory changes and financial innovations and the development of M_1 substitutes

Substitutes for transactions balances held in the form of currency or demand deposits have existed for a long time However, it is only within the past several years that regulatory changes and financial innovations have resulted in new means of facilitating payments for goods and services Today payments may be made through deposits held at banks and nonbank thrift institutions without directly involving currency or demand deposits From an institutional point of view, the single most important factor influencing the development of savings-based transfers[6] is the prohibition of interest payments on demand deposits legislated in the mid-1930's[7] In the 1950's and 1960's the public—particularly the business sector—sought to reduce non-interest-bearing claims in favor of highly liquid earning assets that could be easily transferred into a payments medium, these claims—money market assets such as Treasury bills, commercial paper, and negotiable CD's—were generally available only in large denominations A second important institutional factor leading to savings-based transfers has been the statutory monopoly of demand deposit powers by commercial banks This monopoly has led to vigorous efforts by nonbank thrift institutions to develop payments alternatives that they can offer to their customers as substitutes for demand deposits It is clear that the nonbank thrift institutions as an industry have been more innovative in the payments area because they have been forced to compete with banks for payment-type deposits[8]

Although nonbank thrift institutions in general may not issue payment-type deposits, commercial banks may not pay interest on their demand deposits[9] Thus, as the thrift institutions have introduced money substitutes, commercial banks—seeing their competitive advantage eroding—have sought changes in regulations in order to make bank savings deposits easier to transfer In the past 5 years there have been significant changes relating to ownership and transfer of savings deposits at banks

Innovations and regulatory changes made in the period since 1970 that affect components of M_1, M_2, and M_3 are shown in Table 1

If these types of innovative changes continue—as seems likely, given both their rapid recent increase and the changes that will be induced by activity under electronic funds transfer systems (EFTS)—the basic monetary aggregates may have to be redefined to include in M_1 or some new aggregate all, or part, of the new demand deposit substitutes The remainder of this section provides specific information relating to several of the recently developed money substitutes

NOW accounts

A NOW account is a savings deposit that permits the owner of the deposit to withdraw

[6] Savings-based transfers is a term that will be used in this paper to denote payments involving an initial or direct transfer from interest-bearing deposits, shares, and so forth

[7] Section 19 of the Federal Reserve Act as amended by the Banking Act of 1933

[8] S&L's and MSB s have, of course, been given some competitive advantage over banks in the time and savings deposit markets because of the ¼ percentage point interest ceiling advantage they enjoy

[9] Appendix 1 provides a State by State rundown of transfer powers of State chartered thrift institutions

TABLE 1: Innovations and Regulatory Changes Since 1970

Date of change	Change
Sept 1970	S&L's were permitted to make preauthorized nonnegotiable transfers from savings accounts for household-related expenditures [1]
June 1972	State-chartered MSB's in Massachusetts began offering NOW accounts
Sept 1972	State-chartered MSB's in New Hampshire began offering NOW accounts
July 1, 1973	Federal regulatory authorities introduced a 4-year time deposit (ceiling free) with a minimum denomination of $1,000
July 5, 1973	Federal Reserve amended Regulation Q to modify penalties for early withdrawal of time deposits
Nov 1, 1973	Interest rate ceilings were imposed on 4-year $1,000 minimum time deposits (7¼ per cent for banks and 7½ per cent for S&L's and MSB's)
Jan 1, 1974	All depositary institutions in Massachusetts and New Hampshire (except credit unions) were authorized by the Congress to offer NOW accounts [2] Accounts similar to NOW's, but non-interest bearing, offered by State-chartered thrifts in additional States through the year [3]
Jan 1974	First Federal Savings and Loan, Lincoln, Nebraska, installed customer bank communication terminals (CBCT's) in two Hinky Dinky supermarkets, allowing its customers to make deposits to or withdrawals from savings accounts Such withdrawals can be used to pay for merchandise purchased from the stores The First Federal system, known as Transmatic Money System (TMS), is now being franchised to other S&L's
Early 1974	Money market mutual funds (MMMF's) came into existence on a large-scale basis These funds, which invest in money market instruments, allow their shareholders to redeem shares by checks drawn on accounts established at designated banks, by wire transfer, or by mail
Aug 1974	Federal credit unions were permitted to issue credit union share drafts, which are check-like instruments payable through a commercial bank [4]
Nov 27, 1974	Commercial banks were permitted by Federal regulatory authorities to offer savings accounts to domestic State and local government units
Dec 23, 1974	Federal regulatory authorities introduced a 6-year time deposit, minimum denomination $1,000, with a 7½ per cent ceiling for banks and 7¾ per cent ceiling for S&L's and MSB's
Apr 7, 1975	Member banks were authorized by Federal Reserve to make transfers from a customer's savings account to his checking account upon telephonic order from the customer
Apr 16, 1975	The FHLBB broadened its 1970 action to allow S&L's to make preauthorized third-party nonnegotiable transfers for any purpose
Sept 2, 1975	Commercial banks were authorized by Federal regulatory authorities to make preauthorized third-party nonnegotiable transfers from a customer's savings account for any purpose
Nov 10, 1975	Commercial banks were authorized by Federal regulatory authorities to offer savings accounts to partnerships and corporations operated for profit, limited to $150,000 per customer per bank
Jan 16, 1976	The Federal Reserve adopted an interim policy for access to System-operated automated clearing houses (ACH's) that indicated that ACH transfers could "originate from any account having third-party powers, for example, savings, NOW, and share draft accounts," as well as from demand deposit accounts
Feb 27, 1976	Federal legislation authorizing NOW accounts in Connecticut, Maine, Rhode Island, and Vermont became effective
Mar 15, 1976	The Federal Reserve and the FDIC proposed for comment an amendment to Regulation Q to permit banks upon request of a customer to cover overdraft of a demand deposit account by automatic transfer of funds from the customer's savings account At this writing the rule change has not been made
May 26, 1976	All State-chartered S&L's and MSB's in New York were granted consumer demand deposit powers pursuant to Chapter 225 of the laws of 1976

[1] Authority contained in the Housing Act of 1970

[2] Public Law 93-100, signed August 16, 1973

[3] According to Marilyn G Mathis, "Thrifts continue to gain in third-party payment plans," *Banking*, vol 66 (December 1974), pp 32–38, non-interest-bearing NOW's were offered by at least some thrifts in Connecticut, Delaware, Indiana, Maryland, New Jersey, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, and Utah In 1975 several other States enacted legislation permitting State chartered institutions to offer similar accounts These States include Illinois, Maine, Nebraska, and Vermont See Appendix 1 for a list of transfer powers authorized for State chartered institutions

[4] Section 721 3, Rules and Regulations of the National Credit Union Administration (NCUA), established rules for experimental pilot programs for electronic funds transfers (EFT) that include share draft plans

funds by writing a negotiable order of withdrawal—hence the acronym NOW [10] The withdrawal document is a negotiable draft that can be used to make payments to third parties, essentially like a check drawn on a bank demand deposit This form of savings account came into being following a ruling by the Massachusetts Supreme Judicial Court on June 12, 1972, that found no restriction in the State charter of MSB's prohibiting withdrawals from savings accounts through the use of NOW drafts

State chartered MSB's in Massachusetts soon entered the NOW market, and in September a savings bank in New Hampshire began to offer NOW's after having determined that, as in Massachusetts, there were no statutory restrictions on the manner of withdrawal from savings accounts Immediately, State-regulated savings banks in the two States held a competitive advantage over Federally chartered or insured institutions, which could not offer NOW accounts These institutions sought relief from Federal agencies, which led to congressional legislation (Public Law 93–100), signed into law August 16, 1973, authorizing all depositary financial institutions (except credit unions) in Massachusetts and New Hampshire to offer interest-bearing deposits on which negotiable instruments of withdrawal could be drawn As a result of this legislation, regulations by the Federal Reserve, the FHLBB, and the FDIC authorized NOW's for Federally chartered depositary institutions in Massachusetts and New Hampshire as of January 1, 1974, limited exclusively to individuals and nonprofit organizations [11] The three agencies agreed to impose a uniform interest rate ceiling of 5 per cent on NOW's and to restrict the advertisement of such accounts to Massachusetts and New Hampshire

Outstanding NOW balances at various types of depositary institutions in Massachusetts and New Hampshire from September 1972 to December 1975 are shown in Table 2 Growth in NOW accounts has been rapid throughout the period Table 2 also shows market shares, which have changed considerably over time and have not as yet stabilized fully Originally, MSB's—which pioneered NOW accounts—dominated the market, but more recently commercial banks have entered the NOW market aggressively, and their share of that market has grown very rapidly A few commercial banks have converted all eligible savings accounts to NOW's, and some have notified customers that their demand deposits are eligible for conversion to a NOW account

Table 3 compares some of the characteristics of NOW accounts at competing institutions as of December 31, 1975 Most institutions were paying 5 per cent interest on a day-of-deposit-to-day-of-withdrawal basis A majority of these institutions also compounded interest daily or continuously and offered free NOW drafts The higher proportion of free drafts at nonbank institutions suggests that they see NOW accounts as a means of drawing funds from commercial bank demand deposits—that is, via the absorption of clearing costs as a nonprice means of competitive advantage Table 4 shows how charges per draft and activity per month have changed since January 1974 Accounts with free draft privileges are typically the most active Furthermore, NOW account activity has increased considerably as more institutions offer free drafts [12]

On February 27, 1976, congressional legislation authorizing NOW accounts in Connecticut, Maine, Rhode Island, and Vermont became effective Although little information is yet available regarding the newly authorized NOW markets, it appears that commercial banks entered this market more rapidly than did thrift institutions during the first month of expanded

[10] Much of the material in this subsection is based on the work of my colleague John Williams

[11] From November 1974 until authorization was withdrawn in April 1975, State and local governmental units were permitted to hold NOW accounts at commercial banks

[12] For additional information on NOW account activity in 1974 and 1975, see John D Paulus, "Effects of NOW Accounts on Costs and Earnings of Commercial Banks in 1974–75," Staff Economic Studies 88 (Board of Governors of the Federal Reserve System, 1976)

TABLE 2 Outstanding Balances and Shares—NOW Accounts

Dollar amounts in thousands

Date	All offering insti-tutions	Commercial banks			Share of total NOW's	Mutual savings banks			Share of total NOW's	Savings and loan associations			Share of total NOW's
		Total	Massa-chusetts	New Hamp-shire		Total	Massa-chusetts	New Hamp-shire		Total	Massa-chusetts	New Hamp-shire	
1972—Sept	11,094					11,094	11,094						
Oct	22,386					22,386	22,386						
Nov	34,823					34,823	34,363	−460					
Dec	45,272					45,272	44,522	750					
1973—Jan	60,726					60,726	59,661	1,065					
Feb	73,451					73,451	71,975	1,476					
Mar	86,118					86,118	84,162	1,956					
Apr	94,606					94,606	92,341	2,265					
May	102,045					102,045	99,633	2,412					
June	108,381					108,381	105,688	2,693					
July	113,418					113,418	110,486	2,932					
Aug	117,005					117,005	113,852	3,153					
Sept	120,223					120,223	116,259	3,964					
Oct	130,361					130,361	125,873	4,488					
Nov	136,872					132,872	131,795	5,077					
Dec	143,254					143,254	138,028	5,226					
1974—Jan	143,190	2,556	2,274	282	02	139,779	134,832	4,947	98	855	855		01
Feb	150,447	4,338	3,857	481	03	143,764	138,453	5,311	98	2,345	2,345		02
Mar	165,157	6,588	5,916	672	04	154,007	147,845	6,162	93	4,562	4,325	237	03
Apr	174,682	9,689	8,458	1,231	06	157,412	150,309	7,103	90	7,581	6,913	668	04
May	180,637	11,052	9,296	1,756	06	159,591	151,510	8,081	90	9,994	8,351	1,143	05
June	191,229	13,771	11,156	2,615	07	164,733	155,946	8,787	86	12,725	11,089	1,636	07
July	204,646	17,919	14,175	3,744	09	171,503	161,544	9,959	84	15,224	13,223	2,001	07
Aug	232,386	32,955	28,450	4,505	14	180,335	169,119	11,216	78	19,096	16,781	2,315	08
Sept	249,033	39,253	33,597	5,656	16	187,721	175,340	12,381	75	22,059	19,314	2,745	09
Oct	270,813	46,776	40,245	6,531	17	197,758	184,830	12,928	73	26,279	23,316	2,968	10
Nov	293,305	55,994	48,563	7,431	19	206,764	192,577	14,187	71	30,547	26,689	3,858	10
Dec	312,576	65,249	56,989	8,260	21	213,661	200,083	13,578	68	33,666	29,747	3,919	11
1975—Jan	339,982	82,861	73,517	9,344	24	220,725	206,797	13,928	65	36,396	32,369	4,027	11
Feb	395,190	107,481	96,647	10,481	28	236,580	221,506	15,074	61	41,482	37,215	4,267	11
Mar	449,638	137,519	124,706	12,813	31	262,797	246,259	16,538	58	49,322	43,980	5,342	11
Apr	472,864	150,999	136,165	14,834	32	268,571	250,780	17,791	57	53,294	47,185	6,109	11
May	514,018	172,653	155,318	17,335	34	283,322	263,978	19,344	55	58,043	51,388	6,655	11
June	580,331	210,838	185,923	24,195	36	304,633	283,134	21,499	53	64,860	57,315	7,545	11
July	630,402	233,513	201,607	31,096	37	327,417	303,805	23,612	52	69,472	61,554	7,918	11
Aug	670,790	256,992	217,936	39,056	38	337,684	213,117	25,567	50	76,114	67,519	8,595	11
Sept	713,419	289,308	235,029	45,279	39	351,612	324,005	27,607	49	81,499	72,407	9,092	11
Oct	761,967	305,214	254,821	50,393	40	368,271	338,580	29,691	48	88,482	78,785	9,697	12
Nov	796,533	325,519	271,691	53,828	41	378,792	347,145	31,647	48	92,222	81,863	10,359	12
Dec	839,339	359,023	302,112	56,911	43	386,560	356,319	30,241	46	93,756	84,168	9,598	11

NOTE —Monthly data are released by the Federal Reserve Bank of Boston

SOURCE —John D Paulus, "Effects of NOW Accounts on Costs and Earnings of Commercial Banks in 1974–75," Staff Economic Studies 88 (Board of Governors of the Federal Reserve System, 1976)

authorization This development is significantly different from the experience in Massachusetts and New Hampshire Almost all of the institutions that offered the new accounts were paying the ceiling rate of 5 per cent, although relatively few were offering free drafts The total of the newly authorized NOW balances in the four States as of March 31, 1976, amounted to only $43 million

TABLE 3 Characteristics of NOW Accounts, by Type of Institution, December 31, 1975

In per cent

Institution	Interest			Free drafts
	5 per cent	Continuous or daily com-pounding	From day of deposit to day of withdrawal	
Commercial banks	96	45	73	30
Mutual savings banks	97	86	98	77
Savings and loan associations	99	69	92	82
All institutions	97	69	89	63

Commercial bank savings deposits

From November 1974 to March 1976 the Federal banking authorities made four regulatory changes, and proposed a fifth, which have greatly expanded the possibilities for substitution of savings deposit balances for balances now included in M_1, particularly demand deposits These changes have been of two types (1) to allow for expanded ownership of savings deposits, and (2) to permit banks to offer their customers new services that would facilitate the use of savings deposits for transactions purposes

TABLE 4 NOW Account Activity and Charges

Month	Charges per draft (per cent of issuing institutions)				Drafts per account during average month[2]
	Free	10¢	15¢	Other[1]	
1974—Jan	32.5	17.5	50.0		7.3
Feb	31.2	18.4	45.4	5.0	7.0
Mar	35.1	16.4	42.7	5.8	7.8
Apr	34.0	16.5	42.0	7.4	8.5
May	34.8	16.2	40.7	8.3	8.5
June	33.5	18.5	40.5	7.5	8.1
July	34.5	18.5	39.9	7.1	8.5
Aug	42.5	15.8	31.2	10.5	8.0
Sept	53.7	14.4	21.8	10.1	8.2
Oct	56.0	12.3	19.9	11.9	8.8
Nov	60.4	10.9	16.1	12.6	8.9
Dec	61.7	10.8	12.5	14.9	9.5
1975—Jan	62.3	8.9	10.8	18.0	9.3
Feb	64.0	8.2	10.4	17.4	8.8
Mar	66.0	7.7	8.6	17.8	10.0
Apr	66.6	6.2	9.6	17.7	10.5
May	66.2	5.6	8.8	19.3	10.4
June	64.4	5.1	7.9	22.6	10.4
July	65.7	4.7	6.7	22.9	10.3
Aug	67.2	3.9	5.6	23.3	9.8
Sept	65.6	3.7	5.9	24.9	10.3
Oct	65.8	3.6	5.8	24.8	10.7
Nov	65.3	4.0	5.7	24.9	10.2
Dec	63.5	4.0	6.0	26.5	11.0
1976—Jan	63.4	3.4	5.1	28.0	10.7
Feb	61.6	3.7	5.3	29.5	10.3
Mar	54.9	3.4	5.5	36.2	11.6[3]

[1] Includes a combination of free drafts plus a charge for each draft over a specified number, and free drafts in exchange for a specified minimum balance

[2] Excludes accounts with no activity during the month

[3] Includes NOW accounts in Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont

Domestic governmental units were first permitted to hold savings deposits at commercial banks in November 1974 Effective November 10, 1975, commercial banks were permitted to offer savings accounts to partnerships and corporations, limited to $150,000 per customer per bank These accounts have grown more quickly than originally anticipated and by the end of March 1976 amounted to about $2.5 billion at the weekly reporting banks and $5.4 billion at all insured commercial banks

Authorization to make telephonic transfers from savings to demand deposits and preauthorized third-party nonnegotiable transfers directly from savings deposits provides banks the opportunity to offer their customers more convenient methods for using savings deposits to make payments Because these savings-based services are new, it is difficult to gauge with any degree of certainty their quantitative impact on M_1 The direction of impact, however, is clear these services, if widely offered and utilized, would tend to reduce further the distinction between demand and savings deposits, and thus would erode the significance of M_1 and would alter its relationship to the gross national product

Competition from thrift institutions and the prohibition of interest payments on demand deposits suggest that commercial banks will offer these new services based on customer demand It is difficult to quantify the extent to which these new savings transfer services are being used, however, through informal surveys and monitoring of developments by the Federal Reserve Banks and the FHLBB, it appears that telephonic transfer services are being offered on a fairly wide geographic basis by both large and small banks and also by S&L's Preauthorized third-party nonnegotiable transfer services do not appear to be widely offered

On March 15, 1976, the FDIC and the Federal Reserve issued a proposal to allow banks to offer automatic overdraft protection from savings accounts by means of preauthorized transfers from savings to cover overdrafts If adopted, this new service would be complementary to those savings-based transfer services already permissible Such a service, priced to compete with consumer overdrafts by takedowns of lines of credit, could be widely marketed by banks, has the potential for consumer acceptance, and could induce expanded use of complementary services If these developments were to take place, the average size of demand deposit accounts would tend to decline It should be emphasized that overdraft services would be an additional factor—indeed, an extremely important one—tending to increase the relative importance of savings deposits in the payments process, while reducing the significance of M_1 as it is currently defined

Money market mutual funds

Money market mutual funds (MMMF's) are a fairly new form of investment company, the first was organized in 1971, and others began operation in 1974 It was not until after the period of rising interest rates in early 1974 that the MMMF's began to grow rapidly in number and dollar size As Table 5 shows, between January and December 1974 the number of money market funds increased from 4 to 30 and net assets of the industry grew from less than $200 million to about $2 5 billion The number of funds increased through 1975, although the dollar amount of assets stabilized at about $3 6 billion as market interest rates declined

Designed basically as cash management vehicles, these funds provide shareholders with an interest return that varies with rates in the money market They typically invest in instruments that are issued in large denominations such as Treasury bills, large-denomination CD's, bankers acceptances, and commercial paper, while requiring shareholders to invest relatively small initial amounts such as $500 to $1,000 Shares in these funds can be purchased and redeemed easily, often without transaction charges Management fees of the funds are also relatively low Because of the high liquidity of shares, near-market rate of return, zero or near-zero transaction costs, and low management fees, shares in money market funds provide an attractive substitute for both demand and savings deposits offered by depositary institutions

Most of the funds calculate and pay dividends on a daily basis, shares can be redeemed by check or wire transfer at little or no cost, and most funds have no sales charges The check redemption feature is especially interesting The shareholder may receive a book of ordinary checks from a bank (designated by

TABLE 5 Growth in Money Market Mutual Funds January 1974–March 1976

Month	Number of funds	Assets (millions of dollars)	Change over month (millions of dollars)	Growth rate (per cent per month)	Average yield (per cent per month)
1974—Jan	4	174			8 6
Feb	6	208	34	19 5	8 1
Mar	6	244	36	17 3	7 8
Apr	7	303	59	24 2	8 7
May	8	412	109	36 0	10 0
June	10	542	130	31 6	10 2
July	13	792	250	46 1	11 2
Aug	17	1,106	314	39 6	11 3
Sept	18	1,393	287	25 9	11 3
Oct	22	1,860	467	33 5	10 5
Nov	26	2,208	348	18 7	9 4
Dec	30	2,439	231	10 5	9 0
1975—Jan	32	3,042	604	24 8	9 0
Feb	35	3,501	458	15 1	7 3
Mar	36	3,786	285	8 1	6 5
Apr	37	3,862	76	2 0	5 8
May	38	3,911	49	1 3	6 4
June	39	3,795	−116	−3 0	5 1
July	40	3,694	−101	−2 7	5 7
Aug	40	3,787	93	2 5	6 0
Sept	42	3,750	−37	−1 0	6 2
Oct	42	3,723	−27	− 7	6 1
Nov	46	3,645	−19	− 5	5 6
Dec	47	3,645	−59	−1 6	5 6
1976—Jan	48	3,701	56	1 5	5 3
Feb	48	3,736	35	9	5 0
Mar	48	3,719	−17	− 5	5 1

the particular fund) and can use these checks to make payments However, arrangements often specify minimums such as $500 per check When the check is presented to the payee bank, the bank, acting as the shareholder's agent, instructs the mutual fund's transfer agent to redeem a sufficient number of shares in the shareholder's account to cover the amount of the check This procedure allows the shareholder to earn interest on his investment until payment is made to the bank In a similar manner, shareholders with a large amount of funds invested can arrange for wire transfer of funds both out of and into their share accounts at their commercial banks

The ease with which shares may be purchased and redeemed with minimal transactions costs suggests that the MMMF's make extremely good investments for cash management purposes In fact, a large proportion (about 40 per cent) of all accounts are owned by institutional investors that use them to increase cash management efficiency But both consumers and households may find MMMF's to be useful substitutes for demand, savings, and time deposit balances, and consequently they are another factor altering the relationship between market rates and the monetary aggregates, and between the aggregates and gross national product

Credit union share drafts[13]

Credit union share drafts are a new type of payment instrument and thus are neither widely known nor widely used However, there are approximately 23,000 credit unions in the United States, with total assets of about $35 billion, and if the current rapid growth of credit union shares continues, the potential impact on M_1 and M_2 of widespread use of share drafts will be large

A share draft is a negotiable payments instrument drawn on the issuing credit union but payable through a commercial bank It is one form of the legal payments instrument known as "payable-through drafts" Unlike a check that is drawn directly on the deposit liability of a commercial bank, a credit union share draft is drawn on the credit union that has established a clearing arrangement with the "payable-through bank" In the clearing process, these drafts are treated the same as checks until they are received by the payable-through bank, which notifies the credit union as to the drawer, the amount, and the debit to the credit union's account at the bank for payment of the drafts The credit union will then debit the shareholder's account The important point is that interest will be paid on the shareholder's funds until the draft is cleared and the account is debited

In many respects share draft accounts are like NOW accounts and have the same advantages over non-interest-paying checking accounts As Table 6 indicates, the number of credit unions now offering such accounts is only about 1 per cent of the total, but the recent growth rate has been impressive as early problems have been resolved As indicated above, share draft plans have been authorized for Federal credit unions by the National Credit Union Administration (NCUA) only since August 1974 In order to make the share draft attractive to their shareholders, many credit unions are not, at least at this time, charging for drafts With interest on share accounts in many cases above the maximum that commercial banks, S&L's, and MSB's can pay on savings deposits, share draft accounts are an attractive payments alternative Shareholder knowledge of, and demand for, share draft privileges are the key unknown elements at this time

Changes affecting the time deposit components of M_2 and M_3

The previous section focused on recent regulatory changes and financial innovations that have induced the creation of new substitutes for M_1 Savings deposits, which are included in the "other time and savings" component

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13 Additional information may be obtained from *Savings and Loan News*, vol 97 (April 1976), and "Share Drafts The First Six Months" (report of the Credit Union National Association, 1975)

TABLE 6: Share Drafts at Credit Unions

Month	Credit unions offering drafts			Credit unions approved to offer drafts[2]	Drafts drawn per month[3] (thousands)		Federal credit unions offering share drafts	
	Federal	State[1]	Total		Federal	Total	Amount drawn per month	Shares subject to withdrawal by draft per month
							Thousands of dollars	
1975—May	5	7	12	12	15	23	1,100	2,208
June	6	8	14	29	20	33	1,200	3,471
July	11	15	26	54	26	44	1,800	3,972
Aug	16	17	33	81	32	59	2,100	5,028
Sept	27	19	46	96	51	91	3,100	6,759
Oct	53	19	72	120	184	144	4,500	9,453
Nov	65	29	94	143	106	171	5,600	12,111
Dec	81	37	118	170	179	278	9,300	14,395
1976—Jan	108	55	163	189	189	304	12,300	23,092
Feb	118	63	181	203	247	399	13,939	29,718
Mar	131	59	190	223	375	575	20,846	37,879

[1] Data for State-chartered credit unions include an incomplete industry sample

[2] Federally chartered, includes those now offering drafts

[3] Partially estimated by the National Credit Union Administration

SOURCE —NCUA

of M_2, have been significantly affected by recent regulatory changes This section analyzes two changes in the time deposit component of "other time" deposits First, the effect of penalties for early withdrawal and the establishment of higher interest rates for the newly created, longer-maturity time deposits with small minimum denominations are discussed Second, the inclusion of some large-denomination time deposits within the current definition of other time deposits will be examined

Longer-maturity, consumer-type time deposits

Two recent changes in the Federal regulations governing interest payment on deposits by depositary institutions have affected the composition and meaning of the time deposit components of M_2 and M_3—penalties for early withdrawal of time deposits and the establishment of higher interest rate ceilings on newly created, longer-maturity time deposits[14] The former decreases the liquidity of time deposits because the dollar value of the penalty increases as the maturity date approaches The latter has lengthened the maturity composition of other time deposits because of the relatively attractive rates paid on longer-maturity deposits It also has decreased the over-all liquidity of other time deposits and reduced the substitutability between small-denomination time deposits and demand deposits Time deposits have become more like securities and less like deposits

In July 1973 the Federal Reserve amended Regulation Q to modify the structure of interest penalties for withdrawal of time deposits prior to maturity, the FDIC made a corresponding change in its regulations One reason for this change was to make the penalties for early withdrawal of time deposits the same for banks and for thrift institutions The penalty for early withdrawal was established as (1) the forfeiture of 3 months' interest and (2) for the remainder of the period during which the withdrawn amount was held, the reduction of the rate paid to the regular passbook rate[15]

In addition to the establishment of the modified penalty, banks were also required under Regulation Q to describe fully and clearly by written statement how the penalty provisions applied to time deposits Table 7 provides an example to illustrate the penalty for early withdrawal of a 4-year $1,000 time certificate of deposit It displays the increasing dollar cost of withdrawal of the deposit prior

[14] Much of the information in this section is based on work done by Gerald Nickelsburg, while a member of the research staff of the Board of Governors

[15] The rule for early withdrawal in effect before July 1973 permitted a bank to pay a time deposit before maturity only in an emergency, when the withdrawal was necessary to prevent great hardship to the depositor In such cases, the depositor forfeited accrued and unpaid interest for a period of up to 3 months

TABLE 7 Penalty for Early Withdrawal of a $1,000, 7¼ Per Cent, 4-Year Certificate

Dollars, except as noted

Year and quarter	Imputed value if held to maturity	Value if withdrawn prior to maturity[1]	Penalty for early withdrawal	Effective rate of return if withdrawn at given date[2] (per cent)
1—1	1,018 12	1,000 00	18 12	
2	1,036 58	1,012 50	24 08	2 49
3	1,055 37	1,025 16	30 21	3 33
4	1,074 49	1,037 97	36 52	3 74
2—1	1,093 97	1,050 95	43 02	4 00
2	1,113 80	1,064 08	49 72	4 16
3	1,113 99	1,077 38	56 61	4 28
4	1,154 53	1,090 85	63 68	4 37
3—1	1,175 46	1,104 48	70 98	4 44
2	1,196 77	1,118 29	78 48	4 50
3	1,218 46	1,132 27	86 19	4 54
4	1,240 54	1,146 42	94 12	4 58
4—1	1,263 03	1,160 75	102 28	4 61
2	1,285 92	1,175 26	110 66	4 64
3	1,309 23	1,189 95	119 28	4 66
4	1,332 96	1,204 82	128 14	4 69

1 $1,000, plus interest actually earned, calculated as follows loss of 90 days' (1 quarter's) interest, with interest paid for remainder of the period actually held at the passbook rate of 5 per cent, compounded quarterly

2 Annual percentage rate assuming quarterly compounding

to maturity as the maturity date approaches The calculations assume an interest rate of 7¼ per cent compounded quarterly if the deposit is held for the full 4-year contract life The passbook rate is assumed to be 5 per cent, also compounded quarterly The penalty represents the "cost of liquidity" imposed by the current regulations The effective rate of return if an early withdrawal is made is shown in the last column

Also in July 1973, the Federal Reserve, the FDIC, and the FHLBB created a new time deposit category with a 4-year maturity and a higher ceiling rate than had previously been available These 4-year certificates were at that time, and are still, quite popular since they bear a 7¼ per cent rate ceiling for banks and a 7½ per cent ceiling for MSB's and S&L's [16] As a result, substantial shifting of funds from shorter to longer maturities began in July 1973 The shifting was reinforced in December 1974 by the introduction of a 6-year time deposit maturity category with ceiling rates of 7½ per cent for banks and 7¾ per cent for S&L's and MSB's

As shown in Table 8, which presents data on time and savings deposits by maturity for commercial banks, the trend toward a lengthened maturity distribution of time deposits is fairly easy to identify Similar information is given for MSB's in Table 9 and for S&L's in Table 10

At each type of institution, the longer-maturity, small-denomination time deposits have grown at a considerably more rapid pace than have the shorter-maturity certificates In fact, outstanding small time deposits with maturities of less than 2½ years declined or remained constant in absolute size and declined relative to total small-denomination time deposits except for the latest observation—January 1976—when market interest rates were low relative to time deposits The most rapid growth occurred in small-denomination time deposits with maturities of 4 years or more [17]

16 Originally, the 4 year deposits with minimum denominations of $1,000 had no interest ceilings and were known as "wild card" or "topless" certificates However, following complaints from many depositary institutions that note competition was adversely affecting their lending rates, the Congress made clear its desire that ceiling rates be established for the 4 year certificates Effective November 1, 1973, the Federal agencies imposed interest rate ceilings on these deposits of 7¼ per cent for banks and 7½ per cent for S&L's and MSB's

17 The S&L data are reported as remaining maturity, and thus the 4 year accounts represent only recent sales of certificates for each survey By the time of the next survey, those 4 year certificates previously issued will have less than 4 years remaining to maturity and thus will be counted in the 2 to 4 year maturity category This explains a large part of the growth in accounts with 2- to 4-year remaining maturity

TABLE 8 Time and Savings Deposits at All Commercial Banks, 1973–76

Date	Total	Savings			Small time					Total savings and small time	Large time		
		Total	NOW	Other	Total	Up to 1 year	1 to 2½ years	2½ to 4 years	4 years and over		Total	Up to 1 year	1 year and over
	Millions of dollars												
7–31–73	357,019	130,584	n a	130,584	107,948	46,301	48,510	9,956	3,181	238,532	118,487	104,173	14,314
1–31–74	378,296	130,923	3	130,920	115,064	43,294	45,554	13,262	12,954	245,987	132,309	119,298	13,011
7–31–74	413,452	137,307	17	137,290	117,960	39,848	41,422	15,663	21,027	255,267	158,185	148,580	9,605
1–31–75	433,416	141,122	83	141,039	123,027	39,135	37,741	17,365	28,786	264,149	169,267	157,557	11,710
7–31–75	445,330	158,515	234	158,281	132,999	41,171	36,372	19,500	35,956	291,514	153,816	135,975	17,841
1–31–76	461,640	171,321	394	170,927	146,096	47,067	36,506	20,453	42,070	317,417	144,223	124,300	19,923
	Per cent of total												
7–31–73	100	37	n a	37	30	13	14	3	1	67	33	29	4
1–31–74	100	35	*	35	30	11	12	4	3	65	35	32	3
7–31–74	100	33	*	33	29	10	10	4	5	62	38	36	2
1–31–75	100	33	*	33	28	10	9	4	7	61	39	36	3
7–31–75	100	36	*	36	30	9	8	4	8	65	35	31	4
1–31–76	100	37	*	37	32	10	8	4	8	69	31	27	4

n a Not available
* Less than 0 5 per cent of total

NOTE —Data from F R Quarterly Survey of Time and Savings Deposits, Weekly Condition Report of Large Commercial Banks and Domestic Subsidiaries, Reports of Deposits of Member Banks, Report of Condition of All Commercial Banks (call report)—Large Denomination Time Deposit Supplement

The denominational breakdown of time deposits—under and over $100,000—is available twice each year on the June and December call reports beginning December 31, 1973 The maturity breakdown of large time deposits is taken from the monthly Survey of Negotiable CD Maturity Structure at Weekly Reporting Banks, and it is assumed that all other large time deposits have the same maturity structure A special survey in February 1975 provided evidence for this assumption The weekly reporting bank data provide information on large negotiable CD's, and since 1975 on all large time deposits The maturity distribution for most small time deposits is reported four times per year in the Survey of Time and Savings Deposits These data are for individuals, partnerships, and corporations only

Details may not add to totals due to rounding All data are in original maturity

Savings deposits at S&L's and MSB's declined in relative, though not nominal, amounts during this period Savings deposits at commercial banks, however, experienced a large percentage increase This increase may be due to the convenience factor of having savings and demand accounts at the same institutions, while longer-maturity time deposits are more likely to be placed at the institution offering the highest yield

The relative increases in the longer-maturity categories, coupled with their relatively illiquid nature due to the penalty cost for withdrawal prior to maturity, suggest that not only are those deposits qualitatively different from savings deposits but also they are quite un-

TABLE 9. Time and Savings Deposits at FDIC-Insured Mutual Savings Banks, 1973–76

Date	Total	Savings			Small time					Total savings and small time	Large time		
		Total	NOW	Other	Total	Up to 1 year	1 to 2½ years	2½ to 4 years	4 years and over		Total	Up to 1 year	1 year and over
	Millions of dollars												
7–31–73	82,496	59,300	113	59,187	22,822	1,439	13,383	5,954	2,046	82,122	374	143	231
1–31–74	83,977	56,694	140	56,554	26,816	1,433	12,605	5,183	7,596	83,511	466	213	253
7–31–74	84,607	56,305	172	56,133	27,759	1,191	9,715	5,328	11,525	84,064	543	334	209
1–31–75	86,070	56,341	221	56,120	28,907	1,304	7,871	5,360	14,372	85,248	822	638	184
7–31–75	92,643	60,267	327	59,940	31,682	1,394	6,895	5,431	17,962	91,949	694	482	212
1–31–76	97,772	62,207	401	61,806	34,854	1,728	7,502	5,639	19,985	97,061	711	485	226
	Per cent of total												
7–31–73	100	72	*	72	28	2	16	7	2	99	1	*	*
1–31–74	100	68	*	68	32	2	15	6	9	99	1	*	*
7–31–74	100	67	*	67	33	1	11	6	14	99	1	*	*
1–31–75	100	65	*	65	34	2	9	6	17	99	1	1	*
7–31–75	100	65	*	65	34	2	7	6	19	99	1	1	*
1–31–76	100	64	*	63	36	2	8	6	20	99	1	*	*

* Less than 0 5 per cent of total

NOTE —Aggregate MSB deposit data are available as 1-day figures for the last day of each month The maturity distribution of these deposits is reported four times a year, on the same day as the commercial bank STSD, in the FDIC Quarterly Survey of Most Common Rates of IPC Time and Savings Deposits in FDIC-Insured Mutual Savings Banks

Details may not add to totals due to rounding All data are in original maturity

TABLE 10 Savings Deposits at FSLIC-Insured Savings and Loan Associations, 1973–76

Date	Total	Passbook savings			Term savings							Total passbook and small term savings
		Total	NOW	Other	Total	Maturity				Size		
						Up to 1 year	1 to 2 years	2 to 3½ years[1]	3½ years[1]	Small	Large	
	Millions of dollars											
9–30–73	207,997	99,667	0	99,667	108,330	58,856	34 254	6,088	9,132	105,671	2,659	205,338
3–31–74	228,842	104,504	4	104,500	124,339	66,672	22,072	13,405	22,100	120,904	3,435	225,408
9–30–74	231,721	102,763	19	102,744	128,957	59,999	18,408	30,954	19,596	125,218	3,740	227,980
3–31–75	249,491	109,399	44	119,356	140,092	53,867	17,443	17 110	21,672	134,752	5,340	244,151
9–30–75	270,133	116,819	72	116,747	153,315	56,800	20,613	55,577	20,325	148,024	5,290	264,844
3–31–76	294,912	124,557	98	124,459	164,091	54,276	38,388	46,146	25,281	158,502	5,589	283,059
	Per cent of total											
9–30–73	100	48		48	52	28	16	3	4	51	1	99
3–31–74	100	46	*	46	54	29	10	6	10	53	2	99
9–30–74	100	44	*	44	56	26	8	13	9	54	2	98
3–31–75	100	44	*	44	56	21	7	19	9	54	2	98
9–30–75	100	43	*	43	57	21	8	21	8	55	2	98
3–31–76	100	42	*	42	56	18	13	16	9	54	2	96

[1] These maturity breaks are those used by the FHLBB

* Less than 0 5 per cent of total

NOTE —Aggregate days are reported as 1-day figures for the last day of each month The maturity breakdown of savings capital is reported in the FHLBB Semi-Annual Survey of Selected Interest/Dividend Rates and Account Structure, for March and September of each year These data are reported as remaining maturity and no attempt was made to convert to original maturity

Details may not add to totals due to rounding All data are in remaining maturity

likely to be used for transactions purposes Portfolio theory suggests that the liquidity of these longer-maturity deposits makes them more like securities, and thus complementary to, rather than substitutes for, liquid assets In order to evaluate movements in the monetary aggregates relative to economic activity, some consideration might be given to segregating longer-maturity deposits from those deposits that might be more readily usable for transactions purposes by the depositor

Large-denomination time deposits

In addition to the inclusion of both short- and relatively long-maturity time deposits in the other time components of M_2 and M_3, these aggregates include varying amounts of time deposits in denominations of $100,000 or more that further distort their conceptual meaning Changes in large-denomination time deposits often reflect changing bank aggressiveness in seeking funds Since they are exempt from the Regulation Q ceiling, these deposits have offering rates that vary with market rates Also, a bank's aggressiveness in seeking funds through large-denomination time deposits will depend on its deposit flows, loan demand, relative rate on other sources of funds, and so forth These deposits often behave differently from small-denomination time deposits, which are subject to interest ceilings, and, therefore, rates on large-denomination time deposits tend to be sticky, so that such deposits are sensitive to market rates of interest [18]

To the extent that the time component of M_2 includes large-denomination time deposits, M_2 and M_3 are more heterogeneous measures As currently defined, the time deposit component M_2 consists of total time and savings deposits at all commercial banks less large negotiable CD's at weekly reporting banks This definition was originally adopted in large part because no data on large-denomination time deposits other than CD's were readily available In addition it was felt that negotiable CD's at large banks accounted for a significant share of the volume of, and the volatility in, total large time deposits However, the distinction between negotiable and nonnegotiable deposits may be largely technical since it is reported that many banks permit conversion from one form to the other Moreover, the exclusion of such deposits from

[18] Thrift institutions tend to have relatively insignificant levels of large denomination time deposits Thus the large time deposits in M_2 and M_3 come mainly from large negotiable and nonnegotiable time deposits issued by nonweekly reporting banks and nonnegotiable deposits issued by weekly reporting banks

M_2 and M_3 merely because they are liabilities of large rather than small banks is somewhat arbitrary

The growth of large-denomination time deposits at all banks—regardless of whether they are in negotiable or nonnegotiable form—is different from that of small-denomination time deposits For example, in some periods movements in the other time component of M_2 were not consistent with observed patterns of thrift deposit flows This suggests that either the demand for small-denomination accounts at thrift institutions is different from that for similar accounts at banks, or that changes in the nonexcluded large-denomination time deposits have been obscuring the movements in small-denomination time deposits As noted below, the evidence supports the second hypothesis

While the inclusion of large-denomination time deposits in the other time and savings deposit data has been of concern for some time, evaluation of the quantitative significance of such deposits has been hampered by the sparseness of the data Although the data now available are still extremely limited and can be analyzed only under very gross assumptions, they do shed some light on the magnitude of the problem Beginning in June 1973, when marginal reserve requirements were imposed on all large time deposits above a $10 million base, the approximately 900 member banks affected by these requirements began to report the total amount of their time deposits in denominations of $100,000 or more on a daily-average basis [19] The volume of these deposits reported was surprisingly large At large weekly reporting banks the volume of negotiable CD's ranged between $58 billion and $67 billion in the latter half of 1973 During that same period other large time deposits at all member banks ranged from $30 billion to $40 billion

Recognition of the existence of a significant amount of large-denomination time deposits that were not counted as CD's led the Federal Reserve to collect data on total large-denomination time deposits from its large weekly reporting bank sample beginning in January 1975 These data permit comparison with data on large-denomination time deposits available from special supplements to the June and December call reports since December 1973 [20] With these data as a base, Table 11 shows some very rough estimates of both other time and savings deposits and M_2, with estimates of total large-denomination time deposits—not just negotiable CD's at weekly reporting banks —removed for each month of 1975 Also shown are other time deposits and M_2 as currently defined A comparison of the adjusted series—keeping in mind that the data are only rough estimates—with the series as currently defined suggests that movements in large-denomination time deposits significantly influence M_2 [21] As

[19] Data were also gathered on large denomination time deposits at all member banks as part of the special monthly survey conducted from October 1973 to June 1974 to monitor the growth in 4-year certificates at commercial banks

[20] The December 31, 1975, call report was taken on a Wednesday, allowing for a direct comparison with weekly reporting bank data, which are always for Wednesdays, the last day of the bank statement week A comparison of large time deposits reported on the call and on the weekly report turned up many reporting errors on both reports This suggests that problems still exist with the data on large time deposits and that any estimates based on either the weekly reporting bank sample or the call report should be recognized as crude Unfortunately, since the supplement to the call report on large denomination time deposits was introduced in December 1973, no June or December call date other than December 1975 was on a Wednesday This makes it more difficult to detect reporting errors

[21] The adjusted series in Tables 11 and 12 were constructed by subtracting total large denomination time deposits from total time deposits, both not seasonally adjusted, and then applying the seasonal factors for other time and savings deposits at all commercial banks The series on large time deposits is based on data from the call report, the survey of time and savings deposits, the report of deposits when marginal reserve requirements were imposed, and the weekly reporting data series It should be recognized that the crude method of seasonal adjustment used in constructing the adjusted other time and savings deposits and the adjusted M_2 series bestows on them certain characteristics, which are difficult to quantify However, in the absence of sufficient data to derive seasonal factors for these adjusted series, a judgment was made that it was better to use these data, constructed by the best method available, than to use data not seasonally adjusted The point I wish to illustrate is that movements of M_2 as currently defined and of M_2 less all

TABLE 11 Other Time and Savings Deposits, M_2, and Large-Denomination Time Deposits at Weekly Reporting Banks, 1975

Month	Other time and savings[1]	Other time and savings, adjusted[2]	M_2[3]	M_2,[4] adjusted	Large denomination time: Total	Negotiable	Other	Ratio of other to total
	Seasonally adjusted annual growth rates, monthly averages (per cent)				Levels, last Wednesday of the month, not seasonally adjusted (billions of dollars)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Jan	12.0	14.0	4.1	3.8	128.6	91.3	37.4	29
Feb	13.0	26.7	7.2	12.8	125.0	87.9	37.1	30
Mar	9.6	13.3	9.3	13.1	124.8	89.0	35.8	29
Apr	10.3	21.1	6.1	11.7	120.3	84.2	36.1	30
May	15.1	21.7	13.4	16.4	119.6	83.5	36.1	30
June	18.4	29.1	16.5	21.5	116.3	82.0	34.3	29
July	14.0	24.1	9.5	3.5	114.8	81.2	33.6	29
Aug	6.4	8.9	5.7	7.1	114.6	81.2	33.3	29
Sept	6.0	2.9	4.2	2.3	117.4	84.7	33.2	28
Oct	10.4	11.1	5.1	5.2	116.7	83.3	33.4	29
Nov	11.9	18.7	10.8	13.8	116.1	83.3	32.8	28
Dec	7.9	13.7	3.1	5.5	116.5	82.8	33.7	29

[1] Total time and savings deposits less large denomination negotiable time deposits at weekly reporting banks
[2] Total time and savings deposits less all large denomination time deposits
[3] M_1 plus other time and savings deposits
[4] M_1 plus adjusted other time and savings deposits

can be seen in column 8, the behavior of large-denomination time deposits other than negotiable CD's at weekly reporting banks appears to be similar to that of CD's the ratio of nonnegotiable to total large-denomination time deposits is fairly constant—that is, the two series move together

In order to examine further the relationship between the components of total large time deposits and total time deposits at the weekly reporting banks, weekly data available since January 1975 were examined The simple correlation coefficient between negotiable CD's and all other large-denomination time deposits was calculated to be 0.84 in levels (0.24 in first differences) More important, the correlation between other large-denomination time deposits and small-denomination time and savings deposits was found to be negative, −0.90 in levels and −0.68 in first differences These correlations suggest that at the weekly reporting banks the behavior of negotiable CD's and that of all other large-denomination time deposits are similar, and that large-denomination time deposits other than negotiable CD's behave inversely to small-denomination time deposits This supports the hypothesis that banks manage all large-denomination time deposits, not just negotiable CD's

Finally, Table 12 compares M_2 and other time deposits with corresponding adjusted series that exclude all large-denomination time deposits on a quarterly-average basis from 1973 Q4 to 1975 Q4[22] For comparison pur-

TABLE 12 Growth Rates of Other Time and Savings Deposits and M_2 before and after Adjustment to Exclude Large-Denomination Time Deposits

Quarterly averages, seasonally adjusted annual rates

Quarter	Other time and savings[1]	Other time and savings, adjusted[2]	M_2[3]	M_2[4] adjusted	MEMO Nonbank time and savings[5]
1973—Q4	12.5	2.9	8.9	4.1	7.6
1974—Q1	13.0	10.3	9.6	8.0	7.7
Q2	9.1	3.1	7.5	4.4	5.1
Q3	8.3	1.7	6.4	3.1	4.3
Q4	8.4	5.6	6.4	4.7	6.7
1975—Q1	9.9	13.0	5.6	6.5	10.6
Q2	12.5	22.3	10.2	14.4	16.6
Q3	12.6	19.4	10.1	13.0	18.3
Q4	9.1	11.1	6.1	6.8	14.2

[1] Total time deposits less large denomination negotiable CD's at weekly reporting banks
[2] Total time deposits less estimated total large denomination time deposits
[3] M_1 plus other time and savings deposits as defined in note 1
[4] M_1 plus adjusted other time and savings as defined in note 1
[5] Deposits at S&L's MSB's and CU's

large denomination time deposits are different To the extent that the seasonal factors for other time and savings deposits as currently defined were used to adjust "adjusted" other time and savings deposits, any bias imparted to the data because of the seasonal adjustment should be toward greater, rather than less, similarity in behavior between the series

[22] See note 21, which describes the data and the method used to estimate large time deposits The data should be viewed as rough estimates rather than actual measured stocks

poses, the nonbank thrift deposit component of M_3 is also shown Even on a quarterly-average basis, removal of large-denomination time deposits from M_2 results in an adjusted series that is quite different from M_2 as currently defined For example, during each of the last three quarters of 1974, the adjusted M_2 series grew much more slowly than M_2 as currently defined and then grew more quickly through all of 1975 This difference is understandable, of course, since the series on other time and savings deposits as currently defined is quite different from the series on other time and savings with total large time deposits removed The correlation between M_2 and "adjusted M_2" is only 0 55 in levels, about the same as the correlation (0 49) between other time and savings as now defined and nonbank time and savings More important, the correlation between the adjusted series on other time and savings deposits and the series on nonbank time and savings deposits is 0 92 Inasmuch as the components of these deposit series are characteristically similar, it is not surprising that their movements are highly correlated

Possible recomposition of the monetary aggregates

The regulatory changes and financial innovations discussed in the preceding sections suggest that the characteristics of the components of the monetary aggregates, as currently defined, have been altered greatly in the past few years to become more heterogeneous The pace of change has been rapid, and the distinction between time deposits and savings deposits is more clearly defined now than prior to 1973, conceptually, demand and savings deposits are more similar The components of time deposits have become more distinct in themselves as longer-maturity, small-denomination deposits with higher interest rate ceilings have been created and as banks have increased their use of all large-denomination time deposits—not just negotiable CD's—as a flexible source of funds

Because recent changes either have already affected the behavior of the monetary aggregates or are expected to do so, it is appropriate to consider how current definitions might be altered to reflect evolving developments Two definitional changes are suggested by the previous discussion First, the development of savings-based transfer systems and the liquidity of savings deposits relative to time deposits other than negotiable CD's suggest that some combination of M_1 and savings deposits at banks and thrift institutions might be considered to represent transactional balances Second, the changing maturity structure of small-denomination time deposits and the behavior of large-denomination time deposits suggest that the definition of other time deposits, excluding savings, ought to be reconsidered Such a definitional change would affect M_2 and M_3 and the higher-numbered M's but would have no effect on M_1 The possible permutations and combinations stemming from these two types of definitional changes are fairly large Therefore, the remainder of this paper focuses not on every possible type of monetary aggregate that might be considered but more broadly on the two major categories of change

At present the extent to which regulatory changes and innovations relating to savings deposits have affected, or will affect, the monetary aggregates is unclear Money transfers will in the future involve both demand and savings deposits, and so long as the prohibition of interest payments on demand deposits remains, easily facilitated transfers from savings will make those deposits a highly attractive transactions asset Currently, savings deposits have a small but growing role in the payments mechanism, with a large potential for further growth

Historically, the motives for holding M_1 balances and savings deposits have been different, and therefore movements in these two variables have been different Although both are directly related to income and inversely related to market interest rates, flows of funds into and out of savings deposits have been determined primarily by the relationship between the ceiling on the savings deposit interest rate—the "own" rate—and short-term market rates—competing rates In addition, until recently the transactions costs for transferring funds between savings deposits and M_1-type balances have been significant, often involving such inconveniences as personal presentation of a passbook at the depositary institution This fact suggests that, although statistical analysis of historical movements in an aggregate that combines M_1 and savings deposits may provide some insight as to the appropriateness of such a definition at this time, the decision to include savings should probably rest on evidence that indicates the ongoing substitution of savings for demand deposits in the payments mechanism [23]

Recent changes suggest that substitution is taking place in the payments mechanism and that the conceptual differences between savings deposits and M_1 balances have in fact already been reduced NOW accounts, which are available in New England, are essentially savings deposits that can be transferred to a third party by written draft Share draft accounts at credit unions are similar to NOW's, although there are legal differences between them Both types of drafts are legal payment instruments, as are commercial bank checks However, such accounts allow the depositor to earn interest on the funds subject to draft until payment is made, whereas demand deposits earn no interest As mentioned earlier, several types of savings-transfer systems, including telephonic transfers from savings to demand deposits, third-party nonnegotiable transfers directly from savings, and point-of-sale transfers from savings, have been developed The first type appears to have gained widespread acceptance among banks, S&L's, and MSB's, although the actual volume of use of the transfer arrangements is difficult to measure

At some point, consideration must be given to creating a new monetary aggregate by merging into M_1 those deposits that are close substitutes for M_1 balances Current information suggests that NOW accounts, share draft accounts at credit unions, and checking accounts available at State-chartered thrift institutions would be the first categories of M_1 substitutes that might be considered explicitly as transactions balances Such balances can be quite easily identified and measured, so folding them into current M_1 should present only minor problems The next category of deposits that can be considered as a substitute for M_1 is savings deposits at banks and thrift institutions from which transfers can be initiated As savings-based transfer systems continue to develop and spread, the substitution of savings deposits for demand deposits can be expected to take place and thus what may evolve is one or more monetary aggregates composed of currency, demand deposits, savings deposits against which some form of negotiable draft can be drawn, and all other savings that can directly or indirectly be utilized for making payments

Just when such definitional changes ought to be made is unclear The proportion of savings deposits used for transactional purposes at this time is small but growing, and it is likely that some savings will always be used for the traditional reasons—that is, as a temporary abode of purchasing power Unless some method can be devised to distinguish clearly the transactional from the nontransactional components of savings deposits, it would be better to include all savings in a new M_1-type aggregate, rather than ignore the increasing use of such deposits Savings deposits that can be readily used to make payments—that is, for transactions purposes—should be included in the definition of M_1 But not all savings deposits are transactional in nature

The suggested inclusion of all savings deposits raises the question of whether the traditional distinction between deposits at commercial banks and at thrift institutions should be maintained or dropped The necessity for such a distinction seems to be fading as the thrift institutions continue to assert their presence in the payments mechanism Their expanded role has been recognized by the Federal Reserve's interim access policy to System ACH's (adopted in January 1976), which indicated

[23] Appendix 2 presents the results of some recent staff analysis of M_1 plus savings using historical data

that ACH transfers could "originate from any account having third-party payment powers" without distinguishing between commercial banks and thrift institutions

The discussion in the section on recent regulatory changes suggested that the "other time" deposit component of M_2 suffers from at least two conceptual problems The first problem is that longer-maturity small-denomination time deposits are relatively less liquid compared with those with the shorter maturities, yet it is the longer-maturity deposits that have paid the highest interest rates and, therefore, have attracted relatively more funds than the shorter deposits The 4- and 6-year deposits are more like securities than deposits and, therefore, can be expected to behave differently from the other maturities The second problem stems from the fact that other time deposits contain large time deposits other than negotiable CD's at weekly reporting banks, and according to recently obtained evidence, these deposits behave like negotiable CD's—that is, banks manage such deposit liabilities by seeking to increase them when funds are needed and allowing them to run off when funds are not needed In both cases, it is not unreasonable to categorize both types of time deposits conceptually as being different from small-denomination time deposits with short maturities that are, in many portfolios, "temporary abodes for purchasing power"

Redefining M_2 along these conceptual lines raises certain problems that have been noted earlier For example, what is the appropriate maturity break for separating security-type, small-denomination deposits from other small time deposits? From a conceptual standpoint, 2½ years is not much shorter than 4 years, however, it is significantly less than 6 years The choice of the breaking point could be dictated by data availability Prior to July 1973 all small-denomination time deposits with initial maturities of 2 years or more were subject to the same interest rate ceiling It is unlikely that a large share of deposits subject to that ceiling had maturities of 4 years or more Moreover, data collected after the introduction of 4-year certificates in July 1973 are reliable and so, on the basis of data considerations, the most reasonable maturity break would be deposits with an initial maturity of less than 4 years compared with those with an initial maturity of 4 years or more With large-denomination deposits, most of the problems are related to data availability and comparability through time Data available before 1973 are scanty and may not permit accurate estimation of total large time deposits Thereafter, data are better but still allow only crude estimates of total large time deposits

In order to see how much the exclusion of longer-maturity small time deposits and all large time deposits affects the profile of the growth of M_2, available data were used to create new aggregates, as shown in Table 13 The

TABLE 13. Comparison of M_2, M_2', and M_2'', Not Seasonally Adjusted, 1973–76

Date	Levels (billions of dollars)			Annualized percentage changes		
	M_2	M_2'	M_2''	M_2	M_2'	M_2''
7/31/73	551 1	496 7	486 8			
1/31/74	581 1	502 2	489 0	10 9	2 2	9
7/31/74	597 8	606 9	491 2	5 7	1 9	9
1/31/75	619 5	511 1	492 7	7 3	1 3	6
7/31/75	647 8	537 8	518 3	9 1	10 9	10 4
1/31/76	674 1	550 3	529 8	8 1	4 6	4 4

NOTE —When possible, data are for the date shown If they are unavailable, data for the closest day were used

The following definitions are used

M_2 = M_1 plus total time and savings deposits less negotiable large denomination CD's at weekly reporting banks (current M_2)

M_2' = M_2 less all large denomination time deposits at all commercial banks and small time deposits with maturities of 4 years or more

M_2'' = M_2 less all large-denomination time deposits at all commercial banks and small time deposits with maturities of 2½ years or more data are not seasonally adjusted and are single-day estimates corresponding to dates of the Survey of Time and Savings Deposits (STSD) [24]

For most of the time period shown in Table 13, the growth rates of the newly defined M_2-type aggregates were significantly different from those for M_2 as it is currently defined Moreover, M_2 defined to exclude large time and longer-maturity small time deposits exhibited substantially lower growth rates in each period except for July 1975, when inflows to other time and savings deposits were primarily in the form of savings deposits

The apparent differences in growth among M_2, M_2', and M_2'' are striking, and the causes for the differences can easily be traced Table 13 suggests that growth in M_2 as currently defined may give misleading impressions of changes in the mix of the public's holdings of deposits that serve as a temporary abode of purchasing power More important, it is clear from the table that the behavior of the time deposit components excluded from the M_2' and M_2'' variables is significantly different from that of the remaining components

[24] Some data are for the Wednesday closest to the date of the STSD

Appendix 1: Third-Party Payment Powers of State-Chartered Thrift Institutions

The regulatory changes that have expanded the third-party payment powers of Federally chartered thrift institutions do not, in general, automatically apply to similar institutions that have been chartered under the laws of the States in which they are located A number of States have banking laws that provide for parity in payments powers, and consequently, in those States all thrift institutions generally can now offer authorized telephonic transfer and preauthorized third-party nonnegotiable transfer services to their customers When parity does not exist, some institutions have broader payment powers than Federally chartered thrift institutions Banking laws in many States are not specific about payment powers, and thus the institutions depend on case-by-case rulings by the State banking authority

In order to ascertain the status of State-chartered thrift institutions in the payments mechanism, a special survey of State banking authorities was conducted on a State-by-State basis in June 1976 The results of that survey are summarized in Table A-1, which reports data on five types of payment powers checking accounts, NOW accounts, credit union share drafts, telephonic transfers, and preauthorized nonnegotiable transfer services The checking accounts are non-interest bearing and are indistinguishable from checking accounts at nonmember banks in terms of the payments mechanism clearing process In some States these have existed for a long time and remain today because of grandfather clauses in existing laws In other States the checking powers are fairly new, resulting from efforts by State legislators to provide thrift institutions in their States with powers similar to those of commercial banks Interest-bearing accounts against which written drafts may be drawn are primarily in two forms—NOW accounts and credit union share draft accounts The former are available primarily in New England, although some thrift institutions in Delaware apparently can offer accounts very much like NOW's Many States permit their credit unions to offer share draft accounts

A majority of States have laws that permit thrift institutions to offer transfer services to owners of savings accounts Table A-1 shows two types of savings-based transfer services telephonic transfers from a savings account at a thrift institution to a checking account at a commercial bank, and preauthorized nonnegotiable transfers (bill-paying services) In those States whose banking laws are silent about the power of thrift institutions to offer such services State banking authorities have usually allowed such services upon request by thrift institutions within their jurisdiction

The State banking authorities were also asked in the survey whether they expected State laws to be introduced or amended in the near future to allow State-chartered thrift institutions to offer additional third-party payment powers The predominant response was that State legislation would follow suit should Federal laws be modified to allow expanded payment powers for thrift institutions In States in which competition among financial institutions for deposits appears to be strong, however, the State legislatures are likely to consider the question of expanded payment powers in the near future Those States include New Jersey, Pennsylvania, Michigan, Wisconsin, Minnesota, Montana, and Nebraska

TABLE A-1. Third-Party Payment Powers of State-Chartered Thrift Institutions, June 1976

State	Checking accounts	NOW accounts	CU share drafts	Telephonic transfers	Preauthorized nonnegotiable transfers
Alabama					
Alaska					
Arizona				parity	parity
Arkansas	MSB		CU		
California			CU	parity	parity
Colorado			CU		S&L
Connecticut	MSB, S&L	MSB, S&L	CU	silent	silent
Delaware	MSB, S&L	MSB		MSB	
Florida					
Georgia					
Hawaii				parity	parity
Idaho				parity	parity
Illinois	S&L		CU	S&L	S&L
Indiana	MSB		silent	S&L	S&L
Iowa			silent	S&L	CU silent
Kansas			CU	parity	parity
Kentucky					
Louisiana					
Maine	MSB, S&L	MSB, S&L	CU	silent	MSB, S&L
Maryland	MSB			silent	silent
Massachusetts		CU, MSB, S&L		silent	MSB, S&L
Michigan			CU		CU, S&L
Minnesota			CU	MSB	CU, S&L
Mississippi			silent	silent	silent
Missouri			CU		S&L
Montana			silent		
Nebraska					
Nevada			CU	parity	parity
New Hampshire		MSB, S&L	CU	silent	MSB, S&L
New Jersey	MSB			MSB	MSB
New Mexico				parity	parity
New York	MSB, S&L		CU	MSB, S&L	MSB, S&L
North Carolina			CU	S&L	S&L
North Dakota			CU		CU, S&L
Ohio				CU, S&L	S&L
Oklahoma	S&L	silent	CU		CU
Oregon	MSB		CU	parity	parity
Pennsylvania			CU		CU, MSB
Rhode Island	MSB, S&L	MSB, S&L		silent	CU, MSB, S&L
South Carolina		silent		silent	silent
South Dakota	silent	silent	silent	silent	silent
Tennessee					
Texas					
Utah			CU	parity	parity
Vermont	MSB, S&L	MSB, S&L	CU	silent	MSB, S&L
Virginia			silent		
Washington			CU	parity	parity
West Virginia				silent	silent
Wisconsin			CU	MSB, S&L	MSB, S&L
Wyoming				parity	parity

CU = credit unions
MSB = mutual savings banks
S&L = savings and loan associations

Parity = State-chartered institutions have the same powers as Federally chartered institutions
Silent = law does not say, permitted if approved by banking authority

Appendix 2: Savings Deposits at Banks and Thrift Institutions as Transactions Balances

For a number of reasons, savings deposits at commercial banks and thrift institutions—or more precisely, a growing proportion of such deposits—have come to be used as transactions balances rather than simply as repositories of interest bearing liquid assets The secular uptrend of interest rates has raised the opportunity cost of idle, non-interest-bearing deposits, inducing holders of such balances to seek out convenient alternatives In addition, regulatory changes permitting telephonic transfers between savings deposits wherever held and demand deposits at commercial banks, and nonnegotiable transfers to third parties at both banks and thrift institutions, have facilitated the utilization of savings deposits for such purposes The authorization of savings deposits for profit-making enterprises has widened the scope of users of such accounts to include relatively more sophisticated depositors

These developments suggest the possible need for the formulation of a broader transactions variable than M_1 While M_2, M_3, and still more comprehensive aggregates can be studied for their implications for the general liquidity of the economy, they do not purport to be transactions balances An aggregate broader than M_1 but not so broad as M_2 (which includes time deposits) might be appropriate to reflect the changing habits of the public regarding transactions balances Four such aggregates are examined here demand deposits plus savings deposits at all commercial banks ($DD + SB$),[1] M_1 plus savings deposits at all commercial banks ($M_1 + SB$), demand deposits at all commercial banks plus savings deposits at banks and thrift institutions ($DD + SB + ST$),[2] and M_1 plus savings at banks and thrift institutions ($M_1 + SB + ST$) The principal objective of the analysis is to compare the broader monetary aggregates with M_1 in traditional money demand equations to determine whether the addition of savings deposits to the money stock strengthens or weakens the influence of *GNP* (as a proxy for transactions) In addition, savings deposits themselves are regressed as the dependent variable in money demand equations in order to identify what, if any, relationship exists among these variables

This analysis is part of a complex issue that extends well beyond the demand for money A change in the definition of M_1 to account for all deposits that can be used for transactions balances necessarily has implications for the definitions of M_2 and of the broader aggregates as well In addition, any redefinitions of the monetary aggregates along structural lines may complicate the conduct of monetary policy if the new aggregates are less subject to the control of the monetary authority than their predecessors The linkages between real economic activity and the newly defined aggregates may still be evolving and may be difficult to specify, further complicating the determination of monetary policy

The basic structural form of the estimated money demand equations hypothesizes the monetary aggregate to be a function of interest rates, *GNP*, and the aggregate itself lagged one period[3] The ordinary least squares regressions were run in log form and in real terms, the deflator being the consumer price index The Cochrane-Orcutt technique was used to adjust for serial correlation The results of the regressions are summarized in Tables A-2 and A-3

Savings deposits at banks (*SB*) can be shown to bear a significant relation to GNP during the 9-year period from 1966 Q3 to 1975 Q2 (Equation 1 in Table A-2) The period of observation was shortened to the most recent 5 years to evaluate

NOTE—Paul Boltz prepared this appendix The comments of Raymond Lombra, John Paulus, and Steven Roberts were very helpful in the writing process

[1] Though technically not broader than M_1, $DD + SB$ is evaluated as a separate aggregate since the developments in the payments mechanism toward interest bearing transactions balances may have had only a minor influence on the demand for currency Excluding currency serves to focus the results on the substitutability between demand and savings deposits

[2] Thrift institutions include S&L's, MSB's, and CU's

[3] The source of the data was the data files of the FRB–MIT–Penn quarterly econometric model

TABLE A-2 Coefficients of Variables in Demand-for-Money-Type Equations for Savings Deposits[1]

Equation	Independent variables					Regression statistics	
	Intercept	Lagged dependent variable	Treasury bill rate	Rate on savings deposits	*GNP*	Standard error	R^2
1	− 119	863	− 075	035	119	0086	972
	(− 52)	(20 06)	(−8 44)	(1 84)	(2 79)		
2	376	971	− 074	053	− 027	0089	960
	(42)	(4 68)	(−3 80)	(1 19)	(− 112)		
3	046	795	− 059		146	0090	959
	(05)	(5 27)	(−3 87)		(75)		

[1] The dependent variable is savings The period is 1966 Q3 to 1975 Q2 for Equation 1, and 1970 Q3 to 1975 Q2 for Equations 2 and 3 The numbers in parentheses are *t* statistics For a one tailed test at the 95 per cent confidence level, the critical value of the *t*-statistic is 1 76 for the shorter period (1970 Q3 to 1975 Q2) and 1 70 for the longer period (1966 Q3 to 1975 Q2)

whether the relationship between savings deposits and *GNP* has strengthened in recent years and to evaluate the changing effects of interest rates, which reached unprecedented levels in recent years It was found that the relationship between savings deposits at commercial banks and *GNP*[4] deteriorated into insignificance in the most recent period (Equations 2 and 3 of Table A-2) It appears from these equations that the trend rate of growth of such deposits and market interest rates were the principal determinants of savings deposit movements in recent periods The "own" rate on savings deposits is itself an insignificant explanator of movements of savings accounts in Equation 2, but this may be rationalized by the lack of variation (because of interest rate ceilings) in the savings deposit rate after 1970 Removal of the savings deposit rate in Equation 3 only slightly improves the performance of *GNP* in the equation, which in any event remains insignificant

Equations in Table A-3 show M_1, $DD + SB$, $DD + SB + ST$, $M_1 + SB$, and $M_1 + SB + ST$ run in similar money demand equations for the period 1966 Q3 to 1975 Q2 and 1970 Q3 to 1975 Q2 M_2 and M_3 are also shown for reference to still broader aggregates The equations estimated over the shorter period are labeled "a" and those for the longer period are denoted "b"

The results in Table A-3 indicate that the rate on savings deposits is an insignificant determinant of the broader aggregates $DD + SB$ and $M_1 + SB$, though a significant explanator of DD and M_1 The likely reason is that the rate on savings deposits is an "own" rate for SB but a competing rate for M_1 and DD These opposite influences cancel each other when the savings deposit rate is used to explain $DD + SB$ or $M_1 + SB$ The equations also show that although SB itself is not significantly explained by *GNP* over five recent years, the relationship of DD and M_1 to *GNP* is not significantly weakened by the addition of SA The coefficients of *GNP* are significant in a one tailed test at a 95 per cent level of confidence in all the equations with DD, $DD + SB$, M_1, and $M_1 + SB$ in Table A-3 In deed, the relationship of *GNP* is more significant, though only marginally, to $DD + SB$ than to DD alone in both periods shown (Equations 4a, 4b, 5a, and 5b)

The addition of all savings deposits at banks and thrift institutions to DD and M_1 creates broader aggregates that bear a statistical relationship to the independent variables used in the regressions, a relationship that is similar to M_1 or DD alone The bank rate paid on savings accounts[5] remains significant for both periods shown for $DD + SB + ST$ and $M_1 + SB + ST$ Also, *GNP* is a highly significant explanator of the broader aggregates Indeed, the significance of *GNP* as an independent variable is strengthened by the addition of savings deposits to DD, and the relationship between *GNP* and M_1 is about the same Comparing these aggregates to M_2 and M_3 shows that DD plus savings deposits and M_1 plus savings deposits have a more consistent relationship to *GNP* than M_2 or M_3

* * *

If at present there exists a transactional component in savings deposits, its behavior is apparently swamped by the movements of the level of savings deposits induced by changes in interest

[4] The choice of *GNP* as the appropriate scale variable is open to question, and personal income or some other com prehensive flow variable of the economy could arguably be substituted for it in these equations However, since in fluencing *GNP* is an objective of monetary policy, it was used as the scale variable throughout

[5] A series on the average rate paid by thrift institutions for savings deposits (excluding time deposits) was not avail able for testing

TABLE A-3. Coefficients of Variables in Demand-for-Money Equations for Six Concepts of Money[1]

Equation[2]	Definition of money	Independent variables					Regression statistics	
		Intercept	Money variable lagged	Treasury bill rate	Rate on savings deposits	GNP	Standard error	$\bar{R}^2$
4a	DD	− 223	830	− 031	− 059	179	0078	960
		(− 47)	(6 90)	(−1 83)	(−1 62)	(1 98)		
4b	DD	378	790	− 022	− 072	125	0071	956
		(1 66)	(8 46)	(−2 53)	(−2 90)	(2 07)		
5a	$DD + SB$	− 325	647	− 040	− 060	314	0070	964
		(− 08)	(3 84)	(−2 62)	(−1 53)	(2 10)		
5b	$DD + SB$	269	835	− 041	− 026	112	0063	969
		(1 38)	(13 80)	(−6 84)	(−1 58)	(2 67)		
6a	M_1	− 062	747	− 028	− 055	226	0064	960
		(− 13)	(5 12)	(−1 81)	(−1 74)	(2 30)		
6b	M_1	505	681	− 019	− 068	198	0057	971
		(2 23)	(6 35)	(−2 63)	(−3 35)	(2 86)		
7a	$M_1 + SB$	101	622	− 037	− 051	322	0064	965
		(25)	(3 25)	(−2 58)	(−1 42)	(2 04)		
7b	$M_1 + SB$	310	810	− 039	− 025	130	0056	974
		(1 57)	(11 65)	(−6 67)	(−1 60)	(2 75)		
8a	M_2	722	844	− 037	− 003	197	0047	990
		(76)	(6 13)	(−3 69)	(− 49)	(1 40)		
8b	M_2	1 170	751	− 044	009	305	0050	996
		(2 25)	(8 31)	(−6 81)	(65)	(2 74)		
9a	M_2	− 045	1 029	− 038	− 017	− 034	0056	992
		(− 07)	(8 54)	(−3 17)	(− 87)	(− 21)		
9b	M_2	211	910	− 046	002	156	0054	997
		(59)	(11 17)	(−6 40)	(11)	(1 32)		

[1] The numbers in parentheses are t statistics

[2] The estimation period is 1970 Q3 to 1975 Q2 for equations labeled "a" and 1966 Q3 to 1974 Q2 for equations labeled "b"

rates Thus, aggregate savings deposits alone are not as yet transactional in character to a discernible degree, nontransactional savings deposits apparently still dominate movements in the series Moreover, it is not possible to estimate with precision the minimum proportion of savings that must become transactional in character before being recognized in traditional money demand analysis If savings deposit growth is whipsawed in coming periods by disintermediation followed by large inflows, then the transactional component of savings will be largely obscured On the other hand, if nontransactional savings accounts follow a steady path of growth, a relatively small transactional component—say, 10 to 20 per cent of savings—may be adequate to be perceived in many demand equations

The analysis also suggests that a broader aggregate than M_1 constructed only from deposits at commercial banks may not adequately summarize the available transactional liquidity in the economy *DD* plus bank savings deposits and M_1 plus bank savings deposits did not have a significantly weaker relationship to *GNP* than did *DD* or M_1 alone, but the interest rate payable on savings deposits was predictably found to be positively related to *SB* but negatively to M_1 and *DD* The contrary influences render this rate an insignificant explanator of $DD + SB$ or $M_1 + SB$ as it affects the parts of the aggregate differently Thus, an important rate in an M_1 equation ceases to be significant in an equation relating $DD + SB$ or $M_1 + SB$ to other interest rates and *GNP* The elasticity of demand with respect to this savings deposit rate could be very high when market rates are near ceiling rates

The liquidity of thrift savings deposits is unquestionably comparable to that of bank savings, and the justification for limiting an M_1-type trans actions aggregate to bank deposits is conceptually weak when bank savings deposits are introduced Moreover, the inclusion of all savings deposits, rather than bank savings deposits alone, results in an aggregate with significant and more consistent relationships to the bank rate on savings deposits and *GNP* The likely explanation for the rate's remaining significance is that it affects the M_1 and *ST* components the same way—negatively—overcoming the opposite influence on *SB* The strength and consistency of the relation of *GNP* to the movements of these aggregates are comparable to those of M_1, and in recent periods better than those of M_2, though neither *DD* plus all savings nor M_1 plus all savings clearly dominates *DD* or M_1 alone The results are, however, suggestive of the need for a continuing examination of the conceptual and empirical justifications for the present definitions of the monetary aggregates