

# A Reconstruction of the Federal Reserve Bank of St. Louis'

## Adjusted Monetary Base and Reserves

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### Abstract

This article presents a reconstruction of the Federal Reserve Bank of St. Louis' measures of the adjusted monetary base and adjusted bank reserves. Based on original source data as much as feasible, the revised figures include changes to both the monetary (source) base and RAM. Incorporating figures from previously published research, the adjusted monetary base and adjusted reserves series are extended to earlier periods beginning in December 1917. The revised figures also include the new measure of RAM developed by Anderson and Rasche (2001) that beginning 1994 interprets the operation of retail-deposit sweep programs by U.S. banks as economically equivalent to a reduction in statutory reserve requirements. New seasonal adjustment factors also are presented that incorporate adjustments for the Y2K-related surge in the monetary base and reserves.

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## ***Introduction***

This paper summarizes the results of a benchmark reconstruction of the Federal Reserve Bank of St. Louis' adjusted monetary base and adjusted bank reserves data. With this revision, these series include monthly figures from December 1917 to the present and biweekly figures from February 1984 to the present.<sup>1</sup> During the reconstruction process, we reviewed the historical data used to measure the monetary base and the reserve adjustment magnitude (RAM), as well as the methods of construction for the series. Although all values of the series have changed, the principal changes are:

- Monthly figures on both the adjusted monetary base and adjusted reserves now begin in December 1917. Previously, the adjusted monetary base began in 1936 and adjusted reserves began in 1980.<sup>2</sup> Biweekly figures on the adjusted monetary base and adjusted reserves begin in February 1984, when the Federal Reserve shifted from lagged to near-contemporaneous reserve accounting and lengthened reserve maintenance periods to 14 days from 7 days.
- Figures for the monetary (source) base have changed for January 1959 to December 1990. The revised figures are monthly averages of daily figures for currency in circulation and for deposits held by depository institutions at Federal Reserve Banks. Previous figures for this interval were *pro rata* monthly averages of 7-day or 14-day averages of daily figures. With this change, the monthly monetary base is measured consistently throughout its range as the average of daily figures. Differences between the revised and previous figures are small, typically less than \$50 million.
- Figures for the reserve adjustment magnitude have changed from September 1935 to October

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<sup>1</sup> The data in this analysis end as of September 2002.

<sup>2</sup> Figures on the adjusted monetary base for 1917 to 1935 have been available on the Research Division's Internet web site ([research.stlouisfed.org](http://research.stlouisfed.org)) since publication of Anderson and Rasche (1999). They have not previously been combined with later figures in a consistent format.

1980, to correct calculation errors. The changes are discussed in detail below.

- Beginning January 1994, the previously published RAM has been replaced with the Anderson and Rasche (2001) adjustment that interprets a bank's implementation of a retail-deposit sweep program as equivalent to a reduction in its statutory reserve requirement. This change increases the adjusted monetary base and adjusted reserves by approximately \$24 billion as of the reserve maintenance period that ended on September 30, 2002.

### ***The Role of the Monetary Base in Monetary Policy***

It is commonplace today for monetary policy analysis, both in theory and practice, to be conducted without reference to the monetary base or other monetary aggregates.<sup>3</sup> Given this shift in monetary policy analysis, some readers of this article have questioned the value of reconstructing the St. Louis measure of the adjusted monetary base. We briefly address that question here.<sup>4</sup>

In a recent paper, Nelson (2002b) attributes the omission of monetary aggregates, at least in part, to the intellectual influence of Taylor (1993) and subsequent related research. For near-term policymaking, Taylor's analysis succinctly combined policymakers' concerns regarding deviations of both inflation and GDP from desired target levels, while relegating money supply and demand to an invisible background role.

Recent analyses suggest two roles for the monetary base in policymaking. The first focuses on the long-run implications of monetary base growth for the price level and inflation rate. These authors argue that the truth of Milton Friedman's proposition—"inflation is always

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<sup>3</sup> The monetary base, or "outside money," continues to appear in theoretical structural models, e.g., Sargent (1979, 1987), chapters I-IV, especially section IV.2. This dichotomy has led some economists to suggest that including money (and a central bank) is appropriate in structural models if the researcher wishes to examine changes in the economy's structure, but is unnecessary for near-term monetary policy in the currently popular small canonical models.

<sup>4</sup> Interested readers are referred for further analysis to Nelson (2002a, 2002b).

and everywhere a monetary phenomenon”—does not depend on whether a monetary aggregate appears in the central bank’s policy reaction function. Rather, at least in the theoretical long-run when the effects of other shocks have played out, the inflation rate is determined by the growth rate of money because, absent such growth, the inflation could not continue. It matters not at all in the long-run whether policymakers target interest rates or monetary aggregates for, so long as their actions *permit* the necessary increases in the central bank’s balance sheet, the inflation will follow. Hence, observations on the monetary base may be important evidence useful to analysts seeking to understand the ex post, if not ex ante, effects of central bank actions.<sup>5</sup>

Although this long-run argument is compelling, the issue remains as to whether growth of the monetary base is useful for policymakers in the context of the current canonical model containing a forward-looking IS (aggregate demand) equation, a price-setting (aggregate supply) equation, and a Taylor-style policy rule.<sup>6</sup> It is a truism that central banks achieve their interest-rate targets by managing the quantity of base money held by the public. Yet, recent analyses suggest achieving policy targets via control of the growth of the monetary base is more difficult and generally less successful than via control of a short-term interest rate. Summarizing several recent studies, Nelson (2002b), p. 19, concurs: “But insofar as a key message ... is that the control of inflation around its steady-state value can be accomplished by a monetary policy framework that does not respond explicitly to monetary aggregates, I would not disagree.” McCallum (2001), after formally testing the role of money within his canonical model, reaches the same conclusion. McCallum’s result also suggests that, even in the long run, policymakers

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<sup>5</sup> Allan Meltzer’s recent history of the Federal Reserve System (Meltzer, 2003), for example, cites several episodes, such as 1920-1921, in which economic activity was buffeted by the cross-currents of rising real interest rates and accelerating monetary base growth. Generally, the latter prevailed in bolstering economic expansion. The best of such examples seems to be for the gold standard period, as suggested by footnote 32 in Nelson (2002b). Meltzer’s analysis uses the St Louis adjusted monetary base figures developed in Anderson and Rasche (1999).

may benefit little from monitoring growth of the monetary base: Because the steady-state inflation target is both arbitrary (in the model) and a monetary phenomenon, the same policy mechanism that allows policymakers to achieve their specified inflation target also allows them, by changing growth of the monetary base, to achieve an alternative inflation target.

Overall, therefore, the usefulness to policymakers of monetary base growth as an indicator of the stance of monetary policy remains an open question. Further, the reconstructed series presented in this article likely will be of value to researchers exploring linkages between Taylor-style policy rules and monetary aggregates.

Finally, Nelson (2002a,b) suggests that growth of the monetary base may be valuable as a proxy for, or indicator of, the workings of a broad (but largely hidden) monetary transmission mechanism of the Brunner-Meltzer-Friedman-Schwartz variety which emphasizes that monetary policy actions induce substitution by households and firms among large numbers of assets.<sup>7</sup>

Nelson (2002b) emphasizes that the omission of money from the aggregate demand equation is not a specification error (because the transmission mechanism never suggested it should be there anyway), but the omission of yields other than the short-term policy rate is a serious error.

Indeed, statistical explanatory power for monetary base growth perhaps is due to the omission of this broader set of yields because the omitted terms likely are highly correlated with changes in the growth rate of the monetary base.<sup>8</sup>

The recent nearness-to-zero of policy-target rates in the United States and Japan has

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<sup>6</sup> See for example McCallum (2001).

<sup>7</sup> Brunner and Meltzer (1963, 1968), Friedman and Schwartz (1963, 1982).

<sup>8</sup> Meltzer (2001) and Nelson (2002a) find that real monetary base growth has significant in-sample explanatory power for growth of U.S. real consumption and output, respectively, when a long-term nominal interest rate is included and prices are sticky. Nelson's analysis uses the St Louis measure of the domestically held adjusted monetary base developed in Anderson and Rasche (2000). Nelson also finds a similar result for the U.K.

further stimulated discussion of the role of the monetary base as a policy indicator.<sup>9</sup> McCallum (2003), for example, has emphasized that many low default-risk assets may become cash-equivalents at near-zero yields, and that the central bank may need to purchase unusually large quantities of such assets—that is, boost substantially monetary base growth—if it wishes to affect spending by inducing portfolio substitution into equity, foreign currencies, or various higher-risk private-sector debt. Since the nominal policy-target interest rate ceases to move once it settles near zero, growth of the monetary base may be the most suitable policy indicator available to the central bank.

### ***The Monetary [Source] Base***

The monetary base is defined to be those liabilities of the monetary authorities that households and firms use as medium of exchange and that depository institutions use to satisfy statutory reserve requirements and to settle interbank debts.<sup>10</sup> In the United States, this includes currency (including coin) held outside the Treasury and the Federal Reserve Banks (referred to as *currency in circulation*) plus deposits held by depository institutions at the Federal Reserve Banks. The demand by the private sector for these liabilities gives the Federal Reserve leverage to affect money market interest rates.

In our reconstruction, all monthly and biweekly figures for the monetary source base are averages of daily figures. Previously, monthly figures prior to 1959 and after early 1989 were averages of daily figures, while monthly figures from 1959 through early 1989 were *pro rata* monthly averages of 7-day and, after January 1984, 14-day averages of daily figures. This change to the St. Louis measure of the monetary base removes a measurement inconsistency and makes

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<sup>9</sup> McCallum (1993, 2003), Meltzer (2001b).

<sup>10</sup> Throughout, we use the term *monetary base* to refer to the same concept that frequently in the literature has been referred to as the *monetary source base* or the *source base*. Except for occasional emphasis, we omit the word “source” from the text.

our monetary base figures replicable from published data.<sup>11</sup> With respect to its impact on the time-series behavior of the monetary base, this change is largely a technical revision. From January 1959–December 1990, the mean levels of the revised and previous figures are \$129.307 billion and \$129.351 billion, respectively, with standard deviations of \$76.095 billion and \$76.068 billion. The two series’ average continuously-compounded growth rates are the same (because the series begin and end with the same figures), while their standard deviations differ only slightly, at 11.867 percent for the revised series and 11.834 for the previous.

One problem, likely irresolvable, remains in our measurement of the deposit component of the monetary base: So far as we are aware, there are no published monthly average figures for deposits held by depository institutions at the Federal Reserve Banks. Conceptually, this component of the monetary base should be easily measured because these deposits are liabilities of the Federal Reserve Banks and, hence, appear on the Reserve Banks’ balance sheets. Unfortunately, at least for measurement of the monetary base, since its creation the Federal Reserve has followed the commercial banking industry’s practice of publishing balance sheet figures only for selected days, most often Wednesdays and the last business day of the month.<sup>12</sup> As a proxy for these unavailable deposit figures, we measure the deposit component of the monetary base by the sum of “reserve balances with Federal Reserve Banks” plus, beginning January 1981, “service-related balances and adjustments.”<sup>13</sup> Although this proxy satisfies our criterion to be a monthly average of daily figures, it differs from our ideal deposit figure by

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<sup>11</sup> For months prior to January 1991, figures are from *Banking and Monetary Statistics*, volumes 1 and 2, and various issues of the *Annual Statistical Digest*. Beginning January 1991, figures are from the Board of Governors’s weekly H.4.1 data release and the *Federal Reserve Bulletin* table entitled “Reserves of Depository Institutions and Reserve Bank Credit.” In the January 2003 issue of the *Bulletin*, this is table 1.11, page A5. Additional details regarding data sources are available in the appendix.

<sup>12</sup> In the January 2003 issue of the *Federal Reserve Bulletin*, see table 1.18 on page A10, “Federal Reserve Banks: Condition and Note Statements.” Deposits held by depository institutions at Federal Reserve Banks are shown in line 25.

<sup>13</sup> In the January 2003 issue of the *Federal Reserve Bulletin*, see table 1.11 on page A5, “Reserves of Depository Institutions and Reserve Bank Credit.” Reserve balances are shown in line 25 and service-

including “as-of” accounting adjustments that compensate depository institutions for the time-value of any inappropriate credits or debits to their Federal Reserve deposit accounts, including certain delays in check clearing.

We conducted two experiments to measure the adequacy of our proxy. Both experiments suggested that the proxy is an acceptable measure of deposits held by depository institutions at the Federal Reserve. First, from the Federal Reserve Board’s microfilm archive, we retrieved a sample of several months of unpublished daily balance sheets for the Reserve Banks prior to 1980. We compared aggregate monthly averages of these figures to published monthly figures regarding the average daily reserve balances held by member banks at the Federal Reserve. There were only minor differences. From this experiment, we concluded that the considerable cost to retrieve additional figures likely would far exceed the value of the increase in measurement accuracy. In a second experiment, we obtained unpublished figures from the Board of Governors beginning January 1986 on the monthly averages of aggregate daily deposits held at Federal Reserve Banks. We found only minor differences between these figures and our proxy.

In our opinion, as-of adjustments should be excluded from the monetary base because these amounts cannot be used to settle interbank debits, nor can they be loaned to other depositories in the money market. But the argument is not unambiguous: as-of adjustments *can* be applied to reduce the amount of deposits that a depository institution must hold at the Federal Reserve to satisfy its required reserves. In practice the issue is settled by data availability. In addition, our experiments suggest that as-of adjustments tend to be both small enough in size and random enough in occurrence that the measurement error in our proxy, relative to actual balance-sheet figures of deposits at the Federal Reserve Banks, is minor.

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related balances are shown in line 22.

### *Adjustments for the Effects of Changes in Statutory Reserve Requirements*

Because changes in statutory reserve requirements affect depository institutions' demand for base money, it is necessary to adjust the monetary base and total reserves for the effects of these changes before the figures can be used for economic analysis. In the St. Louis series, this is accomplished by adding to each series the reserve adjustment magnitude, or RAM.<sup>14</sup> RAM measures the effects on monetary base demand of differences in statutory reserve requirements between those in effect on the date of each observation, denoted  $t$ , and those in effect during a specific base period, denoted  $\tau$ .<sup>15</sup> If the reserve requirement regime in effect during a current period,  $t$ , is the same as the regime during the base period,  $\tau$ , then  $RAM_t = 0$ .

Currently, RAM has five segments, referred to as RAM(1922), RAM(1935), RAM(1972), RAM(1975), and RAM(1991). Each segment corresponds to a given structure, or regime, of reserve requirements. The name of each segment refers to the year of its base-period reserve-requirement regime: July 1922, September 1935, December 1972, January 1975, and January 1991, respectively. When a major change occurs in reserve requirements, the previous RAM segment ends and a new RAM segment begins.

The method used to calculate each segment of RAM depends on data availability. Prior to September 1968, values are calculated from aggregate monthly figures. From September 1968

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<sup>14</sup> For previous discussions of the concept of RAM as used here, see Burger and Rasche (1977), Tatom (1980), and Anderson and Rasche (1996, 1999, 2001).

<sup>15</sup> The base-period statutory reserve requirements for RAM(1991) are the requirements applicable to the reserve maintenance period that ended Wednesday, January 9, 1991. The requirements during this period included a low-reserve tranche of \$41.1 million, a reserve-exemption amount of \$3.4 million, a 12 percent reserve-requirement ratio on net transaction deposits in excess of the low-reserve tranche, a 3 percent ratio on net transaction deposits within the tranche, and a 0 percent ratio on net transaction deposits within the reserve-exemption amount and on other deposits and borrowings. Because reserve requirements did not change during 1991, RAM(1991) equals zero for maintenance periods through the period that ended December 25, 1991. RAM(1991) becomes positive for the reserve maintenance period beginning December 26, 1991, because, effective on that date, the low-reserve tranche and reserve-exemption amounts increased to \$42.2 million and \$3.6 million, respectively.

through October 1980, values are calculated from aggregate weekly figures.<sup>16</sup> Beginning October 1980, values are calculated from weekly individual-bank figures, as discussed in Anderson and Rasche (1996, 2001). Prior to November 1980, the calculation includes all Federal Reserve member banks. From November 1980 through December 1990, the calculation includes only those depository institutions with net transaction deposits greater than the low reserve tranche and required reserves greater than their vault cash.<sup>17</sup> Beginning January 1991, the calculations include only those depository institutions with net transaction deposits greater than the \$135 million threshold estimated in Anderson and Rasche (1996).

For this analysis, we collected all available (published and unpublished) historical data relating to deposits and required reserves of member banks prior to 1980.<sup>18</sup> Based on these figures, we reconstructed RAM for the period August 1935 through October 1980. Our efforts changed many of the figures in RAM(1935), RAM(1972), and RAM(1975)<sup>19</sup>

- RAM(1935) has been changed to correct an error that caused it, for dates prior to September 1968, to display one month prematurely the effects of changes in reserve-requirement ratios. The originally intended calculation, which sought to adjust for the delayed availability of aggregate deposit figures relative to figures on the monetary base

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<sup>16</sup> Most of these figures are from the Board of Governor's published H.7 release. Some are unpublished figures from the archives of the Research Division of the Federal Reserve Bank of St. Louis.

<sup>17</sup> Since 1981, RAM cannot be calculated simply by comparing (subtracting) required reserves under the current-period and base-period statutory reserve requirement regimes. If reserve requirements in a given period are lower than those in the specified base period, a depository institution that was constrained by the base-period regime might not be constrained by the current regime. If in this case, as seems reasonable, the amount of reserves held during the current period is less than the amount held during the base period, RAM must be calculated so as to measure only the portion of that reduction which is due to the lower reserve requirements (in general, this is less than the total reduction in required reserves). For details, see Anderson and Rasche (2001), pp 57-8.

<sup>18</sup> In a previous article, we have examined, in detail, historical data beginning November 1980; see Anderson and Rasche (1996). For this study, some data are from published sources while other figures are from unpublished archival records of the Federal Reserve Bank of St. Louis.

<sup>19</sup> The first segment, RAM(1922), is unchanged from the figures in Anderson and Rasche (1999).

and bank reserves, was  $RAM(1935)_t = \sum_j (r_{j,\tau} - r_{j,t}) D_{j,t-1}$ , where  $j$  indexes the type of deposit and  $r_{j,t}$  and  $r_{j,\tau}$ , respectively, are the current and base period ( $\tau =$  September 1935) reserve-requirement ratios. During our reconstruction, we found that the currently published series inadvertently had been calculated as

$$RAM(1935)_t = \sum_j (r_{j,\tau} - r_{j,t+1}) D_{j,t},$$

which displays one month prematurely the effect

of changes in reserve requirement ratios. Our new calculation, which supercedes previously published figures, contains no lags:  $RAM(1935)_t = \sum_j (r_{j,\tau} - r_{j,t}) D_{j,t}$ . So

far as we have been able to determine, values of RAM(1935) for months beginning September 1968, which were calculated from weekly deposit figures, were not affected by this error.<sup>20</sup>

For the period 1935–1949, this correction removes the large negative monthly growth-rate spikes in the adjusted monetary base that are apparent in the third-row panel of the left column in Figure 2 of Anderson and Rasche (1999). The correction does not change, however, our conclusion in that analysis that no regular (stable, estimable) seasonal pattern is apparent between 1933 and 1949.

- RAM(1972) and RAM(1975) have been changed to correct an error that caused their base-period values to differ from zero. The error is due to an incorrect treatment of the supplemental and marginal reserve requirements introduced by the Board of Governors in 1969 (see Table 2). To illustrate the issue, we need to be precise regarding differences between the Federal Reserve reserve-requirements regimes before and after 1969. For dates prior to 1969,

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<sup>20</sup> Values of RAM(1935) for dates after August 1968 differ slightly from previously published figures because they have been recalculated from aggregate deposit and required reserve figures.

member banks' aggregate required reserves were well-approximated by a linear function of their aggregate deposits,  $RR_t = \sum_j r_{j,t} D_{j,t}$ . In addition, member banks changed their holdings of base

money approximately dollar-for-dollar with changes in required reserves. Hence, if we let

$RR_{t,\tau} = \sum_j r_{j,\tau} D_{j,t}$  measure the (counterfactual) amount of base money that these banks would

have held during period  $t$  if the reserve-requirement regime of period  $\tau$  had been in effect, the

RAM adjustment for period  $t$  relative to period  $\tau$  is

$$RAM_t = RR_{t,\tau} - RR_t = \sum_j (r_{j,\tau} - r_{j,t}) D_{j,t}.$$

Due to their complexity, the supplemental and marginal reserve requirements introduced in 1969 are not well-approximated by linear functions of aggregate deposits. Hence, we add a second term to RAM:

$$RR_t = RR_t^{deposits} + RR_t^{other} = \sum_j r_{j,t} D_{j,t} + RR_t^{other}$$

$$RR_{t,\tau} = RR_{t,\tau}^{deposits} + RR_{t,\tau}^{other} = \sum_j r_{j,\tau} D_{j,t} + RR_{t,\tau}^{other}.$$

Then, RAM is

$$\begin{aligned} RAM_t &= \left( RR_{t,\tau}^{deposits} - RR_t^{deposits} \right) + \left( RR_{t,\tau}^{other} - RR_t^{other} \right) \\ &= \sum_j (r_{j,\tau} - r_{j,t}) D_{j,t} + \left( RR_{t,\tau}^{other} - RR_t^{other} \right) \\ &= RAM_t^{deposits} + RAM_t^{other}. \end{aligned}$$

Previously published values for RAM(1972) and RAM(1975) were calculated as

$$\begin{aligned}
RAM_t &= \sum_j r_{j,\tau} D_{j,t} - \sum_j r_{j,t} D_{j,t} - RR_t^{other} \\
&= RAM_t^{deposits} + \left( RAM_t^{other} - RR_{t,\tau}^{other} \right),
\end{aligned}$$

which is correct only if  $RR_{t,\tau}^{other} = 0$ , that is, if the amount of base money held by banks to satisfy supplementary and marginal requirement was zero during the base period,  $\tau$ .

### ***Chaining the Adjusted Monetary Base***

The complete time series of observations for the adjusted monetary base and adjusted reserves, from 1917 to the present, are chained indexes with splices at four dates (August 1935, December 1972, January 1975, and October 1980) corresponding to the segments of RAM. For the adjusted monetary base, the splice factors are:

$$\begin{aligned}
f_1 &= \frac{MB_{1935:8} + RAM(1935)_{1935:8}}{MB_{1935:8} + RAM(1922)_{1935:8}} & f_3 &= \frac{MB_{1975:1} + RAM(1975)_{1975:1}}{MB_{1975:1} + RAM(1972)_{1975:1}} \\
f_2 &= \frac{MB_{1972:12} + RAM(1972)_{1972:12}}{MB_{1972:12} + RAM(1935)_{1972:12}} & f_4 &= \frac{MB_{1980:10} + RAM(1991)_{1980:10}}{MB_{1980:10} + RAM(1975)_{1980:10}}
\end{aligned}$$

Then, the adjusted monetary base is calculated as

$$\begin{aligned}
AMB_t &= \prod_{i=1}^4 f_i * (MB_t + RAM(1922)_t), & t &= 1917:12, \dots, 1935:8 \\
&= \prod_{i=2}^4 f_i * (MB_t + RAM(1935)_t), & t &= 1935:8, \dots, 1972:12 \\
&= \prod_{i=3}^4 f_i * (MB_t + RAM(1972)_t), & t &= 1972:12, \dots, 1975:1 \\
&= f_4 * (MB_t + RAM(1975)_t), & t &= 1975:1, \dots, 1980:10 \\
&= (MB_t + RAM(1991)_t), & t &= 1980:10, \dots
\end{aligned}$$

For the adjusted monetary base, the splice factors  $f_1, f_2, f_3, f_4$  have values 0.99677, 1.03187, 1.00564, and 0.85671, respectively.

### ***Total (Depository Institution) Reserves***

The Federal Reserve Bank of St. Louis measure of adjusted reserves is a chain index that includes the same RAM adjustment as the adjusted monetary base and, hence, is constructed in five segments corresponding to RAM(1922), RAM(1935), RAM(1972), RAM(1975), and RAM(1991).

Each segment of adjusted reserves equals the sum of the monetary (source) base, plus the appropriate RAM, minus the currency component of M1.<sup>21</sup> For dates beginning January 1959, our measure of currency is the Federal Reserve Board's published figures. For January 1947 through December 1958, our figures are from *Banking and Monetary Statistics*, table 1.1B, p. 20. For December 1917 through December 1946, our figures are from Friedman and Schwartz (1970), table 1, pp. 16-37.<sup>22</sup>

For adjusted reserves, the values of the splice factors  $f_1, f_2, f_3, f_4$  are 0.99421, 1.09117, 1.01506, and 0.53626.

The same procedure could be used to construct a nonborrowed or free reserves aggregate, although we have not done so.

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<sup>21</sup> In the January 2003 issue of the *Federal Reserve Bulletin*, see table 1.21 on page A13, "Money Stock Measures." The currency component of M1 is shown on line 4. Note that this measure of currency does not include travelers checks (see footnotes 3 and 4 to table 1.21).

<sup>22</sup> Figures for early years regarding the currency component of M1, and hence total bank reserves, contain significant judgmental estimation and should be used with caution. Currently and in historical series, the currency component of M1 is calculated by subtracting depository institutions' aggregate vault cash from aggregate currency in circulation. Although good quality monthly figures on currency in circulation are available even prior to our starting date of December 1917, prior to implementation of the Monetary Control Act in 1980 monthly figures on vault cash must be estimated from bank call reports. For discussion of periods prior to 1970, see Friedman and Schwartz (1970), chapter 12; for discussion of later periods, see Anderson and Kavajecz (1994).

### *Adjustments for Seasonal Variation*

Seasonal adjustment of the adjusted monetary base and adjusted total reserves follows the procedure outlined in Anderson and Rasche (1999). We do not revisit figures prior to 1950 because our revisions to RAM(1935), RAM(1972) and RAM(1975) do not change the seasonal variation of the adjusted monetary base. In our final “seasonally adjusted” series, we include figures for 1918–1932 based on the seasonal patterns identified in Anderson and Rasche (1999) and, as in that article, include for 1933-1949 the seasonally unadjusted figures.<sup>23</sup>

For the period beginning January 1950, we seasonally adjust the adjusted monetary base and adjusted reserves in a two-step procedure using the Bureau of the Census X-12 seasonal adjustment software. The Census X-12 software package consists of two components. The first component is a flexible Box-Jenkins ARIMA modeling package, while the second component is an enhanced version of the classic Census X-11 seasonal-factor estimation program.

In our first step, we develop an ARIMA model with intervention terms. The X-12 software permits a variety of flexible intervention terms, as shown in the first section of Table 3. Some of the terms are simple 0-1 dummy variables while others, such as the “ramp” and “temporary change” adjustment, are more complex.<sup>24</sup> The fitted model’s intervention terms are used to remove outliers from the data prior to estimation of seasonal factors via the enhanced X-11

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<sup>23</sup> For adjusted reserves, this Bank had not previously published figures prior to 1947. In our seasonal adjustment, results for reserves are similar to those for the monetary base: 1918-1932 display relatively regular patterns and 1933-1949 display noisy indistinct patterns. The X-11 algorithm calculates seasonal factors for 1933-1949 but the unusual size of the factors causes them to fail diagnostic tests; we interpret that failure as indicating a pattern too unstable to be accurately estimated. For 1933-1949, we set seasonal adjustment factors to 1.0 for both the adjusted monetary base and adjusted reserves. Although time-series charts suggest that a regular seasonal pattern might have returned to reserves in 1946, we choose to begin estimation at the same time as the adjusted monetary base, in 1950. Readers who disagree should feel free to estimate their own seasonal factors!

<sup>24</sup> The “ramp” intervention term fits a straight line segment between two points. The “temporary change” term permits an immediate shift in the series followed by decay back to the initial level. The shapes of X-12 intervention variables are discussed in Findley et.al. (1998), which also discusses issues related to test-size and critical values for the sequential testing of non-nested alternative intervention terms. Estimation in X-12 is by exact maximum likelihood.

routines. In addition, the fitted model is used to forecast the series 24 months into the future prior to estimation via X-11.<sup>25</sup> In the second step, we use the X-11 algorithms to estimate seasonal-adjustment factors from the outlier-adjusted data. Our final estimated ARIMA models are shown in Table 3. The estimated seasonal factors are shown in Figure 1.

We focus special attention on two recent periods. The first, during late 1999 and early 2000, is due to the Y2K buildup of precautionary currency holdings. The second, during September 2001, is due to interruptions in the payments system following the New York City terrorist attacks. For the first, we include two ramp intervention terms in the ARIMA models for the adjusted monetary base and for adjusted reserves; one spans August to December 1999, and other spans December 1999 to February 2000.<sup>26</sup> For September 11, 2001, we include an additive outlier in the model for the adjusted monetary base (other intervention terms were rejected), and both a temporary change (for September) and a level shift (October) in the model for reserves. These variables, confirmed by the statistical results, are suggested by time-series plots of total reserves and of the ratio of reserves to transaction deposits (not shown here) which suggest that banks' aggregate holdings of base money increased and remained at an elevated level after September 11, 2001.

In addition to our a priori variables, we allowed the automatic model selection algorithms in the X-12 package to suggest additional intervention variables. The algorithms added seven intervention terms to the model for the monetary base (three of which are related to Y2K and

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<sup>25</sup> The X-11 algorithms are two-sided moving-average filters. Extensive research has shown that the quality of estimated seasonal adjustment factors for most economic time series is improved if the time series is extended forward prior to estimation via X-11 so as to avoid folding the X-11 filters at the end of the series. The ARIMA model forecasts are used for no other purpose. Most often, such forecasts for X-11 estimation are produced by an ARIMA model because the family of data-generating processes for which X-11 provides accurate estimates of the seasonal patterns is the same family for which a Box-Jenkins ARIMA model can closely approximate the data generating process.

<sup>26</sup> Although our two ramp adjustments resemble a linear spline, we do not force the end of first segment to be attached to the beginning of the second segment.

September 11, 2001) and 21 terms to the model for adjusted reserves (including three related to Y2K and September 11, 2001). The large number of intervention terms selected for the reserves model likely reflects its relatively higher volatility. For both series, the final ARIMA model contains a seasonal and nonseasonal difference, a nonseasonal AR polynomial, and a seasonal MA polynomial. The reserves model also contains a nonseasonal MA polynomial.<sup>27</sup>

Seasonal-adjustment factors for biweekly (reserve maintenance period) data, beginning February 1984, are obtained by an iterative 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 for historical data.<sup>28</sup>

### ***Extrapolations of RAM(1991) After A Benchmark***

Observations on the adjusted monetary base and adjusted reserves beginning January 1994 include the variant of RAM(1991) developed in Anderson and Rasche (2001) which interprets a bank's implementation of a retail-deposit sweep program as economically equivalent to a reduction in the bank's statutory reserve requirements.<sup>29</sup> The Anderson-Rasche variant of RAM(1991) must be estimated from panel data on individual banks because each bank has

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<sup>27</sup> In our estimation, we do not include variables for the shift from lagged to near-contemporaneous reserve accounting in February 1984, and from contemporaneous to lagged reserve accounting in July 1998.

<sup>28</sup> For future periods, we project separately the future monthly and biweekly seasonal adjustment factors.

<sup>29</sup> In a retail-deposit sweep program, a bank, subject to certain restrictions, moves customer funds from transaction deposits, subject to reserve-requirement ratios as high as 10 percent, into savings deposits, subject to a zero reserve-requirement ratio. Because customers generally are unaware of these reclassifications and likely share little, if any, of the bank's cost savings, the economic effect of such retail-deposit sweep programs closely resembles a change in the bank's statutory reserve requirements. On the latter, see also Anderson (2002).

complete discretion regarding when [and if] to implement a retail-deposit sweep program, as well as the intensity with which it sweeps transaction deposits. An important finding of Anderson and Rasche (1991) is that many banks, previously constrained by statutory reserve requirements, have been able via retail-deposit sweep programs to reduce their level of statutory required reserves below the amount of base money (vault cash plus deposits at Federal Reserve Banks) that they must hold for use in their normal day-to-day business. For these banks, the correct size of the RAM adjustment is smaller than the decrease in the bank's required reserves. Hence, updating RAM(1991) requires identifying sweeping banks and estimating the size of the effect of the sweep activity on each bank's holdings of base money. As a result, it is costly to update RAM(1991) frequently and, between benchmarks, published values must be constructed from aggregate figures.

The Anderson-Rasche (2001) analysis separates banks into three categories, based on whether or not they have a retail-deposit sweep program and whether or not, during any specific period  $t$ , they are constrained by statutory reserve requirements, that is, whether the partial derivative of the bank's base-money demand function with respect to the statutory reserve requirement ratio is greater than zero.<sup>30</sup> In that analysis, banks that are constrained by statutory reserve requirements are referred to as *economically bound*, or *e-bound*, and banks not so-constrained as *economically nonbound*, or *e-nonbound*. Being e-bound or e-nonbound is not an absorbing state, that is, individual banks can and do move between categories within the sample.

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<sup>30</sup> For a bank to be included in our panel dataset, it must have been constrained by reserve requirements during at least one reserve maintenance period between the beginning of 1991 and the end of 2001. Hence, to be unconstrained during a specific period  $t$ , some circumstance that affects the bank must have changed. An appropriate measure of RAM ignores all such changes except changes in statutory reserve requirements. The four categories mentioned in the text are implemented in our analysis via two time-series indicator variables, one marking the presence or absence of a retail-deposit sweep program and the other whether, in our judgment, the bank is constrained by statutory reserve requirements. For further discussion of the creation of these indicator variables, see Anderson and Rasche (2001).

1. For banks that are e-nonbound during period  $t$  and do not have a retail-deposit sweep program,  $RAM(1991)_t = 0$ . (Note that, prior to implementing their sweep program, many of these banks were e-bound, and fell within category 3 below.)

2. For a bank that during period  $t$  *does* have a retail-deposit sweep program and became economically nonbound as a *result* of implementing that program,

$RAM(1991)_t = RR_{t_0, 9Jan1991} - MB_{t_0}^*$ , where  $t_0$  is the implementation date (reserve maintenance period) of the sweep program,  $RR_{t_0, 9Jan1991}$  is an estimate of the bank's required reserves during period  $t_0$  if the reserve-requirement regime of the reserve maintenance period ending January 9, 1991, had been in effect (calculated using the sum of the bank's reported net transaction deposits plus our estimate of the amount of net transaction deposits reclassified as saving deposits via the retail-deposit sweep program), and  $MB_{t_0}^*$  is an estimate of the amount of base money that would have been held by the bank if it were at the margin between being e-bound and e-nonbound. Note that the RAM adjustment for these banks is a constant amount after date  $t_0$  unless there is a material change in the character of the bank such as discontinuing the sweep program or participating in a merger.

3. For an e-bound bank, with or without a retail-deposit sweep program,

$RAM(1991)_t = RR_{t, 9Jan1991} - RR_t$ . In our panel, not every bank that implements a retail-deposit sweep program becomes e-nonbound. Some banks, for whatever reason, do not sweep enough deposits to fully remove the constraining effects of statutory reserve requirements on their balance sheets. As in category 2, the counterfactual  $RR_{t, 9Jan1991}$  is calculated using the sum of reported net transaction deposits plus our estimate of the amount of net transaction deposits reclassified as saving deposits via the retail-deposit sweep program.

To extend RAM(1991) forward beyond the benchmark reserve maintenance period,  $b$ , (here, the period ending September 30, 2002), note that, as of the benchmark period, the RAM values for banks in the first two categories are constants, either zero or positive numbers. Hence, we carry forward to future periods the aggregate of these constants, denoted  $A_0$ . Then, because all banks in the third category have net transaction deposits greater than the low-reserve tranche, aggregate RAM as of the benchmark period may be written as the sum of a constant, plus 12 percent of the aggregate net transaction deposits at e-bound banks (those banks in category 3), minus the aggregate required reserves of e-bound banks:

$$\begin{aligned} RAM(1991)_b & \\ &= A_{0,b} + 0.12 * (D_b - N * Tranche) + 0.03 * N * (Tranche - Exemption) - RR_b \\ &= A_{1,b} + 0.12 * D_b - RR_b \end{aligned}$$

where  $N$  denotes the number of e-bound banks,  $D_{30Sep2002}$  their aggregate net transaction deposits (including deposits involved in retail-deposit sweep programs),  $RR_b$  their total required reserves, and  $Tranche$  and  $Exemption$  are the low-reserve tranche and reserve-exemption amount, respectively, during the base period (the reserve maintenance period ending January 9, 1991).<sup>31</sup> Then, in the absence of figures on individual banks, we extend  $RAM(1991)_t$  forward, for periods  $t > 2001:12:26$ , via the equation

$$RAM(1991)_t = A_{1,b} + 0.12 * \delta_D * AggD_t - \delta_R * AggRR_t,$$

where  $AggD_t$  is the transaction-deposit component of M1 (demand deposits, not seasonally adjusted, plus other checkable deposits, not seasonally adjusted);  $AggRR_t$  is aggregate required

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<sup>31</sup> The low-reserve tranche and reserve-exemption amounts are subject to statutory reserve-requirement ratios of three and zero percent, respectively. For the reserve maintenance period ending January 9, 1991) the low-reserve tranche was \$41.1 million and the reserve-exemption amount was \$3.4 million. For the benchmark reserve maintenance period ending September 30, 2002, the amounts were \$42.8 million and \$5.5 million.

reserves at all banks;  $\delta_D = \frac{D_b}{\text{Agg}D_b}$ , where  $D_b$  is the transaction deposits of e-bound banks during

the benchmark reserve maintenance period; and  $\delta_R = \frac{RR_b}{\text{Agg}RR_b}$ , where  $RR_b$  is the required

reserves of e-bound banks during the benchmark period. During the benchmark reserve maintenance period in this analysis, ending September 30, 2002,  $\delta_D = 0.192$  and  $\delta_R = 0.095$ .

### ***The Revised and Previous Adjusted Monetary Base***

Differences between our revised series and previously published figures are shown, for the monetary base and adjusted reserves, respectively, in Figures 2 and 3.<sup>32</sup> For clarity, the time series are separated into three segments—1936–1958, 1959–1979, and 1980–2002. Note that the vertical scales differ.<sup>33</sup> In each figure, the first set of panels, A., compare the level of the series, and the second set of panels, B., compare the compound annual growth rate.

Overall, the revised and current levels for the adjusted monetary base and adjusted reserves (panels A) are relatively close until the acceleration of retail deposit sweep programs during April 1995. During 1936-1968, the major issue is correction of the timing error in RAM(1935), a correction that primarily affects pairs of adjacent months. For reserves, the revision due to this change sometimes is as large as 10 percent of the level. Spikes in the difference between the levels of the revised and current series are apparent in late 1972 (positive) and late 1975 (negative), due to our corrections to RAM(1972) and RAM(1975). With respect to growth rates (panels B), the corrections to RAM(1935) cause a large revisions to some monthly growth rates during 1936–7, late 1941, and late 1961. (Once again, note differences in vertical scale.)

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<sup>32</sup> The “previous” figures are as published on FRED, <research.stlouisfed.org>, on July 13, 2003. Note that adjusted reserves on FRED previously began in 1947.

<sup>33</sup> Adjusted monetary base figures are not shown prior to 1936 because these figures did not change. Also, no “previous” series is shown for adjusted reserves because figures were not published for dates prior to

## ***Summary***

This analysis has summarized the results of an extensive reconstruction of the Federal Reserve Bank of St. Louis adjusted monetary base and adjusted reserves. Minor revisions have been made to the monetary (source) base such that it is now measured for all periods, as closely as is feasible, as an average of daily figures. More important corrections have been made to three segments of the RAM adjustment to correct timing and normalization errors. A fourth segment, beginning in 1980, has been updated with new figures beginning 1991. Seasonal adjustment factors also have been updated.

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Table 1: The Five Segments of the Reserve Adjustment Magnitude

Date Span	Date of Base Period Statutory Reserve Requirements	Description
RAM(1922): Aug. 1917–Aug. 1935	July 1922	On July 1, 1922, St. Louis was classified as a reserve city, rather than central reserve city. This reduced the reserve requirement ratio on net demand deposits at larger St. Louis banks to 10 percent from 13 percent.
RAM(1935): Sept 1935–Dec 1972	September 1935	In August 1935, the Banking Act of 1935 imposed on U.S. government demand deposits the same reserve requirement as applied to private demand deposits. The act also changed the definition of net demand deposits subject to reserve requirements so as to allow deductions of certain items against all demand deposits rather than just deposits due to banks. During August 1935, the changes increased required reserves by approximately \$35 million relative to their amount using the July 1922 requirements.
RAM(1972): Dec 1972–Jan 1975	December 1972	Net demand deposits became subject to a graduated (tiered) system of requirements. Previous categories of central reserve city, reserve city and country bank were eliminated.
RAM(1975): Jan 1975–Oct 1980	January 1975	Time deposits became subject to a graduated system of requirements that also depended on deposits' maturity.
RAM(1991): Nov 1980–date	January 1991	Effective November 1980, the Monetary Control Act substantially changed the reserve requirement system. In December 1990, time and savings deposits became subject to a zero reserve requirement.

Table 2: Supplemental and Marginal Reserve Requirements 1969–1980

Date	Change in Requirements
October 1969- August 1978	<p>Effective with the reserve maintenance period beginning October 16, 1969, member banks were required (Federal Reserve Regulation M) to maintain reserves on net Eurocurrency liabilities, that is, the sum of balances due to their related foreign offices and plus certain loans by related foreign branches to U.S. residents and (Regulation D) on borrowings by domestic banking offices from foreign banks</p> <p>Ratios:</p> <ul style="list-style-type: none"> <li>- originally, 10 percent;</li> <li>- increased to 20 percent, Jan. 7, 1971;</li> <li>- reduced to 8 percent, June 21, 1973;</li> <li>- reduced to 4 percent, May 22, 1975;</li> <li>- reduced to 0, Aug. 24, 1978.</li> </ul> <p>Originally, the requirements applied only above a reserve-free base amount. The base amount for loans by related foreign offices to U.S. residents was eliminated on June 21, 1973, and the other base amounts were gradually phased out by Mar. 14, 1974 (thereby increasing the total requirement). Smaller loans and loans at banks with smaller aggregate amounts were excluded.</p>
June 1973- December 1974	<p>“From June 21, 1973, through Dec. 11, 1974, member banks, except as noted below, were subject to a marginal reserve requirement against increases in the aggregate of the following types of obligations: (a) outstanding time deposits of \$100,000 or more, (b) outstanding funds obtained by the bank through issuance by a bank’s affiliate of obligations subject to the existing reserve requirements on time deposits, and (c) beginning July 12, 1973, funds from sales of finance bills. For the period June 21 through August 24, 1973, (a) included only single-maturity time deposits. The requirement applied to balances above a specified base, but was not applicable to banks having obligations of these types aggregating less than \$10 million. Including the basic requirement (5 per cent during the entire period), requirements were: 8 per cent for (a) and (b) from June 21 through Oct. 3, 1973, and for (c) from July 12 through Oct. 3, 1973; 11 per cent from October 4 through Dec 26, 1973; and 8 per cent from Dec. 27, 1973, through Sept. 18, 1974. Beginning Sept. 19, the 8 per cent requirement applied to only those obligations in (a), (b) and (c) with initial maturities of less than 120 days, and effective Dec 12, 1974, the remaining marginal reserve on this type of obligation issued to mature in less than 4 months was removed.” (Federal Reserve Board <i>Annual Report</i> for 1976, Table 13).</p>
August 1978	<p>For the maintenance period beginning August 24, 1978:</p> <ul style="list-style-type: none"> <li>• Reduction to 0 percent from 4 percent on net Eurocurrency liabilities of domestic banks to own foreign branches.</li> <li>• Reduction to 0 percent from 1 percent on deposits that foreign branches of domestic banks lend to U.S. residents.</li> <li>• Reduction to 0 percent from 4 percent on borrowings of domestic banks from unrelated banks abroad.</li> </ul>

November 1978	Effective with the maintenance period beginning November 2, 1978, impose a 2 percent supplementary reserve requirement on time deposits of \$100,000 or more, obligations of affiliates, and ineligible acceptances.
November 1978	Effective with the maintenance period beginning November 16, 1978, domestic deposits of Edge corporations became subject to the same reserve requirements as deposits of member banks. Previously, all deposits of Edge corporations were subject to a 10 percent requirement.
October 1979:	<p>Effective for member banks with the maintenance period beginning October 25, 1979 and for U.S. agencies and branches of foreign banks for the period beginning November 8, 1979 (note that the latter institutions previously did not hold deposits at the Federal Reserve), an 8 percent marginal reserve requirement on increases, above a base amount, in “managed liabilities” at member banks, Edge corporations, and U.S. agencies and branches of foreign banks. These liabilities are those that were actively being used to finance rapid expansion in bank credit, including large time deposits with maturity of less than a year, Eurodollar borrowings, repurchase agreements against U.S. government and federal agency securities, and federal funds borrowings from nonmember institutions.</p> <p>Following this change, the total reserve requirement for large time deposits included a basic requirement of 1 to 6 percent depending on maturity, plus a 2 percent supplemental reserve requirement (November 1978), plus an 8 percent marginal requirement.</p> <p>For Eurodollar borrowings, loans made by foreign offices of member banks to U.S. residents, and to assets sold by member banks, Edge corporations, and U.S. branches and agencies to related foreign offices, the marginal requirement increased to 8 percent from zero.</p> <p>For repurchase agreements against U.S. government and federal agency securities, the marginal requirement increased to 8 percent from zero.</p>
April 1980:	Effective with the maintenance period beginning April 3, 1980, the marginal reserve requirement ratio, as implemented October 1979, was increased to 10 percent from 8 percent.
June 1980:	Effective with the maintenance period beginning June 12, 1980, the marginal reserve requirement ratio, as implemented October 1979, was reduced to 5 percent from 10 percent.
July 1980	Effective with the maintenance period beginning July 24, 1980, the marginal reserve requirement ratio, as implemented October 1979, was reduced to 0 percent from 5 percent, and the supplementary reserve requirement on large time deposits, implemented November 1978, was reduced to 0 from 2 percent.

Source: Compiled by the authors from the *Federal Reserve Bulletin* (various issues), and the *Annual Reports* of the Board of Governors of the Federal Reserve System (various issues).

Table 3

ARIMA Models Used in Seasonal Adjustment  
of the Adjusted Monetary Base and Adjusted Reserves  
(Estimation Period January 1950–December 2001)

*Intervention Variables used in ARIMA Models*

(AO) Additive Outlier at date $t_0$	$AO_t^{(t_0)} = \begin{cases} 1 & \text{for } t = t_0 \\ 0 & \text{for } t \neq t_0 \end{cases}$
(LS) Level Shift at date $t_0$	$LS_t^{(t_0)} = \begin{cases} -1 & \text{for } t < t_0 \\ 0 & \text{for } t \geq t_0 \end{cases}$
(TC) Temporary Change at date $t_0$ , with decay at rate $\alpha$ back to the previous level ( $0 < \alpha < 1$ )	$TC_t^{(t_0)} = \begin{cases} 0 & \text{for } t < t_0 \\ \alpha^{t-t_0} & \text{for } t \geq t_0 \end{cases}$
(RP) Ramp between date $t_0$ and date $t_1$	$RP_t^{(t_0, t_1)} = \begin{cases} -1 & \text{for } t \leq t_0 \\ (t-t_0)/(t_1-t_0) & \text{for } t_0 < t < t_1 \\ 0 & \text{for } t \geq t_1 \end{cases}$

A. Model for the Adjusted Monetary Base

$$(1 - \phi_1 B^3 - \phi_2 B^6 - \phi_3 B^9)(1 - B^{12})(1 - B)AMB_t = C + \sum_j I_{j,t} + (1 + \theta B^{12})\varepsilon_t$$

Intervention Variables (I)	Parameter Estimate	Standard Error
Constant	0.0001	0.00292
TC1981.Jan	-0.0104	0.00236
RP1999.Sep-1999.Dec	0.0143	0.000010
TC1999.Dec	0.0193	0.00387
RP1999.Dec-2000.Feb	-0.0249	0.00281
TC2000.Jan	0.0133	0.00347
TC2001.Sep	0.0347	0.00327
TC1952.Apr	-0.0103	0.00297
AO1954.Jan	0.0080	0.00229
AO1975.May	-0.0091	0.00227
$\phi_1$	0.2247	0.04059
$\phi_2$	0.1890	0.04152
$\phi_3$	0.0489	0.04096
$\theta$	0.6672	0.03090

B. Adjusted Reserves

$$(1 - \phi_1 B^3 - \phi_2 B^6)(1 - B^{12})(1 - B)AMB_t = C + \sum_j I_{j,t} + (1 + \theta_1 B)(1 + \theta_2 B^{12})\varepsilon_t$$

Intervention Variables (I)	Parameter Estimate	Standard Error
Constant	0.0001	0.00292
Rp1999.Sep-1999.Dec	0.0886	0.00467
Rp1999.Dec-2000.Meb	-0.1257	0.00547
AO1951.Apr	0.0282	0.00797
LS1980.Dec	-0.375	0.00866
LS1982.Mar	-0.333	0.00866
TC1982.Jul	-0.0304	0.00836
LS1984.Aug	-0.0316	0.00866
AO1985.Dec	0.0426	0.00776
AO1986.Feb	-0.0259	0.00774
LS1986.June	0.0318	0.00879
TC1986.Nov	0.0314	0.00842
LS1986.Dec	0.0515	0.00879
AO1987.May	0.0326	0.00778
LS1989.Feb	-0.0522	0.00951
TC1989.Mar	0.0364	0.00917
AO1990.Feb	-0.0350	0.00784
AO1990.Dec	0.032	0.00783
AO1991.Dec	0.0322	0.00795
LS1992.Mar	0.0427	0.00890
LS1992.Sep	0.0347	0.00870
AO1999.Sep	0.0407	0.00895
TC2001.Sep	0.2086	0.00980
LS2001.Oct	-0.0705	0.0100
$\phi_1$	0.2159	0.04152
$\phi_2$	0.1305	0.04046
$\theta_1$	0.3867	0.03828
$\theta_2$	0.6104	0.03294

## Appendix: Data Sources and Calculation of the Source Base and RAM

### *The Monetary (Source) Base*

The FRB St. Louis monetary (source) base is defined as those liabilities of the monetary authorities (U.S. Treasury and the Federal Reserve) that (1) the nonbank public uses as media of exchange and (2) depository institutions use to satisfy statutory reserve requirements and/or to settle interbank debts (such as clearing checks or transferring funds by wire).

We measure the monetary base, monthly and biweekly, as the average daily level of (1) currency in circulation outside the Treasury and Federal Reserve Banks, plus (2) the deposits held by depository institutions at the Federal Reserve Banks. Monthly observations on the FRB St. Louis monetary base are available beginning December 1917, and biweekly observations are available beginning with the reserve maintenance period that ended February 15, 1984. (This is the first two-week “reserve maintenance period” under the system of statutory reserve requirements adopted by the Board of Governors as of February 2, 1984.)

**Currency in Circulation:** For monthly figures, our sources are:

- December 1917–December 1958: Figures through 1941 are from *Banking and Monetary Statistics 1914–1941* (1943, reprinted 1976), Table 101, pp. 369–371, the column labeled “Money in circulation.” Later figures are from *Banking and Monetary Statistics 1941–1970* (1976), Table 10.1B, pp. 526–535, the column labeled “Currency in circulation.”
- January 1959–date: internal Board of Governors database. These figures, except for very small infrequent revisions, are the same as those published in *Banking and Monetary Statistics 1941–1970* (above), various issues of the *Annual Statistical Digest*, the Board of Governors H.4.1 release (<http://www.federalreserve.gov/releases/h41/>), and the *Federal Reserve Bulletin* (ref. Table 1.11, page A5, line 17, January 2003).

For biweekly figures, we use arithmetic averages of weekly averages of daily figures. For weekly figures beginning February 1984, our sources are:

- Weeks ending February 15, 1984–December 26, 1984: *Annual Statistical Digest 1984* (Board of Governors, October 1985), Table 2.B., pp. 7–9, line 15, “Currency in circulation.”
- Weeks ending January 2, 1985–December 25, 1985: *Annual Statistical Digest 1985* (Board of Governors, October 1986), Table 2.B., pp. 7–9, line 15, “Currency in circulation.”
- January 1986–date: Board of Governors’ H.4.1 database. These figures are those published in various issues of the *Annual Statistical Digest*, the Board of Governors H.4.1 release <<http://www.federalreserve.gov/releases/h41/>>, and the *Federal Reserve Bulletin* (ref. Table 1.11, page A5, line 17, January 2003).

**Federal Reserve Bank Deposits:** Although the Board of Governors has collected daily balance-sheet figures from each Reserve Bank since the beginning of the System, the Board has not, and does not, publish monthly or weekly averages of these figures.<sup>34</sup> Rather, only Wednesday and end-of-month figures are published. Ideally, if these figures were available, we would measure

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<sup>34</sup> The report that collects these daily figures is referred to within the Federal Reserve as the FR34 report. Wednesday and end-of-month figures are published as the condition statement of the Federal Reserve Banks (ref. Table 1.18, page A10, *Federal Reserve Bulletin*, January 2003).

the monetary base as period averages of the deposits of depository institutions at the Reserve Banks (ref. line 25, table 1.18, page A10, *Federal Reserve Bulletin*, January 2003). Instead, we measure the monetary base by the sum of “reserve balances at the Reserve Banks” (ref. table 1.11, page A5, line 25, *Federal Reserve Bulletin*) plus, beginning August 1981, “service-related balances and adjustments” (ref. table 1.11, page A5, line 22, *Federal Reserve Bulletin*). From an accounting viewpoint, the latter item was zero prior to implementation of the Monetary Control Act in November 1980 and, hence, reserve balances differed from member bank deposits at the Federal Reserve only by a variety of accounting adjustments related to check processing and other financial services. We acknowledge that for some early years this measure omits certain small deposit amounts at held at the Reserve Banks by nonmember institutions for settling interbank payments (as described by Friedman and Schwartz, 1963, p. 763). Beginning August 1981 with the first published figures on service-related balances, in the *Annual Statistical Digest*, reserve balances excludes an amount of deposits at the Federal Reserve equal to the nominal amount of depository institutions’ required clearing balance contracts; for details, see Anderson and Rasche (1994).

The first published monthly average figures for member bank reserves are for August 1917. The St. Louis measures of adjusted monetary base and adjusted reserves begin in December 1917 because that is the first month for which deposit figures permit calculation of RAM.

For monthly figures, our sources are:

- December 1917–December 1970: Figures through 1941 are from *Banking and Monetary Statistics 1914–1941* (1943), Table 101, pp. 369–371, the column labeled “Member bank reserve balances, Total.” Later figures are from *Banking and Monetary Statistics 1941–1970* (1976), Table 10.1B, pp. 526–529, the column labeled “Member bank reserves, Total,” and pp. 530–535, the column labeled “Member bank reserves, With F.R. Banks.” Except for small accounting adjustments, these figures equal the deposits held by member banks at Federal Reserve Banks. So far as we are aware, these volumes are the only source for monthly averages of daily deposits at the Federal Reserve Banks.
- January 1970–December 1979: *Annual Statistical Digest 1970–1979* (Board of Governors, March 1981), Table 2.A., pp. 10–15, row 21, “Member bank reserves with Federal Reserve Banks.”
- January 1980–December 1989: *Annual Statistical Digest 1980–1989* (Board of Governors, 1991), Table 2.A., pp. 11-20, the sum of line 23 “Reserve balances with Federal Reserve Banks,” plus line 19, “Service-related balances and adjustments,” plus line 21, “Required clearing balances.” Note that the required-clearing balance figures reported 1981–1983 include adjustments, that is, although not labeled as such, the figures are the sum of service-related balances and adjustments.
- January 1990–December 1990: *Annual Statistical Digest 1990–1995* (Board of Governors, November 1996), Table 2, p. 7, the sum of line 22 “Reserve balances with Federal Reserve Banks” and line 19, “Service-related balances and adjustments.”
- January 1991–date: Board of Governors’ H.4.1 database. The sum of reserve balances plus service-related balances and adjustments. The figures are those published on the Board’s H.4.1 release and in table 1.18 of the *Federal Reserve Bulletin*.
- For biweekly figures, our sources are the *Annual Statistical Digests* from 1984 through 1990, and the Board of Governors’s H.4.1 database thereafter. Where necessary, biweekly figures are arithmetic averages of weekly figures.

### *The Reserve Adjustment Magnitude (RAM)*

- *December 1917–August 1935*: During this period, the primary change to the Federal Reserve’s statutory reserve requirements was the reclassification in 1922 of St. Louis from a central reserve city to a reserve city. This change had been proposed by large St. Louis banks to reduce their required reserves. Our RAM calculation is based on figures from the *Federal Reserve Bulletin* regarding net demand deposits at weekly reporting member banks in the city of St. Louis. A second major change in reserve requirements occurred in August 1935 when the Banking Act of 1935 changed the calculation (definition) of net demand deposits and made U.S. government deposits subject to the same reserve requirements as applied to private deposits. For further details, see Anderson and Rasche (1999).
- *August 1935–August 1968*: Reserve requirements changed little during this period prior to 1966. Through June 1966, separate reserve-requirement ratios applied to net demand deposits classified by location (central reserve city, reserve city, and country), and a single ratio applied to all time (including saving) deposits. Beginning July 1966, the reserve-requirement distinction between central reserve city and reserve city banks was discontinued. In addition, time deposits became subject to reserve-requirement ratios that differed based on a bank’s aggregate time deposits. Our RAM construction uses deposit figures and reserve-requirement ratios from Tables 10.3 and 10.4 in *Banking and Monetary Statistics 1941-1970*. Beginning July 1966, for time deposits, use unpublished figures from the archives of the St. Louis Fed’s Research division.<sup>35</sup> We measure  $RAM^{deposits}$  as the difference between a counterfactual required-reserve figure calculated from the *BMS* deposit figures and the reserve requirement regime in effect during September 1935, minus the level of required reserves that we calculate from the *BMS* deposit figures.<sup>36</sup> Note that  $RAM_{1935}^{deposits}$  is zero for August 1935–July 1936. For all months in this segment,  $RAM_{1935}^{other}$  is equal to zero.
- *September 1968–December 1972*: Beginning September 12, 1968, banks’ weekly required reserves were computed on the basis of average daily deposits held two weeks earlier. In our calculation of  $RAM_{1935}^{deposits}$ , we apply the 1935 reserve-requirement ratios to monthly averages of lagged weekly deposits even though the 1935 regime (our “base period” for RAM) has contemporaneous requirements. Our monthly average figures for deposits subject to reserve requirements are pro rata averages of (lagged) weekly deposit figures from the Board of Governor’s J.1 and H.7 statistical release, supplemented by data from the archives of the St. Louis Fed’s research division.
- *December 1972–January 1975*: Beginning November 9, 1972, the reserve-requirement distinction for demand deposits between reserve city and country banks was removed. In its

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<sup>35</sup> Different requirement ratios applied to a bank’s total time (and savings) deposits under \$5 million and over \$5 million. Aggregate time deposits in these categories, aggregated across banks, are unpublished figures.

<sup>36</sup> From January 1936 through December 1967, our calculated required-reserve figures differ from the *BMS* published figures by no more than two or three thousand dollars except for June 1966. In that month, the published and calculated values are \$22.212 billion and \$22.201 billion, respectively. We use the calculated values in measuring RAM. The Board of Governors has published revised total required reserves

place, demand deposits became subject to a system of tiered, graduated requirements. On the same date, the system of graduated requirements on time deposits was extended such that the applicable ratios varied both with the bank's aggregate time-deposit liabilities and with the remaining time to maturity of each deposit.<sup>37</sup> During this period, the Board of Governors expanded its practice of imposing special and marginal reserve requirements (see Table 1).<sup>38</sup> Our monthly deposit figures, constructed as pro rata averages of lagged weekly figures, are from the archives of the St. Louis Fed's research division. For the part of required reserves that may be calculated from aggregate monthly deposit figures,  $RAM_{1972}^{deposits}$  varies from zero (the value for each month from December 1972 through June 1973) to a low of -\$715 million in January 1974, with a mean value of -\$421 million. For the remainder of required reserves (largely, due to special and marginal reserve requirements),  $RAM_{1972}^{other}$  ranges from near zero during the early months of the interval to a low of approximately -\$1.5 billion during August and September 1974. Total RAM peaks at -\$2.2 billion in September 1974, and averages approximately -\$1.1 billion.

- *January 1975–October 1980:* Beginning December 12, 1974, requirements on time deposits were changed such that only reserve-requirement ratios on deposits with remaining time-to-maturity of 30-179 days varied with the amount of the bank's aggregate time-deposit liabilities. As above, monthly average deposit figures are constructed from the archives of the St. Louis Fed's Research division.  $RAM_{1975}^{deposits}$  is positive for all months after January 1975, beginning mid-February's approximately \$1 billion reduction in required reserves, and averages approximately \$2.4 billion. During the early part of the period, through October 1978,  $RAM_{1975}^{other}$  is positive and averages approximately \$225 million. With the imposition of supplementary reserve requirements on large time deposits in November 1978,  $RAM_{1975}^{other}$  becomes sharply negative, averaging -\$2.7 billion during the next 21 months (the requirement was removed in July 1980). Total RAM ranges from a high of \$3.4 billion to a low of -\$1.5 billion, and averages \$1.7 billion over the period.
- *November 1980–September 2002:* During this period, for months prior to January 1991, RAM is unchanged. Beginning January 1991 through December 1993, RAM is an updated version, to incorporate revised data, of that proposed in Anderson and Rasche (1996). Beginning January 1994, RAM is an updated version of the "preferred" RAM adjustment shown as line "1." in Figure 10 of Anderson and Rasche (2001). This adjustment regards a bank's implementation of a retail-deposit sweep program as economically equivalent to a reduction in the applicable reserve-requirement ratio for transaction deposits.<sup>39</sup>

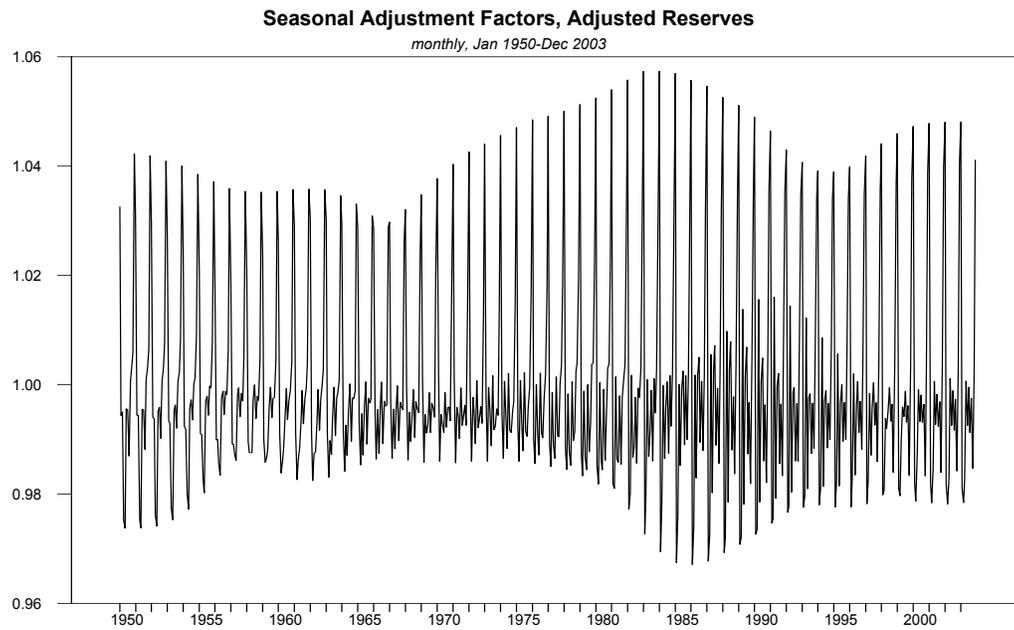
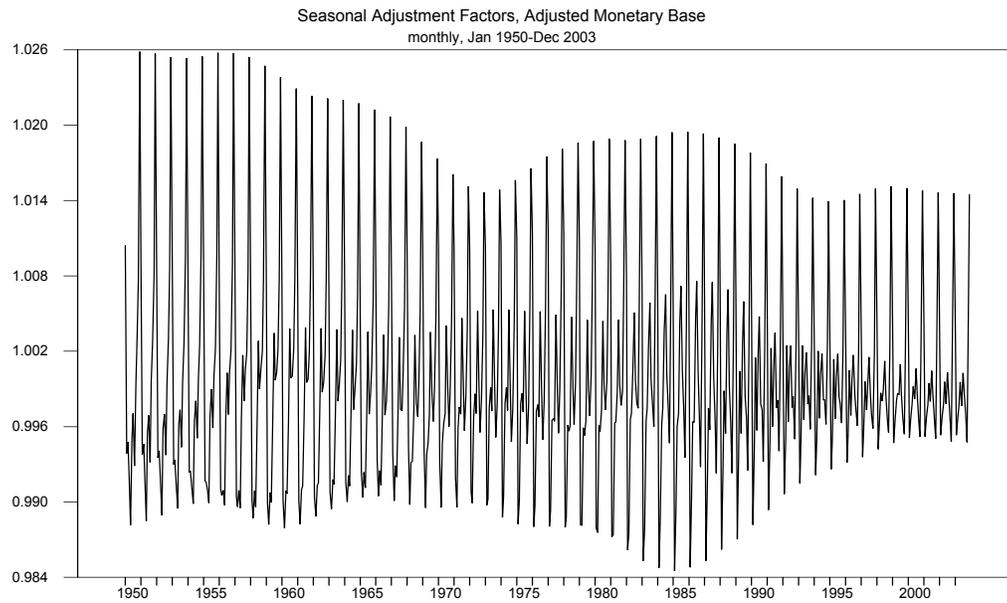
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<sup>37</sup> Burger and Rasche (1977) discuss the impact of these changes on (a previous version of) RAM. Despite the technical change in requirements on time deposits that permitted varying the graduated reserve-requirement ratios by remaining maturity, ratios prior to December 1974 differed only by a bank's aggregate time deposits with a 3 percent ratio applying up to \$5 million, and 5 percent thereafter.

<sup>38</sup> Historically, a supplemental requirement was one imposed on a deposit or other liability that had not previously been subject to a requirement. A "marginal" requirement was a surcharge imposed in addition to a pre-existing regular requirement.

<sup>39</sup> This RAM uses as its base period the reserve-requirement regime that became effective for weekly reporting banks on December 27, 1990 (the reserve maintenance period ending January 7, 1991).

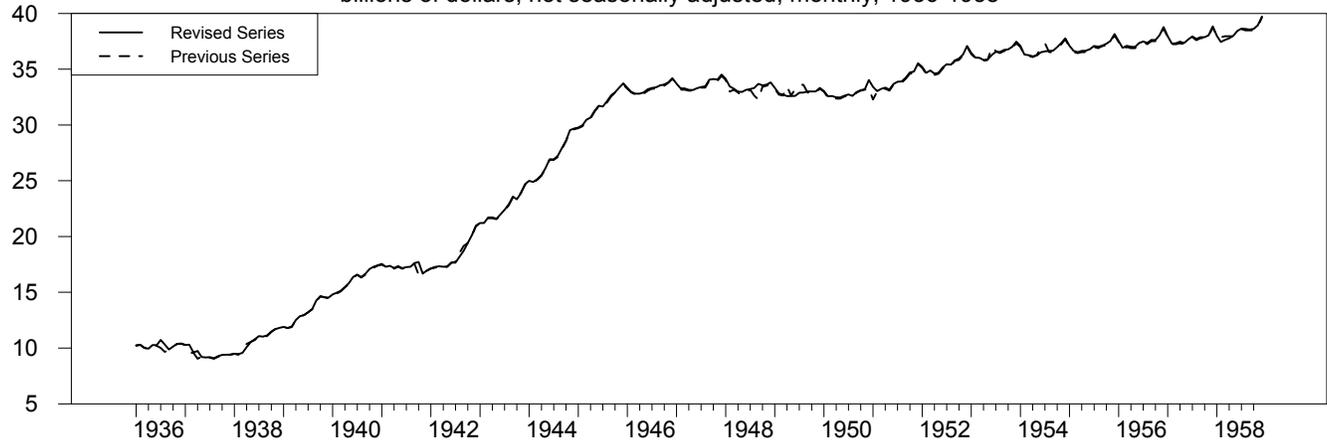
Figure 1: Seasonal Factors for the Adjusted Monetary Base and Adjusted Reserves



# Figure 2: Adjusted Monetary Base, Revised and Previous Series

## A. Levels

billions of dollars, not seasonally adjusted, monthly, 1936-1958



## Revised Series Minus Previous Series

billions of dollars, not seasonally adjusted

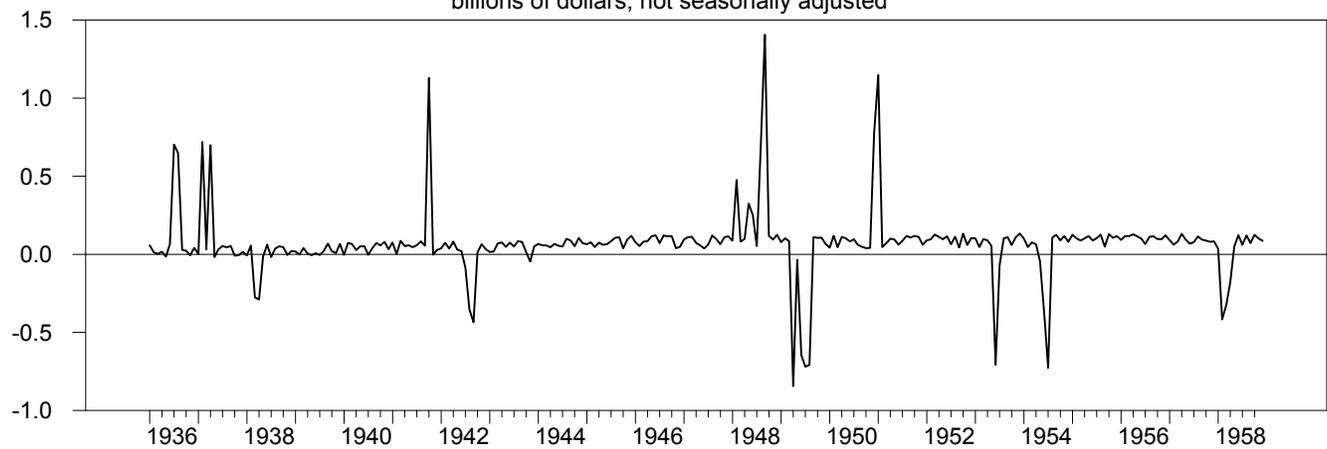
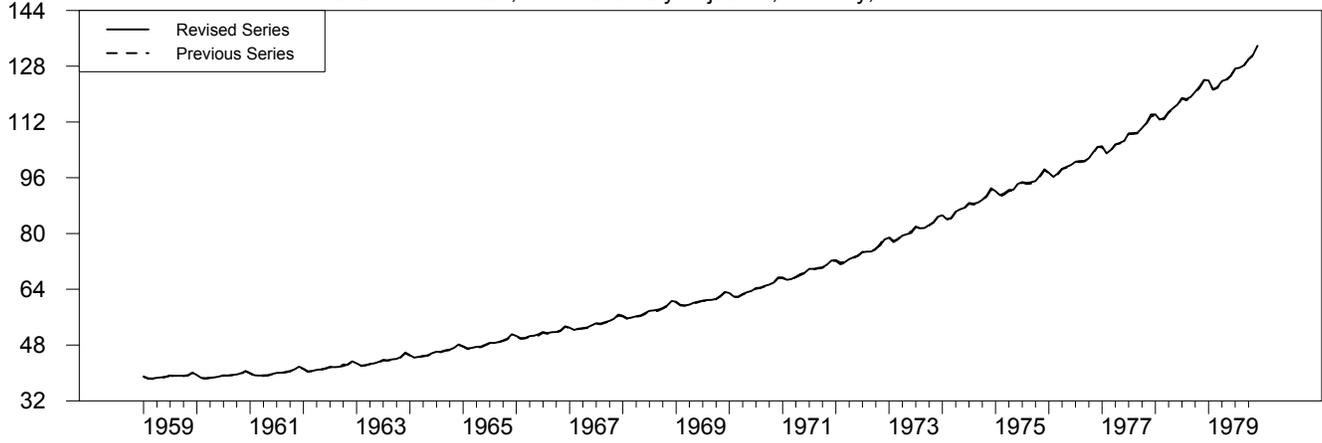


Figure 2: Adjusted Monetary Base, Revised and Previous Series (con't)

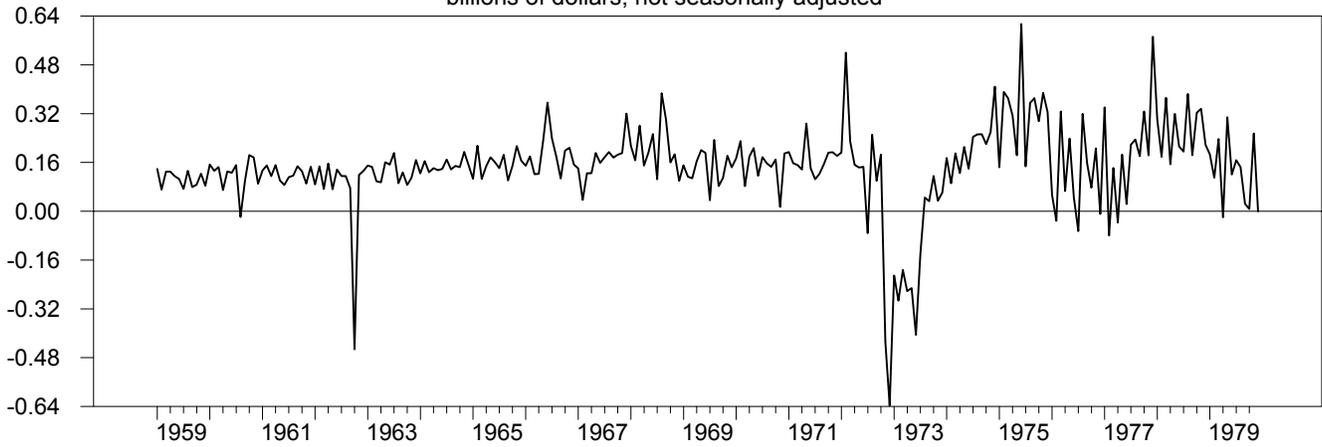
A. Levels (con't)

billions of dollars, not seasonally adjusted, monthly, 1959-1979



Revised Series Minus Previous Series

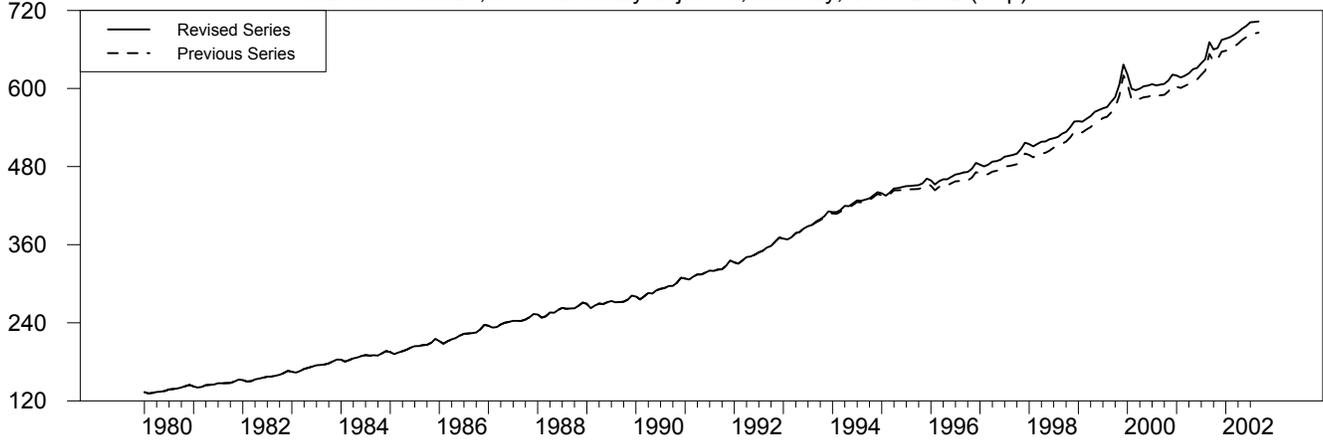
billions of dollars, not seasonally adjusted



# Figure 2: Adjusted Monetary Base, Revised and Previous Series (con't)

## A. Levels (con't)

billions of dollars, not seasonally adjusted, monthly, 1980-2002 (Sep)



## Revised Series Minus Previous Series

billions of dollars, not seasonally adjusted

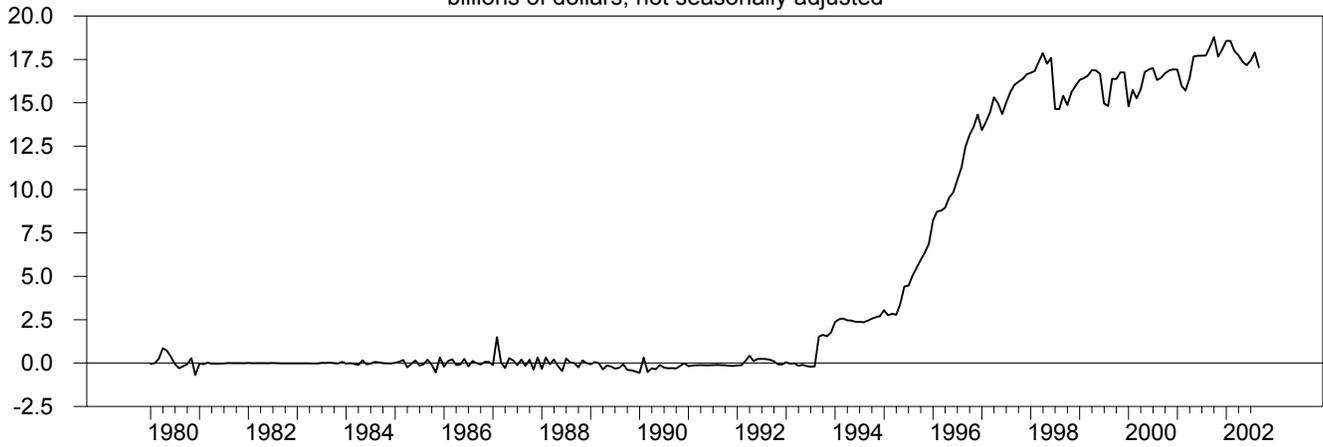
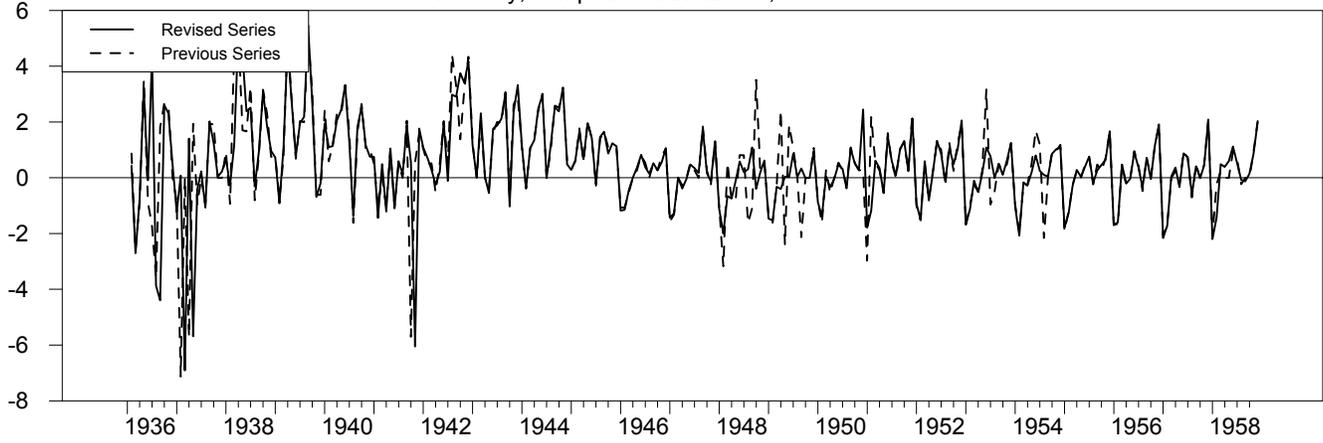
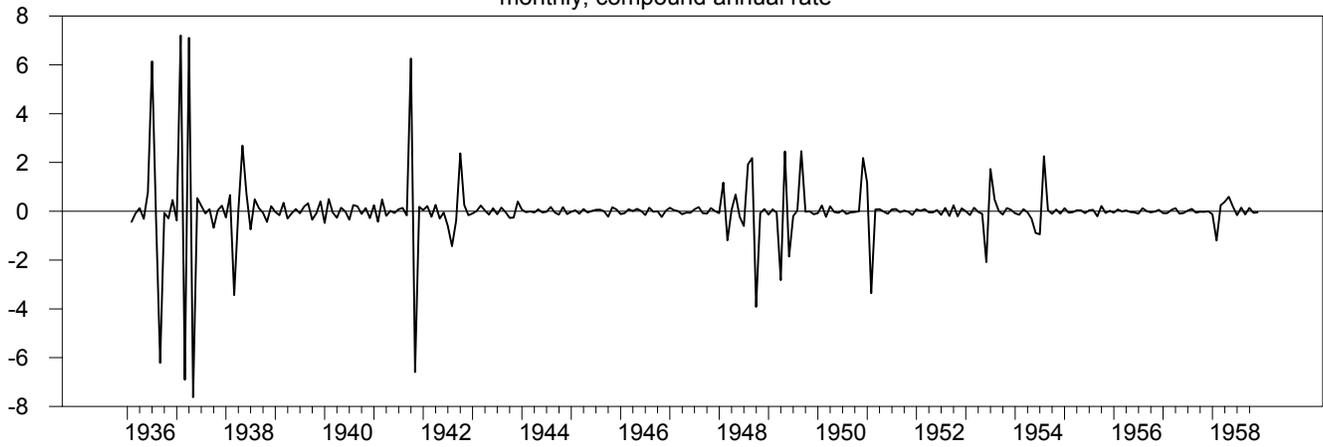


Figure 2: Adjusted Monetary Base, Revised and Previous Series (con't)

B. Growth Rate, Revised and Previous Series  
monthly, compound annual rate, 1936-1958



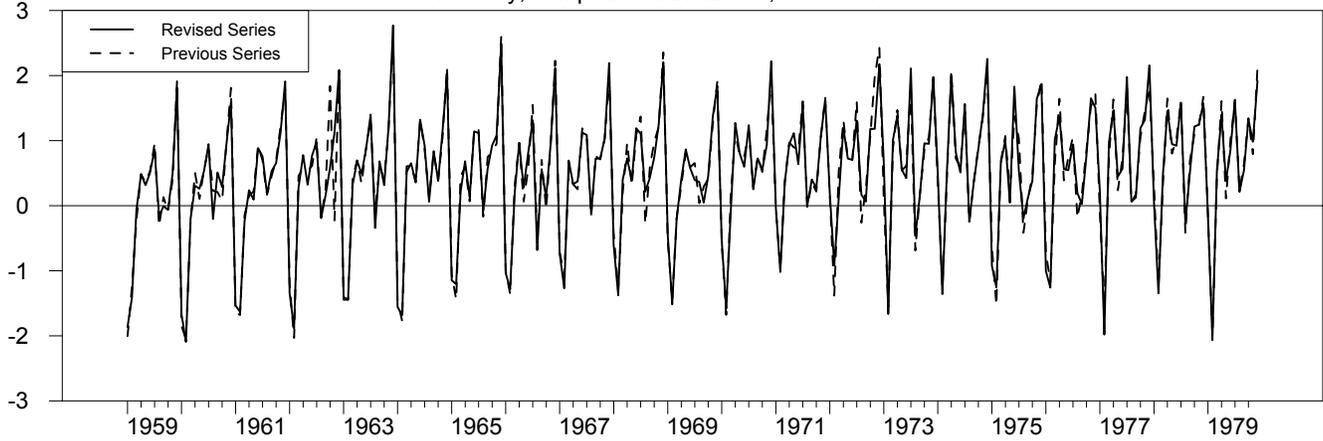
Revised Series Minus Previous Series  
monthly, compound annual rate



## Figure 2: Adjusted Monetary Base (con't)

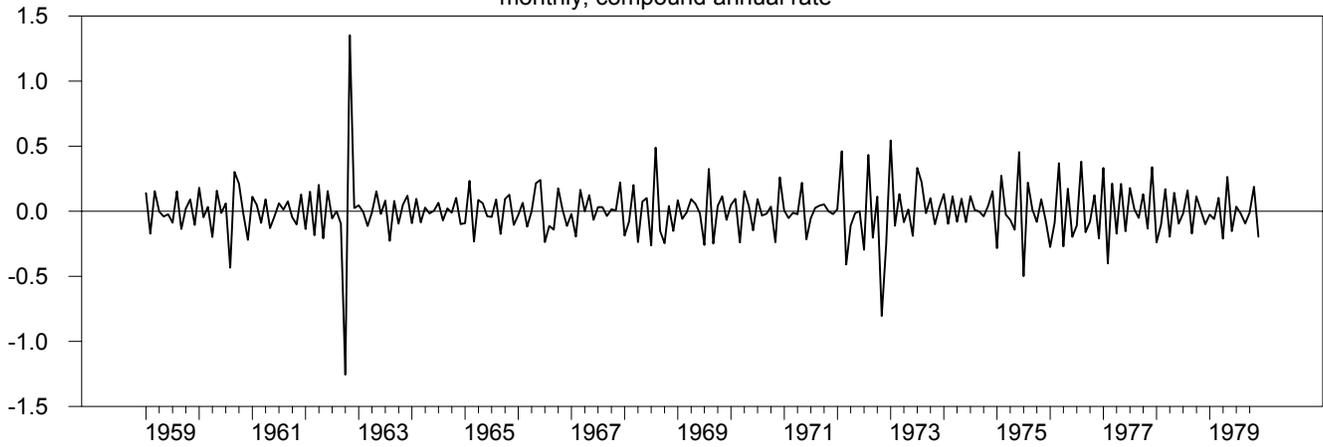
### B. Growth Rate, Revised and Previous Series (con't)

monthly, compound annual rate, 1959-1979



### Revised Series Minus Previous Series

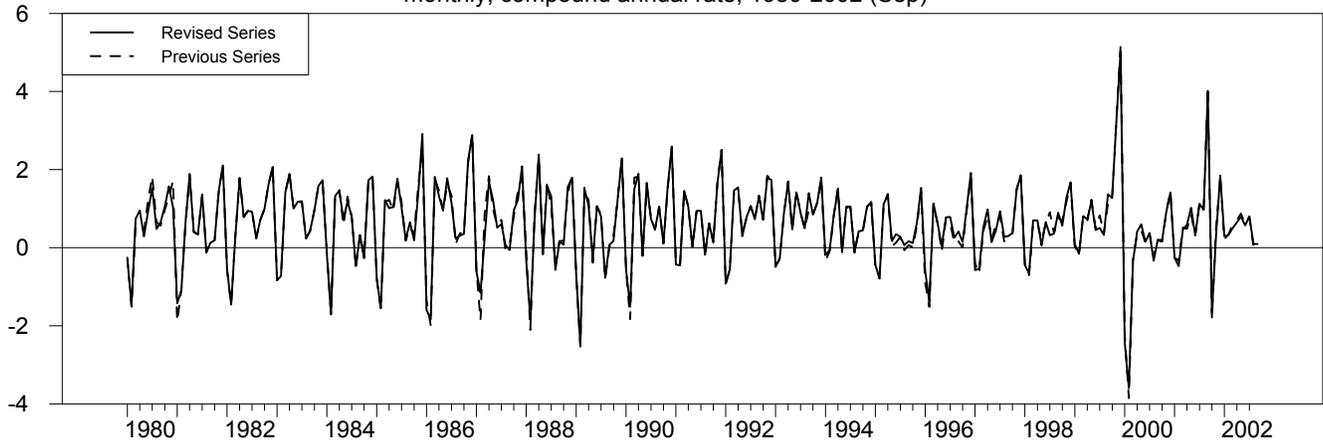
monthly, compound annual rate



## Figure 2: Adjusted Monetary Base (con't)

### B. Growth Rate, Revised and Previous Series (con't)

monthly, compound annual rate, 1980-2002 (Sep)



### Revised Series Minus Previous Series

monthly, compound annual rate

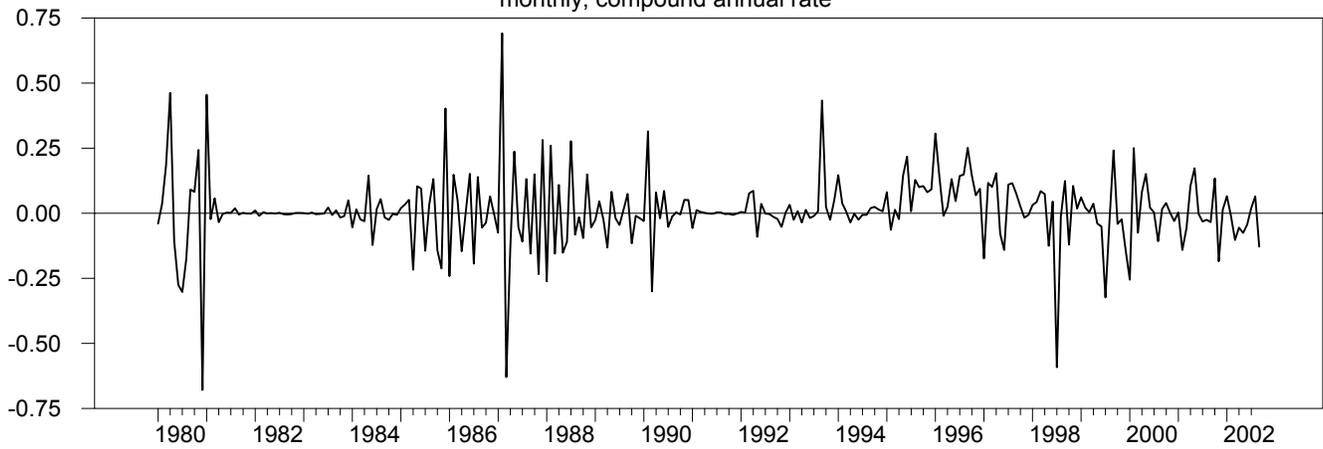
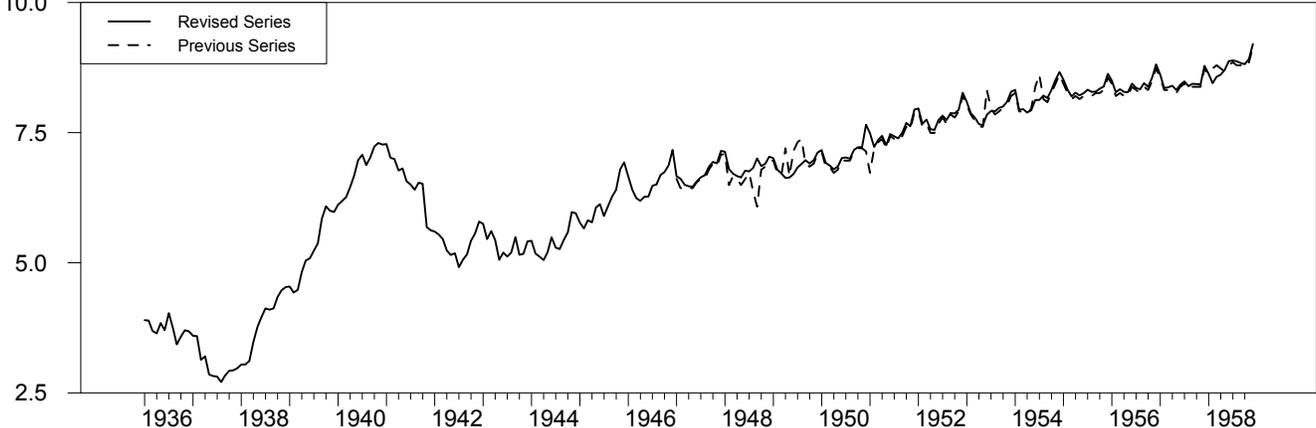


Figure 3: Adjusted Reserves, Revised and Previous Series

A. Levels

billions of dollars, not seasonally adjusted, monthly, 1936-1958



Revised Series Minus Previous Series

billions of dollars, not seasonally adjusted

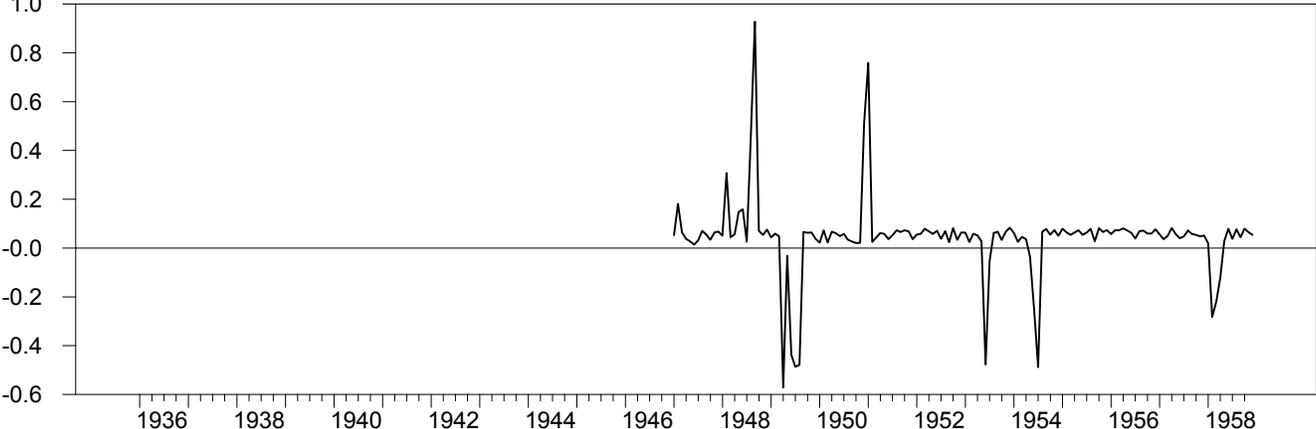
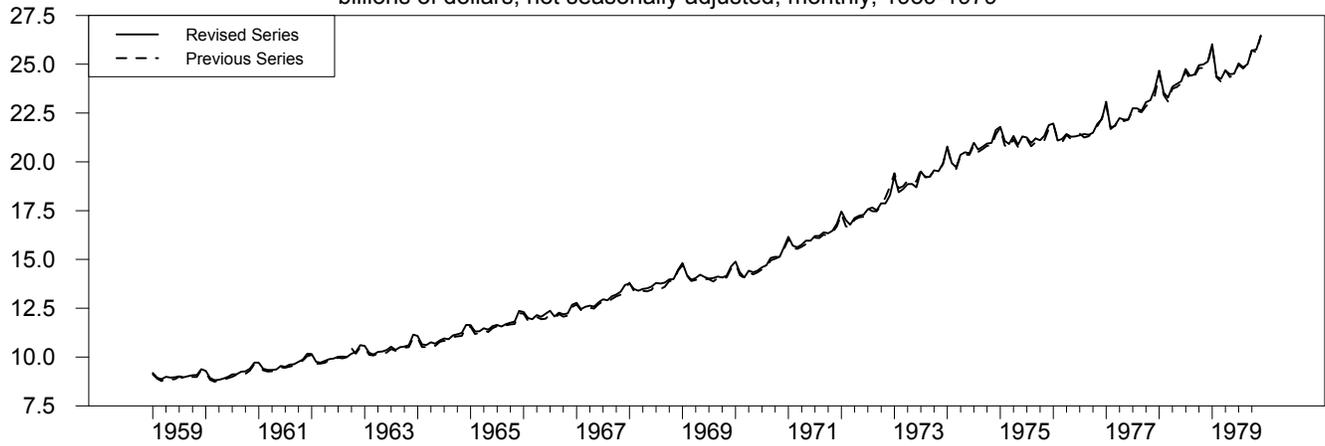


Figure 3: Adjusted Reserves, Revised and Previous Series (con't)

A. Levels (con't)

billions of dollars, not seasonally adjusted, monthly, 1959-1979



Revised Series Minus Previous Series

billions of dollars, not seasonally adjusted

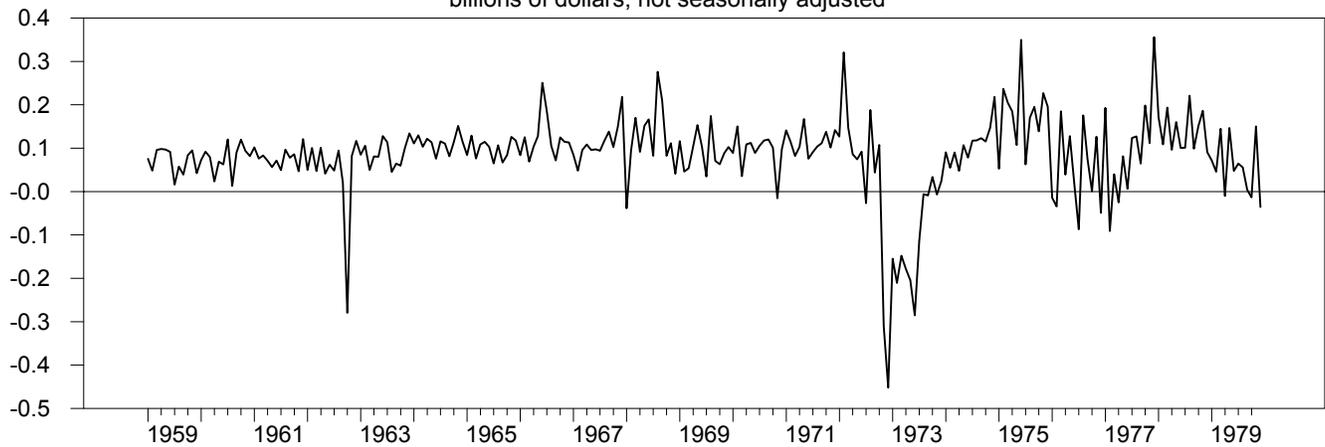
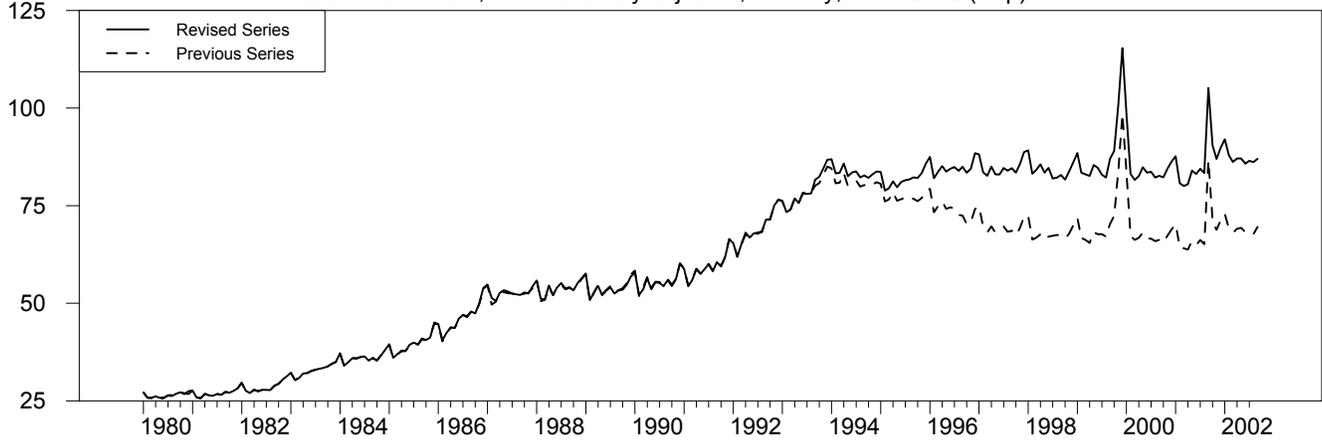


Figure 3: Adjusted Reserves, Revised and Previous Series (con't)

A. Levels (con't)

billions of dollars, not seasonally adjusted, monthly, 1980-2002 (Sep)



Revised Series Minus Previous Series

billions of dollars, not seasonally adjusted

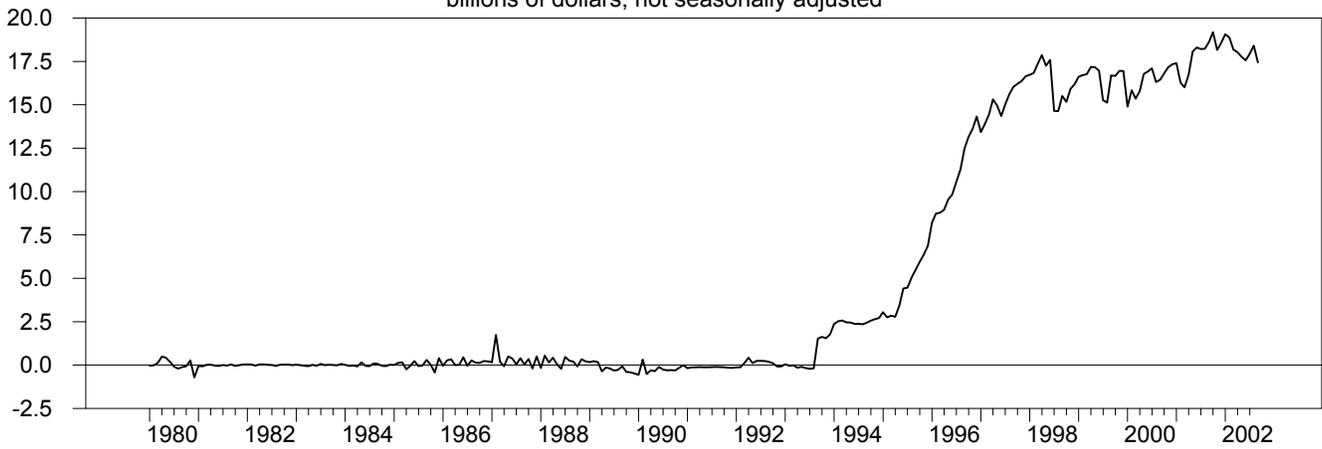
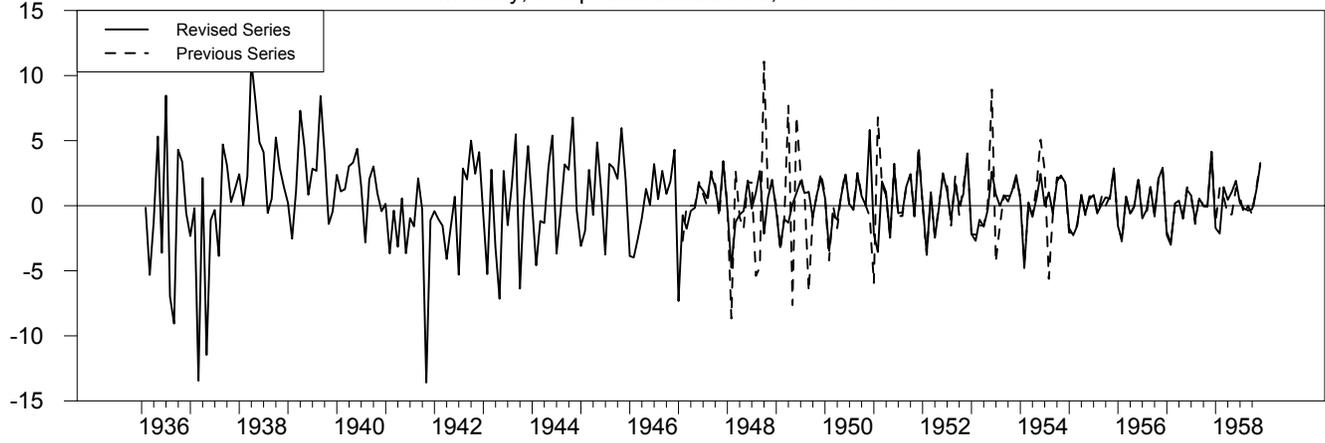
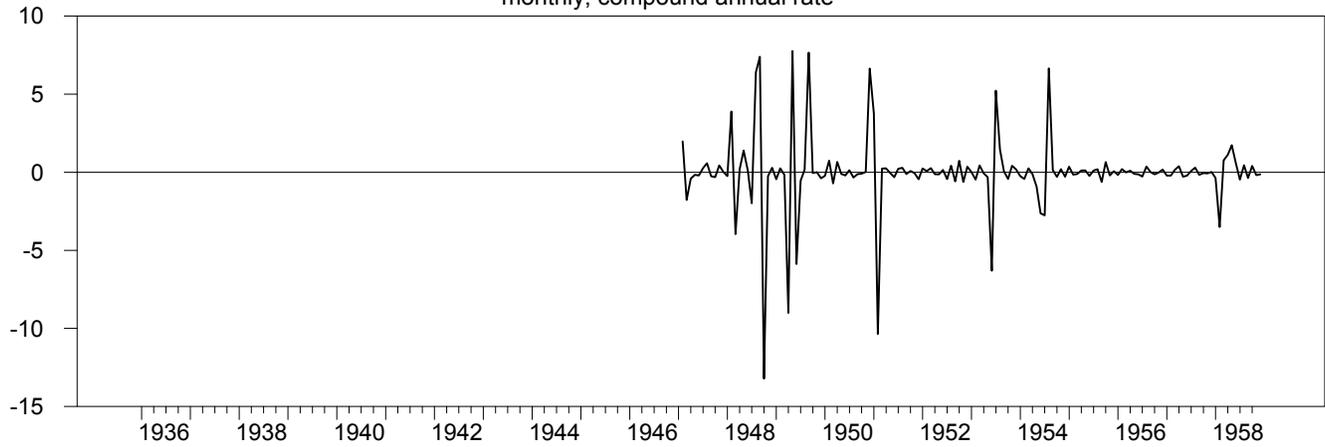


Figure 3: Adjusted Reserves, Revised and Previous Series (con't)

B. Growth Rate, Revised and Previous Series  
monthly, compound annual rate, 1936-1958



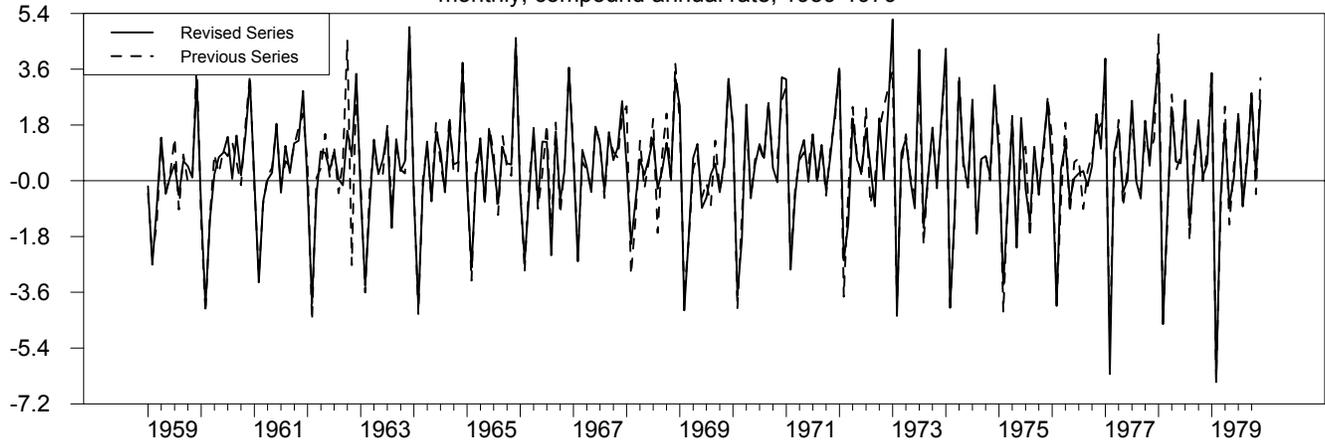
Revised Series Minus Previous Series  
monthly, compound annual rate



# Figure 3: Adjusted Reserves (con't)

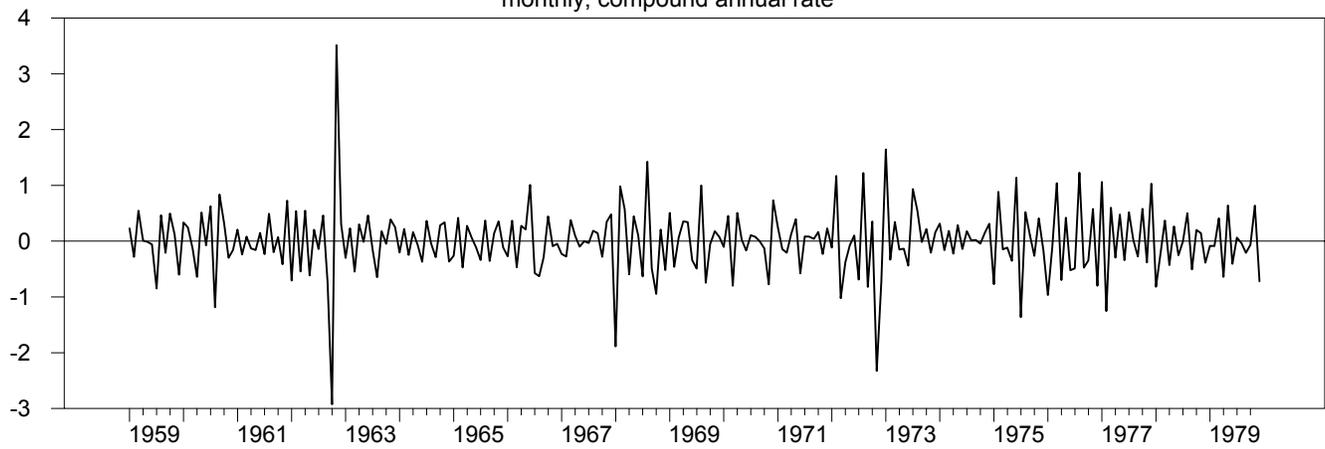
## B. Growth Rate, Revised and Previous Series (con't)

monthly, compound annual rate, 1959-1979



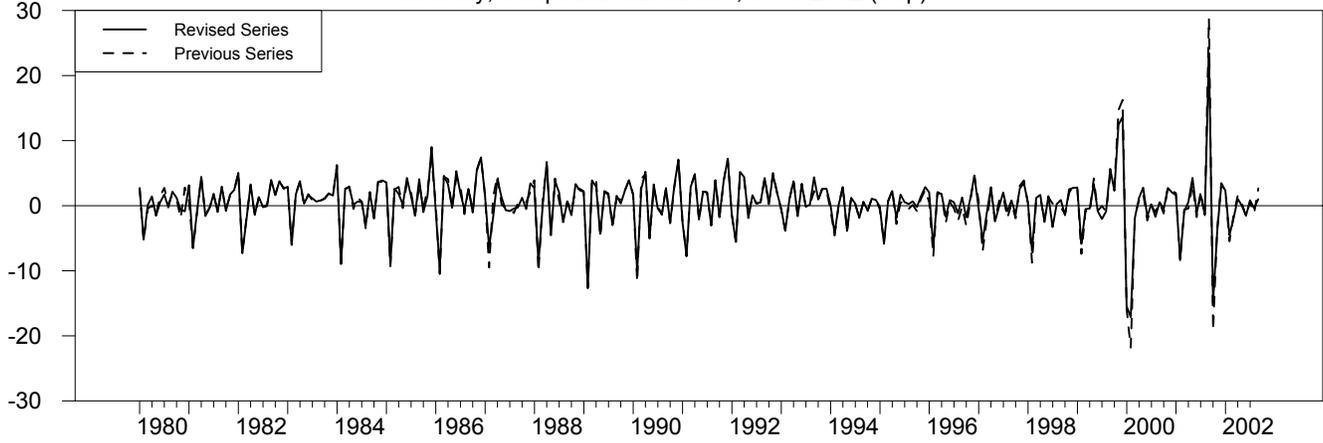
## Revised Series Minus Previous Series

monthly, compound annual rate



# Figure 3: Adjusted Reserves (con't)

B. Growth Rate, Revised and Previous Series (con't)  
monthly, compound annual rate, 1980-2002 (Sep)



Revised Series Minus Previous Series  
monthly, compound annual rate

