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ABSTRACT

This paper examines how recent changes in the U.S. financial system have affected the appropriate definition, construction and interpretation of the St. Louis adjusted monetary base and adjusted reserves. Since 1990, reductions in statutory reserve requirements have significantly reduced the importance of the requirements as a constraint on the deposit and lending behavior of banks and other depository institutions. During the same period, depositories' interbank payments activities have come to determine most, if not all, of their demand for Federal Reserve Bank deposits. Our analysis suggests that measures of the monetary source base should be broadened to include all Federal Reserve deposits held by domestic depository institutions rather than just those deposits available to satisfy statutory reserve requirements, and that adjustments for the effects of changes in reserve requirements must recognize that many depositories' behavior is not affected by such requirements.

KEYWORDS: monetary base, required clearing balances, total reserves

JEL subject numbers: E51, E52, E58

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Defining the Adjusted Monetary Base in An Era of Financial Change*

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Introduction

Economists, policymakers and the public have long debated the usefulness of aggregate financial variables as instruments and indicators of Federal Reserve monetary policy. For more than twenty-five years the Federal Reserve Bank of St. Louis' *adjusted monetary base* has been one of these indicators. In this paper, we explore how changes in the U.S. banking industry and financial markets since the implementation of the Monetary Control Act in 1980 have affected the definition, construction and interpretation of the adjusted monetary base.[1] We propose an expanded measure of the monetary source base and a new adjustment for the effects of changes in reserve requirements.

Central banks worldwide characterize the stance of their monetary policy in terms of a target level for a short-term market interest rate. In the intermediate to longer-run, however, the policy goal of price stability leads to evaluation of policy in terms of the growth of quantitative variables such as bank reserves, the monetary base or monetary aggregates.[2] History suggests that sustained inflation cannot occur without expansion in such financial variables. In his survey of targets and instruments of monetary policy, Friedman (1990) notes the complementary roles of interest rates and monetary aggregates, including measures of the monetary base and total reserves (adjusted for changes in reserve requirements): "Whether to key open market operations to a quantity or a price is an issue of first-order importance in normative monetary economics, and has been so for a long time."[3] Further, Friedman

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[1] The period before 1980 is discussed by Tatom (1980).

[2] See for example the papers in Wijnholds et. al. (1993).

[3] Friedman (1990), p. 1189.

emphasizes that Poole's basic insight -- that the central bank's optimal policy rule involves both an interest rate and a quantity vairable -- carries over into models with more complex aggregate demand-aggregate supply behavior than those examined by Poole.

The first section of the paper briefly addresses the role of the monetary base, adjusted for changes in reserve requirements, as a monetary policy indicator in dynamic stochastic models. In the context of a monetary authority that targets a short-term interest rate according to Taylor's Rule, the adjusted monetary base may furnish additional, marginal information about the stance of monetary policy when the model economy is subject to unobserved shocks. The second section of the paper argues that current measures of the monetary base should be broadened to include all the Federal Reserve deposits held by depository institutions. Current measures exclude the amount of Federal Reserve deposits held to satisfy required clearing balance contracts, thereby implicitly imposing an indefensible separation between Federal Reserve deposits used to settle interbank payments and those used to satisfy statutory reserve requirements. The third section examines the demand for the monetary base in a money supply model. The model differs from earlier analyses by explicitly separating the roles of depository institutions whose portfolio decisions are affected by statutory reserve requirements from those whose actions are not. The fourth section assesses the importance of separating these disparate groups of institutions by analyzing a large longitudinal database.

1. When Might the Adjusted Monetary Base Furnish an Indicator of Monetary Policy?

The shift toward policy activism during the 1960s stimulated research on indicators of the stance of economic policy. Regarding the indicator problem for fiscal policy, Blinder and Solow (1974) wrote:

> "Since Keynes, a common ... presumption in the economics profession has held that the government budget can influence the aggregate level of income and employment. If this is correct, an attempt to quantify the impact seems a natural next step; that is, after classifying policy A as "expansive" and policy B as "contractionary," economists would like to be able to say that policy C is "more expansive" than policy A and to give some *quantitative* meaning to such a statement.

> "None of this necessarily argues for a *single number* to be used as 'the' measure of fiscal influence. Whenever one attempts to reduce a multidimensional concept -- like the influence of the government on aggregate economic activity -- to a single dimension, index number problems inevitably arise.
>
> "However, the political realities of the day seem to dictate settling on a single index to measure the overall expansionary or contractionary effect of any proposed tax and expenditure program. If economists do not come up with one, the public or the Congress will probably invent its own, and the choice is unlikely to be the best. Instead, then, of trying to talk the layman out of seeking such a number, economists might do better to lead him to a "sensible" concept."
>
> Blinder and Solow (1974), pp. 11-12

and the indicator problem for monetary policy was summarized by Brunner and Meltzer (1969):

> "The *indicator* problem of monetary policy is the problem of constructing a scale that is invariant up to a monotone transformation and that provides a logical foundation for statements comparing the thrust of policy. (italics in original)
>
> "The indicator of monetary policy provides a scale (or ordering of policy actions) that permits policy makers, economists, and others to compare the thrust of monetary policy on economic activity, that is, to characterize one policy as more expansive than another or to characterize policies as more (or less) expansive than before. Statements comparing current policies to other policies that might have been chosen or to policies chosen at other times requires such a scale."
>
> Brunner and Meltzer (1969), p. 2.

Many economists have suggested that short-term market interest rates are adequate indicators of the stance of policy when the monetary authority also is concerned about the path of the economy's price level.[4] In these models, the price level is both influenced by monetary policy and provides important feedback regarding how the private sector interprets the current stance of policy relative future inflation. Yet, except for very short periods, central bank actions are but one of many factors that influence market rates.[5] A central bank that attempts to maintain for more than a brief period a short-term interest rate target below the level consistent with the equilibrium real interest rate and current inflation expectations will find itself contributing to an acceleration of inflation by injecting large amounts of high-powered

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[4] It is well-known that the price level is indeterminate in pure interest rate targeting models. This indeterminacy is usually removed if central bank's feedback rules include some weight on the price level, GDP, or another nominal variable.

[5] Numerous authors have emphasized that endogenous variables may be misleading policy indicators. The issue is not the endogeneity of the indicator variable but rather the size of the relative error that results from using one variable versus another; see for example Brunner and Meltzer (1969) and Dewald (1969).

money via purchases of securities. Similarly, an interest rate target set above that which is consistent with the equilibrium real rate and current inflation expectations will force the central bank to withdraw high-powered money from the economy at an accelerating rate, slowing at least near-term growth and perhaps leading to deflation. We accept as axiomatic that, over the long run, the behavior of the price level in modern monetary economies is largely determined by the size of the balance sheet of the central bank.

The concept of the monetary base has been used by many analysts under different names. Burgess (1936, p. 274) discussed the sum of the monetary gold stock and Federal Reserve credit as a foundation for the money stock. Gurley and Shaw (1960) used the concept of "outside money". Tobin (1961) refers to "noninterest bearing government debt", Friedman and Schwartz (1963) utilize "high powered money" and Brunner (1961) discusses the "monetary base". Each of these concepts combines in a single index the effects of three Federal Reserve monetary policy actions on the supply of high powered money -- open market operations, discount window lending and unsterilized foreign exchange market intervention. Although most of these analysts also recognized changes in reserve requirements as an instrument of Federal Reserve monetary policy, they did not integrate this into their monetary policy indicator.

Brunner (1961) defined the *monetary base* as the sum of currency in circulation outside Federal Reserve Banks and the US Treasury, plus the deposits of member commercial banks at Federal Reserve Banks. At the time, these items were most of the non-interest bearing monetary liabilities of the Federal Reserve and the Treasury to the private sector of the economy.[6] Brunner also defined the concept of the *extended monetary base* which added to the monetary base a measure of "liberated" reserves, defined as

[6] Brunner's measure of the monetary base excludes Federal Reserve deposits held by nonmember banks and by Edge Act corporations (the latter having begun in 1959). The measures of the monetary base constructed by Friedman and Schwartz (1963, appendix A) and Cagan (1965) include (estimates of) these deposits.

the amount of reserves absorbed or liberated by changes in legal reserve requirement ratios.[7] So far as we can determine, Brunner (1961) was the first published article to propose analytically combining changes in the monetary base with changes in reserve requirements so as to form an index of quantitative monetary policy actions.[8] In the remainder of this paper, we adopt more current usage and refer to the extended monetary base as the *adjusted monetary base*.[9]

The concept of the adjusted monetary base is important because the monetary base, not adjusted for changes in reserve requirement ratios, is defective as a measure of monetary policy: it omits the iteraction between *current* changes in reserve requirement ratios and *future* changes in the level of reservable deposits. The corresponding problem in measuring fiscal policy is well-known. In their classic discussion, Blinder and Solow (1974) show that a simple unweighted linear combination of different fiscal policy instruments, such as the full employment surplus, is inadequate as a fiscal policy indicator variable because it does not appropriately capture the interaction between *current* changes in tax rates and *future* changes in the level of income. As an alternative to the full employment surplus, Blinder and Solow propose an indicator constructed as a weighted average of various fiscal policy instruments, the weights proportional to the reduced form multipliers from the assumed model of the macroeconomy.

Blinder and Solow's fiscal policy indicator provides a scale, unique up to a monotone transformation, for discussing changes in the stance of fiscal policy. It is straightforward to show, within the context of a very general model, that the adjusted monetary base provides a monetary policy indicator

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[7] The terminology of absorbtion and liberation of reserves through changes in legal reserve ratios can be found in official Federal Reserve publications at least as early as 1954. See Board of Governors of the Federal Reserve System (1954), p. 51.

[8] The precise intellectual heritage of the extended monetary base is clouded. Many researchers before Brunner (1961) had examined models of the supply of money based on a money multiplier/monetary base decomposition, and some of them had explored the effects of changes in reserve requirement ratios on the money multiplier. See for example Tolley (1957), Meigs (1962), Dewald (1963a, b), Teigen (1964) and Benston (1969). Yet, to the best of our knowledge, none of them proposed measuring monetary policy by combining changes in the monetary source base with the effects of changes in statutory reserve requirements on demand for the base.

analogous to Blinder and Solow's fiscal policy measure. Interpreted as a policy indicator, the construction of the adjusted monetary base proceeds exactly as Blinder and Solow (1974) construct their fiscal policy indicator.

Consider the most commonly-used class of macroeconomic models, those in which the Federal Reserve's policy actions are transmitted to the economy through changes in the money stock, M. All macroeconomic models that include checkable deposits, currency and bank reserves contain such a money supply function, explicitly or implicitly; see Anderson and Rasche (1982).[10] Assuming for simplicity a single type of checkable deposit and letting M_t denote transaction money (currency plus checkable deposits), the money stock in such models may be written as $M_t = m_t \times MB_t$, where MB_t is the adjusted monetary base, $m_t \equiv \dfrac{1+k_t}{r_t + e_t + k_t}$ is the monetary base multiplier for M, k_t is the ratio of currency to checkable deposits, r_t is the legal reserve requirement ratio and e_t is the "excess reserve" ratio.[11] Assuming a general equilbrium model, allow the variables k_t and e_t to depend on all the other economic variables of the system, including interest rates and income.[12] Suppressing time subscripts, totally differentiating the money supply function gives

$$dM = m\ dMB + MB\ dm$$

and omitting all terms except those in dr we have

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[9] We caution the reader that Brunner used the term "adjusted monetary base" in some writings to refer to the nonborrowed extended monetary base, equal to the extended base minus borrowings of financial institutions from the Federal Reserve. Here, no such subtraction is made.

[10] For a recent example, see Chari, Christiano and Eichenbaum (1995).

[11] For simplicity and without loss of generality, assume that there have been no changes in reserve requirements and that none are anticipated such that the monetary base equals the adjusted monetary base. Excess reserves here equal all base money held by depository institutions minus their required reserves.

[12] A liquidity effect arises in Chari, Christiano and Eichenbaum (1995), for example, because the public is unable to rapidly adjust its holdings of currency following a helicopter drop of base money. Banks find themselves with substantial amounts of excess reserves, and initially e increases. Subsequently, portfolio adjustments by banks and households cause both e and k to decrease.

$$dm = \cdots - \left(\frac{m}{r+e+k} \right) dr + \cdots \quad .$$

Substituting this expression into that for dM and utilizing the definition of the monetary base as $MB \equiv (r+e+k)D$ where D is checkable deposits gives

$$dM = m[dMB - D\,dr] + \cdots \quad .$$

The term [$dMB - D\,dr$] is Brunner's "extended monetary base" indicator variable, and $-D\,dr$ is the amount of reserves absorbed or liberated by changes in the legal reserve requirement ratio.

The extended monetary base is an indicator, or index, of the stance of monetary policy because it provides a scale that is invariant up to a monotone transformation, where m is the factor of proportionality, for discussing changes in the direction and thrust of monetary policy. Yet, the extended monetary base does not necessarily provide a *complete* indicator for monetary policy in all economic models. In general, the extended monetary base will capture less than the full effect of monetary policy when Federal Reserve quantitative policy actions *directly* affect variables other than M. Such models include, for example, those with utility and production functions in which *MB* and *r* enter as *separate* arguments, rather than in the linear combination [$dMB - D\,dr$]. One such class of models are those that include real private net wealth as an argument in the consumption function. Consider a model in which agents discount future tax liabilities to some extent so that interest bearing government debt does not enter net worth dollar-for-dollar, while non-interest bearing claims on the central bank enter at face value. In such a macroeconomy, open market operations that change the monetary base *directly* affect the nominal net worth of the private sector *in addition to* their effect on the supply of nominal money balances. In contrast, changes in reserve requirements affect the supply of nominal money balances but do not affect the nominal net worth of the private sector. As a second example, the adjusted monetary base might also fail to indicate the complete impact of monetary policy in models that contain both money and credit markets, and which assume that intermediated credit is not a perfect substitute for non-

intermediated credit. In such models, a change in reserve availability may affect bank lending without necessarily causing a parallel change in the money stock, M.

In models such as these where the extended monetary base is not a complete policy indicator, measuring the relative magnitudes of the various monetary transmission channels requires estimates of the structure of a dynamic, and perhaps stochastic, model. Because such estimates are difficult to obtain, few (if any) exist. In the absence of estimates to the contrary, it is our judgment that the extended monetary base likely captures most of the longer-run impact of monetary policy on the price level.

Beyond its definition and measurement, a frequent objection to the *use* of the adjusted monetary base as an indicator of monetary policy is that central banks *in fact* rarely use the base as a monetary policy target.[13] In policy regimes where the central bank targets the level of a short-term interest rate, the adjusted monetary base is jointly endogenous with real output and the price level (or the inflation rate). The objection is faulty, at least in part, because it fails to recognize the difference between the *targets* of monetary policy and *indicators* of the stance of policy. The adjusted monetary base arises as an indicator variable in models of such policy regimes because it may contain marginal information regarding the path of the economy beyond the information contained in other contemporaneously-observable endogenous variables.[14] Such value arises if, when monetary policy pegs a nominal interest rate in the short-run and heavily smoothes fluctuations of the nominal rate in an intermediate run, changes in the growth rate of the adjusted monetary base provide information on unobserved movements in contemporary or future real output and/or the price level after the economy experiences nonmonetary exogenous shocks. Absent a structural model, the way in which such information may arise can be illustrated with the descriptive policy rule suggested by Taylor (1993) in which there is a pegged short-run nominal rate but the peg is adjusted over time through a feedback rule to achieve a long-run inflation

[13] The arguments presented throughout this section also apply to the concept of adjusted total reserves or adjusted nonborrowed reserves.

[14] Friedman (1990) labels such endogenous variables that are not policy targets as "information variables". See also Brunner and Meltzer (1964, 1969).

target under an assumed equilibrium real interest rate. Below, we show that the monetary base may be of value in predicting movements in the price level when such a model is subject to unobserved shocks.

Consider any macroeconomy which is characterized by a demand function for real balances:

$$\frac{M}{P} = L(i, Y, \varepsilon_1)$$

where ε_1 represents all disturbances to the demand for real balances other than i and Y, and we have suppressed time subscripts. Assume that shocks to the demand for real balances are transitory, such that ε_1 is stationary. Since in every time period the product of the adjusted monetary base, AMB, and its associated multiplier, m, are identically equal to the money stock, M = m*AMB, this can be rewritten as[15]

$$\frac{AMB * m}{P} = L(i, Y, \varepsilon_1)$$

Let the excess reserve ratio component, *e*, of the adjusted monetary base multiplier be a function of the nominal interest rate and a stationary disturbance term ε_2

$$e = e(i, \varepsilon_2)$$

and let the currency/deposit ratio, *k*, of the adjusted monetary base multiplier be a function of the nominal interest rate, real output and a disturbance term ε_3

$$k = k(i, Y, \varepsilon_3).$$

[15] We have in mind here a narrow transaction monetary aggregate such as M1 or MzM (M1 + money market mutual funds). For a suitably defined multiplier, a broader monetary aggregate also is acceptable.

These general specifications of the adjusted monetary base multiplier encompass a broad range of models of the financial sector of the macroeconomy.[16]

The relationship between growth of the adjusted monetary base, the monetary base multiplier and the price level is obtained by totally differentiating the above expression for the AMB:

$$\frac{dAMB}{AMB}+\frac{dm}{m}-\frac{dp}{p}=\left(\frac{PL_i}{M}\right)di+\in(L,Y)\frac{dY}{Y}+\frac{d\varepsilon_1}{\varepsilon_1}$$

where ε_1 is normalized so that a one percent shock corresponds to a one percent change in the demand for real balances, $\in(L,Y)=\frac{PYL_Y}{M}$ is the elasticity of the demand for real balances with respect to real output, $L_i=\frac{\partial L(i,Y,\varepsilon_1)}{\partial i}$, and $L_Y=\frac{\partial L(i,Y,\varepsilon_1)}{\partial Y}$.

Given the specification of $e(\,)$ and $k(\,)$, and letting $\in(x,y)$ continue to denote the elasticity of x with respect to y, we also have that

$$\frac{dm}{m}=\in(m,k)\in(k,Y)\frac{dY}{Y}+\left[\in(m,k)\frac{k_i}{k}+\in(m,k)\frac{e_i}{e}\right]di+\in(m,k)\frac{d\varepsilon_2}{\varepsilon_2}+\in(m,e)\frac{d\varepsilon_3}{\varepsilon_3}$$

where ε_2 and ε_3 are also normalized so that a one percent shock corresponds to a one percent change in the corresponding multiplier component.

All models that contain a demand function for real money balances also contain, implicitly or explicitly, equations similar to the above. Combining these equations, we obtain the relationship that the difference between the growth rates of the adjusted monetary base and of the price level in this economy depends on the (net) elasticity of the combined money demand and supply process with respect to market interest rates and real output, the first two righthand side terms below, plus the shocks that hit the

[16] Although our analysis is framed in terms of a money multiplier/monetary base paradigm, we have in mind a general equilibrium framework of the type discussed by Tobin (1961) and, in several papers, by Brunner and Meltzer; see Anderson and Rasche (1982) and Anderson, Johannes and Rasche (1983).

economy, the third righthand side term:

$$\frac{dAMB}{AMB}-\frac{dP}{P}=\left[\frac{PL_i}{M}\epsilon(m,k)\frac{k_i}{k}-\epsilon(m,e)\frac{e_i}{e}\right]di+\left[\epsilon(L,Y)-\epsilon(m,k)\epsilon(k,Y)\right]\frac{dY}{Y}$$
$$+\left[\frac{d\varepsilon_1}{\varepsilon_1}-\epsilon(m,k)\frac{d\varepsilon_2}{\varepsilon_2}-\epsilon(m,e)\frac{d\varepsilon_3}{\varepsilon_3}\right]$$

This equation ties together growth of the economy's price level and growth of the (endogenous) adjusted monetary base, conditional on the economy having a demand function for real balances with stationary disturbances.[17] Under an interest rate-pegging monetary policy, $di=0$.

Within this framework, consider the impact effect of an exogenous shock (other than one of the included shocks ε_i, i=1,...,3) with the nominal interest rate pegged by the central bank ($di=0$). Under these conditions, the relationship between movement in the adjusted monetary base and the price level is

$$\frac{dAMB}{AMB}=\frac{dP}{P}+\left[\epsilon(L,Y)-\epsilon(m,k)\epsilon(k,Y)\right]\frac{dY}{Y}.$$

If $\epsilon(k,Y)\geq 0$ then $0<\left[\epsilon(L,Y)-\epsilon(m,k)\epsilon(k,Y)\right]$. If the latter term is close to 1.0, then the percentage response of the adjusted monetary base is a good indicator of the percentage response of nominal income $\left[\frac{dY}{Y}+\frac{dP}{P}\right]$. If the impact elasticities of the demand for real balances and the currency/deposit ratio are close to zero, then the percentage response of the adjusted monetary base is a good indicator of the percentage response of the price level. This indicator function is obscured when there is a large short-run variability in the composite shock

$$\left[\frac{d\varepsilon_1}{\varepsilon_1}-\epsilon(m,k)\frac{d\varepsilon_2}{\varepsilon_2}-\epsilon(m,e)\frac{d\varepsilon_3}{\varepsilon_3}\right].$$

[17] See Hoffman and Rasche (1991), Hoffman, Rasche and Tieslau (1995) and Hoffman and Rasche (1996)

The long-run indicator property of the adjusted monetary base under the specified feedback policy rule may be illustrated by considering steady-state responses under the assumptions that real output changes are equal to the growth rate of natural output, μ, the real interest rate is stationary around a mean, $ir = ir_0 + \varepsilon_4$, and actual inflation is correctly anticipated. Then

$$\frac{dAMB}{AMB} = \frac{dP}{P} + \left[L_1 - \in (m,k)\frac{k_i}{k} + \in (m,e)\frac{e_i}{e} \right]\left(\frac{dP}{P} + d\varepsilon_4 \right) + \left[\in (L,Y) - \in (m,k) \in (k,Y) \right]\mu + \left[\frac{d\varepsilon_1}{\varepsilon_1} - \in (m,k)\frac{d\varepsilon_2}{\varepsilon_2} - \in (m,e)\frac{d\varepsilon_3}{\varepsilon_3} \right]$$

or

$$\frac{dAMB}{AMB} = (1+\rho)\frac{dP}{P} + \left[\in (L,Y) - \in (m,k) \in (k,Y) \right]\mu + \left[\frac{d\varepsilon_1}{\varepsilon_1} - \in (m,k)\frac{d\varepsilon_2}{\varepsilon_2} - \in (m,e)\frac{d\varepsilon_3}{\varepsilon_3} + \rho d\varepsilon_4 \right]$$

where $\rho = L_i - \in (m,k)\frac{k_i}{k} + \in (m,e)\frac{e_i}{e}$. This relationship implies that, with a stationary composite disturbance, the average growth of the adjusted monetary base over longer periods will reflect (but not necessarily equal) the average inflation rate. Central banks that seek to achieve price stability should likely regard sustained near-term accelerations or decelerations of the monetary base with concern.[18]

2. Broadening the Measure of the Monetary Source Base

High-powered money equals the monetary liabilities of the monetary authorities (in the United States, the Federal Reserve and the Treasury) to the rest of the economy. The monetary base includes

[18] The stationarity of ε_1 and ε_4 is examined in Hoffman and Rasche (1996), and of ε_4 in Crowder and Hoffman (1996).

part, but not all, of these liabilities.[19] The sources and uses of high-powered money are shown in Table 1 for December 1995.

2.1 The Supply of High-Powered Money

The largest factor supplying high-powered money is Reserve Bank credit (line 1 in Table 1), consisting of the assets of the 12 Federal Reserve Banks. Reserve Bank credit varies directly with the quantity of government and other securities held by the Federal Reserve, with Federal Reserve lending to financial institutions, and with Federal Reserve float. The aggregate supply of high-powered money also increases with the quantity of SDR (line 2) and gold certificates (line 3) owned by the Federal Reserve, and with the amount of US Treasury currency and coin outstanding (line 4).

2.2 The Demand for High-Powered Money and the Monetary Base

Most of the high-powered money supplied by the Federal Reserve and the Treasury is represented by currency in circulation and the deposits of domestic financial institutions at Federal Reserve Banks; together, these constitute the monetary base.[20] The current measure of the St. Louis monetary base (line 6) equals the sum of currency in circulation outside the Treasury and Federal Reserve (line 6a) plus reserve balances of depository institutions (line 6b). Reserves balances is an accounting concept intended to measure the aggregate amount of depository institution reserves available to support deposit expansion. Reserve balances are measured by subtracting the aggregate amount of depository institutions' required clearing balance contracts from their aggregate Federal Reserve deposits. Uses of high-powered money other than as the monetary base (line 7) were about $25 billion in December 1995.

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[19] The major uses of high-powered money excluded from the monetary base are the Federal Reserve deposits of foreign central banks and of the U.S. Treasury. For discussion of some arguments for their inclusion and exclusion, see Advisory Committee on Monetary Statistics (1976). The term high-powered money as used in this section is slightly broader than the concept used by Friedman and Schwartz (1963).

[20] This concept also is widely referred to as simply the source base.

The revised measure of the monetary base recognizes the similarity between the Federal Reserve deposits classified as reserves balances (line 6b) and the Federal Reserve deposits classified as held to satisfy required clearing balance contracts (line 7d). [21] Both categories of deposits are used by depository institutions to settle interbank payments, and both types are available to satisfy legal reserve requirements (albeit perhaps at the cost of failing to satisfy a required clearing balance contract). The revised measure of the monetary base (line 8) equals the sum of currency in circulation (line 8a) and all the Federal Reserve deposits held by domestic depository institutions (line 8b). Including Federal Reserve deposits putatively held to satisfy required clearing balance contracts increases the amount of Federal Reserve deposits including in the base by about one-fourth, and increases measured total reserves of depository institutions by 8 percent.

The demand for the monetary base may be separated into three parts: the public's holdings of hand-to-hand currency and coin, depository institutions' holdings of vault cash, and depository institutions' holdings of deposits at Federal Reserve Banks; the sum of the latter two items equals the reserve component of the monetary base. Although strong foreign demand for U.S. currency has complicated interpretation of the monetary base during the last decade, the revision discussed in this paper changes only the reserve component of the base.

The Monetary Control Act of 1980 significantly changed the demand for Federal Reserve deposits. Prior to the Act, almost all deposits at Federal Reserve Banks were held by member banks of the Federal Reserve System.[22] Banks used these balances both to satisfy reserve requirements and to make payments on behalf of customers. For most member banks, the latter came "free": the amount of reserves that they were required to hold against deposits was more than sufficient to satisfy any demands arising from interbank payments (perhaps with some intraday Federal Reserve overdraft credit). Nonmember banks and thrifts, lacking access to the Federal Reserve's books for final settlement of

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[21] For further discussion, see Anderson and Rasche (1996).

[22] Nonmember banks also held small amounts of Federal Reserve deposits used for payments, as previously noted.

payments, made interbank payments and settled checks through correspondent accounts at member banks. The Act made nonmember institutions subject to Federal Reserve reserve requirements and, at the same time, gave them direct access to the payments system through reserve balance accounts. Since reserve requirements were phased-in for these institutions over an eight-year period, many initially (at least) found their vault cash more than sufficient to satisfy their new Federal Reserve reserve requirements. The Act's changes created a large set of depository institutions with access to Federal Reserve check clearing and other payments facilities but little experience in reserve account management. With the relatively low level of reserve balance requirements during the during the Act's initial phase-in period, the possibility and frequency of overdrafts on reserve balance accounts became a problem for some institutions.[23]

During the early 1980s, the Federal Reserve required some depository institutions that used Federal Reserve payments services to maintain *required clearing balances,* or levels of Federal Reserve deposits above and beyond the amounts necessary to satisfy the institutions' statutory reserve requirements. Based on its payments activity and past management of its Federal Reserve account, an institution negotiated with Federal Reserve Bank staff a minimum amount of Federal Reserve deposits that it would maintain in addition to the amount of deposits necessary to satisfy its statutory reserve requirement. (Required clearing balance requirements must be negotiated on an individual institution basis because the Monetary Control Act forbid the Federal Reserve from imposing a blanket supplemental reserve requirement for payments purposes, except in times of emergency.) To offset the cost of holding these balances and make the requirement more palatable, the Federal Reserve paid the institutions, at (approximately) the federal funds rate, "earnings credits" that could only be used to pay for Federal Reserve priced services such as check clearing and wire transfers of funds.

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[23] Some institutions, newly subject to Federal Reserve reserve requirements, held very low levels of Federal Reserve deposits and encountered overdraft problems for two reasons. First, vault cash could be applied to satisfy reserve requirements. Second, some institutions held relatively small amounts of transaction deposits relative to total

During the mid-1980s, and especially following the February 1984 shift to contemporaneous reserve accounting, an increasing number of institutions realized that they could simplify their reserve management by *voluntarily* agreeing to maintain a required clearing balance. Maintaining voluntarily a "required" clearing balance changes the expected cost to the depository of satisfying its statutory reserve requirements because the additional Federal Reserve deposits provide an inexpensive cushion against possible shortfalls relative to statutory reserve requirements. Deficiencies relative to the agreed upon clearing balance impose little cost on the institution while permitting it to use all its Federal Reserve deposits to satisfy its statutory requirements; at the same time, the Federal Reserve deposits used to satisfy the clearing balance contract accumulate earnings credits at about the federal funds rate.

The Federal Reserve deposits held to satisfy a voluntary required clearing balance contract act as a buffer stock because, under Federal Reserve accounting rules, balances in a depository's Federal Reserve account are applied first to satisfy its statutory required reserves and only thereafter to satisfy the clearing balance requirement. Hence, when an institution's Federal Reserve deposit balance falls below its expectation, the shortage is recorded in the Federal Reserve's accounting system as a deficiency on a clearing balance requirement rather than as a deficiency on a statutory reserve requirement (provided the sum of vault cash and Federal Reserve deposits exceeds the institution's required reserves). No penalties are imposed for small deficiencies on voluntary clearing balance contracts, and larger shortfalls are penalized at only a 2 or 4 percent annual interest rate.[24] Deficiencies relative to required reserves are subject to significant penalties and "administrative counseling," while comparable deficiencies relative to a clearing requirement are subject to minimal penalties. An institution that sometimes has been forced to borrow at either the discount window or a penalty federal funds rate to cover reserve deficiencies may find the required clearing balance account comforting.

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deposits, and most nontransaction deposits were not subject to reserve requirements. See *Federal Reserve Bulletin*, March 1981, pp. 247-49 and December 1982, p. 756.

[24] For discussions of the accounting rules, see Appendix 2 and Stevens (1993).

By 1985, about 4500 institutions had clearing balance contracts, totaling about $1-1/4 billion. These numbers were about the same in the third quarter of 1990, before the December 1990 reduction in reserve requirements on nonpersonal time deposits and certain other liabilities. Two years later, during the third quarter of 1992, the amount of contracted required clearing balances had nearly tripled to about $4-1/2 billion while the number of institutions increased to about 4700 (see Figure 1).[25] More recently, reductions in clearing balance contracts seem to be an adjustment margin for depositories following shifts in the stance of monetary policy: aggregate clearing balance contract amounts fell sharply following the Committee's decision to increase its federal funds rate target in February 1994. Finally, the accelerating spread of OCD sweep programs since mid-1995 appears to have encouraged many depositories to re-label their Federal Reserve deposits, previously held to satisfy statutory reserve requirements, as clearing balances.[26]

2.3 Should clearing balances be included in the monetary base?

The contracted required clearing balances of depository institutions are not currently included in the published adjusted monetary base, as shown in line 6 of Table 1.[27] We include required clearing balances in our revised adjusted monetary base, shown in line 8, just as we include other Federal Reserve deposits held by domestic depository institutions at Federal Reserve Banks.

Our revised measure of the of monetary base is suggested by the definitions of Balbach and Burger (1976):

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[25] The actual amount of Federal Reserve deposits used to satisfy depository's clearing balance contracts is not available. These data are the minimal contracted amounts only.

[26] In a sweep program, a depository reclassifies transactions deposits at the end of the business day as money market deposit accounts (MMDA), the latter subject to a zero reserve requirement. By doing so, many large depository institutions are able to satisfy their statutory required reserves with vault cash and need to hold Federal Reserve deposits only to settle interbank debits such as check clearing and wire transfers; see Appendix 3. As of March 1996, Federal Reserve Board staff estimated that about one-sixth of the decrease in Federal Reserve deposits due to sweep programs had been reflected in increased required clearing balances; see Kohn (1996).

[27] Required clearing balances are included in the Board staff's monetary base not adjusted for changes in reserve requirements, currently published on page 2 of the Board's weekly H.3 release and in Table 1.20 of the *Federal Reserve Bulletin*, but are excluded from the Board's base adjusted for changes in reserve requirements and the St. Louis monetary base.

> "... (the monetary base) can therefore be identified in any monetary system by ascertaining and summing the following:
> 1. those assets which the consolidated banking sector uses to settle interbank debt; and
> 2. those items, aside from bank liabilities, which are used as money."

and of the Advisory Commission on Monetary Statistics (1976, p. 8):

> "With respect to monetary aggregates, one basis for defining such a total is to regard money as corresponding to assets that are generally used to discharge obligations and that are not the explicit liability of nongovernmental entities in the society. Traditionally, such assets have corresponded to specie. In the United States today they correspond primarily to the non-interest-bearing fiat issues of the ultimate monetary authority. The terms "high-powered money" and "monetary base" have been used to refer to this total. We shall refer to it as "the base."
>
> "For the United States today the base includes all currency outside the Federal Reserve and the Treasury plus all bank deposits at Federal Reserve Banks.

Although broader than the old measure of the base that it replaces, the new revised measure continues to exclude an important asset that these definitions suggest should be included: the amount of intraday credit, in the form of Federal Reserve deposits, used for payments activity. During 1994, such intraday deposits averaged approximately $50 billion, or nearly *twice* the close-of-business-day amount of Federal Reserve deposits included in the monetary base; see Richards (1995), p. 1066. The major barrier to inclusion of intraday deposits is the lack of timely published data: close of business deposit levels are published weekly on the Board of Governors's H.4.1 statistical release, while intraday credit is not published in any release.[28]

The argument for the inclusion of required clearing balances also rests on several observations regarding depository institutions of Federal Reserve deposits. First, so far as we are aware, contracted clearing balances today are a voluntary commitment to maintain a reserve balance at a Federal Reserve Bank. Most of these balances are maintained in reserve accounts that are also used to satisfy legal

[28] The revised measure of the base, like previous measures, excludes Federal Reserve deposits held by the U.S. Treasury and by foreign central banks, included in lines 7b and 9b of Table 1. These deposits are not used to make interbank payments nor to discharge debts of nongovernmental units; see Advisory Committee on Monetary Statistics (1976).

reserve requirements against deposits, not as a separate deposit. For most institutions, the funds held to satisfy a clearing balance contract are available to make interbank payments in the same way as other reserve balances. An institution may change its clearing balance commitment, and its holdings of reserve balances, appropriate to its business needs.[29] This suggests that reserve balances held to satisfy a clearing balance contract are a close substitute for other reserve balances. Second, when reserve requirements were reduced in 1990-91, some institutions found that the level of reserve balances required against deposits was less than the amount desired for interbank transaction activity. As a result, they increased their contracted clearing balance. Third, contracted clearing balances are not a distinct types of funds. Rather, the reserve balances used to satisfy clearing balance contracts are supplied by the Federal Reserve via actions such as open market operations in the same way as other high-powered money.

Including contracted clearing balances in the adjusted monetary base is not without objection. Some depository institutions seem to adjust the amount of contracted clearing balances inversely to changes in the federal funds rate, seeking apparently to generate only enough earnings credits to pay for their use of Federal Reserve priced services. For these institutions, the demand for reserve balances may be highly interest elastic and largely unrelated to either liquidity management or lending decisions. If so, some analysts have argued that required clearing balances should be excluded from the monetary base.

The macroeconomic analysis developed above shows, however, that this argument has no implications for definition or measurement of the adjusted monetary base. We noted in our illustration of the adjusted monetary base as a monetary policy indicator that some components of the money multiplier, such as k and e, are generally functions of economic variables such as interest rates and income.[30] It seems likely that inclusion of required clearing balances in the measure of the adjusted monetary base will, in fact, increase the interest elasticity of the excess reserve ratio, e. Yet, the essential

[29] However, Federal Reserve operating rules generally discourage changes more frequently than once a month, or approximately every third or fourth maintenance period.

point is that *the role of the adjusted monetary base as an indicator of the stance of monetary policy is independent of the size of the elasticity of multiplier components such as k and e with respect to variables such income and interest rates*.

The argument to support this conclusion is straightforward. The larger the average interest elasticity of the excess reserve ratio e, the smaller the mean estimated size of the reduced form multipliers for the adjusted monetary base, all else equal. In models where the adjusted monetary base satisfies the Blinder/Solow criterion, the reduced form multipliers of the underlying macroeconomic model for changes in both the monetary base dMB and reserve requirement ratios $-Ddr$ are affected proportionately by the size of the interest elasticity of the excess reserve ratio. Therefore, in such models, the effect of changes in the interest elasticity of e are confined to the *scale factor* for the monetary policy indicator variable. The size of the interest elasticity of the excess reserve ratio is irrelevant to the definition of the scale variable.

3. Adjusting the Monetary Base for Changes in Reserve Requirements

Measuring the extended monetary base requires a mechanism for mapping changes in reserve requirements into "equivalent" changes in the quantity of base money demanded by depositories. Combining the effects of reserve requirement changes with those from open market operations and similar instruments is not a simple a matter. Open market operations, discount window lending and foreign exchange market intervention all directly change the supply of Reserve Bank credit by changing the quantity of assets (securities or loans) held by the Federal Reserve Banks. Reserve requirement changes alter the demand for Reserve Bank credit.

The adjusted monetary base published by Andersen and Jordan (1968) included an adjustment for "... reserves released by changes in reserve requirements". The adjustment, constructed as suggested by Brunner (1961), added to the monetary base at each date the cumulative dollar amount by which past

[30] For empirical evidence, see Anderson and Rasche (1982) and Anderson, Johannes and Rasche (1983).

changes in reserve requirements had changed the level of required reserves. Although each change in reserve requirements was viewed as absorbing or liberating a certain dollar amount of required reserves, these amounts depended only on the amount of reservable deposits on the date of the reduction: they did not vary in later periods with changes in the levels of reservable deposits.

In 1977, Burger and Rasche (1977) showed that Brunner's adjustment was inadequate because it did not consider the amount by which past reductions (increases) in reserve requirements reduced (increased) a bank's current required reserves. They showed that an adjustment that varies with deposit levels is necessary for the adjusted monetary base to remove the total effect of the change in reserve requirements from the monetary base multiplier (and no more). They proposed that the adjusted monetary base be measured as the sum of the source base and a time-varying reserve adjustment magnitude (RAM), a methodology that has generally been maintained in subsequent revisions of the St. Louis adjusted monetary base. Since 1980, the adjusted base has included a modification of the Burger-Rasche reserve adjusted magnitude due to Gilbert (1980, 1987).

The substantial changes in the structure of reserve requirements that have occurred since 1980 suggest that the methodology introduced by Burger and Rasche needs reexamination. Here, we formalize their analysis by considering a model with two classes of institutions. Institutions in the first class resemble the member commercial banks considered by Burger and Rasche. For these institutions, the total quantity of required reserves generally exceeds their vault cash, and legal reserve requirements play an important role in determining their demand for base money. Institutions in the second class find legal reserve requirements much less influential in their portfolio allocation decisions. Often, their level of required reserves is less than their vault cash and, hence, they are not legally required to hold any reserve balances at Federal Reserve Banks. Their demand for reserve balances depends largely on their need to make inter-bank payments in immediately available funds on the books of the Federal Reserve Banks, and perhaps on Federal Reserve restrictions regarding daylight overdrafts on their reserve accounts.

3.1 Monetary Base Multipliers before 1980

We begin with a model that reflects the institutional environment before the Monetary Control Act of 1980. Since our purpose is to illustrate the dependence of the RAM adjustment on the distribution of deposits among different classes of depository institutions, we separate member and nonmember banks more explicitly than previous authors.[31] We assume (1) a central bank that issues two liabilities, currency *Cu* and reserve balances (deposits) *RB*, and (2) two types of depository institutions, indexed by superscripts *M* and *N* (corresponding to member banks and to nonmember banks and thrifts, respectively), that issue demand $D = D_M + D_N$ and time $T = T_M + T_N$ deposits. The two types of depositories are dissimilar in four characteristics:

- type *M* institutions are subject to central bank reserve requirements against deposits that may be satisfied by holding either vault cash or reserve balances at the central bank;
- government deposits are only at type *M* institutions;
- type *N* institutions hold deposits at type *M* institutions but not *vice versa*;
- type *N* institutions are not permitted to hold deposits at the central bank.

but similar in two others:

- both types of institutions hold vault cash to satisfy reserve requirements and/or to convert deposits into currency on demand;
- both types of institutions issue deposits that the nonbank public regards as perfect substitutes.

We assume that transaction among banks, the government and the nonbank public are settled in terms of currency Cu, demand deposits held by the government at type *M* depositories D_M^G, demand

[31] Burger (1971) provides a similar analysis without as explicit a separation of different classes of institutions.

deposits held by the nonbank public at type *M* and *N* depositories, D_M^P and D_N^P respectively, and demand deposits held by type *N* at type *M* depositories, D_M^N. (Throughout, superscripts refer to the owner of the deposit and subscripts to the issuer of the deposit.) Define $D^P = D_M^P + D_N^P$ and $D_M = D_M^P + D_M^G + D_M^N$, and note that $D^P = D_M + D_N^P - D_M^G - D_M^N$. The Federal Reserve imposes legal reserve requirements against demand D_M and time T_M deposits at rates r^D and r^T, respectively, such that the required reserves of a type *M* institution are $RR = r^D D_M + r^T T_M$.[32] These must be satisfied by holding either vault cash or a reserve balance (deposit) at the central bank.

The monetary base multiplier in this model is easily derived. Suppressing time subscripts, the monetary base is by definition

$$\begin{aligned} MB &= RB + Cu \\ &= r^D D_M + r^T T_M + k\ D^P + VC_N + (VC_M + RB - r^D D_M - r^T T_M) \\ &= [r^D d_M + r^T t_M + k + v_N + e_M] D^P \end{aligned}$$

where $(r^D D_M + r^T T_M)$ are the required reserves of type *M* institutions,

kD^P is currency held by the nonbank public,

VC_M and VC_N are vault cash held by type *M* and *N* institutions, respectively,

RB are the reserve balance deposits held by type *M* institutions at the central bank,

$$d_M = \frac{D_M}{D^P},\quad t_M = \frac{T_M}{D^P},\quad v_N = \frac{VC_N}{D^P},\ \text{and}\ \ e_M = \frac{VC_M + RB - r^D D_M - r^T T_M}{D^P}.$$

The term $(VC_M + RB - r^D D_M - r^T T_M)$ equals the amount of high-powered money -- vault cash plus reserve balances -- held by type *M* institutions above and beyond their required reserves.

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[32] Historically, some nonmember banks and thrifts faced state-imposed reserve requirements that had to be satisfied with holdings of vault cash, deposits in other banks, U.S Treasury bills or certain other liquid securities. See Gilbert

For clarity, it may be useful to relate the reserve constructs in our model to currently published Federal Reserve Board reserve concepts, which differ from those of the Federal Reserve Bank of St. Louis by excluding surplus vault cash from the definition of excess reserves. For an individual depository institution *i*,

- if $VC_{i,M} > (r^D D_{i,M} + r^T T_{i,M})$, then the difference $(VC_{i,M} - r^D D_{i,M} + r^T T_{i,M})$ is referred to as *surplus vault cash*. If $VC_{i,M} \leq (r^D D_{i,M} + r^T T_{i,M})$, then surplus vault cash is zero. In either case, $VC_{i,M}$ is referred to as *applied vault cash*.

- If $VC_{i,M} > (r^D D_{i,M} + r^T T_{i,M})$ and $RB_{i,M} > 0$, then $RB_{i,M} - RCB_{i,M}$ is referred to as *excess reserves*, where $RB_{i,M}$ are the total reserve balances held by depository institution *i* at the Federal Reserve and $RCB_{i,M}$ is the amount of its required clearing balance contract (if any). Note that $RCB_{i,M}$ may be zero, and $RB_{i,M} - RCB_{i,M}$ may be negative. If $RB_{i,M} - RCB_{i,M} = 0$, then excess reserves equals zero even though surplus vault cash is greater than zero.

- If $VC_{i,M} < (r^D D_{i,M} + r^T T_{i,M})$, then $RB_{i,M} - RCB_{i,M} - (r^D D_{i,M} + r^T T_{i,M} - VC_{i,M})$ is *excess reserves*.

Data on total and excess reserves currently published by the Board of Governors of the Federal Reserve System include applied vault cash and reserve balances (= Federal Reserve deposits less the nominal amount of required clearing balance contracts) but omit surplus vault cash and an amount of Federal Reserve deposits equal to depository institution's required clearing balance contracts. [33] Reserve measures currently published by the Federal Reserve Bank of St. Louis, as of March 1996, include surplus vault cash but also subtract required clearing balance contracts.

(1978), Gambs and Rasche (1978), and Gilbert and Lovati (1978).

[33] See table 1.20 in the Federal Reserve Bulletin or the Board's weekly H.3 statistical release.

The monetary base multiplier for M1 is straightforward

$$M1 = Cu + D^P = (1+k)D^P$$
$$= \left\{ \frac{(1+k)}{r^D d_M + r^T t_M + k + v_N + e_M} \right\} MB$$
$$= m_1 MB$$

and for M2,

$$M2 = Cu + D^P + T = (1+k+t)D^P$$
$$= \left\{ \frac{1+k+t}{r^D d_M + r^T t_M + k + v_N + e_M} \right\} MB$$
$$= m_2 MB$$

where $t = (M2 - M1) / D^P = (T_M + T_N) / D^P$.

The objective of the reserve adjustment to the monetary base (RAM) is to map the effects of changes in reserve requirement ratios into an adjusted monetary base (AMB = MB + RAM) such that the multipliers $m_1(r^D, r^T, k, e_M, t, t_M, d_M, v_N)$ and $m_2(r^D, r^T, k, e_M, t, t_M, d_M, v_N)$ are (approximately) invariant to changes in the legal required reserve ratios r^D and r^T. At the same time, the adjustment should not change the response of the multipliers to other arguments in the functions that reflect the behavior of depository institutions or the nonbank public. The adjusted monetary base and adjusted monetary base multiplier (m_{1b}) for M1 are defined as

$$M1 = m_{1b}(MB + RAM) = m_{1b} AMB$$

where AMB is the adjusted monetary base, $m_{1b} = \dfrac{(1+k)}{r_0^D d_M + r_0^T t_M + k + v_N + e_M}$, and r_0^D and r_0^T are the reserve requirement ratios on transaction and time deposits in a chosen base period, respectively. The reserve adjustment magnitude

$$RAM = \left[(r_0^D - r_t^D)d_M + (r_0^T - r_t^T)t_M\right]D^P$$

maps the change in required reserves due any change in reserve requirement ratios since the specified base period into an equivalent change in the monetary base.

The M2 multiplier for the adjusted monetary base is

$$M2 = m_{2b}AMB = m_{2b}(MB + RAM)$$

or

$$[1+k+t]D^p = m_{2b}[r_t^D d_m + r_t^T t_m + k + v_n + e_m]D^p + m_{2b}[(r_0^D - r_t^T)d_m + (r_0^T - r_t^T)t_m]D^p$$

Therefore

$$m_{2b} = \frac{(1+k+t)}{r_0^D d_m + r_0^T t_m + k + v_n + e_m}$$

which is invariant to changes in the legal required reserve ratios r^D and r^T.

The above analysis may be extended to the case where type *M* institutions (those subject to central bank reserve requirements) issue $i = (1,...,I)$ classes of transaction deposits and $j = (1,...,J)$ classes of time deposits, each with possibly different reserve requirement ratios. Let $\delta_{Mi} = \frac{D_{Mi}}{D^P}$ and $\tau_{Mj} = \frac{T_{Mj}}{D^P}$ be the ratios of the nonbank public's holdings of demand and time deposits in the i^{th} and j^{th} reserve classifications, respectively, at type *M* depository institutions to their total holdings of demand deposits. Then aggregate required reserves are

$$\left(\sum_{i=1}^{I} r_{Mi}^D \delta_{Mi} + \sum_{j=1}^{J} r_{Mj}^T \tau_{Mj}\right)D^P$$

and the monetary base multiplier is

$$m_{1b} = \frac{1+k}{\left(\sum_{i=1}^{I} r_{Mi0}^{D}\delta_{Mi} + \sum_{j=1}^{J} r_{Mj0}^{T}\tau_{Mj} + k + v_N + e_M\right)}.$$

Note the presence of base period reserve ratios for each class of deposit, r_{Mi0}^{D} and r_{Mj0}^{T}, in the denominator. The corresponding reserve adjustment magnitude is

$$RAM = \left(\sum_{i=1}^{I}\left(r_{Mi0}^{D} - r_{Mi}^{D}\right)\delta_{Mi} + \sum_{j=1}^{J}\left(r_{Mj0}^{T} - r_{Mj}^{T}\right)\tau_{Mj}\right)D^{P}.$$

Finally, as a cavaet and extension to earlier remarks, note that the RAM adjustment does not make all money and credit multipliers invariant with respect to changes in statutory reserve requirements. Consider the bank credit (BC) monetary base m_{BC} multiplier of Brunner and Meltzer (1968), defined as $BC = m_{BC}MB$. In our notation,

$$m_{BC} = \frac{(1+t) - (r_t^{D}d_m + r_t^{T}t_m + e_m + v_n)}{r_t^{D}d_m + r_t^{T}t_m + k + e_m + v_n}$$

(see equation A.8, p. 32, Brunner and Meltzer (1968)). Let the bank credit-adjusted monetary base multiplier be defined as

$$BC = m_{BCb}AMB = m_{BCb}[MB + RAM].$$

Then:

$$[(1+t) - (r_t^{D}d_m + r_t^{T}t_m + e_m + v_n)]D^{p} = m_{BCb}[r_t^{D}d_m + r_t^{T}t_m + e_m + v_n]D^{p} + m_{BCb}[r_0^{D} - r_t^{D})d_m + (r_0^{T} - r_t^{T})t_m]D^{p}$$

so

$$m_{BCb} = \frac{(1+t) - (r_t^{D}d_m + r_t^{T}t_m + e_m + v_n)}{r_0^{D}d_m + r_0^{T}t_m + k + e_m + v_n}$$

which is not invariant to change in legal required reserve ratios r^D and r^T. Thus in models in which intermediated (bank) credit provides a channel of monetary policy independent of that provided by monetary aggregates, the adjusted monetary base defined above is not an adequate indicator variable for the stance of monetary policy.

3.2 Adjusting for Reserve Requirement Changes with "Economically Nonbound" Institutions

For periods prior to late 1980, depository institutions are easily separated into two groups based on their holdings of base money (vault cash and reserve balances). Member banks held vault cash, were subject to Federal Reserve reserve requirements, and generally held reserve balances at Federal Reserve Banks. Nonmember banks and thrifts held vault cash and were not eligible to hold reserve balances directly, although they often held them indirectly through correspondent member banks.

Studies of the adjusted monetary base conducted prior to 1980 generally assumed that member banks would change their holdings of base money about dollar-for-dollar following a change in Federal Reserve reserve requirements. During that period, member banks held few excess reserves and most banks likely faced required reserve ratios sufficiently high to constrain their portfolio allocation decisions.[34] Banking analysts paid little attention to payments issues. It seemed generally to be assumed that either banks' reserve balances were more than adequate to service any debits against their reserve accounts, or the Federal Reserve would supply adequate intra-day credit. Time deposits, with the exception of large negotiable certificates of deposit, were subject to effective Regulation Q interest rate ceilings. Banks and the public were likely sufficiently constrained that other multiplier components (such

[34] In 1977 required reserve ratios at member banks ranged from a minimum of seven percent on the first two million of net demand deposits to 16.25 percent on net demand deposits in excess of 400 million dollars. The required reserve ratio on savings deposits was three percent and the reserve requirements on time deposits maturing in less than 180 days were three percent on the first five million dollars and six percent on time deposits in excess of five million dollars. (Federal Reserve Bulletin, December, 1977, p. A9)

as the ratio of time and savings deposits to transaction deposits) were unaffected by changes in legal reserve requirements ratios on deposits.

Under this regime, the total base money demanded by depositories equaled the sum of required and excess reserves held by member banks, and vault cash held by other depositories. Since member banks applied essentially all their vault cash to satisfy reserve requirements and required clearing balances were approximately zero, excess reserves at member banks equaled the difference between their reserve balances and the portion of their required reserves not satisfied by vault cash, or $ER_M = RB_M - (r^D D_M + r^T T_M - VC_M)$. Excess reserves for the banking system as a whole equaled the sum of excess reserves at member banks and vault cash at nonmember banks VC_N, and the average aggregate excess reserve ratio was $e = e_M + v_N = \frac{ER_M + VC_N}{D^P}$.

Today's environment is considerably different. The Monetary Control Act extended reserve requirements to all depository institutions, reduced to zero required reserves on savings and personal time deposits, and significantly reduced other reserve requirements on member banks. During December 1990 and January 1991, required reserve ratios on nonpersonal time deposits and Eurodollar liabilities were reduced to zero for all depository institutions. In April 1992, required reserve ratios on transaction deposits were reduced to 10 from 12 percent.[35] Depository institutions also gained greater freedom to adjust their mix of reservable and nonreservable deposits during the during the 1980s following the end of Regulation Q ceilings on deposit offering rates.

After the Monetary Control Act, many depository institutions found that their vault cash, although largely held for retail business reasons, also satisfied their reserve requirements.[36] In the

[35] In 1995, the required reserve ratio on the first $3.8 million of net transaction deposits is zero (the so-called reserve exemption amount), and only three percent on the next $51 million (the low reserve tranche). The cutoff for the low reserve tranche is changed annually.

[36] Reserve requirements were increased from zero on all depository institutions which were not member banks. The full imposition of reserve requirements on these institutions was phased in over the period 1981-87.

Federal Reserve System, depository institutions that fully satisfy their required reserves with vault cash are known as "nonbound" institutions; other institutions are known as "bound" institutions. In this article, we refer to these groups of institutions as L-Nonbound and L-Bound, respectively. Table 2 shows the percentage distribution of L-Bound and L-Nonbound depository institutions among depositories reporting data to the Federal Reserve for selected years from 1981-95. (The rows labeled E-Bound and E-Nonbound are explained later.) Part A of the table includes only institutions that reported data weekly, while Part B includes institutions that reported quarterly and annually.[37] In mid-1983, after the initial phase-in of the Monetary Control Act, about 40 percent of the total deposits at weekly reporting institutions were held in L-nonbound institutions; for all reporting institutions shown in Part B, about 43 percent of deposits were held by L-nonbound institutions. By mid-1989, the proportion of total deposits held by L-nonbound weekly reporting institutions had fallen to about 18 percent (in Part A), and to about 25 percent for all L-nonbound reporting institutions (Part B). The 1990-91 reduction in reserve requirements increased the proportion of total deposits at L-Nonbound weekly reporting institutions to about 27 percent in 1991. We regard L-Nonbound institutions as facing no effective reserve requirement constraint, in the precise sense that they seem unlikely to change their portfolio mix of assets in response to a change in reserve requirements. Alternatively stated, the marginal reserve requirement tax rate on such depository institutions is zero.

The amount of vault cash held by nonbound institutions in excess of reserves required against their deposits is known as "surplus vault cash". Surplus vault cash is "surplus" only in the sense that some part of the bank's vault cash is not used to satisfy legal reserve requirements. Since these balances reflect voluntary portfolio choices of the managers of depository institutions, they presumably are the desired cash holdings for the anticipated transaction of those institutions and are not surplus in any economic sense of a portfolio disequilibrium. (Surplus vault cash is included in the St. Louis' adjusted

[37] Data for weekly reporters are the first complete reserve maintenance period in July of the specified year. For quarterly and annual reporters, June data are used.

monetary base and is also included in the monetary base, not adjusted for reserve requirement changes and not seasonally adjusted, published by the staff of the Board of Governors. As noted above, it is excluded from the monetary base adjusted for changes in reserve requirements published by the Board staff.)

Historical data on surplus vault cash is shown in Figure 2. Before 1959, vault cash could not be used to satisfy reserve requirements and all vault cash was "surplus". Surplus vault cash decreased sharply during 1959-60 when Federal Reserve member banks were gradually allowed to apply vault cash toward satisfying required reserves. The percentage of vault cash eligible to satisfy required reserves increased linearly at the rate of one-twelfth per month, reaching 100 percent in December 1960. From 1961 to 1981, surplus vault cash equals the vault cash held by nonmember banks and thrift institutions, since virtually all vault cash at member banks was applied to meet reserve requirements. Surplus vault cash grew rapidly during the 1970s as the fraction of banks who were members of the Federal Reserve System declined. Although the Monetary Control Act extended reserve requirements to all depository institutions, the requirements were phased in during 1980-1987. During these years, surplus vault cash generally declined. In the later 1980s, the average amount of surplus vault cash remained quite constant but exhibited substantial seasonal fluctuation.

L-Bound institutions, holding vault cash less than or equal to required reserves, also may not be constrained by legal reserve requirements. Although *legally* bound in the sense that their required reserves exceed their vault cash, some of these institutions (particularly smaller institutions) may be "economically nonbound" in the same sense as institutions that hold surplus vault cash: legal reserve requirements against deposits may not be an important factor in their portfolio decisions. In this paper, we denote such economically nonbound institutions as E-Nonbound, and other institutions -- for which reserve requirements are binding in the traditional sense -- as E-Bound.

How might the portfolios of "bound" and "nonbound" institutions change when reserve requirement ratios change? The ordinary business of a depository institution places some restrictions on its response. Generally, the institution must maintain adequate stocks of vault cash to convert customer deposits into currency and of reserve balances to make interbank payments. However, both constraints are somewhat flexible. There is an intraday market in vault cash, at least within larger cities, suggesting that a bank might request that a customer seeking a large amount of cash wait until later in the day when adequate currency can be obtained from the Federal Reserve or a correspondent. Some banks require customers planning to withdraw a significant amount of currency to provide at least one business day's notice. It also is not uncommon for ATM machines to run out of currency. For reserve balances, there is a national secondary market, the federal funds market. For interbank payments, the Federal Reserve may delay an interbank payment if it exceeds applicable daylight or overnight overdraft limitations. Since a failure to convert a deposit into currency or to make a requested interbank payment may damage a customer relationship, a depository cannot be indifferent to the mix of vault cash and reserve balances that it holds.

In the case of E-Bound institutions, changes in reserve requirements within the range where the requirement remains an effective constraint should allow a portfolio adjustment of total reserves (total base money) close to one dollar for each dollar change in required reserves, leaving "excess reserves" almost unchanged. If all institutions are "economically bound", then the aggregate excess reserve ratio, e, should be almost unaffected by the change in reserve requirement ratios. The most famous historical example of this type of portfolio response is the reaction of member banks to the increases in reserve requirement ratios in 1936-37. Contrary to the expectations of Federal Reserve officials, major reductions in the aggregate excess reserve ratio did not follow increases in reserve requirement ratios.[38] Surplus deposits at Federal Reserve Banks -- "excess" in a legal sense -- were an optimal portfolio

decision by member banks, and were not excess in an economic sense. The reserve requirement ratios of 1935 were effective constraints on the banking system.

In contrast, consider the portfolio response of an "economically nonbound" depository institution to a change in reserve requirement ratios. The business needs of the institution are the primary determinant of its holdings of base money, not legal reserve ratios. The excess reserves of a nonbound institution will vary approximately dollar-for-dollar but in *opposite* direction to the change in required reserves, leaving their total reserves largely unaffected.

The behavior of surplus vault cash and required clearing balance contracts following changes in reserve requirement ratios in 1990-91 and in 1992 suggest that a substantial proportion of depository institutions are economically nonbound. Surplus vault cash, shown in Figure 1, increased sharply in 1991 following the reduction in reserve requirement ratios to zero from 3 percent on nonpersonal time deposits and Eurodollar liabilities, suggesting that at least some depository institutions with surplus vault cash were economically nonbound during 1990. More dramatic perhaps was the sharp increase in required clearing balance contracts in 1991, shown in Figure 1, likely due at least in part to replacement of formerly "required" reserve balances with contractual required clearing balances. The increase in required clearing balances occurred after several years of stability in the amount of such balances. The aggregate data are also consistent, at least in part, with the alternative hypothesis that a large part of contracted clearing balances are held primarily to defray the cost of Federal Reserve priced services. Clearing balances surged during 1991 and 1992 as an increased supply of high powered money by the Federal Reserve caused sharp decreases in the federal funds rate, and then fell sharply during 1994 as the federal funds rate rose.

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[38] See Friedman and Schwartz (1963), pp. 521-34 for a discussion of the changes in reserve requirements and documentation that the Fed anticipated that the increases in reserve requirement ratios would substantially reduce the excess reserves of the banking system.

If E-nonbound institutions represent a significant share of the monetary base held by depository institutions, it is important to separate E-nonbound and E-bound institutions when measuring the RAM component of the adjusted monetary base because the institutions will respond differently to changes in reserve requirements. To make the analysis more precise, consider an economy with two distinct groups of depository institutions, both subject to Federal Reserve reserve requirements. Define *economic excess reserves* as $ER_i = RB_i - (r^D D_i + r^T T_i - VC_i)$, i = (B,NB), where subscripts denote groups of economically bound and nonbound institutions, respectively. Economically bound institutions are assumed to change the amount of high-powered money they demand (relative to reservable deposits) about dollar-for-dollar when required reserves ratios change. For this group, changes in reserve requirement ratios leave their excess reserve ratio $e_B = \frac{ER_B}{D^P}$ approximately unchanged. Economically nonbound institutions do not change the quantity of high-powered money they hold (relative to reservable deposits) when reserve requirements change. Their excess reserve ratio $e_{NB} = \frac{ER_{NB}}{D^P}$ changes in equal absolute amount but *opposite* direction to the reserve requirement ratio.

In section 2, we derived the RAM adjustment proposed by Burger and Rasche (prior to the Monetary Control Act) from a decomposition of the monetary base into the amounts of base money held by member banks, other depository institutions, and the nonbank public:

$$\begin{aligned} MB &= RB + Cu \\ &= r^D D_M + r^T T_M + k\ D^P + VC_N + (VC_M + RB - r^D D_M - r^T T_M) \\ &= [r^D d_M + r^T t_M + k + v_N + e_M] D^P \end{aligned}$$

The analysis of this section suggests the usefulness of a similar decomposition between economically bound and nonbound depository institutions for the period since implementation of the Act. In obvious notation, the monetary base may be written as

$$MB = [r_B^D \delta_B + r_B^T \tau_B + r_{NB}^D \delta_{NB} + r_{NB}^T \tau_{NB} + k + e_B + e_{NB}]D^P$$

The appropriate RAM for inclusion in the adjusted monetary base is then

$$RAM = [(r_{B,0}^D - r_B^D)\delta_B + (r_{B,0}^T - r_B^T)\tau_B]D^P .$$

Note that this RAM includes only deposits at economically bound institutions. In all essential aspects, the treatment of economically nonbound institutions in this RAM adjustment is analogous to the treatment of nonmember banks in Burger and Rasche (1977). The adjusted monetary base may be written as

$$\begin{aligned} AMB &= MB + RAM \\ &= \left[r_{B,0}^D \delta_B + r_{B,0}^T \tau_B + r_{NB}^D \delta_{NB} + r_{NB}^T \tau_{NB} + k + e_B + e_{NB}\right]D^P . \end{aligned}$$

The adjusted monetary base multiplier is

$$\frac{M1}{AMB} = \frac{1+k}{(r_{B,0}^D \delta_B + r_{B,0}^T \tau_B + e_B) + (r_{NB}^D \delta_{NB} + r_{NB}^T \tau_{NB} + e_{NB})} .$$

By assumption, e_B does not change when $r_{B,0}^D$ or $r_{B,0}^T$ changes because E-Bound institutions match reductions in their required reserves due to changes in statutory reserve requirements about dollar-for-dollar with reductions in their holdings of base money. In contrast, e_{NB} is assumed to change when r_{NB}^D or r_{NB}^T change in such a way that $r_{NB}^D \delta_{NB} + r_{NB}^T \tau_{NB} + e_{NB}$ does not change.

To measure accurately this post-Monetary Control Act RAM, it is necessary to determine the time-varying fractions of transaction deposits, δ_1, and time deposits, τ_1, that are held at E-bound depository institutions. These measurements cannot be identified in aggregate data, and must be obtained from data on individual financial institutions. Later in this article we present a statistical analysis of individual bank data that allows us to develop criteria for separating E-bound and E-nonbound institutions. Some of the results of that analysis are shown in Figures 3 and 4, and in Table 2. The estimated number of E-bound depository institutions, shown in Figure 3, fell by 80 percent following

the 1990-91 reduction in reserve requirements, to about 500 institutions. The proportions of transaction and nontransaction deposits at E-bound institutions, shown in Figure 4, fell from peaks in 1990 to about 65 and 54 percent, respectively, following the 1990-91 reduction in reserve requirements. (Recall that the reserve requirement ratio on time and savings deposits was reduced to zero in December 1990.) In Table 2, the rows labeled "E-Nonbound" and "E-Bound" are a similar separation of depository institutions. In 1995, we estimate that only about 2 percent of U.S. depository institutions were E-bound, or in other words, found statutory reserve requirements to be an important determinant of their business decisions. Only deposits at these E-bound institutions are included in the new RAM adjustment for the St. Louis adjusted monetary base; see Anderson and Rasche (1996).

3.3 Time Deposit Ratios and Reserve Requirement Changes

Our discussion of RAM has focused to this point on the direct impact of changes in reserve requirement ratios on the monetary base multiplier. Specifically, earlier in this article we developed the concept of the adjusted monetary base as a policy indicator by substituting into the total derivative of the money supply function, $dM = m\ dMB + MB\ dm$, the terms involving dr from the total derivative of the multiplier $dm = \cdots - \left(\frac{m}{r+e+k} \right) dr + \cdots$. This derivation assumes that other ratios included in the multiplier are not affected by changes in the reserve requirement ratios, or that $\frac{dm}{dr} = \frac{\partial m}{\partial r} = -\left(\frac{m}{r+e+k} \right)$. Our analysis above of economically bound and nonbound banks suggested that the excess reserve ratio e might be a function of r for nonbound banks. In this subsection, we explore whether the time deposit ratio t might also be a function of r.

The end of Regulation Q ceilings on deposit offering rates gave depository institutions, in principle, the means to adjust their reserve position by changing the mixture of reservable and nonreservable deposits. In a competitive market, absent legal interest rate ceilings, it seems reasonable to expect that changes in reserve requirement ratios will affect the rates offered by economically-bound

institutions on different types of deposits in a competitive market. It further seems reasonable that economic agents decide on how much wealth to hold in the form of time deposits, in part, on the rates of return offered on time deposits relative to the other assets. If so, competitive pressures may have caused increases in offering rates on savings and time deposits relative to those on transaction deposits following the Monetary Control Act. Similarly, the reduction to zero of reserve requirements on nonpersonal time deposits in January 1991 may have increased offering rates on large negotiable CDs relative to other instruments. In both cases, this might have increased the ratio of time deposits to total transaction deposits at economically bound institutions, τ_1, that enters the adjusted monetary base multiplier.[39]

Testing for a shift circa 1980 is difficult due to Regulation Q controls. Data from the latter period (1990-91) suggest, however, that banks likely do not alter offering rates in response to substantial changes in reserve requirements. The spreads between rates on large negotiable CDs and on Treasury bills and commercial paper are shown in Figure 5. Although there is considerable variability from week-to-week, there is no discernible trend. The spread of CD rates over 3 and 6 month Treasury bill rates fluctuates around 50 basis points; the spread of CD rates to commercial paper rates fluctuates around zero. Neither has any discernible spikes or shifts at the beginning of 1991 when the reserve requirement ratio was reduced to zero on nonpersonal time deposits. Hence, we do not include in RAM any adjustment for potential indirect effects of reserve requirement changes on the multiplier via changes in the time deposit ratio at economically bound institutions.

4. Microeconomic Evidence: Are Banks "Bound" by Reserve Requirements?

In this section, the reactions of commercial banks to the December 1990 - January 1991 and April 1992 reductions in reserve requirement ratios are examined in an analysis of variance (ANOVA)

[39] The multiplier discussed here is for transaction money, M1. Multipliers for the broader measures of money such as zero maturity money, MzM, M2 and M3 include additional terms in their numerators which, in a more detailed analysis, would be shown as components of the time deposit ratio, t. For examples, see Rasche and Johannes (1985).

framework.[40] The analysis seeks to quantify the different reactions of legally bound (L-bound) and legally nonbound (L-nonbound) banks, of various sizes, to changes in statutory reserve requirements. The goal of the analysis is to develop a set of criteria that distinguish E-bound from E-nonbound institutions, consistent with the construction of RAM outlined above.

Officially, the terms bound (L-bound) and nonbound (L-nonbound) describe the reserve position of an individual depository institution during a specific reserve maintenance period. For tractability in statistical analysis, it is necessary to classify institutions, over a number of maintenance periods, as being either of type L-bound or type L-nonbound. Some small and medium size banks, for example, tend to frequently change categories, being L-nonbound in periods when retail cash demands are heavy and L-bound in others, while larger banks tend to remain consistently in a single category. In our analysis, we experimented with several criteria for classifying a bank as type L-bound or type L-nonbound, including: (1) the bank was L-bound during only the later maintenance periods in 1992; (2) the bank was L-bound during only the initial maintenance periods in 1990; and, (3) the bank was L-bound in all maintenance periods included in our sample. All statistical inferences regarding the reaction of banks to changes in statutory reserve requirements were robust to reasonable alternative criteria. Parts A and B of Tables 4, 5 and 6 below show comparative results based on cases (1) and (3), respectively.

Our size grouping of banks is broadly consistent with categories used in other banking studies. Banks classified as L-bound are separated into four size classes-- small, medium, regional and large -- based on net transaction deposits, while L-nonbound banks are separated into only two, small and medium; there are too few larger nonbound banks for analysis. The Monetary Control Act of 1990 established a tiered system of reserve requirements wherein the first $25 million of net transaction deposits, the "low reserve tranche", was subject to a 3 percent requirement while larger amounts were subject to a 12 percent requirement; initially $25 million, the low reserve tranche is indexed to the annual growth of aggregate transaction deposits. We classify banks in our sample data as "small" if their

[40] Because of the unsettled state of the thrift industry during this period, we exclude thrifts from the analysis.

holdings of net transaction deposits did not exceed the *low reserve tranche*, or $41.1 million, during any reserve maintenance period in the second half of 1990.[41] We classify banks in the "medium" category if their average level of net transaction deposits during the second half of 1990 was greater than the low reserve tranche but less than $135 million, in the "regional" category if net transaction deposits averaged more than $135 million but less than $500 million, and in the "large" category if net transaction deposits averaged more than $500 million.

Statistical inferences regarding the behavior of banks are robust to reasonable alternatives for classifying banks into different size groups. The use of the low reserve tranche for delineating small banks provides an important control in our analysis because the April 1992 change in requirement ratios affected only banks with transaction deposits above the tranche. Results for the medium and regional groups are not sensitive to the precise cut-off selected to separate the groups because there are relatively few banks with net transaction deposits between about $100 to $150 million. The $500 million cut-off places about 150 banks in our large category, similar to the group of large weekly reporting banks published by the Federal Reserve.[42] The estimated models shown below also are not sensitive to inclusion or exclusion of banks that acquired other institutions.

Summarizing our results, we find that:

- L-Nonbound banks did not change their holdings of base money (vault cash plus Federal Reserve deposits), relative to transaction deposits, when reserve requirements changed in 1990-91 or 1992. These banks have chosen to hold enough vault cash to fully satisfy their reserve requirements. If their vault cash holdings are primarily determined by their needs to convert deposits into currency on request, then their holdings of vault cash will likely be insensitive to changes in statutory reserve requirements. The amount of Federal Reserve deposits held by these banks (if any), including

[41] The Garn-St. Germain Act of 1982 created the reserve exemption amount, which is subject to a zero reserve requirement. Originally $2.1 million of deposits, it also is indexed. See Anderson and Kavajecz (1994) or the Federal Reserve System's Regulation D, *Reserve Requirements*, for details.

deposits held to satisfy required clearing balance contracts, is likely determined primarily by the bank's decision to purchase services such as check clearing and wire transfer from a Federal Reserve Bank rather than a correspondent bank. Since these Federal Reserve deposits are not necessary to satisfy reserve requirements, the quantity should be insensitive to changes in reserve requirements.

- Small L-Bound banks changed their holdings of base money somewhat in response to the 1990-91 reduction from 3 percent to zero of reserve requirements on time and savings deposits, but did not respond to the 1992 reduction in the reserve requirement ratio to 10 from 12 percent. Small bound institutions differ primarily from small nonbound institutions (which are excluded from RAM) by choosing to hold less vault cash relative to transaction deposits than small nonbound institutions, thereby also choosing to satisfy the remainder of their required reserves with Federal Reserve deposits. Absent a fully worked out model of bank reserve management, it is difficult to conclude what this might imply for the institution's response to changes in reserve requirements. One possibility perhaps is that if the bank purchases services such as check clearing and wire transfer from the Federal Reserve rather than a correspondent, then its holdings of Federal Reserve deposits might be insensitive to changes in reserve requirements. The 1992 reduction in reserve requirements affected only net transaction deposits above about $42 million, having (algebraically) no effect on the required reserves of banks with net transaction deposits subject to only a 3 percent marginal reserve requirement and only a weak effect on moderate size banks that faced a 12 percent requirement on only a part of their transaction deposits.

- Larger L-Bound banks responded strongly to the 1990-91 reduction and somewhat less strongly to the 1992 reduction. For these banks, statutory reserve requirements force holding a level of Federal Reserve deposits in excess of the amounts necessary for payments-related activities such as check

[42] See Table 1.27 in the *Federal Reserve Bulletin*.

clearing and wire transfer. If reserve requirements are binding for *any* group of banks, it must be for these.

Our models seek to estimate the response of banks' holdings of base money to changes in reserve requirements. Measuring the amount of base money held by some nonmember institutions is problematic, however. While all banks in our dataset report their daily holdings of vault cash to the Federal Reserve, some nonmember banks do not hold Federal Reserve deposits directly in their own name but rather hold them indirectly via a passthrough contract with a correspondent bank.[43] In addition, some nonmember banks hold Federal Reserve deposits both indirectly through a correspondent and directly in their own account. We increased the Federal Reserve deposits reported by each of these banks by the difference between its required reserves and its applied vault cash. At the same time, we reduced each correspondent's reported Federal Reserve deposits by the amount of its respondents' required reserves charged against the correspondent's Federal Reserve account. Given the data reported by banks to the Federal Reserve, this is the only feasible method for measuring the amount of Federal Reserve deposits held (indirectly) by banks with passthrough reserve contracts.

Summary statistics for our sample of banks are shown in Table 3. The sample consists of commercial banks that reported data weekly to the Federal Reserve from mid-1990 through the end of 1992.[44] Banks without data for all included reserve maintenance periods are omitted, as are banks involved in mergers or acquisitions.[45] The upper panel, Part A, and lower panel, Part B, of the table

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[43] Nonmember depository institutions may contract with the Federal Reserve to satisfy their required reserves (beyond vault cash) with Federal Reserve deposits held by an eligible correspondent institution (a so-called "passthrough" reserve contract). Nonmember institutions that satisfy required reserves via passthrough contract may open an additional Federal Reserve account in their own name. Federal Reserve deposits in this second account may be used to satisfy a required clearing balance contract but may not be used to satisfy required reserves. (Of course, the funds could be loaned via the federal funds market to the correspondent.)

[44] Our sample may underrepresent small depository institutions that are not required to report data weekly to the Federal Reserve. We assume that virtually all of these institutions likely would be classified as economically nonbound and excluded from the calculation of RAM. For a discussion of Federal Reserve data reporting requirements, see Anderson and Kavajecz (1994).

[45] Banks that acquire other depository institutions are permitted under the Federal Reserve's Regulation D to phase-out of the benefit of the acquired institution's low reserve tranche during the following eight quarters. Hence, we exclude all banks involved in acquisitions from our statistical analysis. All such banks are included in the calculation

show banks classified as L-bound and L-nonbound via two alternative schemes. In Part A, banks are classified as L-bound if they were L-bound in 1992 H2, after both the 1990-91 and 1992 reductions in reserve requirements; banks not classified as L-bound are classified as L-nonbound, even if they were bound during some reserve maintenance periods in 1990 and 1991. In Part B, banks are classified as L-bound if and only if they were L-bound in every reserve maintenance period during 1990 H2, 1991 H2 and 1992 H2; otherwise, they are classified as L-nonbound. Application of the latter criteria reduces the number of L-bound banks from 1822 in part A to 710 in part B, primarily by pushing banks that are close to being L-nonbound (or in other words, hold enough vault cash to fully satisfy their required reserves in some maintenance periods) from the L-bound group in part A into the L-nonbound group in part B.[46]

Focusing on Part A of Table 3, the 1990-91 reduction in reserve requirements on nonpersonal time and savings deposits reduced required reserves at small, medium, regional and large banks by about 44, 19, 17 and 18 percent, respectively, after allowing for increases in their net transactions deposits. On average, these banks satisfied about one-half of their required reserves with vault cash (column 4).[47] Contracted clearing balances increased sharply from 1990 to 1992, about doubling for the smallest banks and increasing by almost an order of magnitude for large banks.

4.1 A Traditional Fixed Effects ANOVA Model

In Table 4, we present traditional ANOVA fixed-effects regression estimates for the effects of changes in reserve requirements in 1990-91 and 1992 on the ratio

$$\left\{\frac{\text{vault cash + Federal Reserve deposits}}{\text{net transactions deposits}}\right\}$$

during the last 13 reserve maintenance periods in 1990, 1991 and 1992, a total of 39 observations on each bank. The model is

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of RAM, where we allow for this effect by adjusting the size of the tranche loss adjustment to reflect the tranche in the base period, January 7, 1991; see Anderson and Rasche (1996).

[46] The overall sample size also is smaller in Part B because 13 regional and large L-bound banks in Part A are reclassified as L-nonbound in Part B, and dropped from the analysis.

$$y_{ijt} = \phi + \sum_{i=1}^{N-1} D_{ijt}^{B}(\alpha_i - \alpha_N) + \sum_{t=90}^{91}(\lambda_t - \lambda_{92})D_{ijt}^{Y} + \sum_{j=1}^{12}(\gamma_j - \gamma_{13})D_{ijt}^{P} + \xi D_{ijt}^{R} + \varepsilon_{ijt}$$

where y_{ijt} = the ratio of base money (vault cash plus Federal Reserve deposits) to net transaction deposits held by bank i in maintenance period j in year t, (i = 1,..., N), (j=1,...,13), (t = 90,...,92).

D_{ijt}^{B} = 1 for bank i, and = 0 otherwise,

D_{ijt}^{Y} = 1 in year t, and = 0 otherwise,

D_{ijt}^{P} = 1 in maintenance period j, and = 0 otherwise,

D_{ijt}^{R} = 1 if bank i had a clearing balance contract in maintenance period j of year t,

and ε_{ijt} is an assumed i.i.d. disturbance.

The dummy variables D_{ijt}^{P} index the relative position of reserve maintenance period j within the year, with the first period in July each year being numbered "1" and the last period of the year numbered "13." As such, they absorb seasonal fluctuations that may differ in strength across banks. We interpret the D_{ijt}^{Y} as representing the effects of changes in reserve requirements between 1990, 1991, and 1992, although as dummy variables they may also pick up other year-specific effects. Estimates presented in Parts A and B of Table 4 correspond to the banks summarized in Parts A and B of Table 3. Because the estimates are similar, we discuss only the estimates shown in Part A. Standard errors reported in the table are Huber-White robust estimates of the regression covariance matrix.

For all groups of banks, the null hypothesis of no significant year effects in the behavior of y_{ijt} is rejected. Consider, then, the regression results for each group of banks:

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[47] In December 1995, for example, required reserves of all depositories were $56.6 billion, of which $37.5 billion was satisfied with vault cash (H.3 release, April 25, 1996, Table 2).

Small L-Bound banks: The model estimates suggest a strong response to the 1990-91 reduction in reserve requirements. To gauge the reasonableness of the estimated regression coefficient, an *ex ante* projection of the size of the response of these banks may be calculated from the data in Table 3 under the null hypothesis that the banks are E-Bound, or in other words, that the banks will reduce their holdings of base money about dollar-for-dollar with the reduction in their required reserves. About half of the required reserves of these banks in 1990 was due to net transaction deposits ($620 million) and about half was due to nontransaction deposits. Each category of deposits was subject to a 3 percent marginal requirement, suggesting (absent the zero reserve requirement on the reserve exemption amount) that the reduction to zero of the requirement on nonpersonal time and savings deposits might be expected to reduce the banks' average ratio of base money to net transaction deposits by about one-half, relative to its 1990 value of 0.056, or 0.028. The ANOVA effect is $(\hat{\lambda}_{90} - \hat{\lambda}_{91}) = 0.021 - 0.001 = 0.02$, equal to the estimated coefficient on the 1990 year dummy less the coefficient on the 1991 year dummy variable (both $\hat{\lambda}_{90}$ and $\hat{\lambda}_{91}$ are estimated relative to 1992 because $D^{Y}_{ij,92}$ is omitted from the regression). The ANOVA effect is close to the projected value.

The regression coefficient reported for 1991, $\hat{\lambda}_{91}$, measures the reaction of small L-bound banks to the April 1992 reduction in the marginal reserve requirement on net transaction deposits from 12 to 10 percent. Because net transaction deposits at these banks were below the low reserve tranche, their required reserves were unaffected by the change. The estimated ANOVA effect, 0.0006, is about zero, as expected.

Medium L-Bound Banks: These results are similar to those for small bound banks. A projection of the reduction in their ratio of base money to net transaction deposits may be calculated from Table 3 under the null hypothesis that the banks are E-Bound both before and after the change in the legal requirements. About three-fourths of the required reserves of these banks were due to net transaction deposits in 1990,

and their total required reserves averaged about 8.1 percent of their net transaction deposits. Thus, reducing to zero the reserve requirement on nonpersonal time and savings deposits seems likely to reduce their overall ratio of required reserves and base money holdings, relative to net transaction deposits, by about one-fourth.

The estimated effect of the 1990 reduction is $(\hat{\lambda}_{90} - \hat{\lambda}_{91}) = 0.017 - 0.003 = 0.014$, equal again to the coefficient on the 1990 year dummy less the coefficient on the 1991 year dummy variable. The effect is economically significant, although smaller in size than a dollar-for-dollar reduction in base money relative to the decrease in reserve requirements.

The effect of the 1992 reduction, while statistically significant with such a large sample, is only 0.003, less than 15 percent of the 0.02 change in the marginal statutory reserve requirement ratio. This estimate suggests that banks in this size range reduced their holdings of Federal Reserve deposits little, if at all, in response to the lower reserve requirement. Some evidence is found of a differential response by banks that had required clearing balance contracts: banks without such contracts are estimated to have reduced their holdings of base money more than banks with such contracts. This seems consistent with our conjecture that required clearing balances are, for some banks at least, a low cost type of excess reserves. Further, banks with required clearing balance contracts likely are purchasing payments-related services from the Federal Reserve and need sufficient Federal Reserve deposits to avoid overdrafts.

Overall, for the small and medium bound banks, the estimated coefficients for the 1990-91 reduction are economically significant and the coefficients for the 1992 reduction are not. The insignificance of the latter coefficient for small banks is expected, since their marginal reserve ratio remained unchanged at 3 percent. While the 1992 year effect for the medium bound banks is statistically significantly greater than zero, its small size makes it difficult to attribute the effect to changes in the marginal reserve requirement ratio. This result also might reflect in part the lower federal funds rate that

prevailed during 1992 relative to 1991. Below, we compare their responses to the responses of similar legally nonbound banks.

As a result of this analysis, small and medium-size L-Bound depository institutions are assumed to be E-Bound prior to January 1991 and are included in RAM through December 1990, but are assumed to be E-nonbound beginning January 1991 and are excluded from RAM. With the exclusion of these depository institutions, only about 5-1/2 percent of weekly reporting institutions, and 2 percent of all institutions (see Table 2), are included in the revised RAM adjustment for the St. Louis adjusted monetary base.

Regional and Large L-Bound Banks: On balance, banks in these groups are estimated to have responded significantly to both the 1990-91 and 1992 reductions, or in other words, are E-Bound. Required reserves against net transaction deposits were about 83 percent of these banks required reserves in 1990, and their ratios of aggregate required reserves to net transaction deposits were about 12.2 and 13.9 percent, respectively. If the 1990-91 reductions were reflected fully in reduced holdings of base money, we would project an effect of more than 0.02. The ANOVA effect for regional banks, $(\hat{\lambda}_{90} - \hat{\lambda}_{91}) =$ 0.032 - 0.013 = 0.019, and for large banks, $(\hat{\lambda}_{90} - \hat{\lambda}_{91})$ = 0.036 - 0.013 = 0.023, are almost precisely what would occur if these banks had reduced their holdings of base money dollar-for-dollar with the reduction in their required reserves.

In contrast, both groups of banks seem to have responded to the April 1992 reduction in reserve requirements by reducing their holdings of base money less than proportionately. The estimated coefficients $\hat{\lambda}_{92}$ for regional and large banks, both 0.013 and 0.013, are statistically significantly greater than zero and less than the reduction in the marginal statutory requirement of 0.02. Banks with required clearing balance contracts again are estimated to have reduced their holdings of base money less than other banks: the estimated coefficients are positive and statistically significant. The lower federal funds

rate during 1992 likely attenuated the reduction in Federal Reserve deposits that otherwise would have followed the reduction in reserve requirements. In addition, the smaller size of the estimated coefficient (relative to the 0.02 reduction) likely reflects some large banks becoming economically-nonbound following the 1990-91 and 1992 reductions.[48]

Small and Medium-size L-Nonbound Banks: Estimates for L-Nonbound banks suggest economically insignificant responses to changes in reserve requirements since 1990. Again, a projection of the potential effect of the 1990-91 reduction in reserve requirements may be made from the data in Table 3. Required reserves against nontransaction deposits were about 40 and 30 percent, respectively, of the total required reserves of these banks in 1990. The average aggregate ratio of required reserves to net transaction deposits at these banks was 4.1 and 6.2 percent, respectively, suggesting that these banks ratio of base money to net transaction deposits might decrease by as much as 1.8 percent. The ANOVA effects of the reduction (0.006 for small banks and 0.003 for medium banks) are fairly similar in size and less than one-third of the projected change. Considering the generally lower federal funds rate that prevailed during this period, it seems difficult to attribute the change in these banks' holdings of base money (relative to net transaction deposits) to changes in legal reserve ratios.

Like small and medium L-Bound banks, small and medium L-Nonbound banks did not respond to the 1992 reduction in the reserve requirement on net transaction deposits. The estimated ANOVA effects are not economically different than zero.

4.2 An ANOVA Model with Idiosyncratic Bank-Year Interactions

The ANOVA model shown above includes a single fixed effect for each bank, α_i, and assumes that the response of all banks to the changes in statutory reserve requirements is the same, measured by $\hat{\lambda}_{90}$ and $\hat{\lambda}_{91}$. Because it seems unlikely that all banks responded in the same way, we estimated a

[48] See Feinman (1993) and Hilton, Cohen and Koonmen (1993).

second ANOVA model that permits idiosyncratic responses by each bank to the year effects:

$$y_{ijt} = \phi + \sum_{i=1}^{N-1}(\alpha_i - \alpha_N)D_{ijt}^B + \sum_{i=1}^{N}\sum_{t=90}^{91}(\beta_{it} - \beta_{i,92})D_{ijt}^B D_{jjt}^Y + \sum_{j=1}^{12}(\gamma_j - \gamma_{13})D_{ijt}^P + \xi D_{ijt}^R + \varepsilon_{ijt}$$

where y_{ijt} is the same as above. This model becomes the same as the previous ANOVA if the bank-year effects are constrained to be equal for all banks during each year, or in other words, $\beta_{1,t} = \cdots = \beta_{N,t} = \frac{1}{N}\lambda_t$, $t = 90,91$. In the ANOVA, the effect of the 1990-91 reduction in reserve requirements is measured by $\hat{\beta}_{i,90} - \hat{\beta}_{i,91} = \left(\hat{\beta}_{i,90} - \hat{\beta}_{i,92}\right) - \left(\hat{\beta}_{i,91} - \hat{\beta}_{i,92}\right)$, and the effect of the 1992 reduction by $\hat{\beta}_{i,91} - \hat{\beta}_{i,92}$. Distributions (histograms) of these individual bank year effects are shown in Figures 6-8. Summary statistics and hypothesis tests for this model are shown in Table 5.[49] Although Parts A and B of Table 5 show estimates under alternative L-bound classification criteria, we limit our discussion to Part A. Figures 6-8 are based on the regressions summarized in Part A of Table 5.

The null hypothesis that there was no change in the behavior of y_{ijt} across 1990, 1991 and 1992 is easily rejected by the F-statistics reported in Table 5. The estimated responses of individual small, medium, regional and large L-bound banks to the 1990-91 reduction in reserve requirement ratios are shown, respectively, in panels A and C of Figures 6 and 7. The panel titles show the number of estimates plotted in each panel. On balance, L-bound banks responded by significantly reducing their holdings of base money: most of the shaded area in each distribution is well to the right of zero (marked by a vertical line). Substantial variation in the responses of individual banks is evident in the figures, in part because different banks held different proportions of transaction and nontransaction deposits (recall that the dependent variable is the ratio of the bank's base money holdings to its transaction deposits).

[49] The ANOVA models are estimated with the GLM and REG procedure in SAS, version 6.11, on an HP Unix workstation.

In contrast, the estimated response of L-bound banks to the April 1992 reduction in reserve requirement ratios, shown in panels B and D of Figures 6 and 7, is more varied. This latter change reduced the marginal reserve ratio on transaction deposits to 10 from 12 percent, and did not directly affect small banks. Hence, as expected, the distribution for small L-bound banks (panel B of Figure 6) is tightly centered about zero. In addition, medium-size L-bound banks (panel D of Figure 6) responded weakly to the change, most commonly reducing their ratios of base money to transaction deposits by about half of what would be implied if they had matched the decrease in required reserves dollar-for-dollar.[50] For regional-size banks (panel B of Figure 7), the ratio fell about 1-1/2 percentage points, close to what would be projected from their average net transaction deposits of about $280 million (see Table 3). Large L-bound banks (panel D of Figure 7) most commonly reduced their base money holdings by about the full 2 percentage points.

The ANOVA effects for L-nonbound banks are shown in Figure 8. Because these banks satisfy their entire statutory reserve requirement with vault cash, we anticipate little reaction to the reductions in reserve requirement ratios. Although there is some variety in individual bank effects, the distributions of the effects for the L-nonbound banks generally are symmetric about zero, for both the 1990-91 changes (panels A and C) and the 1992 change (panels B and D).

4.3 Repeated-Measures Analysis of Variance

The panel, or longitudinal, structure of our data requires attention to the implied covariance structure of the data generating process. Each bank is observed for 13 reserve maintenance periods in each of 3 years, 1990, 1991 and 1992. As such, it seems unlikely that the disturbances in the above ANOVA models, ε_{ijt}, are in fact independent and identically distributed as we assumed. If not, the

[50] Medium-size L-bound banks averaged about $80 million in net transaction deposits (see Table 3), the first $3.6 million subject to a zero reserve requirement ratio, the next $38.6 million to a 3 percent ratio and, before the April 1992 reduction, the balance to a 12 percent ratio. Their ratio of base money to net transaction deposits would have decreased by about a 1 percentage point if the banks had matched the reduction in their required reserves with a dollar-for-dollar reduction in their holdings of base money.

coefficient estimates are unbiased and inefficient, while the estimated covariance matrix is biased and inconsistent. An appropriate covariance structure likely would be block-diagonal, with a separate block for each bank.

A test for the responses of depository institutions that is consistent with this covariance structure may be constructed by viewing the banks as if they were clinical subjects engaged in a laboratory experiment. It is commonplace in clinical studies to measure certain characteristics of subjects both "pre-treatment" and "post-treatment", asking whether the change in the measurement for each subject, when averaged across all subjects, is statistically significant. Since there are multiple observations on each subject, the models are widely referred to as *repeated measures* models.[51] In these models, the repeated observations for each subject are treated as multiple time series, and the disturbance is assumed to be multivariate normal.

In our dataset, we observe the ratio of base money to net transaction deposits for each bank during 13 reserve maintenance periods in each of three years: 1990, 1991 and 1992. In the repeated measures ANOVA, the observations for each year are treated as 13 realizations of a single time series process; pooled across the three years, the observations are regarded as a multiple time series process composed of three univariate processes. The data for 1990-91 form a pre- and post-treatment contrast for the 1990-91 reserve requirement reduction, and the data for 1991-92 form a similar contrast for the April 1992 reduction. Inferences regarding the response of banks in various groups to the reserve requirement changes are made by testing for the existence of significant interaction effects across years between (and among) each individual year's reserve maintenance period effects.

Repeated measures ANOVA results are shown in Table 6 and in Figures 9 and 10. Two tests are shown in each of Parts A and B in the table. The first is based on an estimated multivariate ANOVA, or MANOVA, model wherein the dependent variable is the vector $[y_{ij,90}, y_{ij,91}, y_{ij,92}]'$, the explanatory

variables are dummy variables representing each reserve maintenance period and the presence of a required clearing balance contract, and the disturbance vector for each bank is assumed multivariate normal without any restrictions on its covariance matrix. The value of Wilks' lambda, a multivariate analog of more familiar F-tests, suggests rejection of the hypothesis that coefficients on the period dummy variables are the same in all three equations. The second test shown in the table is based on an estimated single-equation regression that includes interaction effects between the reserve maintenance period dummy variables and year dummy variables for 1990 and 1991 (relative to 1992). The null hypothesis of no year effects is again strongly rejected. The test statistics shown in Parts A and B of Table 6 reinforce the inferences obtained from the fixed-effects ANOVAs: L-nonbound banks also were E-nonbound at the time of the 1990-91 reduction, and larger L-bound institutions responded more strongly to the reductions than smaller banks.

Our final repeated measures test is graphical, shown in Figures 9 and 10. The test is based on the differences $D_{ij,91} = y_{ij,91} - y_{ij,90}$ and $D_{ij,92} = y_{ij,92} - y_{ij,91}$, respectively, where y_{jit} is the ratio of base money (vault cash + Federal Reserve deposits) to net transaction deposits held by depository institution i in reserve maintenance period j, j=1,...13, during year t, t=90, 91, 92. Letting denote $D_{\bullet jt}$ the mean of the D_{ijt} for maintenance period j, then under suitable regularity conditions a $(100-\gamma)$ percent confidence interval for the null hypothesis that $D_{\bullet jt} = 0$ is

$$\left(D_{\cdot j} - t_{(1+\gamma)/2}\sqrt{\frac{\sum_i (D_{ij}-D_{\cdot j})^2}{n(n-1)}}, D_{\cdot j} + t_{(1+\gamma)/2}\sqrt{\frac{\sum_i (D_{ij}-D_{\cdot j})^2}{n(n-1)}} \right)$$ where $t_{(1+\gamma)/2}$ is the $[(1+\gamma)/2]$th quantile of the t distribution with n-1 degrees of freedom.[52] These confidence intervals are plotted as horizontal line segments in Figures 9 and 10. The length of each line segment shows the width of the confidence interval, the numbers on the vertical axis index the reserve maintenance period j, and the means $D_{\bullet jt}$ are

[51] See Crowder and Hand (1990), Diggle, Liang and Zeger (1994), or Davidian and Giltinan (1995). An earlier reference is Hsiao (1986).

indicated by the large dots on each line. We show the confidence intervals graphically, rather than reporting significance levels (p-values) for rejection/acceptance of the null hypothesis of no response to a change in the reserve requirement ratio, because inferences drawn from a graphical presentation likely are more robust to deviations of our sample data from the regularity conditions that justify use of the (asymptotic) t-distribution in construction of the intervals. A graphical presentation also is somewhat easier to interpret than classical test statistics when between bank, within-group variances are small, as reflected in the short length of the confidence intervals.

The responses of banks to the 1990-91 reduction in the reserve requirement ratios on nonpersonal time and savings and on Eurodollar borrowings to zero from 3 percent are shown in Figure 9. The results are clear: L-bound banks, shown in the second row of the figure, reduced their holdings of base money relative to net transaction deposits by about -0.02, close to the estimates obtained in the ANOVA models, while L-nonbound institutions did not respond. Of special interest is the confidence interval for the change between the 13th maintenance period in 1990 and in 1991. The reduction was phased-in, with only one-half of the reduction in force during the final reserve maintenance period of 1990. E-bound banks would be expected to respond to the phased reduction by displaying a smaller response for this 13th period than for the other 12 periods. Such a response is distinct for L-bound banks and absent for L-nonbound banks. We conclude that: (1) L-nonbound depository institutions likely were E-nonbound before the 1990-91 reduction, and hence should be excluded from RAM; and (2) L-bound institutions generally were E-bound, and responded as expected to the reduction in requirements.

A corresponding test for the effect of the April 1992 reduction in the marginal reserve requirement ratio on transaction deposits to 10 from 12 percent is shown in Figure 10. Small and medium-size L-nonbound and L-bound banks did not respond to the change: their confidence intervals either include, or are very close to, the origin. Larger L-bound banks reduced their holdings of base money. On average, the response of these banks was less than the 0.02 reduction in the statutory

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[52] See for example Mood, Graybill and Boes (1974), p. 387.

requirement, perhaps reflecting the effect of a falling federal funds rate. The less-than-proportionate response also may signal that the banks were becoming, or had become, E-nonbound. In fact, by the end of 1992 about half of these banks had required clearing balance contracts voluntarily obligating themselves to maintain Federal Reserve deposits in excess of amounts necessary to satisfy statutory reserve requirements. We conclude that by the end of 1992 only a small number of U.S. depository institutions found statutory reserve requirements to be the primary factor governing their demand for base money.

5. Conclusions

The evidence presented in this article suggests that the trend toward lower reserve requirements since the Monetary Control Act has significantly reduced the role of legal reserve requirements as a determinant of depository institutions' demand for base money. As a result, additional care must be exercised when combining the effects of changes in reserve requirements with changes in the monetary base if the adjusted monetary base is to remain interpretable as an index of quantitative monetary policy actions. In particular, the RAM adjustment included in the St. Louis adjusted monetary base should be modified to include only economically-bound depository institutions. Both the apparently incomplete adjustment of depositories to the April 1992 reduction in reserve requirements and the continuing spread of OCD-based sweep programs suggest that many, if not most, depository institutions may either be economically nonbound or will become so in the near future.

{Editor's Note: In September 1996, the Federal Reserve Bank of St. Louis began publication of new adjusted monetary base and adjusted reserves series incorporating the changes to the monetary (source) base and the new RAM adjustment discussed in this paper.}

References

Advisory Committee on Monetary Statistics (Bach Commission). *Improving the Monetary Aggregates* (Washington DC: Board of Governors of the Federal Reserve System, 1976)

Andersen, Leonall C. and Jerry L. Jordan. "The Monetary Base - Explanation and Analytical Use". Federal Reserve Bank of St. Louis *Review,* August 1968, pp. 7-11.

Anderson, Richard G. "Sweeps Distort M1 Growth". *Monetary Trends*, Federal Reserve Bank of St. Louis, November 1995

Anderson, Richard G. and Kenneth A. Kavajecz. "A Historical Perspective on the Federal Reserve's Monetary Aggregates: Definition, Construction and Targeting". Federal Reserve Bank of St. Louis *Review*, March/April 1994, pp. 1-31.

_____and Robert H. Rasche. "A Revised Measure of the St. Louis Adjusted Monetary Base". Federal Reserve Bank of St. Louis *Review,* March/April 1996

_____ . "What Do Money Market Models Tell Us About How to Implement Monetary Policy?". *Journal of Money, Credit and Banking* (November 1982), pp. 796-828.

_____ , James Johannes and Robert H. Rasche. "A New Look at the Relationship Between Time Series and Structural Models," *Journal of Econometrics* (October, 1983), pp. 234-51.

Benston, George. "An Analysis and Evaluation of Alternative Reserve Requirement Plans," *Journal of Finance*, December 1969, 24(5), pp. 849-70.

Blinder, Alan S. and Robert M. Solow. "Analytical Foundations of Fiscal Policy." In Alan Blinder and others, eds., *The Economics of Public Finance* (Washington, D.C.: Brookings Institution, 1974).

Board of Governors of the Federal Reserve System. *Federal Reserve System: Purposes and Functions*, 3rd ed., 1954.

Brunner, Karl. "A Schema for the Supply Theory of Money," *International Economic Review* (January 1961), pp. 79-109.

_____ and Allan H. Meltzer, "The Federal Reserve's Attachment to the Free Reserve Concept," paper presented to the House Subcommittee on Banking and Currency, 88th Congress, May 7, 1964. Reprinted in Karl Brunner and Allan H. Meltzer, eds., *Monetary Economics* (Oxford: Basil Blackwell, 1989)

_____ and _____ . "Liquidity Traps for Money, Bank Credit, and Interest Rates," *Journal of Political Economy*, Jan.-Feb. 1968, pp. 1-37. Reprinted in Karl Brunner and Allan H. Meltzer, eds., *Monetary Economics* (Oxford: Basil Blackwell, 1989)

_____ and _____ , "The Nature of the Policy Problem," in Brunner, ed., *Targets and Indicators of Monetary Policy* (San Francisco: Chandler, 1969)

Burger, Albert E. *The Money Supply Process*, Belmont CA: Wadsworth Publishing Company, 1971.

Burger, Albert E. and Robert H. Rasche. "Revision of the Monetary Base," Federal Reserve Bank of St. Louis *Review* (July 1977), pp. 13-27.

Burgess, W. Randolph. *The Reserve Banks and the Money Market*. (Harper and Row, 1936)

Cagan, Phillip. *Determinants and Effects of Changes in the Money Stock, 1875-1960* (National Bureau of Economic Research, 1965).

Chari, V.V., Lawrence J. Christiano and Martin Eichenbaum. "Inside Money, Outside Money, and Short-Term Interest Rates". *Journal of Money, Credit and Banking*, November 1995, Part 2.

Crowder, M.J. and D.J. Hand. *Analysis of Repeated Measures* (Chapman and Hall, 1990)

Crowder, William J. and Dennis L. Hoffman. "The Long-Run Relationship between Nominal Interest Rates and Inflation: The Fisher Equation Revisited," *Journal of Money, Credit and Banking*. Vol. 28, 1 (February 1996), pp. 102-18.

Davidian, Marie and David M. Giltinan. *Nonlinear Models for Repeated Measurement Data* (Chapman and Hall, 1995)

Dewald, William G. *Monetary Control and the Distribution of Money*, unpublished Ph.D. dissertation, University of Minnesota, 1963a (abstract, *Journal of Finance*, XIX, 3, September 1964, p. 557).

_____. "Free Reserves, Total Reserves and Monetary Control", *Journal of Political Economy*, April 1963 (1963b).

_____, "A Review of the Conference on Targets and Indicators of Monetary Policy," in Karl Brunner, ed., *Targets and Indicators of Monetary Policy* (San Francisco: Chandler, 1969), pp. 313-30.

Diggle, Peter J., Kung-Yee Liang and Scott L. Zeger. *Analysis of Longitudinal Data* (Oxford: Clarendon Press, 1994)

Feinman, Joshua. "Reserve Requirements: History, Current Practice and Potential Reform," *Federal Reserve Bulletin* (June 1993), pp. 569-89.

Friedman, Milton and Anna J. Schwartz. *A Monetary History of the United States, 1867-1960* (Princeton University Press, 1963).

Gambs, Carl M and Robert H. Rasche. "Costs of Reserves and the Relative Size of Member and Nonmember Bank Demand Deposits," *Journal of Monetary Economics* (November 1978), pp. 715-723.

Gilbert, R. Alton. "Effectiveness of State Reserve Requirements," Federal Reserve Bank of St. Louis *Review* (September 1978), pp. 16-28.

_____. "Revision of the St. Louis Federal Reserve's Adjusted Monetary Base," Federal Reserve Bank of St. Louis *Review* (December 1980), pp. 3-10.

_____. "A Revision in the Monetary Base," Federal Reserve Bank of St. Louis *Review* (August/September 1987), pp. 24-29.

_____ and Jean M. Lovati. "Bank Reserve Requirements and Their Enforcement: A Comparison Across States." Federal Reserve Bank of St. Louis *Review* (March 1978), pp. 22-31.

Gurley, John G. and Edward S. Shaw. *Money in a Theory of Finance*. Washington, DC: The Brookings Institution, 1960.

Hilton, Spence, Ari Cohen and Ellen Koonmen. "Expanding Clearing Balances," in *Reduced Reserve Requirements: Alternatives for the Conduct of Monetary Policy and Reserve Management*, Ann-Marie Muelendyke, ed., Federal Reserve Bank of New York, 1993.

Hoffman, Dennis and Robert H. Rasche. "Long-Run Income and Interest Elasticities of the Demand for M1 and the Monetary Base in the Postwar U.S. Economy." *Review of Economics and Statistics* , vol. 73 (1991), pp. 665-74.

_____ and _____ . *Aggregate Money Demand Functions: Applications of Cointegration Analysis.* Boston, MA: Kluwer Academic Publishers, 1996.

_____ , _____and M.A. Tieslau. "The Stability of Long-Run Money Demand in Five Industrialized Countries." *Journal of Monetary Economics*, 1995.

Hsiao, Cheng. *Analysis of Panel Data.* New York: Cambridge University Press, 1986.

Kohn, Donald L. "Comments on Anderson and Rasche, 'Redefining the Adjusted Monetary Base' ", Federal Reserve Bank of St. Louis *Review*, November/December 1996, forthcoming.

Meigs, James. *Free Reserves and the Money Supply Process* (Chicago: University of Chicago Press, 1962)

Mood, Alexander M., Franklin A. Graybill and Duane C. Boes. *Introduction to the Theory of Statistics* New York: Mc Graw Hill, 1974.

Richards, Heidi Willman. "Daylight Overdraft Fees and the Federal Reserve's Payment System Risk Policy," *Federal Reserve Bulletin* (December 1995), pp. 1065-77.

Robert H. Rasche and James M. Johannes. *Controlling the Growth of Monetary Aggregates* . Boston: Kluwer Academic Publishers, 1985.

Stevens, E.J. "Required Clearing Balances". Federal Reserve Bank of Cleveland *Economic Review*, vol. 29., no. 4 (1993), pp. 2-14

Tatom, John A. "Issues in Measuring An Adjusted Monetary Base," Federal Reserve Bank of St. Louis *Review* (December 1980), pp.11-29.

Taylor, John B. "Discretion versus Policy Rules in Practice", *Carnegie-Rochester Conference Series on Public Policy*, vol. 39 (1993), pp. 195-214.

Teigen, Ronald L. "Demand and Supply Functions for Money in the U.S.: Some Structural Estimates," *Econometrica*, 32 (1964), pp. 476-509.

Tobin, James. "Money, Capital and Other Stores of Value." *American Economic Review*, (May 1961), pp. 26-37.

Tolley, George S. "Providing for the Growth of the Money Supply." *Journal of Political Economy*, December 1957, pp. 465-85.

Wijnholds, J. Onno de Beaufort, Sylvester C.W. Wijffinger and Lex H. Hoogduin. *A Framework for Monetary Stability* (Amsterdam: Kluwer Academic Publishers, 1993.

Table 1

Current and Revised Measures of the Monetary Base, December 1995

Factors Supplying High-Powered Money		
(1) Reserve Bank credit		
(a) Securities held by the Federal Reserve	387.132	
(b) Loans to depository institutions	0.209	
(c) Federal Reserve float	1.223	
(d) Other Federal Reserve assets	32.212	
Total Reserve Bank credit		420.776
(2) Gold stock	11.050	
(3) SDR certificates	10.168	
(4) US Treasury currency and coin outstanding	23.958	
Total supply of high-powered money other than Reserve Bank credit		45.177
(5) Total supply of high-powered money		465.952

Factors Using High-Powered Money: Old Measure of the Monetary Base		
(6) The Monetary Base: Current Measure		
(a) Currency and coin in circulation	419.604	
(b) Reserve balances of depository institutions at Federal Reserve Banks	20.402	
Total use as the monetary base		440.006
(7) Uses of high-powered money other than as the monetary base		
(a) Treasury cash holdings	0.271	
(b) Deposits of other than domestic financial institutions at Federal Reserve Banks	7.349	
(c) Other Federal Reserve liabilities and capital	12.841	
(d) Deposits, other than reserve balances, of domestic financial institutions at Federal Reserve Banks, including contractual amount of required clearing balances	5.002	
Total other factors using high-powered money		25.462

Factors Using High-Powered Money: Revised Measure of the Monetary Base		
(8) The Monetary Base: Revised Measure		
(a) Currency and coin in circulation	419.604	
(b) Deposits of financial institutions at Federal Reserve Banks (revised measure)	25.404	
Total use as the monetary base		445.008
(9) Uses of high-powered money other than as the monetary base		
(a) Treasury cash	0.271	
(b) Deposits of other than domestic financial institutions at Federal Reserve Banks	7.349	
(c) Other Federal Reserve liabilities and capital	12.841	
Total other factors using base money (revised measure)		20.460

billions of dollars, not seasonally adjusted
Components may not add to totals due to rounding.

Source: Board of Governors of the Federal Reserve System

Table 2

Statistics on Legally and Economically Bound and Nonbound Depository Institutions, Selected Years

A. Statistics on Weekly-Reporting Depository Institutions (Federal Reserve FR2900 report)

	1983	1985	1987	1989	1991	1993	1995
Distribution of Number of Weekly-Reporting Depository Institutions, by reserve status (percent of weekly-reporting institutions)							
L-Bound	33.7	33.6	45.4	47.5	27.4	34.4	30.2
L-Nonbound	66.3	66.4	54.6	52.5	72.6	65.6	69.8
E-Bound	33.7	33.6	45.4	47.5	5.9	6.0	5.5
E-Nonbound	66.3	66.4	54.6	52.5	94.1	94.0	94.5
Distribution of Total Deposits at Weekly-Reporting Depository Institutions, by reserve status (percent of total deposits of weekly reporters)							
L-Bound	60.4	70.3	79.3	81.6	72.9	78.2	75.1
L-Nonbound	39.6	29.7	20.7	18.4	27.1	21.8	24.9
E-Bound	60.4	70.3	79.3	81.6	54.8	57.7	56.3
E-Nonbound	39.6	29.7	20.7	18.4	45.2	42.3	43.7
Distribution of Net Transactions Deposits at Weekly-Reporting Institutions, by reserve status (percent of aggregate net transactions deposits of weekly reporters)							
L-Bound	74.6	78.9	85.1	86.1	80.0	85.3	82.1
L-Nonbound	25.4	21.1	14.9	13.9	20.0	14.7	17.9
E-Bound	74.6	78.9	85.1	86.1	64.5	67.7	66.6
E-Nonbound	25.4	21.1	14.9	13.9	35.5	32.3	33.4
Distributions of Required Reserves of Weekly-Reporting Depository Institutions, by reserve status (percent of aggregate required reserves of weekly reporters)							
L-Bound	92.0	93.0	94.9	95.2	93.1	94.8	91.8
L-Nonbound	8.0	7.0	5.1	4.8	6.9	5.2	8.2
E-Bound	92.0	93.0	94.9	95.2	82.8	83.1	81.2
E-Nonbound	8.0	7.0	5.1	4.8	17.2	16.9	18.8

Table 2 (con't)

B. Statistics on the sum of Weekly, Quarterly and Annual Reporting Depository Institutions

	1983	1985	1987	1989	1991	1993	1995
Distribution of Number of Reporting Depository Institutions, by reserve category (percentage of reporting institutions)							
L-Bound	19.1	19.8	22.1	19.8	11.1	14.4	11.7
L-Nonbound	80.9	80.2	77.9	80.2	88.9	85.6	88.3
E-Bound	19.1	19.8	22.1	19.8	2.4	2.5	2.1
E-Nonbound	80.9	80.2	77.9	80.2	97.6	97.5	97.9
Distribution of Total Deposits, by reserve category (percentage of reported total deposits)							
L-Bound	56.9	66.8	73.9	75.5	67.1	72.1	69.1
L-Nonbound	43.1	33.2	26.1	24.5	32.9	27.9	30.9
E-Bound	56.9	66.8	73.9	75.5	50.4	53.2	51.8
E-Nonbound	43.1	33.2	26.1	24.5	49.6	46.8	48.2

Notation: L-Bound denotes legally-bound, L-Nonbound denotes legally nonbound (applied vault cash exceeds required reserves), E-Bound denotes economically-bound (as defined in this article), E-Nonbound denotes economically-nonbound. All quarterly and annual reporting institutions are considered as both legally and economically nonbound in the construction of this table.

Source: tabulations by the authors from unpublished Federal Reserve data.

Table 3

Summary Statistics for Depository Institutions Used in ANOVA
(by reserve status and size, billions of dollars except number of institutions)

A. Banks Classified on Legal Reserve Status in 1992, and on Size in 1990[1]

	Required Reserves Total	Required Reserves Against Net Transaction Deposits	Required Clearing Balances (contracted amount)	Applied Vault Cash	Aggregate Net Transaction Deposits	Amount of Base Money Held (Vault Cash + Federal Reserve Deposits	Number of Banks
L-Bound Banks							
1990							
Small	1.16	0.62	0.11	0.68	24.3	1.37	1139
Medium	2.67	2.04	0.14	1.37	33.0	2.89	512
Regional	3.41	2.81	0.12	1.37	27.4	3.57	122
Large	8.68	7.12	0.10	3.64	61.1	8.86	49
1991							
Small	0.72	0.72	0.17	0.61	26.9	1.09	1139
Medium	2.34	2.34	0.20	1.38	35.7	2.64	512
Regional	3.07	3.07	0.16	1.40	29.6	3.28	122
Large	7.41	7.41	0.36	3.57	63.6	7.83	49
1992							
Small	0.94	0.94	0.21	0.70	31.8	1.30	1139
Medium	2.56	2.56	0.26	1.47	41.3	2.89	512
Regional	3.06	3.06	0.35	1.43	34.4	3.46	122
Large	7.08	7.08	0.89	3.55	72.4	8.01	49
L-Nonbound Banks							
1990							
Small	1.45	0.85	0.21	1.33	35.78	2.33	2209
Medium	0.14	0.10	0.02	0.13	2.27	0.19	45
1991							
Small	0.93	0.93	0.25	0.93	38.37	2.33	2209
Medium	0.11	0.11	0.02	0.10	2.29	0.18	45
1992							
Small	1.08	1.08	0.30	1.08	43.35	2.48	2209
Medium	0.11	0.11	0.02	0.11	2.46	0.20	45

[1] Banks are classified based on their legal reserve status in 1992 H2 and on their size in 1990 H2. Banks are classified as L-Bound if they were legally bound in one or more reserve maintenance periods during 1992 H2; if not, they are classified as L-Nonbound. Banks are classified as small if their net transactions deposits did not exceed the low reserve tranche ($40.4 million) in any reserve maintenance period during 1990 H2, and are classified as medium or regional if their average level of net transactions deposits during 1990 H2 did not exceed $125 million or $500 million, respectively. Banks with net transactions deposits averaging more than $500 million during 1990 H2 are classified as large.

Table 3 (continued)

B. Banks Classified on Legal Reserve Status in 1990, 1991 and 1992, and on Size in 1990[2]

	Required Reserves Total	Required Reserves Against Net Transaction Deposits	Required Clearing Balances (contracted amount)	Applied Vault Cash	Aggregate Net Transaction Deposits	Amount of Base Money Held (Vault Cash + Federal Reserve Deposits	Number of Banks
L-Bound Banks							
1990							
Small	0.33	0.14	0.02	0.09	5.5	0.36	236
Medium	1.95	1.52	0.09	0.82	22.5	2.06	316
Regional	3.15	2.61	0.12	1.17	25.3	3.30	114
Large	8.10	6.61	0.09	3.28	56.7	8.26	44
1991							
Small	0.18	0.18	0.03	0.09	6.2	0.25	236
Medium	1.73	1.73	0.11	0.85	24.4	1.87	316
Regional	2.86	2.86	0.15	1.22	27.5	3.04	114
Large	6.87	6.87	0.34	3.24	58.9	7.27	44
1992							
Small	0.24	0.24	0.04	0.10	7.5	0.32	236
Medium	1.86	1.86	0.15	0.89	28.3	2.05	316
Regional	2.84	2.84	0.34	1.25	31.9	3.21	114
Large	6.64	6.64	0.86	3.21	67.9	7.53	44
L-Nonbound Banks							
1990							
Small	2.28	1.32	0.30	1.92	54.6	3.34	3112
Medium	0.86	0.63	0.75	0.67	12.8	1.01	241
1991							
Small	1.47	1.47	0.38	1.44	59.0	3.18	3112
Medium	0.72	0.72	0.11	0.63	13.6	0.96	241
1992							
Small	1.77	1.77	0.47	1.67	67.7	3.46	3112
Medium	0.81	0.81	0.13	0.69	15.4	1.04	241

[2] Banks are classified as L-Bound if they were legally bound in all reserve maintenance periods in 1990 H2, 1991 H2 and 1992 H2; if not, they are classified as L-Nonbound. Banks are classified as small if their net transactions deposits did not exceed the low reserve tranche ($40.4 million) in any reserve maintenance period during 1990 H2, and are classified as medium or regional if their average level of net transactions deposits during 1990 H2 did not exceed $125 million or $500 million, respectively. Banks with net transactions deposits averaging more than $500 million during 1990 H2 are classified as large.

Table 4

ANOVA Model Estimates for Weekly-Reporting Banks

A. Banks Classified on Legal Reserve Status in 1992 and on Size in 1990[1]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
F Statistics						
(numerator degrees of freedom)						
for bank fixed effects	25.9 (1138)	101.3 (511)	72.4 (121)	69.0 (48)	4119.7 (2208)	144.7 (44)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
for year fixed effect	430.2 (2)	3917.2 (2)	346.4 (2)	1152.5 (2)	2781.9 (2)	10.4 (2)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Coefficient Estimates (t-statistic)						
Year effects						
1990 versus 1992	0.021 (25.9)	0.017 (84.9)	0.032 (26.5)	0.036 (47.9)	0.009 (75.1)	0.003 (4.0)
p-value (Pr > | t |)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1991 versus 1992	0.001 (0.8)	0.003 (17.5)	0.013 (10.5)	0.013 (17.4)	0.003 (30.7)	0.0 (0.0)
p-value (Pr > | t |)	0.4582	0.0001	0.0001	0.0001	0.0001	0.9978
Required Clearing Balance	0.004 (2.0)	0.006 (9.4)	0.022 (6.8)	0.015 (11.3)	0.009 (26.9)	0.001 (0.4)
p-value (Pr > | t |)	0.0465	0.0001	0.0001	0.0001	0.0001	0.6756
Summary Statistics						
Model degrees of freedom	1153	526	136	63	2223	59
Error degrees of freedom	43267	19441	4621	1847	83927	1695
R-Squared	0.41	0.75	0.67	0.75	0.76	0.79

[1] Banks are classified as L-Bound if they were legally bound in one or more reserve maintenance periods during 1992 H2; if not, they are classified as L-Nonbound. Banks are classified as small if their net transactions deposits did not exceed the low reserve tranche ($40.4 million) in any reserve maintenance period during 1990 H2, and are classified as medium or regional if their average level of net transactions deposits during 1990 H2 did not exceed $125 million or $500 million, respectively. Banks with net transactions deposits averaging more than $500 million during 1990 H2 are classified as large.

Table 4 (continued)

B. Banks Classified on Legal Reserve Status in 1990, 1991 and 1992, and on Size in 1990[2]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
F Statistics						
(numerator degrees of freedom)						
for bank fixed effects	47.4 (235)	85.6 (315)	73.0 (113)	75.5 (43)	32.2 (3111)	131.1 (240)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
for year fixed effect	426.7 (2)	2786.0 (2)	305.9 (2)	1040.7 (2)	825.9 (2)	965.8 (2)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Coefficient Estimates (t-statistic)						
Year effects						
1990 versus 1992	0.029 (24.3)	0.019 (70.6)	0.032 (24.6)	0.037 (44.8)	0.012 (39.0)	0.011 (41.6)
p-value (Pr > | t |)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
1991 versus 1992	-0.002 (1.9)	0.004 (14.4)	0.013 (10.0)	0.012 (15.5)	0.003 (9.7)	0.002 (8.4)
p-value (Pr > | t |)	0.0612	0.0001	0.0001	0.0001	0.0001	0.0001
Required Clearing Balance	-0.004 (1.1)	0.006 (6.9)	0.030 (7.4)	0.015 (11.3)	0.007 (8.8)	0.004 (4.7)
p-value (Pr > | t |)	0.2631	0.0001	0.0001	0.0001	0.0001	0.0001
Summary Statistics						
Model degrees of freedom	250	330	128	58	3126	255
Error degrees of freedom	8953	11993	4317	1657	118241	9143
R-Squared	0.57	0.73	0.67	0.76	0.46	0.79

[2] Banks are classified as L-Bound if they were legally bound in all 39 reserve maintenance periods in 1990 H2, 1991 H2 and 1992 H2; if not, they are classified as L-Nonbound. Size criteria are the same as in the previous footnote.

Table 5

ANOVA Model Estimates for Weekly-Reporting Banks, with Bank*Year Interaction Effects

A. Banks Classified on Legal Reserve Status in 1992 and on Size in 1990[1]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
F Statistics (numerator degrees of freedom)						
for bank fixed effects	42.9 (1138)	269.4 (511)	126.9 (121)	194.7 (48)	269.0 (2208)	298.4 (44)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
for bank*year fixed effect	14.0 (2278)	52.7 (1024)	20.3 (244)	100.9 (98)	27.6 (4418)	21.3 (90)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Coefficient Estimates (t-statistic)						
Required Clearing Balance	0.005 (1.3)	0.010 (12.0)	0.022 (4.2)	0.018 (9.2)	0.006 (10.9)	0.014 (4.1)
p-value (Pr > | t |)	0.20	0.0001	0.0001	0.0001	0.0001	0.0001
Summary Statistics						
Model degrees of freedom	3429	1548	378	159	6639	147
Error degrees of freedom	40991	18419	4379	1751	79511	1607
R-Squared	0.66	0.91	0.82	0.92	0.90	0.90

[1] Banks are classified as L-Bound if they were legally bound in one or more reserve maintenance periods during 1992 H2; if not, they are classified as L-Nonbound. Banks are classified as small if their net transactions deposits did not exceed the low reserve tranche ($40.4 million) in any reserve maintenance period during 1990 H2, and are classified as medium or regional if their average level of net transactions deposits during 1990 H2 did not exceed $125 million or $500 million, respectively. Banks with net transactions deposits averaging more than $500 million during 1990 H2 are classified as large.

Table 5 (continued)

B. Banks Classified on Legal Reserve Status in 1990, 1991 and 1992, and on Size in 1990[2]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
F Statistics						
(numerator degrees of freedom)						
for bank fixed effects	76.8 (235)	236.9 (315)	127.7 (113)	252.0 (43)	54.6 (3111)	310.1 (240)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
for year fixed effect	15.8 (472)	58.8 (632)	20.0 (228)	122.9 (88)	14.7 (6224)	36.2 (482)
p-value (Pr > F)	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Coefficient Estimates (t-statistic)						
Required Clearing Balance	0.007 (1.09)	0.008 (8.11)	0.020 (3.1)	0.0195 (10.4)	0.006 (3.6)	0.014 (10.6)
p-value (Pr > | t |)	0.27	0.0001	0.0018	0.0001	0.0003	0.0001
Summary Statistics						
Model degrees of freedom	720	960	354	144	9348	735
Error degrees of freedom	8483	11363	4091	1571	112019	8663
R-Squared	0.75	0.91	0.82	0.93	0.70	0.91

[2] Banks are classified as L-Bound if they were legally bound in all 39 reserve maintenance periods in 1990 H2, 1991 H2 and 1992 H2; if not, they are classified as L-Nonbound. Size criteria are the same as in the previous footnote.

Table 6

Test Statistics for Repeated Measures ANOVA Models
Null Hypothesis: No Year-Period Interaction Effect for 1990, 1991 and 1992

A. Banks Classified on Legal Reserve Status in 1992 and on Size in 1990[1]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
MANOVA Model						
Wilks' Lambda						
Value of statistic	0.996	0.909	0.957	0.775	0.982	0.924
F Value	2.02	25.1	2.67	6.52	20.1	1.77
degrees of freedom	(24, 27310)	(24, 12262)	(24, 2902)	(24, 1150)	(24, 52990)	(24, 1054)
p-value	0.0023	0.0001	0.0001	0.0001	0.0001	0.013
Univariate ANOVA						
F Value	1.98	27.8	1.51	5.92	20.45	1.75
(degrees of freedom)	(24, 27312)	(24, 12264)	(24, 2904)	(24, 1152)	(24, 52992)	(24, 1056)
p-value	0.0029	0.0001	0.0543	0.0001	0.0001	0.014

B. Banks Classified on Legal Reserve Status in 1990, 1991 and 1992, and on Size in 1990[2]

	Category					
	L-Bound Banks				L-Nonbound Banks	
Statistic	Small	Medium	Regional	Large	Small	Medium
MANOVA Model						
Wilks' Lambda						
Value of statistic	0.982	0.891	0.952	0.768	0.997	0.942
F Value	2.13	18.8	2.84	6.05	4.99	7.32
(degrees of freedom)	(24, 5638)	(24, 7558)	(24, 2710)	(24, 1030)	(24, 74662)	(24, 5758)
p-value	0.0011	0.0001	0.0001	0.0001	0.0001	0.0001
Univariate ANOVA						
F Value	2.67	20.3	1.52	6.10	3.62	7.57
(degrees of freedom)	(24, 5640)	(24, 7560)	(24, 2712)	(24,1032)	(24, 74664)	(24, 5760)
p-value	0.0001	0.0001	0.0522	0.0001	0.0001	0.0001

[1] Banks are classified as L-Bound if they were legally bound in one or more reserve maintenance periods during 1992 H2; if not, they are classified as L-Nonbound. Banks are classified as small if their net transactions deposits did not exceed the low reserve tranche ($40.4 million) in any reserve maintenance period during 1990 H2, and are classified as medium or regional if their average level of net transactions deposits during 1990 H2 did not exceed $125 million or $500 million, respectively. Banks with net transactions deposits averaging more than $500 million during 1990 H2 are classified as large.

[2] Banks are classified as L-Bound if they were legally bound in all 39 reserve maintenance periods in 1990 H2, 1991 H2 and 1992 H2; if not, they are classified as L-Nonbound. Size criteria are the same as in the previous footnote.

Figure 1
Required Clearing Contract Amounts

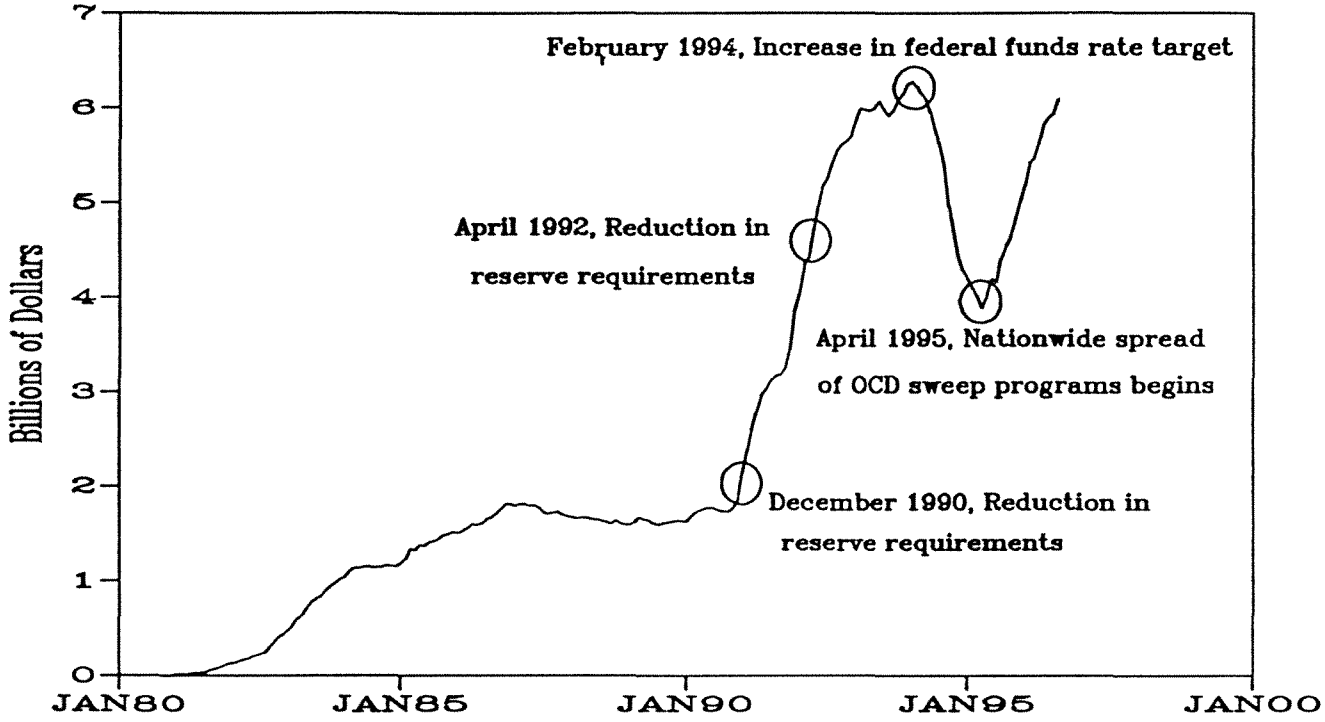


Figure 2
Surplus Vault Cash

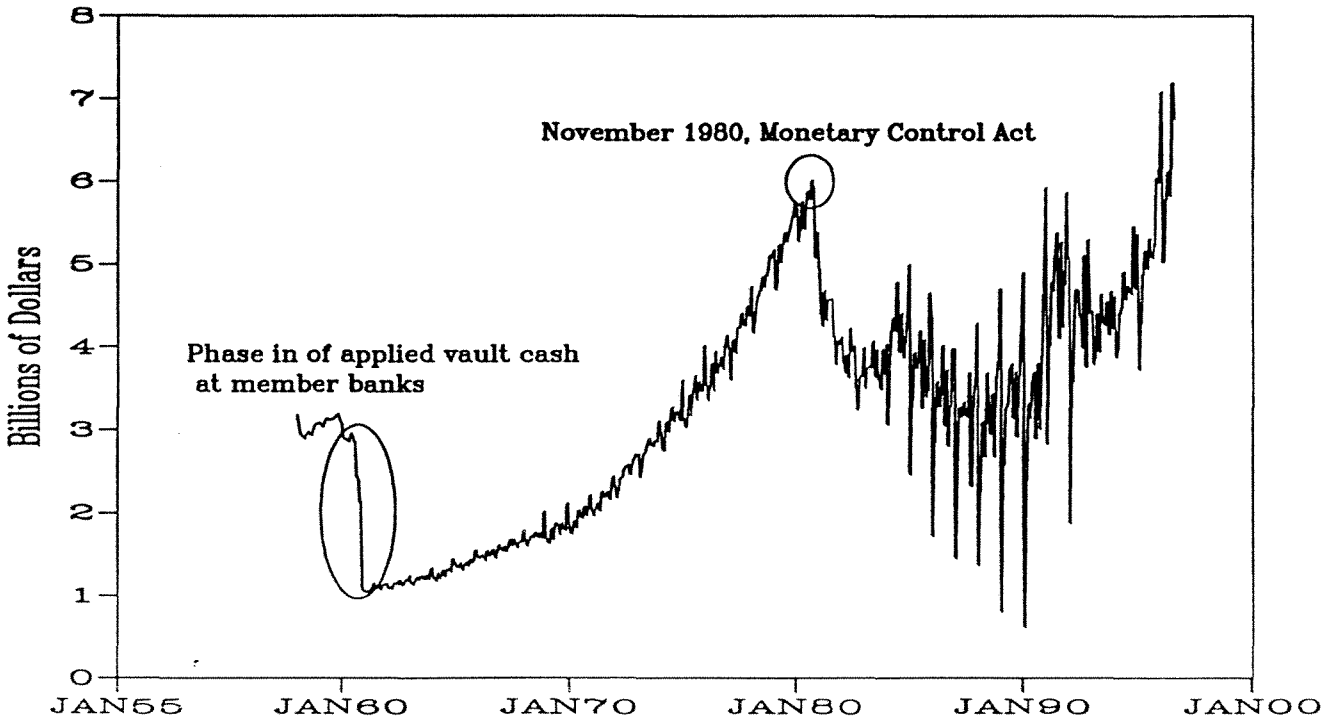


Figure 3
Number of Institutions Included in RAM
selected reserve maintenance periods

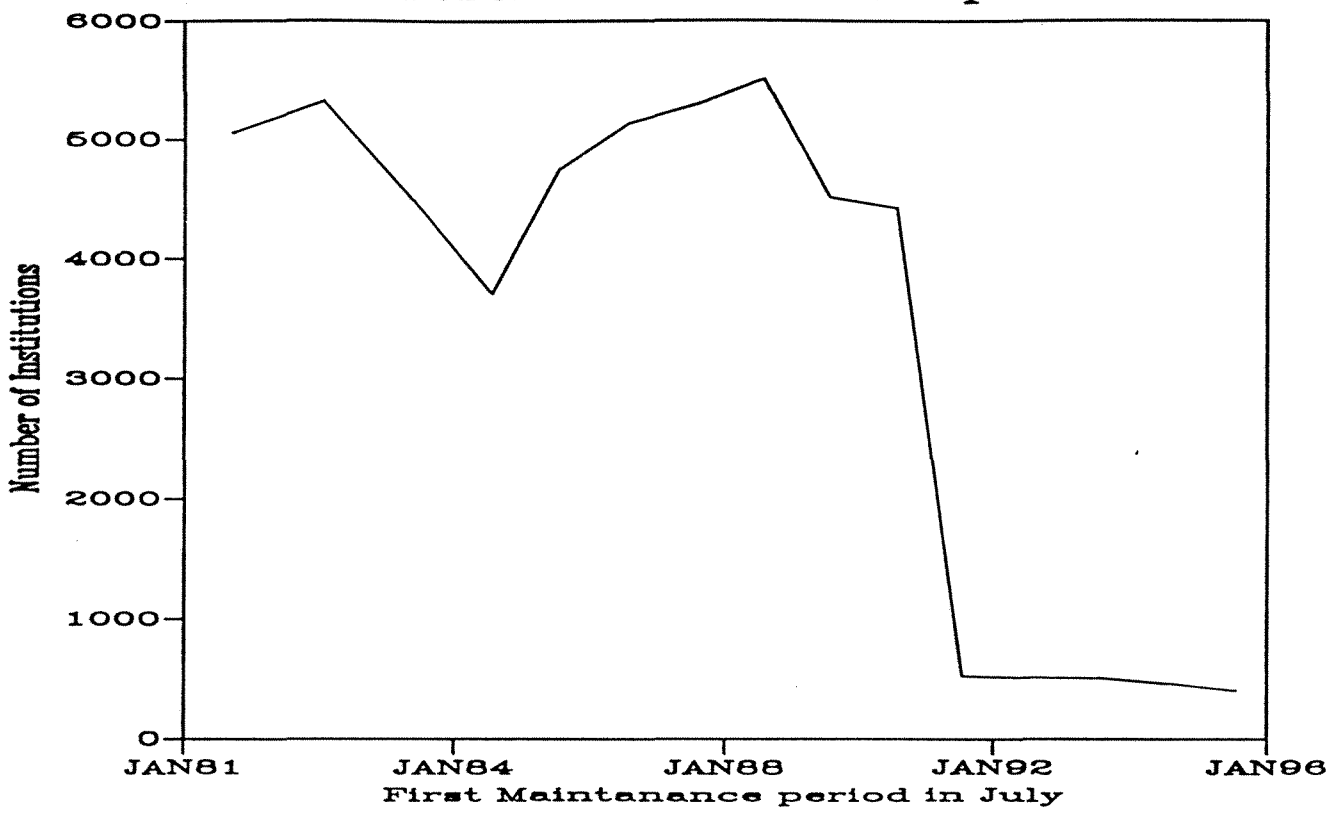


Figure 4
Proportions of Deposits in Economically Bound Institutions

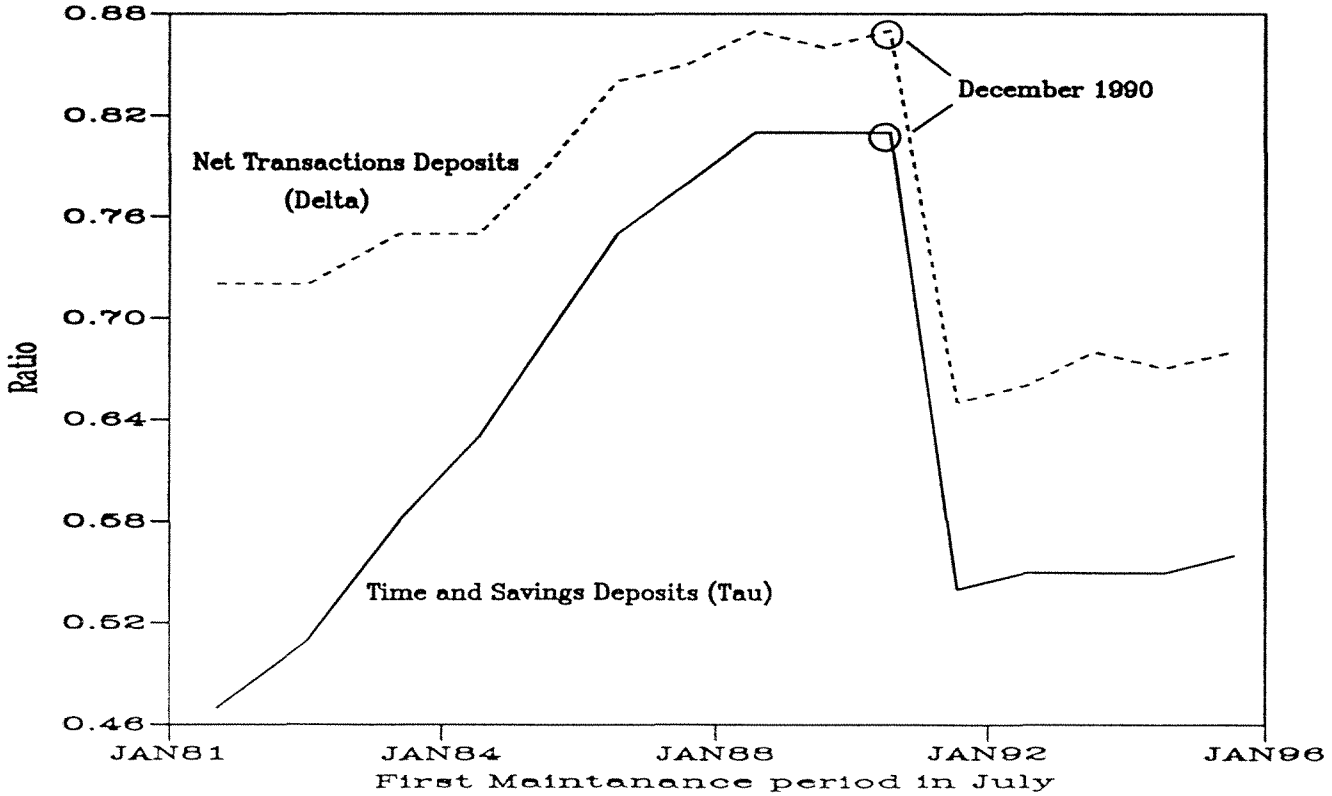
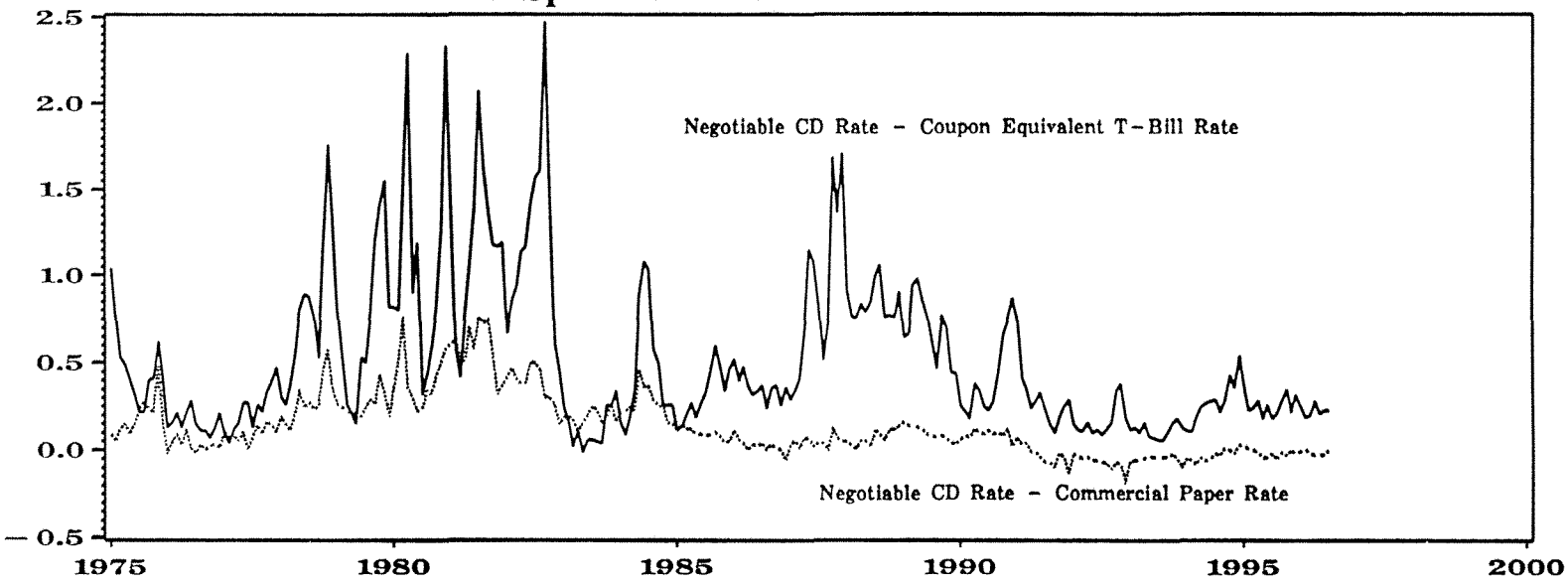


Figure 5

Monthly Data, Percent

Rate Spreads on 3-Month Instruments



Rate Spreads on 6-Month Instruments

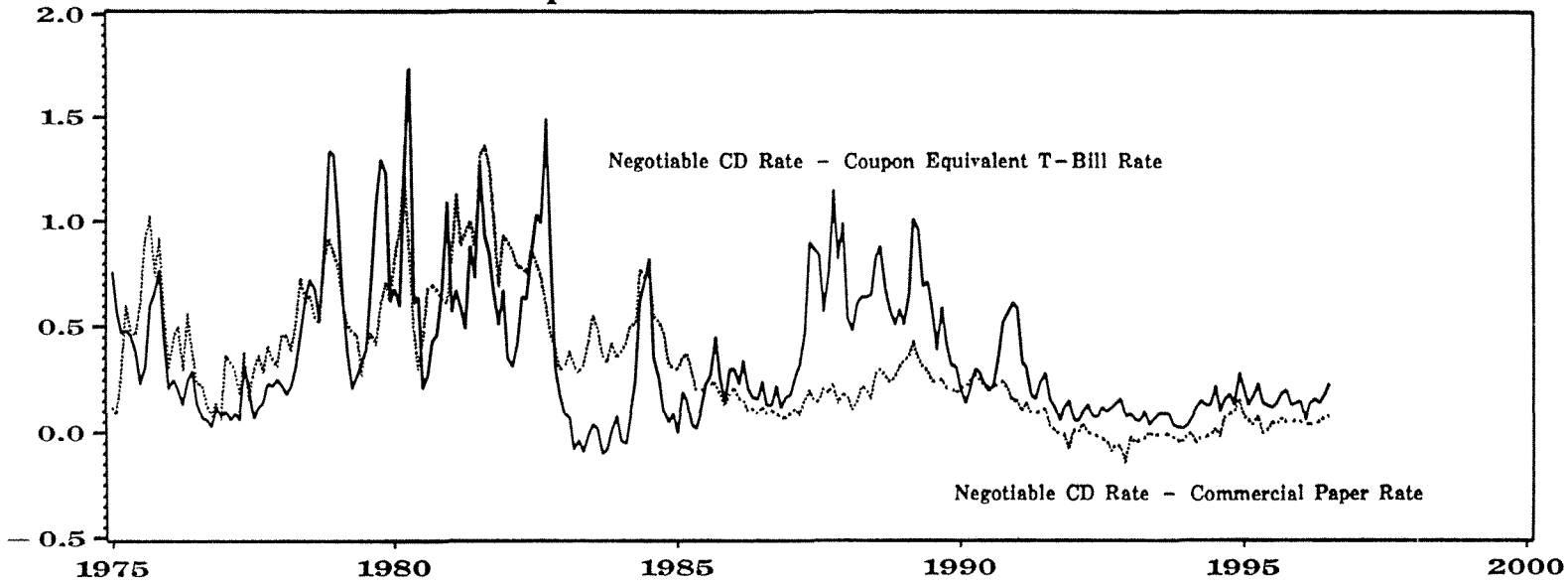


Figure 6

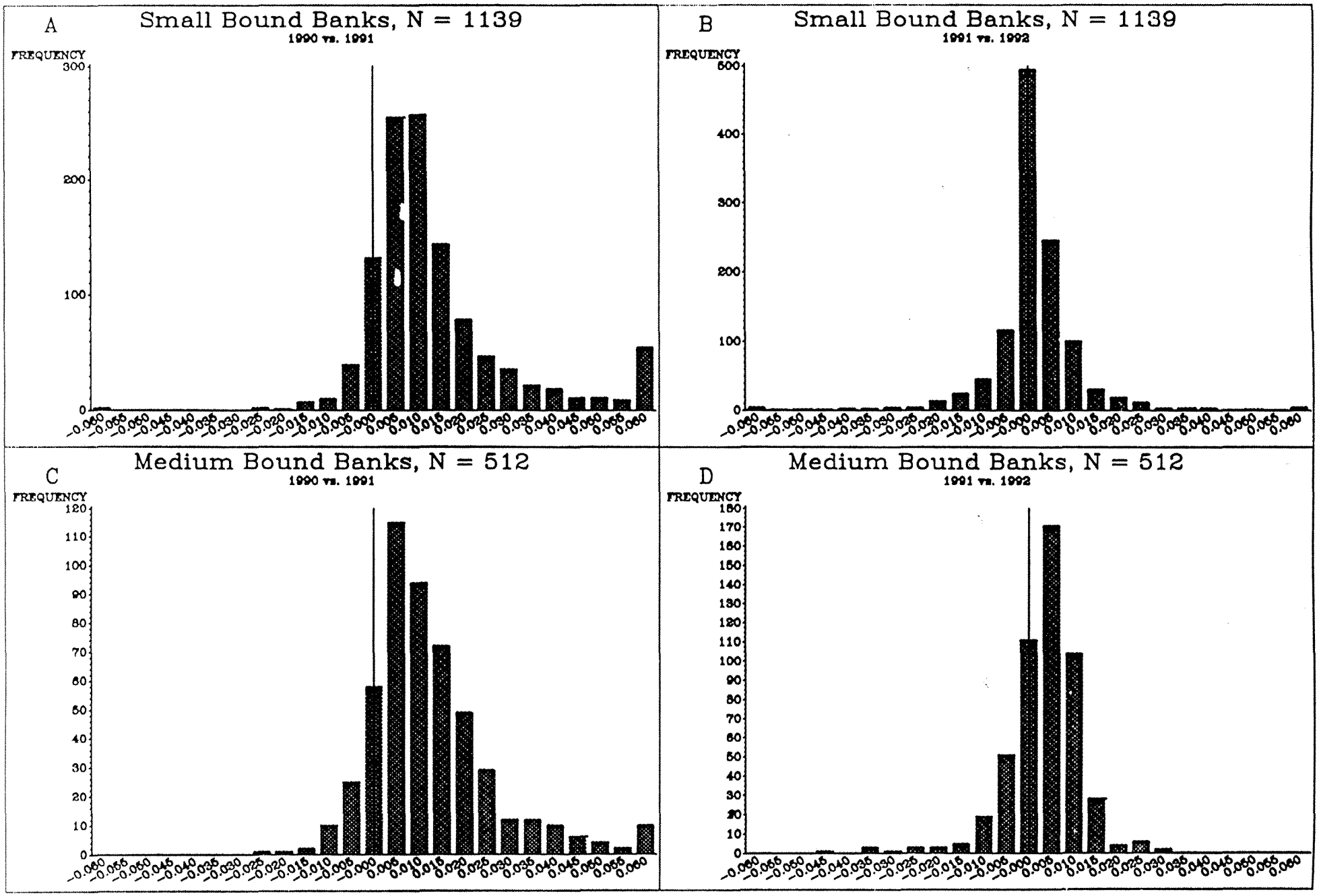

A
Small Bound Banks, N = 1139
1990 vs. 1991
FREQUENCY
B
Small Bound Banks, N = 1139
1991 vs. 1992
FREQUENCY
C
Medium Bound Banks, N = 512
1990 vs. 1991
FREQUENCY
D
Medium Bound Banks, N = 512
1991 vs. 1992
FREQUENCY

Figure 7

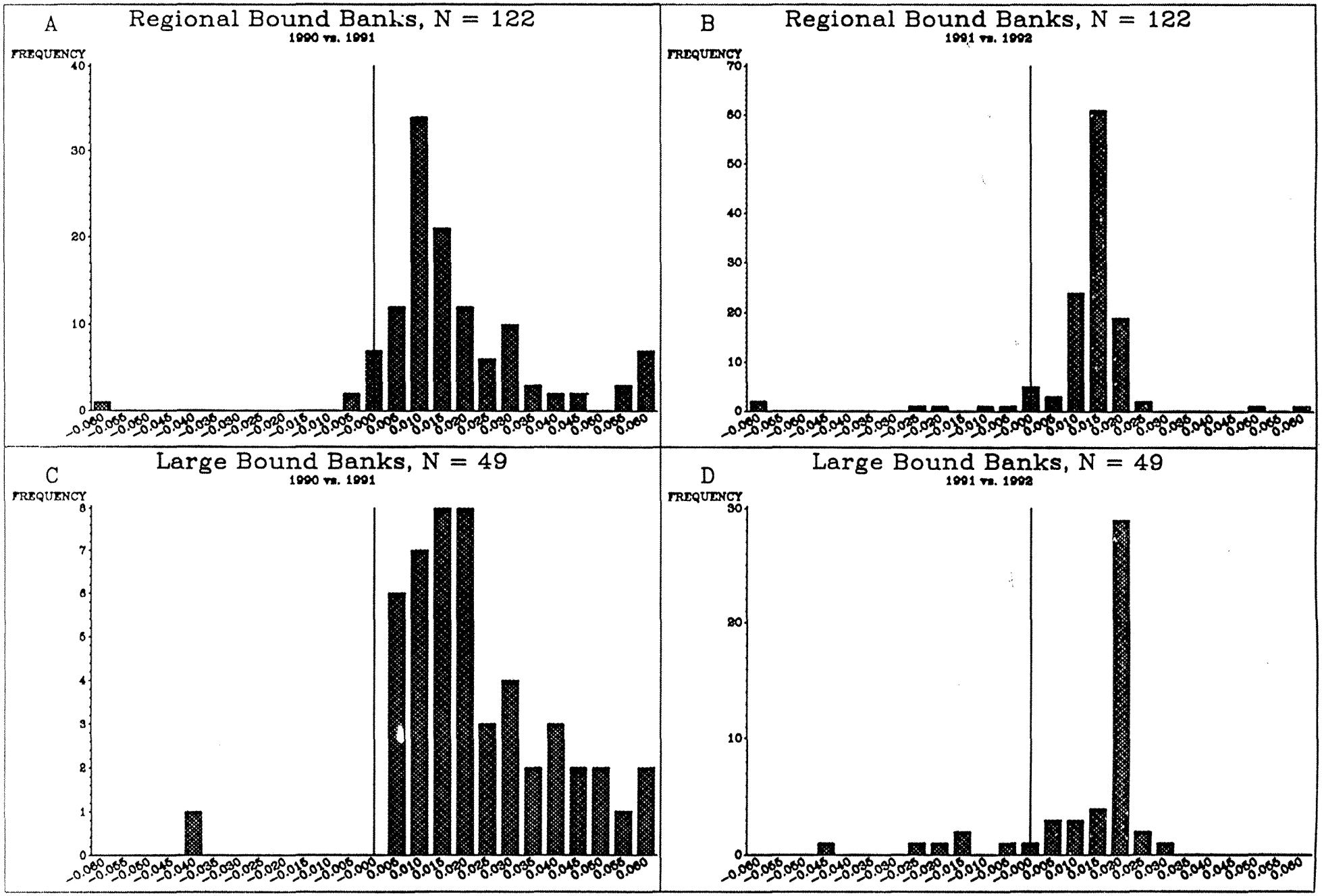

A
Regional Bound Banks, N = 122
1990 vs. 1991
FREQUENCY
B
Regional Bound Banks, N = 122
1991 vs. 1992
FREQUENCY
C
Large Bound Banks, N = 49
1990 vs. 1991
FREQUENCY
D
Large Bound Banks, N = 49
1991 vs. 1992
FREQUENCY

Figure 8

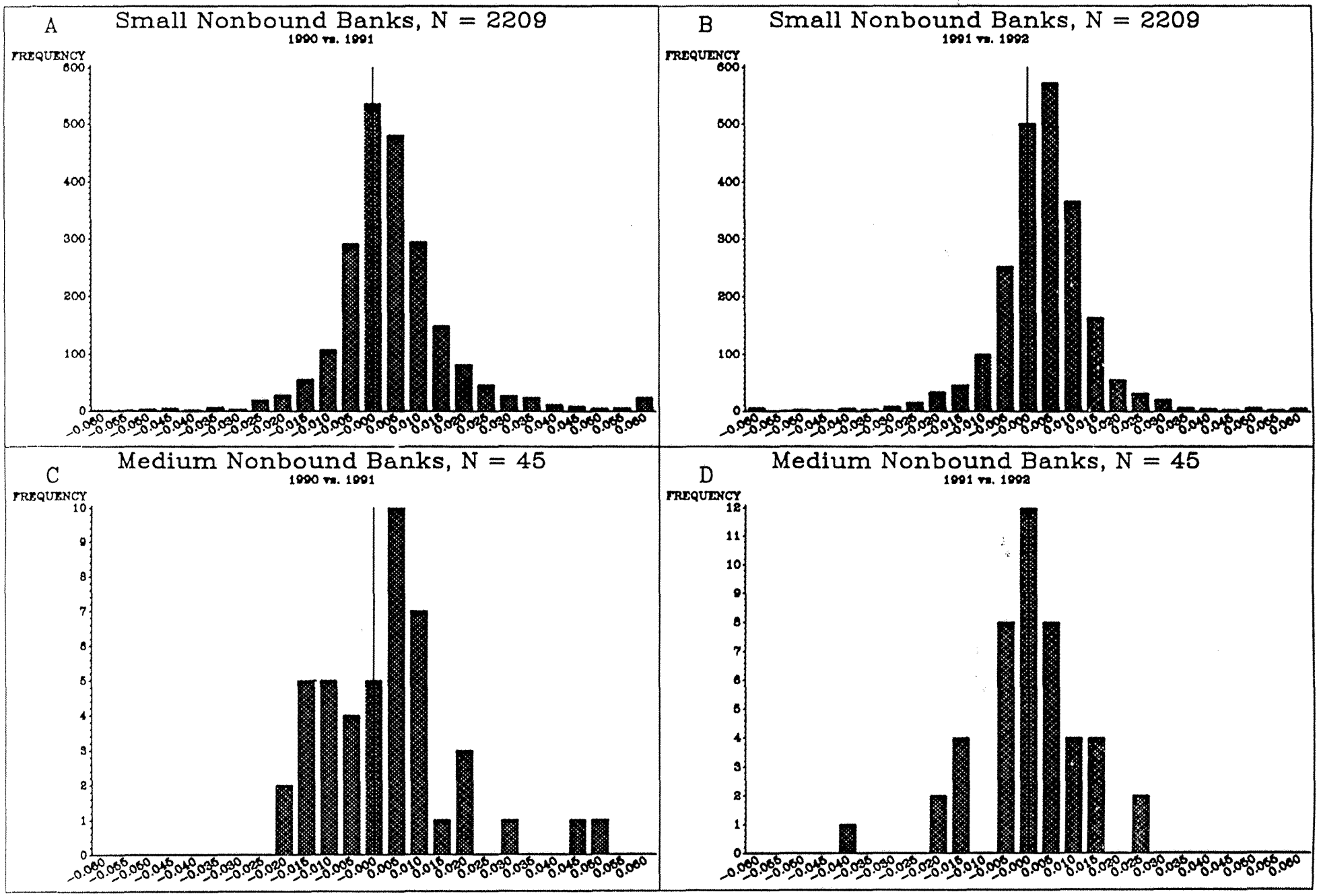

A
Small Nonbound Banks, N = 2209
1990 vs. 1991
FREQUENCY
B
Small Nonbound Banks, N = 2209
1991 vs. 1992
FREQUENCY
C
Medium Nonbound Banks, N = 45
1990 vs. 1991
FREQUENCY
D
Medium Nonbound Banks, N = 45
1991 vs. 1992
FREQUENCY

Figure 9

Confidence Intervals

For the Difference between 1990 and 1991's
Monetary Base to Net Transaction Ratio
Selection Criteria: All Bound in 1992

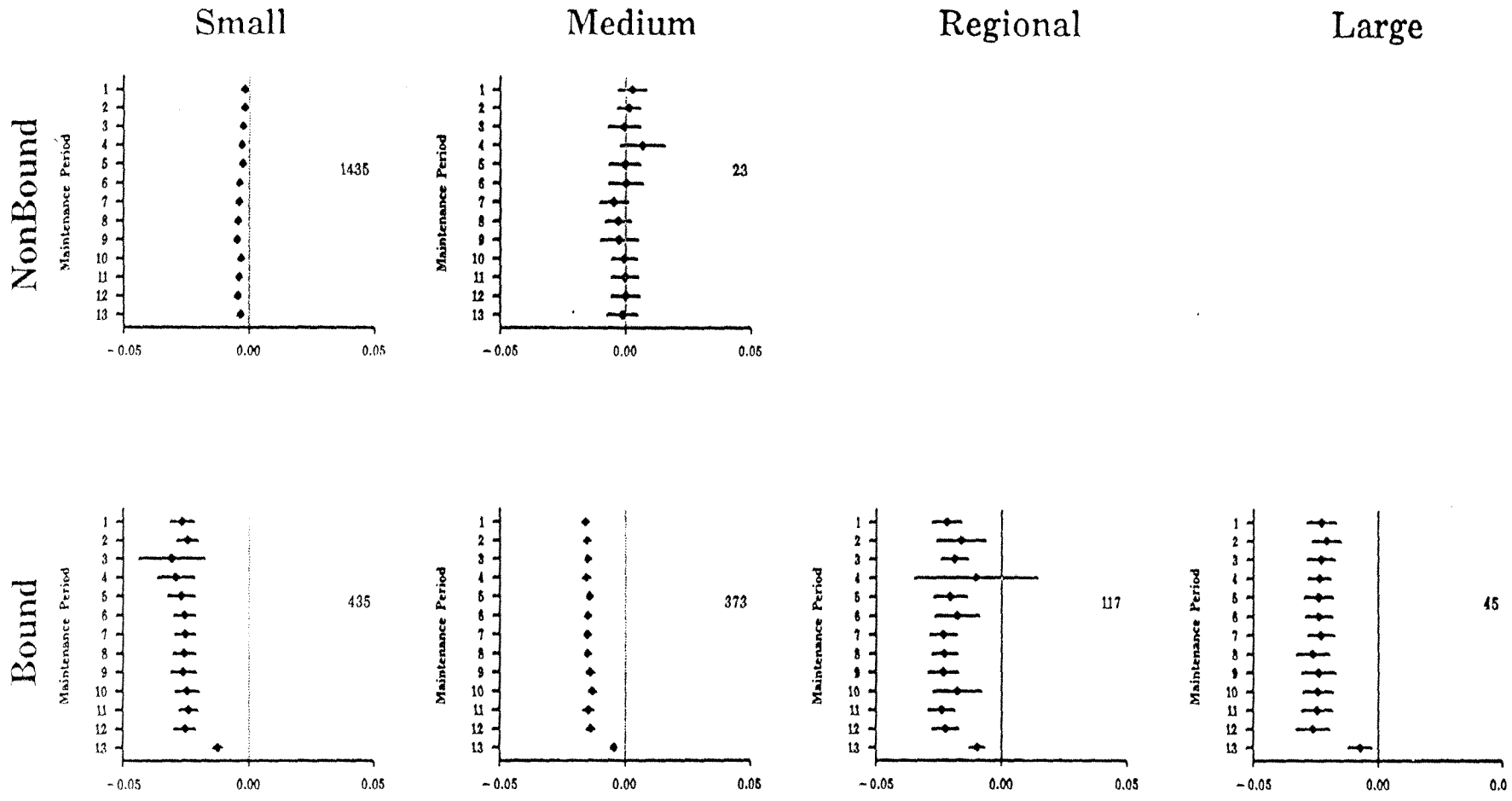
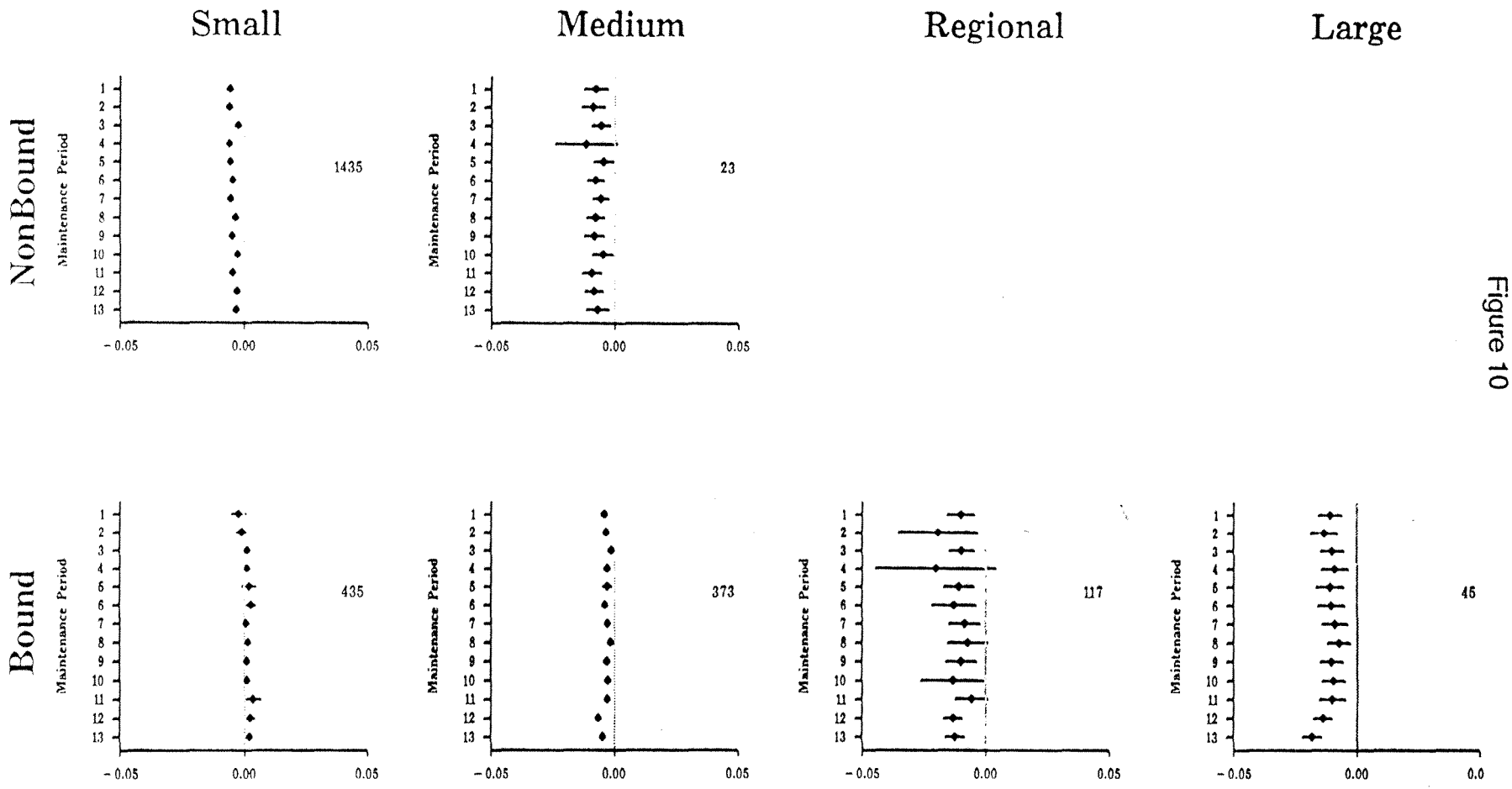


Figure 10

Confidence Intervals

For the Difference between 1991 and 1992's
Monetary Base to Net Transaction Ratio
Selection Criteria: All Bound in 1992



APPENDIX 1

MEASURING THE NEW ADJUSTED MONETARY BASE AND RESERVES

The St. Louis adjusted monetary base, adjusted total reserves and adjusted nonborrowed reserves equal, respectively, the sum of the monetary source base, total reserves, and nonborrowed reserves plus an appropriate RAM adjustment. The new adjusted monetary base and reserves time series are chain indexes, created in segments. The beginning and end of segments are demarcated by major changes in the structure of reserve requirements. Between these dates, the reserve adjustment magnitude, or RAM, "adjusts" the monetary base for changes in the demand for base money due to changes in statutory reserve requirement ratios within a given structure of reserve requirements (where the structure defines the types of deposits that are reservable, perhaps by class or type of depository institution), conditional on an assumed model of depository institutions' demand for base money; see Burger and Rasche (1977) and Anderson and Rasche (1996a). When there is a major change in the structure of reserve requirements – such as the extension of reserve requirements to nonmember banks and thrifts under the Monetary Control Act – the old RAM ends and a new RAM begins. During periods both before and after the break, for example, the AMB equals the sum of the monetary source base and *a* RAM – but not the *same* RAM before and after the break.

The Adjusted Monetary Base as a Chain Index

The new AMB index is constructed in four segments: January 1936 - December 1972, December 1972 - January 1975, January 1975 - October 1980, and October 1980 to date. The overall AMB for 1936 - date is created by splicing the individual segments at the overlapping months: December 1972, January 1975, and October 1980. The methodology is described in Tatom (1980).

The major cause of the discontinuity at each break is that the adjacent RAM adjustments necessarily have different base periods. The new adjusted monetary base presented in this article is built from four RAMs: $RAM1_{1936-72}$, $RAM2_{1972-75}$, $RAM3_{1975-80}$, and $RAM4_{1980-96}$. Each RAM has a

different base period, corresponding to a particular structure of reserve requirements. The statutory reserve requirements that correspond to the first three are discussed in Tatom (1980). The base period for the fourth is the set of reserve requirements in effect during the reserve maintenance period ending January 7, 1991; see Anderson and Rasche (1996a). Adjacent pairs of RAM are measurable at each splice date -- December 1972, January 1975, and October 1980 – permitting chaining the overall AMB index.

For the most recent subinterval, from November 1980 - date, the AMB equals the sum of the monetary base and $RAM4_{1980-96}$. For the period January 1975 - October 1980, the AMB equals the sum of the monetary base and $RAM3_{1975-80}$, multiplied by the ratio of the adjusted monetary base in October 1980 (including the RAM appropriate to 1980-96) to the adjusted monetary base in October 1980 (including the RAM appropriate to 1975-80). For example, the AMB for September 1980 is

$$\text{AMB}_{\text{September1980}} = \left(\text{Monetary Base}_{\text{September 1980}} + \text{RAM3}_{\text{1975-80, September 1980}}\right) \times \left(\frac{\text{Monetary Base}_{\text{October1980}} + \text{RAM4}_{\text{1980-96, October 1980}}}{\text{Monetary Base}_{\text{October1980}} + \text{RAM3}_{\text{1975-80, October 1980}}}\right).$$

For earlier periods, the AMB is multiplied by more than one ratio. The AMB for July 1974, for example, equals: $\text{Monetary Base}_{\text{July 1974}} + \text{RAM2}_{\text{1972-75, July 1974}}$ multiplied by

$$\left(\frac{\text{Monetary Base}_{\text{January1975}} + \text{RAM3}_{\text{1975-80, January 1975}}}{\text{Monetary Base}_{\text{January1975}} + \text{RAM2}_{\text{1972-75,January 1975}}}\right) \times \left(\frac{\text{Monetary Base}_{\text{October 1980}} + \text{RAM4}_{\text{1980-96, October 1980}}}{\text{Monetary Base}_{\text{October 1980}} + \text{RAM3}_{\text{1975-80, October 1980}}}\right)$$

The first ratio chains the 1972-75 data to the 1975-80 data, and the second chains the 1975-80 data to the 1980-96 data.

Growth rates of the current (old) and revised (new) AMB since 1980 are shown in Figure A-1. Differences between the old and new AMB are evident during the 1981-84 segment of the phase-in of new reserve requirements under the Monetary Control Act, and during the 1990 recession and later recovery.

The RAM Adjustment

$RAM1_{1936-72}$, $RAM2_{1972-75}$, and $RAM3_{1975-80}$ are due to Tatom (1980); see his Appendix 1, Table 1. We use only the RAM adjustment, not the published adjusted monetary base or adjusted reserves data shown in Tatom (1980); a different monetary source base, discussed in the next section, is used to construct the new adjusted monetary base. Tatom's three RAM adjustments are based, respectively, on the structures of reserve requirements in effect during 1935, 1972 and 1975.

The new RAM4 presented in this article for dates beginning October 1980 is calculated by the method described in Anderson and Rasche (1996a). The new RAM is computed from deposit and reserves data submitted weekly since 1980 to the Federal Reserve by about 12,000 depository institutions. For each week (through January 1984), or biweekly reserve maintenance period (beginning February 1984), the calculation proceeds in three steps:

1) First, depository institutions are separated into two groups, based on the statistical research discussed in this article. The first group includes all economically-bound (E-Bound) institutions, or in other words, all institutions subject to Federal Reserve reserve requirements whose (i) net transactions deposits exceed the low reserve tranche, and (ii) required reserves exceed the amount of vault cash that they may use to satisfy required reserves. Other depositories are placed in the second group. In addition, for reserve maintenance periods beginning January 8, 1991, depository institutions with net transactions deposits less than about $135 million are moved from the first group to the second (this cutoff is indexed to the annual growth in aggregate net transactions deposits) .

2) Next, for each institution in the first group, an individual-institution RAM is calculated by subtracting the institution's required reserves in that week (or reserve maintenance period) from an estimate of what the institution's required reserves would have been if the reserve requirements that prevailed during the reserve maintenance period ending January 7, 1991 had been in effect. This is

the Burger-Rasche (1977) adjustment applied to individual institutions, using the January 1991 base period.

3) Finally, the aggregate reserve adjustment magnitude is calculated for each week (or reserve maintenance period) by summing the individual reserve adjustment magnitudes across all depository institutions in the first group. Nothing is included in RAM for depositories in the second group.

The old (published by the Federal Reserve Bank of St. Louis through October 1996) and new RAM adjustments are shown in Figure A-2, beginning in 1981. Note that both series have been normalized to zero in December 1980; in fact, the new RAM adjustment is about $10 billion smaller than the old adjustment. The difference in size between the two adjustments is due to the choice of different base periods, and is economically unimportant (the choice of base period is unimportant for most index numbers). The adjustments differ during the 1980s because the new RAM more carefully separates L-Bound and L-Nonbound institutions. Major differences arise following the 1990-91 and 1992 changes in statutory reserve requirements for the same reason.

The above methods describe the construction of RAM through December 1995 (and, after benchmark revisions in future years, through December of the last complete calendar year). During the current year, it is important to measure RAM by a method that is less data-intensive and easier to implement on a weekly basis. For the current year, beginning January 1996, RAM for each reserve maintenance period t is calculated as $\mathrm{RAM}_t = \left[\delta_B^{95} \times NT_t\right] \times 0.02$ where δ_B^{95} is the estimated proportion of aggregate net transactions deposits in E-Bound depository institutions at the end of 1995, equal to 0.65, and 0.02 is the difference between the marginal reserve requirement on transactions deposits in January 1991 (= 0.12) and during 1996 (= 0.10). In early 1997, RAM will be recomputed for 1996 from data on individual depository institutions and a new proportion δ_B^{96} calculated.

The Monetary (Source) Base

For January 1936 - December 1958, the new AMB includes the currently-published (on FRED) St. Louis monetary source base. Beginning January 1959, the new AMB includes a revised St. Louis monetary source base equal to the sum of three variables: currency in circulation outside Federal Reserve Banks and the Treasury; deposits of domestic depository institutions at Federal Reserve Banks; and float-pricing related as-of adjustments. This measure of the monetary source base corresponds to line 8 of Table 1 in Anderson and Rasche (1996a, 1996b). Data are obtained from the Division of Monetary Affairs at the Federal Reserve Board of Governors; preliminary data are published each week on the Board's H.4.1 statistical release. The second item, Federal Reserve deposits, equals the sum of two items published on the H.4.1: *reserve balances* and *required clearing balance contracts*, the latter shown in a footnote on the first page of the release. The third item, float-pricing related adjustments, is a small item mandated by the Monetary Control Act's requirement that the Federal Reserve recover from depository institutions the value of float generated in check processing; it is included in "service-related adjustments" in a footnote on the first page of the release. (Note that the aggregate amount of reserve balances shown on the H.4.1 is defined by Board staff as equal to: the aggregate amount of depository institutions' Federal Reserve deposits, minus the aggregate amount of required clearing balance contracts and service-related adjustments, minus other small unpublished accounting adjustments.)

Seasonal Adjustment

The new monthly AMB is seasonally adjusted with a sliding window X11-ARIMA procedure. First, an ARIMA model is used to forecast the not seasonally adjusted AMB two years beyond the end of last full year of data (at the time of this writing, 1995), through December 1997. Then, beginning in 1950 (fluctuations in earlier data seem too unstable to reasonably estimate a seasonal component), the standard Bureau of the Census X11 filter is applied sequentially to a window of 8 years of data, the final window spanning January 1990 through December 1997. This method permits more time variation in the estimated seasonal factors than would be obtained by applying X11 directly to longer spans of data.

Such flexibility seems desirable for the monetary base because a time-series plot of its monthly growth rates suggests a sharp decrease in its seasonal amplitude after 1990, perhaps due to heavy exports of currency.

Seasonal adjustment factors for biweekly (reserve maintenance period) data are obtained by a ratio-of-moving-average procedure. In this method, a set of initial estimates of biweekly seasonally-adjusted levels of the adjusted base is obtained via polynomial interpolation between observations on seasonally-adjusted monthly levels. An initial set of seasonal adjustment factors are obtained by dividing actual not-seasonally-adjusted biweekly levels by these initial estimated seasonally-adjusted levels. This process is iterated to convergence, subject to the restriction that the final seasonally-adjusted biweekly levels average to the given seasonally-adjusted monthly levels.

ADJUSTED TOTAL RESERVES

Issues in Defining "Total Reserves" of Depository Institutions

There are two major, alternative economic measurements of "total reserves."

A. A Definition Motivated by Statutory Reserve Requirements

This narrow definition is "eligible assets of depository institutions subject to Federal Reserve reserve requirements." "Eligible" here refers to assets that may be used to satisfy statutory reserve requirements against deposits, not be confused with the concept of assets eligible to be used as collateral for discount window loans. This definition focuses on satisfying statutory reserve requirements; a depository's business needs for vault cash and Federal Reserve deposits are not explicitly considered. Rather, it is assumed that the amounts of vault cash and Federal Reserve deposits held to satisfy statutory requirements are sufficient to satisfy the depository's payment needs.

Under this definition, "total reserves" includes:

1. for dates prior to November 1, 1959: Total Reserves = Federal Reserve deposits held by member commercial banks. Vault cash was not an eligible asset prior to December 1959; required reserves were satisfied with Federal Reserve Bank deposits.

2. December 1, 1959 - November 11, 1980: Total Reserves = Federal Reserve deposits held by member banks plus lagged vault cash of member banks. Only vault cash held by a bank two weeks prior to the current week was eligible to satisfy reserve requirements. Because the required reserves of virtually all member banks exceeded their (lagged) vault cash, essentially all lagged vault cash is included in member bank reserves. The eligibility of vault cash to satisfy statutory required reserves was phased-in from December 1, 1959 - November 23, 1960; beginning November 24, 1960, all lagged vault cash was an eligible asset. Vault cash held by nonmember banks and thrifts is not included.

3. November 1980 - date: Total Reserves = current period vault cash of depository institutions in which lagged vault cash exceeds required reserves, plus lagged vault cash for depository institutions in which required reserves exceeds vault cash, plus the reserve balances of all depository institutions. Reserve balances is defined to equal aggregate Federal Reserve deposits minus aggregate required clearing balance contracts. The amount of required clearing balance contracts is excluded because, it is argued, depository institutions regard the Federal Reserve deposits necessary to fulfill those contracts as unavailable to support the issue of additional deposits or loans.

Published sources for these data are shown in the following table.

Series	Sources
Total Reserves, adjusted for changes in reserve requirements and seasonally adjusted	1) Table 1 of the Board's weekly H.3 release and line 1, Table 1.20 of the *Federal Reserve Bulletin*. 2) Federal Reserve Bank of St. Louis FRED database, series "trarr"
Total Reserves, adjusted for changes in reserve requirements, not seasonally adjusted	3) Table 3 of the Board's weekly H.3 release and line 6 in Table 1.20 of the *Federal Reserve Bulletin*. (Not available on the FRED database.)

Total Reserves, not adjusted for changes in reserve requirements, not seasonally adjusted	1) Table 2 of the Board's weekly H.3 release and line 11, Table 1.20 of the *Federal Reserve Bulletin.* 2) Federal Reserve Bank of St. Louis FRED database, series "totresns"
Nonborrowed reserves, adjusted for changes in reserve requirements, seasonally adjusted	3) Table 1 of the Board's weekly H.3 release and line 2, Table 1.20 of the *Federal Reserve Bulletin* 4) Federal Reserve Bank of St. Louis FRED database, series "bognonbr"
Excess reserves, not adjusted for changes in reserve requirements, not seasonally adjusted	5) Table 1 of the Board's weekly H.3 release and line 16, Table 1.20 of the *Federal Reserve Bulletin* 6) Federal Reserve Bank of St. Louis FRED database, series "excresns"
Free reserves, adjusted for changes in reserve requirements, not seasonally adjusted	7) Calculated by this Bank from Board of Governors' data, equal to excess reserves minus the sum of adjustment plus seasonal discount window borrowing; Federal Reserve Bank of St. Louis FRED database, series "nsorbres"

Total discount window borrowing, not seasonally adjusted	1) Table 1 of the Board's weekly H.3 release and line 17, Table 1.20 of the *Federal Reserve Bulletin* 2) Federal Reserve Bank of St. Louis FRED database, series "borrow"
Extended credit discount window borrowing, not seasonally adjusted	3) Table 1 of the Board's weekly H.3 release and line 9, Table 1.11 of the *Federal Reserve Bulletin* 4) Federal Reserve Bank of St. Louis FRED database, series "extendns"
Adjustment plus seasonal discount window borrowing, not seasonally adjusted	5) Equal to the sum of lines 7 and 8, Table 1.11, *Federal Reserve Bulletin.* 6) Federal Reserve Bank of St. Louis FRED database, series "adjborns"
Data Sources: Federal Reserve Board, *Aggregate Reserves of Depository Institutions and the Monetary Base* (H.3), weekly statistical release, and Table 1.20 in the *Federal Reserve Bulletin*, monthly.	

B. A Definition Motivated by Depository Institutions as Financial Intermediaries and Sellers of Payments Services

One implication of the results reported in this article and in Anderson and Rasche (1996a) is that broad measures of reserves may be important to modeling the role of depository institutions in the economy. In addition to satisfying statutory reserve requirements, depository institutions must hold

sufficient vault cash and Federal Reserve deposits to convert retail customer deposits into currency and to make interbank payments, on request.

Although reserve requirements have varied significantly since the founding of the Federal Reserve, it seems inappropriate to analyze the behavior of depository institutions solely from the narrow viewpoint of assets eligible to satisfy statutory reserve requirements. Consider, for example, the exclusion of vault cash at nonmember depository institutions from the narrow measure of total reserves discussed in section A (above) for dates prior to the Monetary Control Act. The monetary aggregates (M1, M2 and M3) were extended in 1980 to include deposits at nonmember institutions, but the narrow definition of total reserves excludes the vault cash held by these institutions to service their deposits. This argument may be extended to the inclusion of required clearing balance contracts in total reserves: Federal Reserve deposits are held to service the customer deposits included in the monetary aggregates. A desire to maintain logical consistency among measures of money and measures of total reserves suggests that narrow measures of reserves may be incomplete.

The measure of total reserves published by the Federal Reserve Bank of St. Louis includes all the base money held by domestic depository institutions, equal to the adjusted monetary base minus currency held by the nonbank public, as explained in this article and in Anderson and Rasche (1996a).

Adjusted Total Reserves

Similar to the AMB, and for the same dates, adjusted total reserves is constructed in four segments. Within each segment, adjusted total reserves equals the adjusted total reserves component of the AMB. The overall adjusted total reserves series is built by chaining together the four segments at the same dates and in the same manner as the AMB.

Despite common practice, adjusted total reserves for dates prior to November 1980 cannot be obtained by subtracting the currency component of M1 from the AMB. Rather, adjusted reserves must

be calculated from unchained data on the adjusted reserves component of the AMB, and then chained as is the AMB.

Levels and growth rates of the current (old) and new (revised) adjusted total reserves series are shown in Figures A-3 and A-4, respectively. The difference in level is due primarily to a different choice of the base period for RAM and is economically unimportant. The new adjusted total reserves series grows more rapidly than the old series during the phase-in of the Monetary Control Act from 1981-86 and following the 1990-91 and 1992 reductions in reserve requirements. During the former, our RAM adjustment based on individual institution data likely captures changes in the mix of L-Bound and L-Nonbound banks better than the old RAM based on aggregate reserve and deposit data. In the latter, our new measure of the monetary source base captures the significant increase in required clearing balance contracts that is omitted from the old measure. Finally, our new measure of reserves grows more slowly after the February 1994 tightening of monetary policy than the old series and more rapidly than the old series after mid-1995; this difference also is largely due to the omission of the Federal Reserve deposits used to satisfy required clearing balance contracts from the old measure of the monetary base.

Unadjusted Total Reserves

For dates through December 1958, unadjusted total reserves (the reserves component of the monetary source base) are unchanged from data previously published by this Bank. For dates beginning January 1959, unadjusted total reserves is obtained by subtracting the currency component of M^1 from the monetary source base described above. Measured in this way, total reserves includes all vault cash of nonmember banks and thrifts prior to the Monetary Control Act.

The RAM Adjustment

The RAM adjustment is the same RAM used for the adjusted monetary base.

Seasonal Adjustment

Monthly and biweekly data are seasonally adjusted by the same methods used for the adjusted monetary base.

Adjusted Nonborrowed Reserves

Similar to total reserves, adjusted nonborrowed reserves is constructed in four segments. Within each segment, adjusted nonborrowed reserves equals nonborrowed reserves plus RAM. The overall adjusted nonborrowed reserves series is built by chaining together the four segments at the same dates and in the same manner as the AMB. This procedure is necessary because a correct time series for adjusted nonborrowed reserves cannot be obtained by subtracting borrowings from chained adjusted total reserve.

The RAM adjustment is the same RAM used for the adjusted monetary base. Monthly and biweekly data are seasonally adjusted by the same methods used for the adjusted monetary base.

Series Title	FRED abbreviation	frequency of data	included in FRB St. Louis publication:
New Monetary Base and Total Reserves, Available on FRED			
Data Series Described in this article			
Revised St. Louis Adjusted Monetary Base, not seasonally adjusted	ambns_r	monthly	none
Revised St. Louis Adjusted Monetary Base, seasonally adjusted	ambsl_r	monthly	*Monetary Trends*
Revised St. Louis Adjusted Total Reserves, not seasonally adjusted	aresns_r	monthly	none
Revised St. Louis Adjusted Total Reserves, seasonally adjusted	aressl_r	monthly	*Monetary Trends*
Revised Monetary (source) Base, not seasonally adjusted	sbasens_r	monthly	none
Revised RAM, not seasonally adjusted	ram_r	monthly	none
Revised St. Louis Total Reserves, not adjusted for changes in reserve requirements, not seasonally adjusted	resns_r	monthly	none

Revised St. Louis Adjusted Monetary Base, seasonally adjusted	base_r	bi-weekly	*U.S. Financial Data*
Revised St. Louis Adjusted Total Reserves, seasonally adjusted	adjres_r	bi-weekly	*U.S. Financial Data*

Data Series on FRED that will be discontinued at the end of 1996

Adjusted St. Louis Monetary Base (old), not seasonally adjusted	ambns	monthly	none
Adjusted St. Louis Monetary Base (old), seasonally adjusted	ambsl	monthly	*Monetary Trends*
Adjusted St. Louis Total Reserves (old), not seasonally adjusted	aresns	monthly	none
Adjusted St. Louis Total Reserves (old), seasonally adjusted	aressl	monthly	*Monetary Trends*
Monetary (source) base (old), not seasonally adjusted	sbasens	monthly	none
RAM (old), not seasonally adjusted	ram	monthly	none

Data Series on FRED that are discontinued as of October 10, 1996 (data will not be updated or extended)

Adjusted Fed Credit, nsa	afcns	monthly	none
Adjusted Fed Credit, sa	afcsl	monthly	none
Adjusted Fed Credit, sa	afedcr	weekly	none

APPENDIX 2

FEDERAL RESERVE ACCOUNTING RULES APPLICABLE TO REQUIRED CLEARING BALANCE CONTRACTS

Why are Required Clearing Balances a Reserve Management Tool?

In this appendix, we summarize some of the accounting rules facing institutions with and without contracted clearing balances.[1] Our purpose is expository, focusing on the ways in which the accounting practices encourage depositories to utilize required clearing balance contracts as a form of reserve management.

The Federal Reserve deposits held to satisfy a required clearing balance contract are a buffer stock for the depository. Federal Reserve accounting rules first apply a depository's Federal Reserve deposits toward satisfying its statutory reserve requirements. (If the depository is L-Nonbound, or in other words satisfies its statutory requirements with vault cash, this amount is zero.) Within the bounds of its required clearing balance contract, remaining Federal Reserve deposits accumulate earnings credits that may be used to pay for Federal Reserve priced services. If after application of its Federal Reserve deposits to satisfy required reserves the depository institution has a deficiency relative to the amount of its required clearing balance contract, the institution is penalized at a 2 or 4 percent annual rate, depending on the size of the deficiency. The deficiency is not recorded as a loan or as an advance to the depository institution. This aspect of the accounting rules – the ability to implicitly borrow reserve balances at a 2 or 4

[1] Depository institutions include commercial banks, savings banks, savings and loan associations, and credit unions. Many other institutions hold accounts at Federal Reserve Banks, including Edge Act and Agreement corporations, bankers' banks, branches and agencies of foreign banks, credit card banks, nonbank banks, limited purpose trust companies and industrial banks. We exclude all these latter institutions from our analysis. Federal Home Loan Banks are permitted to open clearing and/or passthrough deposit accounts at a Reserve Bank if they provide services for depository institutions in that District. In our analysis, we attribute all such reserve deposits held by Federal Home Loan Banks back to their beneficial owners and exclude the Home Loan Banks from further consideration.

percent rate without incurring the discomfort of borrowing at the discount window – endows the required clearing balance contract with characteristics of a reserve management tool.

Required Reserves Against Deposits

Reserve Balance Accounts

Reserve balances are defined by Federal Reserve Board staff as equal to a depository's gross Federal Reserve deposits less the amount of its required clearing balance contract, if any. All member banks must maintain an individual reserve account at a Federal Reserve Bank; other depository institutions that are required to hold reserves against deposit or other liabilities may either maintain their own reserve balance account or arrange a passthrough contract with an approved correspondent.[2] Under a passthrough contract, the amount of reserve balances that a L-Bound respondent institution must maintain to satisfy its reserve requirement (beyond its vault cash) is charged against its correspondent's reserve account. A correspondent may open a separate account to hold the reserve balances of respondents or may commingle respondent balances in the correspondent's reserve account. The correspondent does not submit to the Federal Reserve data on the amount of reserve balances that it holds for the benefit of each respondent bank. In our work, as explained above, we attribute all excess reserves in a correspondent's reserve account to the correspondent.

Required Reserve Accounting Without a Required Clearing Balance Contract

Most depository institutions calculate their level of required reserves from their average daily levels of its liabilities during a 14-day *reserve computation period* that begins on Tuesday and ends on the second following Monday. (Small institutions that report quarterly and annually calculate required reserves from one week of data; the amount is held constant until the next

[2] Only correspondents approved by the Board of Governors may be used. In addition to some depository institutions, these include special purpose institutions such as the Federal Home Loan Banks and the

reporting date.) Depositories satisfy the requirement during a 14-day *reserve maintenance period.* The reserve maintenance period begins two days after the beginning of the current reserve computation period (on Thursday, rather than Tuesday). For background, see Anderson and Kavajecz (1994).

An institution may satisfy its reserve requirement in two parts. First, the average amount of vault cash held during the reserve computation period that ended just prior to the current reserve computation period is applied toward its requirement.[3] If required reserves are less than this "applied vault cash", the depository is legally nonbound (L-Nonbound) and is not required to hold Federal Reserve deposits to satisfy statutory reserve requirements. If the level of the depository's required reserves exceeds the amount of its applied vault cash, then the depository is legally bound (L-Bound) and must satisfy the remainder of its requirement by holding Federal Reserve deposits either in its own Federal Reserve account (without a passthrough contract) or in a correspondent's reserve account (if it has a passthrough contract).

If a depository is deficient (fails to satisfy) its required reserves over a reserve maintenance period, the depository is charged a penalty at a rate equal to the lowest discount rate in effect on the first day of that calendar month plus 2 percentage points. It also may be subject to various administrative actions and counseling. Recall that because the institution's Federal Reserve deposits are applied first to satisfying its statutory required reserves, satisfaction of its required reserves is unaffected by whether the institution has signed a required clearing balance contract.

National Credit Union Central Liquidity Facility that otherwise would not hold reserve balance accounts at Federal Reserve Banks.

[3] This has differed through time. Prior to 1992, applied vault cash was based on vault cash held during the reserve computation period two, not one, period prior to the current period.

Clearing Balance Requirements

Required Clearing Balance Accounts

Depository institutions may voluntary sign a *required clearing balance contract* with a Federal Reserve Bank. The accounting rules differ for depository institutions with and without passthrough reserve contracts.

If the depository satisfies its statutory required reserves with a passthrough contract, the Federal Reserve deposits necessary to satisfy the contract will be maintained in a separate *reserve clearing account*. The smallest clearing balance contract usually permitted is $25,000. Funds held in this account are treated separately for accounting purposes from any funds held by a correspondent for the benefit of the respondent depository. The clearing account provides the respondent access to Federal Reserve priced services such as wire transfers and check processing in addition to services purchased by the respondent from a correspondent. (Some smaller depositories apparently maintain a Federal Reserve deposit account as a reserve clearing accounts to assure some degree of independence from their correspondent.)

If the institution does not have a passthrough contract, the Federal Reserve deposits necessary to satisfy the clearing balance contract are held in the same Federal Reserve account as funds necessary to satisfy statutory reserve requirements. If the depository fully satisfies its statutory reserve requirements with vault cash (or in other words is L-Nonbound), then the depository need maintain no Federal Reserve deposits except those necessary to satisfy its required clearing balance contract and/or to avoid overnight and over-the-limit daylight overdrafts.

A Federal Reserve Bank may impose a clearing balance requirement on an institution with a poor account management record.

Generally, depositories are discouraged from changing the amounts of required clearing balance contracts more often than once a month.

Required Clearing Balance Accounting

For depositories with a passthrough contract, the average amount of funds in its clearing account during a reserve maintenance period is its *maintained clearing balance*. For a bank without a passthrough contract, the maintained balance equals the average amount in its reserve account during the reserve maintenance period minus any part of the reserve balance applied to satisfy required reserves.

A depository with a contracted clearing balance requirement has a *clearing balance band* centered around the contracted clearing balance. The band equals the greater of ± $25,000 or ± 2 percent of the contracted clearing balance. The band affects both the amount of earnings credits received and the depository's ability to carryover excess reserve balances to the next maintenance period.

Depositories accumulate *earnings credits* on the maintained balance. Credits may only be used to pay for Federal Reserve priced services.[4] They may not be transferred, converted to cash, or used to pay Federal Reserve penalties. Credits expire 52 weeks after being earned. The credits are accumulated in the same manner as if interest were being earned on the maintained balance.

The *earnings credit rate* varies with the institution's marginal reserve requirement on transactions deposits. Depositories that face marginal reserve requirements on transactions deposits of zero, 3 and 10 percent accumulate credits at 90, 93 and 100 percent of the weekly

[4] These include charges for provision (but not delivery of) currency and coin, check clearing and collection, electronic funds transfer, securities transactions, automated clearing house payments, Federal Reserve float, and various electronic access fees for Federal Reserve services.

average federal funds rate, respectively.[5] If the maintained balance falls within the depository's clearing balance band, earnings credits are paid on the maintained balance. No credits are earned on any portion of the maintained balance greater than the upper bound of the clearing balance band, but the excess may be carried over to the next reserve maintenance period up to a maximum of 4 percent of the sum of the bank's reserve and clearing balance requirements minus the greater of $25,000 or 2 percent of its contracted clearing balance requirement.

If the maintained balance is less than the lower bound of the clearing balance band, the institution is considered to be deficient. The depository may carry forward into next period all or part of the deficiency, up to a maximum of 4 percent of the sum of its reserve and clearing balance requirements minus the greater of $25,000 or 2 percent of its contracted clearing balance requirement. Any remaining deficiency below the lower bound of the clearing balance band but greater than 80 percent of the contracted clearing balance requirement is assessed a penalty at a 2 percent annual rate. The penalty increases to a 4 percent annual rate on any shortfall below 80 percent of the contracted amount. A deficiency greater than the entire contracted clearing balance requirement is a deficiency on required reserves for an L-Bound institution, and is penalized at the discount rate plus 2 percentage points. Any part of a deficiency carried over to the next maintenance period but not offset by adequate surplus reserves during that period is charged penalties as if they had not been carried over. Penalties must be paid in cash, not in earnings credits.

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[5] A bank may face a marginal reserve requirement of zero either because it falls within the reserve exemption amount (and hence is a very small bank) or because it satisfies its reserve requirement fully with vault cash (is "nonbound" in Federal Reserve jargon). A bank will face a marginal requirement of 3 percent if it falls within the low reserve tranche (has less than approximately $50 million in reservable deposits) and does not hold enough vault cash to fully satisfy its reserve requirement. These percentages arise because clearing balances held by a respondent at a correspondent bank are classified as "due from banks" in the Federal Reserve's accounting system and are deductible from the total amount of deposits against which the respondent must maintain required reserves. Clearing balances at Federal Reserve Banks are not so deductible. See Stevens (1993) for further details.

Carryover of Reserve Surpluses and Deficiencies, with and without contracted reserve clearing balances

Depositories with passthrough reserve contracts are not permitted to carry over reserve deficiencies or surpluses to the next maintenance period, regardless of whether they maintain a clearing account. Depositories without passthrough contracts that do not have contracted clearing balance requirements may carry over reserve surpluses and deficiencies up to 4 percent of their required reserves. Depositories with contracted clearing balance requirements may carry over surpluses and deficiencies in excess of the upper and lower bounds, respectively, of their clearing balance band. The carryover is limited to 4 percent of the sum of their reserve and clearing balance requirements minus the greater of either $25,000 or 2 percent of the clearing balance requirement.

Payments-Related Reserve Balance Requirements

As we note in the manuscript above, published measures of the monetary base and depository institution reserves include only end-of-day, close-of-business levels of Federal Reserve deposits. An important additional source of Federal Reserve deposits used by depositories for interbank payments is daylight overdrafts on their Federal Reserve deposit accounts. During 1995, daylight overdrafts related to wire transfer, check clearing and other interbank payments activity averaged about $22 billion per day; see Richards (1995).

Banks may incur daylight overdrafts at Federal Reserve Banks up to a *net debit cap*. Well-capitalized banks may self-select their desired cap, as a percent of risk-based determined by well capitalized banks, and is set by the Federal Reserve Bank for less well capitalized banks.

The Federal Reserve monitors the status of each bank's reserve or clearing account at one minute intervals during the day, and may reject Fedwire transfer requests for institutions deemed to present special risks or for transactions that exceed an institution's net debit cap.

In April 1994, the Federal Reserve began charging for daylight overdrafts. The rate charged is currently 15 basis points, quoted on a 24-hour day, and is applied to a bank's average overdrafts (sampled every minute) incurred in their Federal Reserve accounts during the 10 hours per day that Fedwire operates.

Overnight overdrafts are generally not permitted, and may cause the bank to receive special Federal Reserve counseling on management of its reserve account. Overnight overdrafts are penalized at the greater of (i) the effective federal funds rate on the date the overdraft occurred plus 2 percentage points, or (ii) a ten percent annual rate. The minimum charge is $100. Charges may be increased if the number of overdrafts is judged excessive. Charges for overdrafts of less than $10,000 will normally be waived unless the number of overdrafts has been judged excessive by Reserve Bank staff.

APPENDIX 3

RETAIL DEPOSIT SWEEP PROGRAMS AND THE MONETARY BASE

"Old" versus "New" Sweep Programs

During the last 30 years, the term "sweep program" has been used as a label for two distinctly different types of deposit and reserve management programs. Because recently developed (since January 1994) retail sweep programs differ significantly from the sweep programs developed during the 1960s, it is essential that they not be confused:

- During the 1960s, some banks began moving funds late in the day, typically for larger business customers, from demand deposits into overnight investments including money market mutual funds, overnight Eurodollar deposits and overnight repurchase agreements. These sweep programs were driven by two forces: banks were legally prohibited from paying explicit interest on demand deposits, and demand deposits were subject to relatively high marginal statutory reserve requirements. See for example Stigum (1990), chapter 6.
- Since January 1994, some depository institutions have reclassified, late in the day, some retail transaction deposits (ATS/NOW and demand deposits) as money market deposit accounts (MMDA). These sweep programs have been driven entirely by reserve avoidance: MMDA accounts are classified for reserve requirement purposes as saving deposits and hence have a zero required reserve ratio.[1] The zero reserve requirement applies only if no

[1] The Garn-St. German Act created the MMDA deposit. Section 327 of the Act reads:
Section 204 of the Depository Institutions Deregulation Act of 1980 (12 U.S.C. 3503) is amended by adding at the end thereof the following:
"(c)(1) The Committee shall issue a regulation authorizing a new deposit account, effective not later than 60 days after the date of enactment of this subsection. Such account shall be directly equivalent to and competitive with money market mutual funds registered with the Securities and Exchange Commission under the Investment Company Act of 1940.
"(2) No limitation on the maximum rate or rates of interest payable on deposit accounts shall apply to the account authorized by this subsection.
"(3) For purposes of section 19(b) of the Federal Reserve Act, accounts established pursuant to this subsection which are not 'transactions accounts' as defined by the reserve requirement regulations of the Board of Governors of the Federal Reserve System as those regulations existed on August 1, 1982, shall not be subject to transaction account reserves, even though no minimum maturity it required, and even though up to three preauthorized or automatic transfers and three transfers to third parties are permitted monthly."

more than six transfers per month are made from the MMDA to a transaction account; as a result, the most common types of sweep programs reclassify transactions deposits as MMDA just before the close of business on Friday and reverse that reclassification at the opening of business on Monday. (For reserve accounting, Friday's close of business deposit level counts as three days – Friday, Saturday and Sunday.)

The Motivation for Recent Sweep Programs

Recent sweep programs likely have several motivations.

- By implementing a sweep program, most L-Bound depository institutions are able to reduce their required reserves – based solely on close-of-business levels of transactions deposits – below the amount of their vault cash and thereby become L-Nonbound. (Recall that reserve requirements on liabilities other than transaction deposits were reduced to zero in December 1990.) As a result, these institutions no longer have to manage their Federal Reserve deposit account so as to satisfy statutory reserve requirements over 14-day reserve maintenance periods. If the depository's optimal amount of vault cash is unaffected by the sweep program (which seems reasonable), then the economic effect is the same as if the Federal Reserve and the Congress had abolished statutory reserve requirements: the requirements no longer are a factor in the depository's decision making and the reserve requirement tax on the institution is zero.
- Although most L-Bound depositories sharply reduce their Federal Reserve deposits as they become L-Nonbound following implementation of a sweep program, the size of the reduction usually is less than the reduction in their required reserves. L-Nonbound institutions must manage their Federal Reserve deposits based on their payments activity, including wire

transfers and check clearing. If all receipts and debits to the institution's Federal Reserve account were perfectly predictable, then the institution would have no incentive to hold a nonzero balance overnight in a Federal Reserve deposit. In fact, the timing of payments is uncertain, some are likely to occur late in the day, and overnight balances are necessary to avoid close-of-business (overnight) overdrafts. The institution might choose to offset the cost of holding overnight Federal Reserve deposits by signing a required clearing balance contract. In this way, Federal Reserve deposits formerly used to satisfy statutory reserve requirements can be used to defray the cost of Federal Reserve priced services.

- Daylight overdrafts provide an alternative to maintaining larger close-of-business deposit balances. Federal Reserve charges for daylight credit are small.

Implications for Measuring the Adjusted Monetary Base and Adjusted Reserves

Effect on the Monetary Source Base

The spread of retail transaction deposit sweep programs since January 1994 reinforces the importance of broadening the definition of the St. Louis monetary source base to include all Federal Reserve deposits. The distortion to the previous measure is evident: a depository that implements a sweep program and subsequently re-labels its Federal Reserve deposit as held to satisfy a required clearing balance contract rather than to satisfy statutory required reserves would cause the old measure of the monetary source base to decrease by the amount of the required clearing balance contract *even if the institution did not, in fact, reduce its Federal Reserve deposits*. (Note that the Board of Governors' adjusted monetary base continues to exclude the amount of required clearing balance contracts, and hence is affected by this distortion.)

The amounts of Federal Reserve deposits included in the new St. Louis source base and the amounts that would have been included if we continued our previous practice of excluding

required clearing balance contracts are shown in the upper two panels of Figure A-5 (which is the same as Figure 1 above). The difference is small until the December 1990 reserve requirement reduction, and decreases sharply following the January 1994 increase in the federal funds rate target. The difference grows rapidly, even with the federal funds rate constant, beginning mid-1995 as the spread of sweep programs accelerates. Sweeps program jumped from about $14 billion in May 1995 to about $150 billion in October 1996, while the difference between the two Federal Reserve deposit measures (essentially required clearing balance contracts) increased by about $2 billion. These changes are consistent with Kohn's (1996) estimate that about one-sixth of the aggregate potential decrease in Federal Reserve deposits due to sweep programs has been reflected in larger required clearing balance contracts.

Effect on RAM

The new RAM adjustment presented in this paper includes only E-Bound depository institutions, defined as those depository institutions whose holdings of base money in each reserve maintenance period, relative to deposits, likely has been affected by the difference between that period's reserve requirements and those that prevailed during a selected base period in January 1991. Our statistical analysis suggests that the April 1992 cut in the marginal statutory reserve requirement ratio on transactions deposits reduced this number to about 400 institutions. We suspect that many, and perhaps most, of these institutions that have implemented sweep programs are now L-Nonbound and hence E-Nonbound.

The spread of sweep programs has two partially-offsetting effects on aggregate RAM. For an individual institution, the sweep program increases RAM; recall that RAM during each reserve maintenance period equals an estimate of what the institution's required reserves would have been in January 1991 (absent the sweep program) minus the institution's actual required

reserves. At the same time, however, the program's implementation may cause the institution to become L-Nonbound and hence omitted from RAM.

Our current RAM incorporates these effects only through December 1995. As explained in the main text and in Appendix 1 above, RAM through December 1995 has been calculated from data on individual banks. For the current year, beginning January 1996, RAM is calculated as $\mathrm{RAM}_t = \left[\delta_B \times NT_t\right] \times 0.02$ where $\delta_B = 0.65$ is the estimated proportion of aggregate net transactions deposits in E-Bound depository institutions at the end of 1995, and 0.02 is the difference between the marginal reserve requirement on transactions deposits in January 1991 (= 0.12) and during 1996 (= 0.10). The full effect of sweep programs implemented during 1996 will not be included in RAM until January 1997, when we revise and benchmark the series for 1996 data. Preliminary estimates through 1996 Q3 suggest that the number of E-Bound institutions has fallen to about 200 from about 400 at the end of 1995, and that δ_B has fallen to about 0.40 from 0.65. We expect that by early 1997 all depository institutions in the United States will be E-Nonbound, either because they have become L-Nonbound or because some aspect of their business makes it unattractive to implement a sweep program. If so, RAM will become zero.

Growth rates of Current and Revised Adjusted Monetary Base

Monthly Data, Year – Over – Year Growth Rates, Seasonally Adjusted

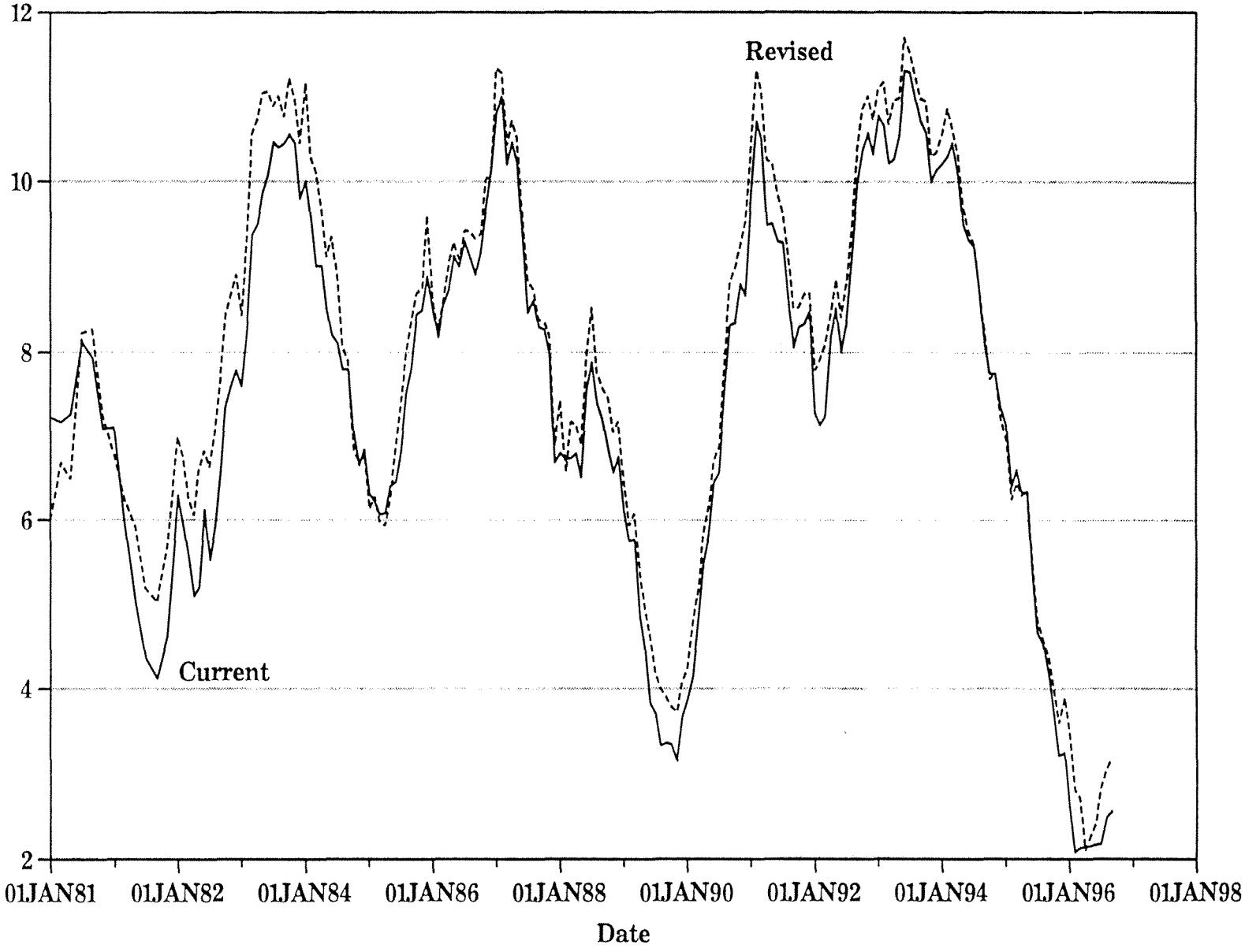
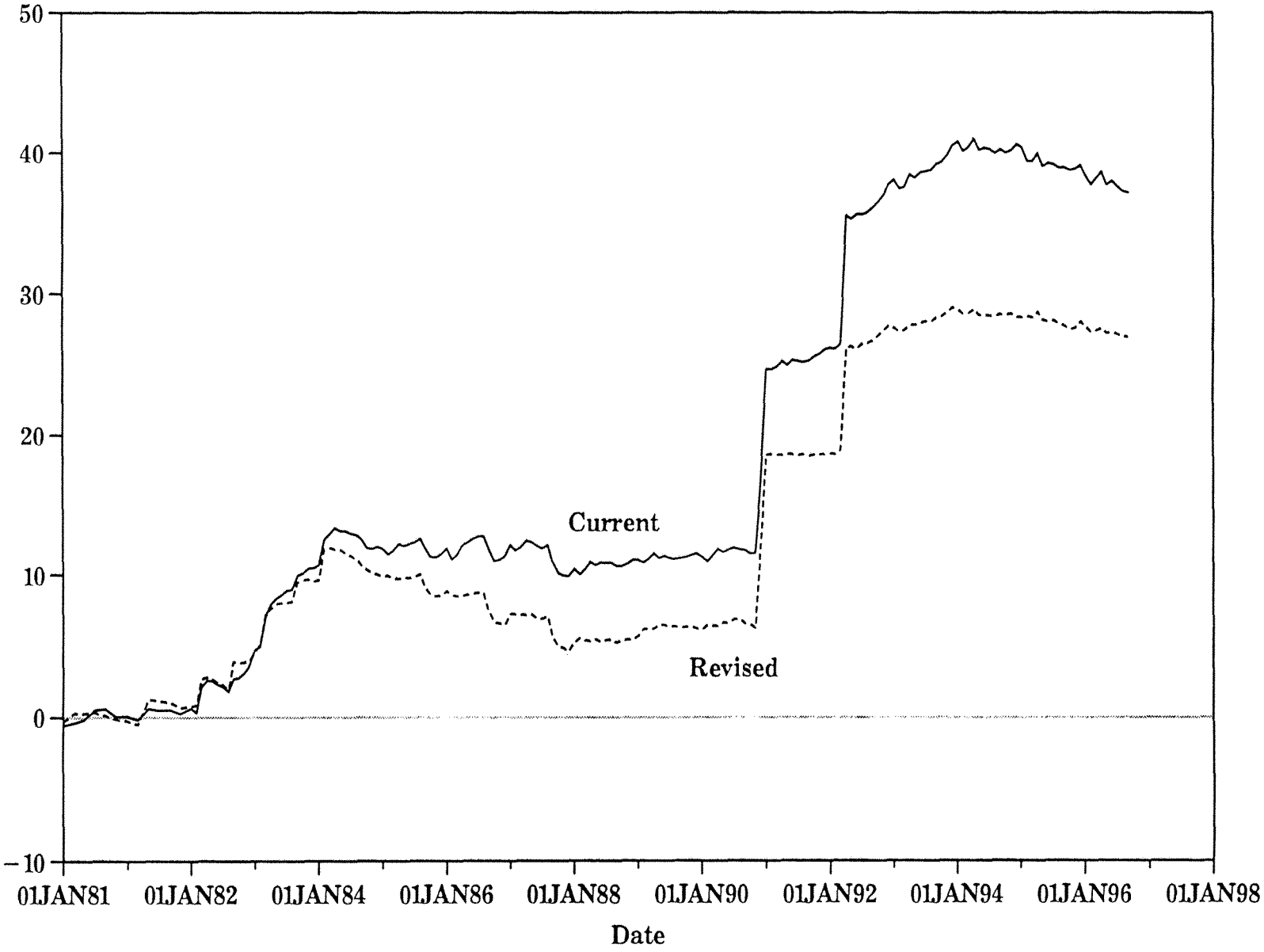


Figure A-1

Current and Revised Reserve Adjustment Magnitude

Monthly Data, Billions of Dollars, Not Seasonally Adjusted



Note: December 1980 = 0

Figure A-2

Current and Revised Adjusted Reserves

Monthly Data, Billions of Dollars, Seasonally Adjusted

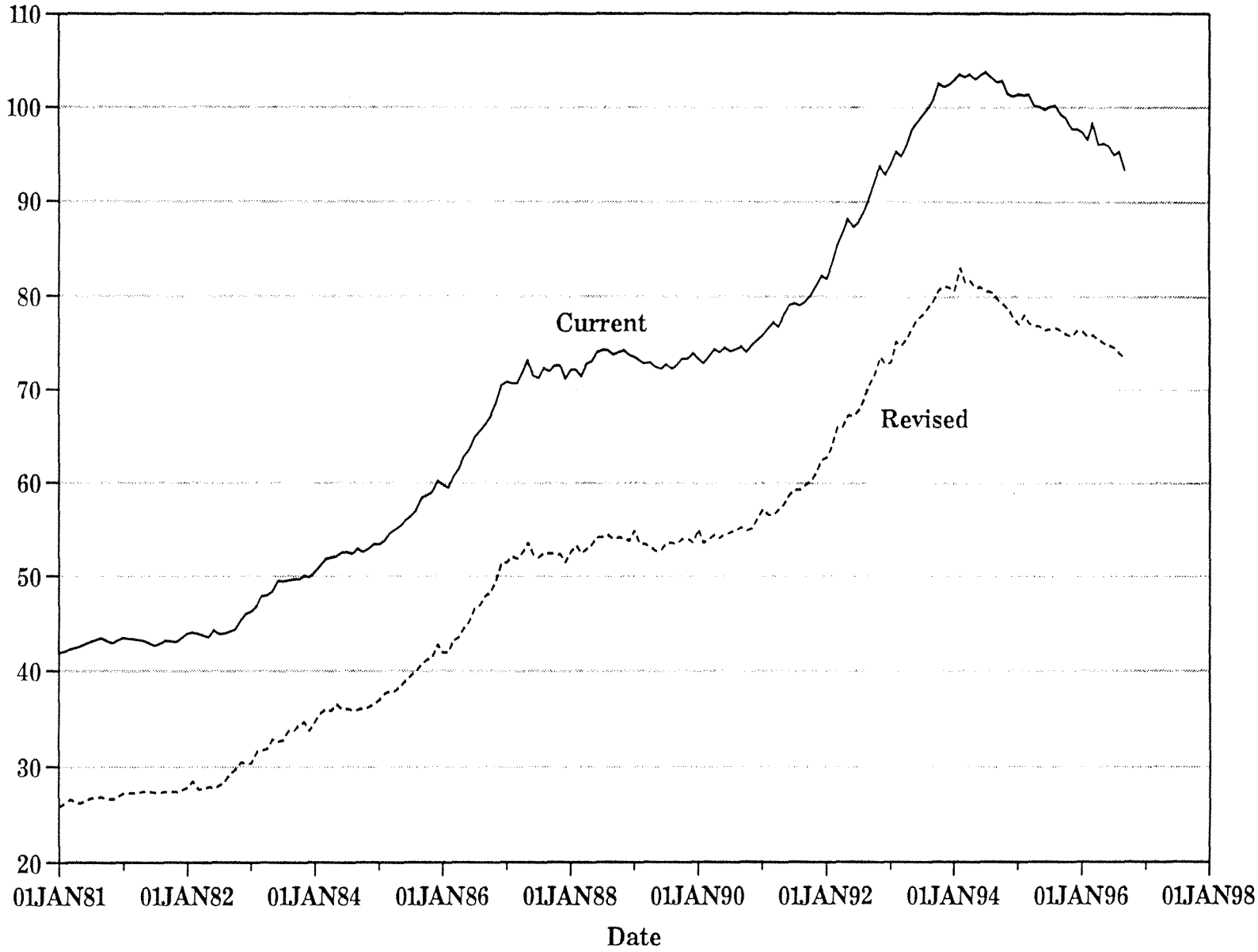


Figure A-3

Growth Rates of Current and Revised Adjusted Reserves

Monthly Data, Year – Over – Year Growth Rates, Seasonally Adjusted

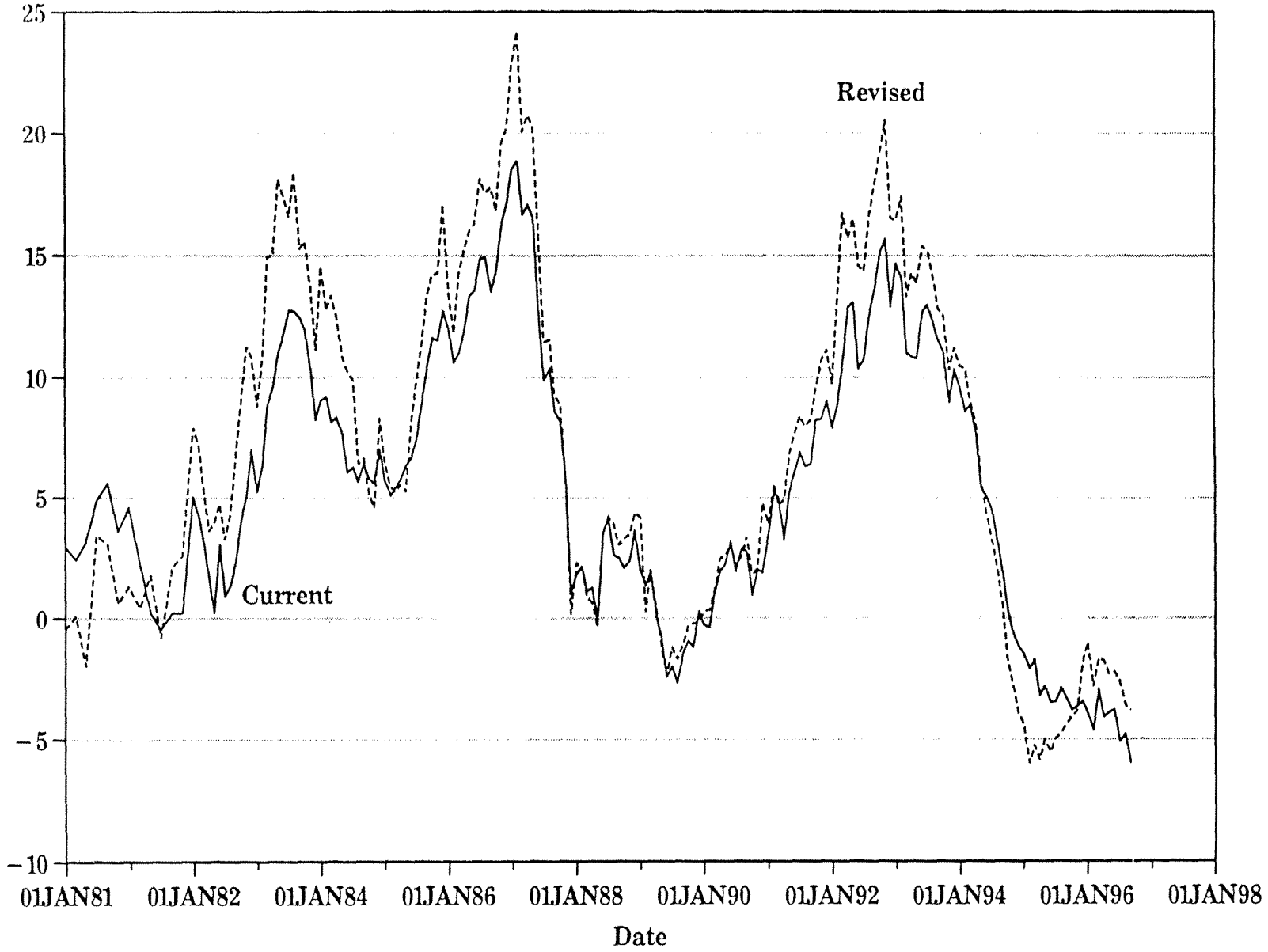
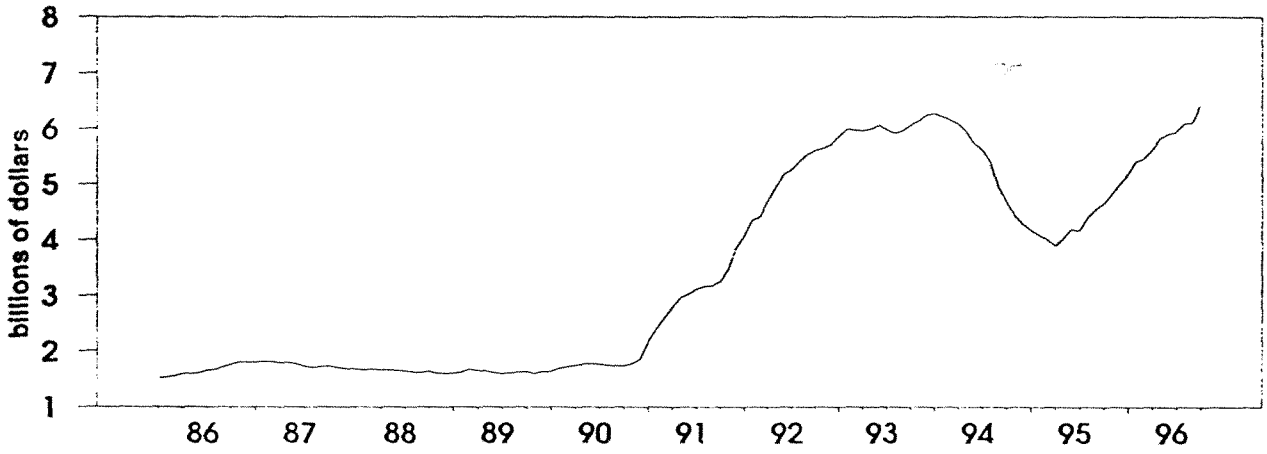


Figure A-4

Figure A-5

New and Old Measures of Federal Reserve Deposits

New Measure minus Old Measure



Sweep Programs