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Institutions for Stable Prices: How To Design an Optimal Central Bank Law

William Poole

I am pleased to be here today to discuss an extremely important topic. But I believe it wise to begin on a humble note. The title of this session includes the phrase "optimal central bank law." In designing a central bank law, we do not have a well-specified mathematical model to optimize, and consequently we cannot expect to find *the* optimal law. It would be a mistake, I believe, to be so bold as to recommend a legal framework for all countries for all time. The fact is that most high-income countries today, and many low- and middle-income countries, have achieved a high degree of success in maintaining low inflation, even though laws in these countries display substantial differences. We need to think rather abstractly about the design of the legal framework for the central bank and recognize that there are different ways to achieve the same end.

We should also recognize that success in achieving low and stable inflation, or price stability if you prefer that formulation, is relatively recent. We may well discover that some institutional arrangements are more robust over time, as we observe how various arrangements stand up to stresses not yet observed.

An institution as important as a central bank cannot take a particular form without substantial public understanding of the reasons for that form. A century ago, most informed people believed that the only sound basis for a monetary system was for paper money to be convertible into gold. For some years after World War II, most observers believed that fixed exchange rates were essential to monetary stability. Clearly, popular opinion and understanding of economic ideas imposes limits on our ability to transform the economy by changing laws.

William Poole is the president of the Federal Reserve Bank of St. Louis. This article was adapted from a speech of the same title presented at the First Conference of the Monetary Stability Foundation at the Regional Office of the Deutsche Bundesbank, Frankfurt, Germany, December 5, 2002. The author thanks colleagues at the Federal Reserve Bank of St. Louis for their comments, especially William T. Gavin and Robert H. Rasche. The views expressed do not necessarily reflect official positions of the Federal Reserve System.

Before proceeding, I want to emphasize that the views I express here are mine and do not necessarily reflect official positions of the Federal Reserve System. I thank my colleagues at the Federal Reserve Bank of St. Louis for their comments, but I retain full responsibility for errors.

I'll organize my thoughts in four sections. In the first, very brief section, I'll discuss economic principles. I start there because the legal framework within which a central bank operates must be consistent with the way a market system works, and the goals assigned to a central bank must be within its power to achieve. Next, I'll discuss central bank law consistent with economic principles and, in a separate section because of its importance, the design of central bank independence. Finally, I'll address the issue of central bank transparency.

To make the exposition a bit easier, I'll refer to the leadership of a central bank as the "governor," which will refer to the governor, chairman, or governing board as appropriate. I'll refer to the top elected official of the government as the "president," which will refer to the president or prime minister as appropriate.

ECONOMIC PRINCIPLES

The logical place to begin an analysis of how to design an optimal central bank law is with a simple statement of economic principles. The principles I believe should guide our thinking are these:

- Inflation, anticipated and especially unanticipated, above some threshold rate is costly. Deflation is also costly. Costs are low when the departure of the rate of price change, whether above or below the threshold rate, is small; costs are larger when the departure is larger. The evidence suggests that the costs of departures are not symmetric; deflation of 5 percent per year is likely to be much more costly than inflation of 5 percent per year.
- There is no long-run tradeoff between inflation and unemployment, and the short-run tradeoff may well be too unreliable to be useful for policymakers.

- Market expectations about future monetary policy (and future economic policies generally) are extremely important in determining how well monetary policy will work.

CENTRAL BANK LAW

Because inflation and deflation are costly, a central bank ought to have an inflation target. I believe that the appropriate target is zero inflation, properly measured—that is, abstracting from measurement errors in price indexes. Others believe that a small, positive rate of inflation is appropriate. The difference between 0 and, say, 2 percent inflation per year is a minor matter relative to other issues. In particular, reasonable stability in the rate of inflation and especially in the expected rate of inflation over the medium term are more important than whether the target rate is 0 or 2 percent per year. Whether the target is expressed as a point or a range is an interesting issue, but not fundamental.

I personally favor a legislated inflation target, but whether the target is legislated is not the main issue. If the weight of public opinion is not behind a legislated target, it will not be effective. The United States does not have a legislated target, but since the mid-1990s the Federal Reserve has been successful in achieving and maintaining a low average rate of inflation. What is needed is not so much a legislated inflation target but a target framework that the public regards as having constitutional force. In the United States, the gold standard used to have constitutional force even though it was never written into the Constitution explicitly.

What I mean by "constitutional force" is that a law or practice cannot be changed without resort to lengthy discussion and, in the case of a law, by a super majority or its equivalent. A provision of constitutional force is basic to the functioning of society; it is part of the shared consensus, backed by widespread consent, within which everyday legislation is crafted.

In the United States, repeal of First Amendment protection of freedom of speech is unthinkable, and that was essentially the situation applying to the gold standard for many years. But when the gold standard ceased to have constitutional force as a consequence of the Great Depression, over time Congress repealed legislation providing for gold coins and other features of the gold standard. I think it is true—I hope it is true—that in the United States today the idea that Congress or the Federal Reserve would deliberately aim for, or tolerate, a sustained inflation rate of, say, 8 percent per year is now unthinkable. If so, the idea that the Federal Reserve has a responsibility to maintain low and stable inflation in the neighborhood of recent experience is approaching the level of constitutional force.

I am sure, however, that in many countries debate over a legislated inflation target has been extremely valuable in helping to create a consensus of constitutional force. What I am emphasizing is that such legislation can never be the end of the matter; central bankers and others must constantly explain the reasons for a legislated target to ensure that it is not simply absorbed into the immense mass of legislation on the books of our democratic countries that is widely ignored and largely forgotten.

Because the effectiveness of a central bank in achieving sustained low inflation depends importantly on its credibility, there is no substitute for consistent policies that build market confidence over time. Once credibility is lost, regaining it takes time and a willingness to endure short-run pain, where the short run may be measured in years. Maintaining credibility over time requires institutional strength that transcends current leadership. Absent crisis conditions, policy should evolve relatively slowly over time, with each change studied carefully and then explained fully. Otherwise, the predictability upon which credibility depends may be incomplete. The purpose of sustained low inflation is to minimize price level shocks that upset business planning and redistribute income and wealth arbitrarily. For the same reason, the central bank should strive to avoid surprises in its own policy procedures.

One of the most difficult and hotly debated issues is whether monetary policy should be confined to an inflation objective or should also have an employment or growth objective. My view is that it does not make economic sense for the central bank to have objectives stated in terms of the level of employment or the rate of growth of real gross domestic product (GDP). It is within the power of the central bank to achieve a long-run inflation objective, but not to achieve an objective for the level of employment or the unemployment rate. No organization should be assigned an objective that it cannot achieve or, at best, achieve only temporarily.

I think it is within the power of the central bank, however, to contribute to employment stability. If inflation expectations are solidly held, which is an expected outcome of achieving an inflation objective on a sustained basis, then the central bank can

reliably change real interest rates in the short run. Provided that the central bank's short-run policy decisions do not shake confidence in the long-run policy, it can direct short-run policy to help cushion employment fluctuations. It is reasonable to interpret a number of episodes in the United States since 1982 in this way; most recently, I think that it is undeniable that the Fed's rapid reduction in its federal funds rate target in 2001 helped to soften the extent of the recession. Of course, we cannot judge the success of a policy by one incomplete episode—the judgment of history might be that policy was too easy too long, although that is certainly not my judgment at this time.

My point is not to offer commentary on recent Federal Reserve policy but to emphasize that success on the inflation front provides the opportunity to employ monetary policy to stabilize, or to work in the direction of stabilizing, short-run fluctuations in real activity. And if I am correct that a central bank that is successful on the inflation front has the power to contribute to economic stability, then I see no reason why a government should not assign a central bank an objective of contributing to stability of the real economy to the extent consistent with the inflation objective. The Federal Reserve operates under a vague legislated instruction—vague in the sense that no numerical targets are specified—to contribute to achieving high employment and price stability. If the statutory language is interpreted as I have suggested, then I think such objectives make perfectly good sense.

A legislated employment stabilization objective complicates the relationship between the elected government and the central bank because the central bank must maintain a long horizon. That horizon is typically considerably longer than the horizon of elected officials who quite naturally and understandably have an intense focus on the next election. Because of the way the economy works, a central bank must be willing to back away from efforts to stabilize income and employment when such efforts threaten the inflation objective. Failing to maintain the primacy of the inflation objective only puts economic stability at risk over the longer run. The United States and many other countries had ample experience with this scenario in the 1970s; excesses in short-run recession fighting created higher inflation over the longer run and deeper recessions later on.

Central bank independence is the institutional design that promises to reconcile the different horizons of elected officials and the central bank. This subject is so important that it deserves special attention.

CENTRAL BANK INDEPENDENCE

There is widespread agreement that central bank independence leads to better monetary policy. I've introduced the logic of independence by referring to different horizons of elected officials and central banks, but I'm not sure that is the total story. Elected officials do maintain some policies with great continuity over time and make some investments with long payback periods. For two quite different U.S. examples, consider the long horizon behind decisions to invest in national parks and military research.

I note, however, that competition among those seeking electoral office does not work well in the context of central bank leadership. Democratic leaders compete for office promising change and improvement rather than continuity and stability, whereas an incoming central bank governor will almost certainly want to continue the policies of a successful predecessor and will emphasize his commitment to do so. In contrast, I don't think I've ever heard a candidate emphasize that he or she is running for office to continue the policies of a successful predecessor of a different political party. Political independence and nonpartisan monetary policy provide the promise of policy stability over time, which in turn stabilizes expectations in asset markets. Such stability and continuity is essential to a successful monetary policy.

Central bank independence requires that the governor have a substantial term of office and that individual policy decisions not be subject to revision by the government. However, such structural features of the central bank institutional design are only the starting point for central bank independence. If a president publicly attacks the central bank's policies, then independence will certainly be incomplete. This subject is a very difficult one for a democratic society: How can an important area of public policy be off limits for comment and criticism by elected officials? Yet, such criticism clearly unsettles markets and damages the effectiveness of monetary policy.

The only way around this problem, it seems to me, is for the government to exercise great forbearance and confine criticism to internal discussions with the central bank. That has come to be the practice in the United States, but it has not been

established long enough that it can be regarded as institutionalized. Consideration of this issue makes clear that optimal central bank design goes far beyond legal issues per se; it is ludicrous to consider the possibility of passing a law saying that the president is not allowed to comment on central bank policy! Clearly, though, if the president does not retain confidence in the central bank, the country is in substantial trouble. In this situation, the president must be prepared to replace a failing central bank leadership when terms expire.

Central banking is a governmental function, but I think that some observers most committed to democratic principles overlook the possibility of employing private-sector activity and principles for governmental ends. A well-understood example is the value of using pollution taxes rather than command-and-control regulations to achieve environmental objectives.

The organization of the Federal Reserve System fits this perspective very nicely. Members of the Board of Governors are appointed by the President of the United States and confirmed by the Senate. However, presidents of the Reserve Banks are appointed by the directors of the Reserve Banks, subject to approval by the Board of Governors. Directors of Reserve Banks have powers and responsibilities that are closer to those of a private company than of those of a government agency. At each Reserve Bank, six of the nine directors are elected by the commercial banks that are members of the Reserve Bank; the other three directors are appointed by the Board of Governors on the recommendation of the Reserve Bank. The directors are explicitly nonpolitical; they are drawn from the local community and are not permitted to hold partisan political office or participate in political activity through such activities as heading campaign committees or leading political fund-raising efforts. The directors, in turn, select the Bank president and first vice president, subject to approval by the Board of Governors.

This institutional arrangement clearly involves ultimate control of the Federal Reserve System through the political process centered on the Board of Governors. Yet, a considerable part of the System's leadership obtains office through what is essentially a private-sector process. My own case illustrates the point nicely. I was a university professor in Rhode Island, with no personal or institutional connection to the Federal Reserve Bank of St. Louis. If the appointment of the Bank president were controlled by a political process involving, say, the state governors of the states with territory in the Eighth Federal Reserve District (Missouri, Arkansas, Mississippi, Tennessee, Kentucky, Indiana and Illinois), then it is very unlikely that a university professor from the state of Rhode Island would have become Bank president. Nor is it likely that I would have been appointed through a Washington political process, given that I had served in a Republican administration but that a Democratic administration controlled the White House in 1998 when I was named St. Louis Fed president.

What this private-sector process does is to reinforce the nonpolitical nature of the Federal Reserve System. The process also involves the Reserve Bank directors in an important way. The Federal Reserve pays the Bank directors very little; what they get out of service as director is an intense education in monetary policy. Over their years of service, and for years thereafter, the directors spread knowledge of monetary policy processes and challenges throughout their communities. I cannot imagine a more effective way of building support for sound monetary policy than having community leaders from many different professions serve as directors. Consider, for example, the breadth of experience on the current St. Louis board; the board includes CEOs of commercial banks, the managing partner of a major law firm, CEOs of both large and small businesses, a university professor who also manages a family farm, an expert in the venture capital industry, and the CEO of a nonprofit community organization. Some Reserve Banks include trade union leaders; although that is not the case currently for the St. Louis Fed, one of the Bank's branch boards does include a trade union leader. Taking the twelve Federal Reserve Banks together, directors are drawn from every sector of the economy and every geographic region.

Equally important to the Federal Reserve is the flow of information from Reserve Bank directors to Bank presidents, who in turn use this information in formulating monetary policy decisions. Valuable information also comes from numerous advisory committees that meet from time to time at the Board of Governors and the Reserve Banks, and from contacts between Federal Reserve officials and their audiences as they travel to speak at various events and meet with business and community leaders. The Federal Reserve has maintained a continuous association with what are known in the United States as "grass roots" contacts throughout the

country. Although this organization of the Federal Reserve System did not prevent the monetary policy mistakes that contributed to the Great Depression and the Great Inflation, I believe that the current process contributes greatly to the prospects for continued sound monetary policy in the years ahead.

TRANSPARENCY

In recent years, central banks have become more open in many different ways. In the past, central bankers often discussed monetary policy in obscure ways and seemed to relish the mystique of central banking. As an academic, I never thought that extensive secrecy served central banks well, and still don't.

Particularly given central bank independence, openness is essential to political accountability. Whether by law or confirmed practice, good central bank design calls for central banks to make timely reports about policy actions, including the reasons for these changes.

I've discussed transparency on several occasions at considerable length; here I want to make two main points. First, prompt disclosure of policy decisions and the rationale for those decisions is essential. However, disclosure of policy debates leading up to decisions must be handled extremely carefully. Excessive disclosure will damage the openness of the internal debate and thereby increase the likelihood of policy mistakes. Moreover, with many different views expressed around the policy table, and views expressed provisionally and for the sake of argument and thoroughness, full disclosure of internal debate without a substantial lag is more likely to confuse markets than enlighten them. I believe that the Federal Reserve practice of disclosing the transcript of Federal Open Market Committee (FOMC) meetings with a five-year lag works well. A lag of that length maintains ultimate accountability and provides a valuable record for scholars while preventing damage to the policy process.

My second main point is that prompt disclosure of policy decisions and their rationale is necessary for markets to function efficiently. Monetary policy works through markets; if markets expect one policy direction when the central bank intends another, both the markets and the central bank are likely to be surprised at some point and disappointed by the results.

CONCLUSION

There is no uniquely optimal way to write a central bank law and to institutionalize central bank practices. Different countries have different histories and different preferences. Let me pull together the threads of my argument: A good design for the central bank will contain three main elements.

First, the government should assign clear and obtainable objectives to the central bank. I favor a legislated inflation target, but more important than legislation is an understanding in the society that low and stable inflation is the central bank's responsibility and that the bank should be judged on how well it achieves that objective. A government may assign to the central bank a policy goal of contributing to stability in income and employment, provided there is a clear understanding that there can be no central bank target for the *level* of employment or the rate of growth of GDP.

Second, the central bank should operate independently within the government; the governor should have a reasonably long term of office and should not be subject to removal by the president, except for cause through an impeachment process. The president should not be able to overturn individual monetary policy decisions and ideally should confine comment on those decisions to confidential communications with the central bank.

Third, the central bank should be transparent in the way it makes decisions and implements policy. Political accountability requires transparency; so also does the efficient operation of the markets through which monetary policy affects the economy.

These three principles broadly characterize all major central banks today. We should not, however, take that fact as reason to assume that the issue is settled. We are bound to face stresses in the future when many will question these principles. Stating them now, defending them and explaining them, is our best hope for improving public understanding and maintaining the progress of recent years that is so evident to all central banks and students of central banking.

How Banks Can Self-Monitor Their Lending To Comply with the Equal Credit Opportunity Act

James H. Gilkeson, Drew B. Winters, and Peggy D. Dwyer

The Equal Credit Opportunity Act (ECOA) prohibits lenders in the United States from discriminating against potential borrowers on the basis of certain demographic characteristics, including gender, marital status, color, race, national origin, and age (assuming the applicant has reached his or her majority).[1] The ECOA also prohibits discrimination against applicants who receive public assistance income and against those who have exercised rights granted under the Consumer Credit Protection Act or comparable state laws. The ECOA is implemented through Regulation B (Reg B), which originally prohibited the collection of these demographic data in the loan application process to prevent the information from being used to discriminate against underserved groups. Subsequently, mortgage loans were excluded from this prohibition to conform to the requirements of the Home Mortgage Disclosure Act (HMDA). Recently, Reg B has been modified and now allows lenders to collect certain demographic data—namely, race, color, religion, national origin, and gender—if done for the purpose of conducting the kinds of self-tests described in the revised regulation, including self-monitoring of the commercial lending process for compliance with the ECOA.

Self-monitoring of the lending process for equal credit access will be a new endeavor for most lenders. This paper describes one way for a lender to implement self-monitoring of its lending process, including data collection, data analysis, and interpretation of the results. In addition, we discuss some of the problems inherent in self-monitoring and why there is a constructive role in this process for regulatory oversight.

We focus on the primary question that bank examiners and regulators ask to determine whether a lender is in compliance with the ECOA: Are traditionally underserved groups given the same access to credit by this lender as traditionally well-served (majority) groups? The objective of this paper is to show lenders how to examine their loan process and its outcomes to determine whether they are providing equal access.

During our discussion, we will introduce empirical (statistically based) tests that lenders can use to self-monitor their loan process. We will provide examples of these tests using data from the 1993 Survey of Small Business Finances. With over 2,000 usable survey responses for this analysis, the amount of data from the survey is roughly equivalent to the pool of business loan applicants at a single, large urban bank. Although the process we describe can be used by all lenders, we will also highlight problems that small lenders in particular might have with self-monitoring.

Before going further, one point must be emphasized: This article will not transform the reader into an expert. We will provide a basic outline of the steps that a self-monitoring process should follow and provide a particular empirical example. Each lender will face its own issues with model development, data collection, statistical estimation, and interpretation of results. Appropriate expertise is required during each of these steps.

We also provide some background on lending discrimination. We then step through the process of self-monitoring a lender's loan practices, providing examples from the survey data along the way. We conclude by discussing some problems of self-monitoring and indicating why we believe that there remains a constructive role for bank examiners and regulators that complements a lender's self-monitoring efforts.

BACKGROUND AND MOTIVATION

In August 1998, the Federal Reserve Board proposed changes to Reg B that would allow lenders to collect previously prohibited demographic data on

[1] Some demographic data can be collected and used during the loan application process (e.g., geographic data such as street address or census tract).

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all loan applicants. Following the proposal, the Board of Governors of the Federal Reserve System received a joint agency memo that supports the proposed changes.[2] The memo makes several key points, two of which relate to self-monitoring of the loan process: first, that previous demographic data collected from mortgage lending (as required by the HMDA) have not been used for discriminatory purposes; second, that the lifting of this prohibition on collecting demographic data on loan applications will facilitate both private sector and government detection and prevention of lending discrimination. The concurring agencies believe these points are important because "evidence indicates that discrimination in business and consumer lending remains a serious problem."

Because the change will allow lenders to self-monitor for compliance with ECOA, it is important for them to understand existing evidence of discrimination. This section discusses the literature on lending discrimination.

To date, the majority of empirical studies on lending discrimination have focused on the residential mortgage market where, as Nesiba (1996) notes, "Empirical researchers see evidence of racial discrimination in virtually every study [of residential mortgage markets] they conduct." Among these studies is the frequently cited Munnell et al. (1996), commonly known as the Boston Fed study. These authors examine loan approval and rejection data for the Boston metropolitan statistical area that were collected as a result of the HMDA, as well as supplemental information regarding applicants' finances and employment and the property they wished to purchase. Despite substantial credit quality controls in the study, Munnell et al. (1996) find that black and Hispanic applicants were significantly more likely than others to have their mortgage applications rejected.

A reexamination of the Boston Fed data by Hunter and Walker (1996) finds that discrimination occurred only among applicants of marginal credit worthiness. That is, when the rational or profit-maximizing lending decision could have gone either way, black and Hispanic applicants were more likely to be rejected than white applicants. Hunter and Walker (1996) interpret their findings as being consistent with the cultural-affinity hypothesis, arguing that, at the margin, lender decisions will favor those borrowers with whom the lenders perceive a shared background and culture.

The recent large-scale mortgage lending studies do not report evidence of gender-based discrimination. However, researchers find evidence of gender-related discrimination in other types of lending. In a study of consumer lending by Texas finance companies, Elliehausen and Lawrence (1990) find evidence of discrimination against a subset of female applicants. Specifically, they identify an interaction of gender and marital status on lending decisions that is suggestive of discrimination against divorced women and widows, but not against divorced men or widowers.[3]

Empirical research on business-lending discrimination has been lacking because of the paucity of data, and we are aware of only two studies on this subject. In 1987, the Federal Reserve began a survey of small business finances, which included survey questions about small business banking activities such as loan requests and denials. The Federal Reserve has continued to monitor small business finances, with additional surveys in 1993 and 1998. One of the studies in question—Cavalluzzo and Cavalluzzo (1998)—uses the 1987 survey; the other—Cavalluzzo, Cavalluzzo, and Wolken (2002)—uses the 1993 survey. Both studies can be described as identifying lending discrimination against minority-owned small businesses, but only at the margin. Cavalluzzo and Cavalluzzo (1998) find that minority-owned small businesses are more likely to be denied the full amount of their credit request than white-male-owned small businesses. Cavalluzzo, Cavalluzzo, and Wolken (2002) show that in competitive banking markets minority-owned small businesses are denied loans at a rate of 39 percent, whereas white-male-owned businesses of similar credit quality are denied loans at a rate of 32 percent.

As seen above, recent evidence indicates lending discrimination at the margin. In other words, after careful credit analysis and when the lending decision can go either way (i.e., when it is at the margin), members of underserved groups are denied credit more frequently than members of the majority. For compliance with the ECOA, lenders need to

[2] The agencies joining in the memo are as follows: the Department of the Treasury, Department of Justice, Department of Housing and Urban Development, Federal Trade Commission, Comptroller of the Currency, Office of Thrift Supervision, Office of Federal Housing Enterprise Oversight, and Small Business Administration.

[3] In contrast to the Elliehausen and Lawrence (1990) findings, Peterson (1981) reported no evidence of gender-based discrimination in consumer lending. However, Peterson's (1981) approach of using ex post data on loans charged off as losses to infer discrimination has been criticized in subsequent research as inappropriate.

show that their lending decisions are based solely on credit quality and are not influenced by group membership. Loan applications tend to divide easily into one of three decision categories: clearly accept, clearly reject, and uncertain. The recent literature suggests that the clearly accept and clearly reject decisions are not influenced by prohibited demographic characteristics. However, as we noted, the decisions ultimately reached for the uncertain category of applications appear to be less favorable for underserved groups, making self-monitoring both important and difficult.

Self-monitoring is important because lenders attempting to comply with the ECOA have no chance of identifying marginal discrimination in their loan processes without the ability to collect demographic data. Self-monitoring for compliance is difficult because problems likely occur in those lending decisions where even a careful credit analysis will not provide a certain decision on whether to accept or reject the loan application. When self-monitoring, the lender will first have to determine whether they have a problem at the margin (and evidence suggests that there is a positive probability of this) and then determine how to remove demographic factors from the uncertain lending decisions so that underserved groups get the same "benefit of the doubt" that the majority receives.

THE CREDIT ANALYSIS PROCESS AND ITS INPUTS

Now that we have identified the key issue in self-monitoring, we begin the discussion of the loan process itself. We refer to monitoring the process instead of monitoring the loan portfolio because a lender's portfolio includes only the loan applicants that the lender has accepted, whereas self-monitoring must also examine the loan applicants that the lender rejects. Throughout this discussion, we will continue to refer to self-monitoring of the process—and not the portfolio—to avoid any tendencies on the part of the reader to consider a specific portfolio.

An important theme of the self-monitoring process is *don't panic*. We have already introduced a number of issues to consider, with more to come; but self-monitoring is not an insurmountable task for an individual lender. We describe here some fairly basic analysis that can make self-monitoring a reasonable task.

The first step in the self-monitoring process is to identify potentially underserved applicant groups. Typically, these are traditionally underserved groups such as businesses owned by women and racial and ethnic minorities, but the list will vary from lender to lender, depending on the demographics of its applicant pool. Once a list of groups is determined, any application not coming from one of the potentially underserved groups is deemed to be from the majority, or control group, which is assumed to be well-served. The 1993 Survey of Small Business Finances provides demographic information about each business's owners that allows the owners to be categorized into the majority or one or more of three traditionally underserved demographic groups: females, minorities (which includes blacks, Asians, Pacific Islanders, Native Americans, and Alaska Natives), and Hispanics. In this case, the control group is businesses owned by white males. In the survey, a business is classified as owned by members of a specific group only if *more than* 50 percent of its equity is owned by members of that group. This is fairly stringent compared with rules that have been used to classify ownership for various government programs (particularly those related to government purchasing).[4] However, the rule does exclude small businesses that are owned jointly (50-50) by a husband and wife, which is appropriate because a lender inclined toward discrimination would be unlikely to view such a business as being female owned.

The next step in the process is to gather basic information from all loan applications submitted to the lender. Because the primary question being asked is whether potentially underserved groups are given the same access to credit by the lender as traditionally well-served (majority) groups, it is critically important to know whether the loan application was accepted or rejected, as well as whether the applicant belongs to one or more of the potentially underserved groups. The 1993 Survey of Small Business Finances asked respondents "What was the outcome of the most recent credit application by the business?" and allowed one of two answers: approved or denied. Table 1 summarizes answers to this question by the owner's demographic group. The results show that white-male-owned small businesses were approved 89.04 percent of the time, while Hispanic-owned firms were approved at a rate of 84.38 percent, female-owned firms at a rate

[4] Until recently, Reg B prohibited collection of certain demographic data. We expect that, as self-monitoring begins to occur, regulators will provide guidance as to an appropriate ownership rule.

Table 1

Credit Availability by Business-Ownership Classification

	Female-owned firms	Minority-owned firms	Hispanic-owned firms	White-male-owned firms
What was the outcome of the most recent credit application by the business?				
Approved	78.57%*	59.92%*	84.38%	89.04%
Denied	21.43%	40.08%	15.63%	10.96%
No. of responses	294	257	96	1424

NOTE: *Indicates business-ownership differences between females and white males, minorities and white males, and Hispanics and white males at the 1 percent level using a χ^2 test.

of 78.57 percent, and minority-owned firms at a rate of 59.92 percent. These acceptance rates show why female-, minority-, and Hispanic-owned businesses are referred to as underserved groups and would likely be a reason for examiners to thoroughly investigate the particular loan product or market in which such disparities arose. A lender engaged in self-monitoring who sees similar disparities will need to show that its loan process is in compliance with the ECOA, which requires showing that the different approval rates occur because of different levels of credit quality between demographic groups. This issue is the focus of the remainder of this article.

The process of demonstrating credit quality differences begins by defining the lender's credit analysis process and the inputs used in the process. Each lender analyzes credit a little differently, and so we must clearly define their process and the inputs they use. This is *extremely* important because the inputs defined here become the control variables used later in the analysis of the lender's loan process.

A good starting point that we think all lenders can agree on is that they make loans that they believe will be repaid in accordance with the loan contract. The question that arises is: What do lenders analyze to make this lending decision? In theory, lenders analyze the future cash flows of the loan applicant over the life of the proposed loan to determine whether the cash flows are sufficient to repay the loan. However, without a crystal ball, lenders have no way of knowing the future cash flows of the loan applicant, so they must examine other variables (proxies) that they believe indicate their likely repayment behavior. Identifying these proxy variables is a big step in the self-monitoring effort.

Each lender will use a different set of proxy variables, so it is important for each lender to identify the inputs they use in their loan decision process. For each variable identified, a brief description of how it provides information about future repayment behavior should be created. This is important in demonstrating compliance with the ECOA—that underserved groups do get equal access to credit from the lender in question. In other words, the lender must demonstrate that its credit decisions are based on the credit quality of the loan applicant without regard to demographic characteristics.

Lenders should be aware that examiners recognize three types of evidence when determining whether lending discrimination has occurred. The first is overt evidence of disparate treatment, which occurs when a lender openly discriminates on a prohibited basis. The second is comparative evidence of disparate treatment, which occurs when a lender treats one credit applicant differently from others based on a prohibited basis. The third is disparate impact, which occurs when a lender applies an otherwise neutral policy or practice equally to all credit applicants, but the policy or practice disproportionately excludes or burdens certain persons on a prohibited basis. This third type of evidence means that lenders must be careful in arguing that denials based on nondiscriminatory factors are lawful, if such factors disproportionately affect certain underserved groups.

A word of warning at this point. Each lender should spend some time identifying a complete list of input variables. The reason is that the lender must collect these variables from every loan application and then record these variables in a database to be used for self-monitoring. Whenever there is doubt about whether a variable is truly an important part

of the decision process, the variable should be collected for the database. It is much easier to delete unnecessary variables from the analysis later in the process than it is to add a missing variable to the database. In the remainder of this section we define the variables we use in our example and discuss how they relate to credit quality.

Credit Quality Variables

It is important to note that the set of variables we discuss here must *not* be viewed as *the* definitive set of credit quality variables. Instead, they should be seen as one viable set of variables identified by a particular lender to describe its own credit analysis process. In particular, while we chose a set of variables that are collected in most credit applications, our choice of variables is constrained by the data available in the survey. A self-monitoring lender is not constrained in this manner because the lender defines the variables that describe its loan analysis process and then collects data on those variables out of its own loan application files for its self-monitoring database.

Each lender must identify the variables it uses for credit analysis and then define how each variable relates to credit quality. Lenders should be able to do this, but may feel uncomfortable with the process. Academic literature and banking textbooks should be helpful, and there is a multitude of sources for reference. Commercial banking is based on the business of evaluating loan applications, so bank management texts tend to provide extensive coverage of the topic (e.g., Koch, 1995, Chap. 21). Ongoing development and use of automated credit scoring models provides another source of the structure and content of such models (e.g., Saunders, 1999). In addition, a number of researchers have developed similar models in their work (e.g., Blackwell and Winters, 1997; Melnik and Plaut, 1986; and Petersen and Rajan, 1995).

Since we are not lenders actively involved in credit analysis, we begin by finding a model of credit quality in the academic literature and then adapt that model to the variables available in the survey. We employ the linear model of credit quality control variables used in Petersen and Rajan (1994). We find this model to be particularly appropriate for our study because it was used to examine the 1987 Survey of Small Business Finances and is therefore easily adapted to our data and to the data normally available to lenders. Petersen and Rajan's model includes a number of measures intended to capture three categories of applicant characteristics: investment opportunities, cash flow quality, and existing banking relationships. In our analysis, we include a total of 18 credit quality variables; as more fully discussed later, two of these capture the firm's investment opportunities, ten capture cash flow quality, and the remaining six measure the firm's existing banking relationships. These individual variables are listed in Table 2 and are described below, along with their expected impact on the lending decision.

A firm's investment opportunities are proxied for by its size and age, both of which are expected to have positive effects on its credit quality. Larger firms have better internal diversification than smaller firms and can therefore better survive either a failed project or declining economic conditions. Older firms have an established performance record and are more likely to have experienced owners and upper management.

A firm's cash flow quality is measured using a variety of proxies. The level of equity is a rough proxy for the owners' investment in the firm; in the banking literature, this measure is often used to indicate the amount of cushion the firm has to absorb business losses without defaulting on loans. Equity should have a positive impact on credit quality because more equity implies more protection for creditors. In contrast, leverage measures the size of a firm's debts relative to its total size. Higher leverage increases the likelihood of default; therefore, leverage should be negatively related to credit quality. In addition, sales is a direct measure of business health and should be positively related to credit quality.[5] Profits is another common measure of cash flow quality that lenders should consider for their control variables. However, as is fully discussed later, we cannot include both sales and profits in our model because these variables are too highly correlated. We chose to include sales because it fits better with our data, so we do not fully describe a profit variable. However, this is one of those examples where a lender should collect both variables when building a self-monitoring database and then later choose which variable to use in the analysis.

The remaining proxies for cash flow quality are dummy variables (binary variables) that take on a value of 0 or 1. In general, we assign a value of 1 to a dummy variable if the condition it represents is true. For instance, the next variable we discuss is

[5] In other literature, sales is often used as a proxy for firm size. Regardless of the interpretation, sales is typically expected to be positively associated with credit quality.

Table 2

Variable Definitions and Their Anticipated Impact on the Probability of Loan Approval

Variable	Description	Expected impact
Dependent variable	"Was the most recent credit application approved or denied?" 0/1 dummy = 1 if application was approved	
Test variables		
Female	0/1 dummy = 1 if more than 50 percent of the business is owned by females	
Minority	0/1 dummy = 1 if more than 50 percent of the business is owned by blacks, Asians, Pacific Islanders, Native Americans, or Alaska Natives	
Hispanic	0/1 dummy = 1 if more than 50 percent of the business is owned by Hispanics	
Control variables		
Investment opportunities		
Size	Natural log of business's total assets	+
Age	Natural log of business's age in years	+
Cash flow quality		
Equity	Business's total equity (in $millions)	+
Leverage	(Total assets – total equity)/total assets	–
Sales	Business's 1992 total sales (in $millions)	+
Leases	0/1 dummy = 1 if the business has any leases	?
Trade credit denied	0/1 dummy = 1 if any supplier has denied the business trade credit within the last 3 years	–
Owner delinquent	0/1 dummy = 1 if the principal owner of the business has been 60+ days delinquent on any obligation within the last 3 years	–
Business delinquent	0/1 dummy = 1 if the business has been 60+ days delinquent on any obligation within the last 3 years	–
Accounts receivable	0/1 dummy = 1 if the business has accounts receivable	+
Inventory	0/1 dummy = 1 if the business has inventory	+
Corporation	0/1 dummy = 1 if the business is a corporation	+
Banking relationship		
Business checking	0/1 dummy = 1 if the business has a checking account	+
Credit card	0/1 dummy = 1 if the business has one or more credit cards	+
Line of credit	0/1 dummy = 1 if the business has one or more lines of credit	+
Vehicle loans	0/1 dummy = 1 if the business has one or more vehicle loans	+
Equipment loans	0/1 dummy = 1 if the business has one or more equipment loans	+
MSA location	0/1 dummy = 1 if the business is located within an MSA, suggesting a more competitive banking environment	+

leases. As a dummy (binary) variable, leases equals 1 if the firm in question has any business leases. The relationship between this variable and credit quality is ambiguous. One the one hand, a firm that has existing leases has already proven itself to be credit worthy, suggesting a positive relationship. On the other hand, leases allow a firm to use various assets on a long-term basis without necessarily recognizing ownership of the assets or the debt payments required by the lease (i.e., some leases represent off-balance-sheet financing). The presence of leases means that our leverage variable (which should have a negative impact on credit quality) is understated, suggesting that leases could have a negative impact on credit quality in some cases. The next three variables, trade credit denied, owner delinquent, and business delinquent, are measures of existing problems with the firm's credit quality and should be negatively related to the lending decision because, not surprisingly, firms with credit problems should be less worthy of receiving new loans.

It should be noted that the "trade credit denied" variable may bias our tests against a finding of noncompliance with the ECOA, but we still include this variable because it is information that is commonly collected on business loan applications and used by lenders to screen loan applicants. However, if discrimination influences all types of credit decisions, denial of trade credit that was influenced by discrimination could be misinterpreted by our tests as a rational basis for denial of the most recent loan application.[6] Bank examiners and regulators will be concerned about the potential bias. For variables like trade credit denied that may bias empirical results, the analysis should be done with and without the variable in question to determine its impact on the test results for equal access to credit for the underserved groups. We show later that the trade credit denied variable is significant in our regression model, but note here that removing the trade credit denied variable from our regression model does not alter our results or conclusions regarding access to credit for traditionally underserved groups.

Levels of accounts receivable and inventory are two other indicators of cash flow quality. Both accounts receivable and inventory should be positively related to credit quality because they indicate assets that can be converted to cash relatively easily (i.e., liquid assets) and assets that are commonly pledged as collateral in business lending. Finally, the firm type (corporation versus sole proprietorship or partnership) is included because of prior evidence that corporations are less likely to default on business loans than other types of organizations.

The firm's existing banking relationships are proxied by a series of dummy variables that measure whether the firm has a *business* (versus *personal*) checking account, a business credit card, a line of credit, vehicle loans, or equipment loans. Most banks practice "relationship lending" in which they are more likely to lend to existing customers; thus, any sign of an existing banking relationship should be positively related to loan approval. Further, the existence of current loans suggests that the firm has already passed earlier credit quality screens and is worthy of credit. Lenders commonly acquire information about existing credit during the application process, both to ensure that the applicant is not overextended and to see whether other lenders have "pre-certified" the applicant.[7]

In addition to these banking relationship variables, we also include a dummy that equals 1 if the firm is located within a metropolitan statistical area: A more metropolitan setting implies more competition (more banks and other lenders), which typically means that lenders are more likely to approve applicants of a given credit quality. This variable may not be needed by all lenders, but lenders with multiple locations should consider a variable such as this to control for the variability in the level of competition across its different bank locations.[8] Including metropolitan statistical areas in our model allows us to control somewhat for the competitive nature of the local banking market.

We close our discussion of credit quality variables with two reminders. First, the control variables for credit quality that we include in our model are by no means exhaustive. However, it is not our intent to include every possible variable in the model. Instead, we develop a set of variables that should measure credit quality and that are part of the normal data collection process for a loan application. Our intent is to provide an *example* of a credit quality model that lenders could easily use to self-monitor

[6] In a simple test that regresses the "trade credit denied" dummy against borrower age, size, and minority status, firms of all ages and sizes that are owned by minorities are significantly more likely to have been denied trade credit.

[7] Although having too many existing loans could be viewed in a negative way, we already control for that with the leverage variable.

[8] Blackwell and Winters (2000) show that different levels of local competition across different bank locations within a bank holding company affect the loan rate offered at each location, with the less-competitive locations offering higher loan rates.

Table 3

Summary Statistics of Credit Quality Variables (Means and Percentages of Yes Answers)

	All firms		Female-owned firms		Minority-owned firms		Hispanic-owned firms		White-male-owned firms	
Variables	Approve	Deny	Approve	Deny	Approve	Deny	Approve	Deny	Approve	Deny
Total assets	$3,542,593	$742,090	$1,519,421	$456,548	$1,024,233	$234,458	$701,202	$392,893	$4,297,026	$1,134,360
Age (yr)	16.27	11.29	13.56	10.35	12.10	9.14	14.44	10.87	17.22	12.74
Equity	$1,228,498	$111,447	$481,875	$121,382	$311,580	$99,714	$414,631	$147,032	$1,497,121	$117,309
Leverage	44.84%	68.02%	87.26%	60.31%	55.25%	65.14%	21.45%	81.63%	39.35%	82.99%
Sales	$7,378,312	$1,530,285	$4,153,528	$502,793	$2,575,238	$626,414	$2,336,552	$1,217,826	$8,772,085	$2,401,917
Accounts receivable	77.46%	64.74%	67.53%	55.56%	73.38%	62.14%	66.67%	66.67%	80.05%	69.87%
Inventory	67.14%	63.46%	63.20%	50.79%	59.74%	57.28%	61.73%	53.33%	68.45%	71.79%
Leases	23.19%	27.56%	15.58%	25.40%	21.43%	20.39%	16.05%	20.00%	25.00%	31.41%
Trade credit denied	7.91%	24.04%	11.26%	25.40%	15.58%	21.36%	8.64%	20.00%	6.47%	25.64%
Owner delinquent	8.91%	32.69%	12.99%	33.33%	23.38%	46.60%	16.05%	13.33%	6.62%	25.64%
Business delinquent	20.71%	46.15%	24.24%	42.86%	35.71%	48.54%	20.99%	26.67%	18.38%	46.15%
Corporation	46.31%	34.29%	37.66%	26.98%	46.10%	31.07%	40.74%	33.33%	47.79%	36.54%
Checking	99.47%	95.19%	99.13%	93.65%	98.05%	91.26%	100.00%	86.67%	99.68%	98.08%
Credit card	41.30%	34.29%	41.99%	33.33%	40.26%	34.95%	41.98%	26.67%	41.01%	33.97%
Credit line	65.13%	27.56%	54.55%	22.22%	51.30%	24.27%	58.02%	13.33%	68.69%	32.05%
Vehicle	35.34%	32.69%	35.50%	28.57%	35.71%	31.07%	38.27%	40.00%	35.17%	35.26%
Equipment	30.38%	27.56%	24.68%	30.16%	25.32%	22.33%	28.40%	20.00%	32.26%	29.49%
MSA	77.05%	85.90%	77.49%	84.13%	91.56%	94.17%	83.95%	86.67%	75.24%	80.77%

NOTE: MSA is metropolitan statistical area.

their loan process. Second, our list of control variables should not be considered *the* definitive list of variables to be used in self-monitoring; instead, it should be considered illustrative of the types of variables to include. We believe our chosen set of variables describes the factors considered by small business lenders when evaluating loan requests. However, every lender evaluates credit a little differently, so the control variables used for self-monitoring should describe the factors each lender uses in their own credit-granting decision process.

Summary Statistics for the Control Variables

Once the control variables are chosen, it is a good idea to look at summary statistics of the control variables. The summary statistics, which will pool accepted and denied loan requests according to ownership group, begin to describe the credit-granting decision process; but summary statistics must be viewed only as a first step and not as the end of the journey. Summary statistics, it should be noted, do not allow for the multi-dimensional relationships between variables that occur in a lender's decision process, which we capture later in a regression. We report summary statistics for the control variables in Table 3.

For the continuous variables, we report means or averages, which is a common choice, as the goal of reporting a summary statistic is to provide a representative number for the variable in the data set. A viable alternative to the mean is the median, which provides a better measure of a representative num-

ber when the data are skewed. (Data are skewed when the mean or average value is closer to one end of the range of values in the data than the other.) The data for the continuous variables do not appear to be highly skewed, so we chose to report means. For the binary variables that record yes or no (true or false) answers, we report the percentage of yes answers. Note that the form presented in Table 3 is not necessarily the form used in the statistical estimation. For example, we report the mean total assets, but use the natural log of total assets in our tests, as discussed in the previous section.

In each grouping of firms, we see the expected relationship for approved versus denied loan requests across all the continuous variables. That is, within each group, the firms that had their loan requests approved have more assets, more equity, more sales, and less leverage and are older than the firms that had their loan requests denied. (An exception to the expected relationships is the leverage variable for female-owned businesses; however, a closer look showed that leverage for female-owned businesses is highly skewed.) The binary variables are also generally consistent with our expectations. More accounts receivable and inventory are associated with approved loans, whereas previous credit problems are related to loan denials. Also, previous banking relationships are generally positively related to loan approvals. However, the summary statistics are different enough across groups that it is impossible to determine whether group membership plays a role in the credit-granting decision without using a process that considers the joint effects of all of the credit quality variables along with the group membership.

In summary, the basic statistics are designed to provide a first-pass description of the data. In this case, the basic statistics reported in Table 3 suggest that the relationship between the credit-granting decision (approval or denial) and each variable is consistent with our expectations. This further suggests that the variables describe at least some part of the credit evaluation process. If a variable appears to have the opposite effect from what is expected, a closer look at the variable might be needed to root out possible input problems, such as a calculation error or an unusual observation (i.e., an outlier). Another consideration would be whether the variable measures an effect that is different from the intended effect. Measuring a different effect does not mean the variable should be removed from the analysis, but instead warns us that we may need to add additional variables because some component of the credit evaluation may have been omitted from our set of variables.

In the next section, we combine the variables in a regression model to determine whether the preliminary relationships between each variable and the credit-granting decision hold up when we let the variables work together to describe a loan applicant. We will also see whether, after controlling for these credit quality variables, group membership plays a role in the credit-granting decision.

THE PRIMARY SELF-MONITORING TEST FOR COMPLIANCE WITH THE ECOA

In the previous section, we defined our credit quality variables and calculated summary statistics for them. These statistics indicated that each individual variable tended to relate to credit quality within each demographic group in the manner that we anticipated. However, the variables show large differences between groups that prevent the summary statistics from providing any information about equal access to credit for traditionally underserved groups. Regression methods provide a way to measure how all of the credit quality variables work together to provide information about applicant credit quality and credit access across groups. In this section, we discuss our regression methods and the results from tests using the survey data.

Specifically, our regression is designed to determine whether businesses owned by underserved groups are granted credit at the same rate as white-male-owned businesses of the same credit quality. Regressions contain three types of variables: dependent variables, test variables, and control variables. Our credit quality variables become the control variables in our regression model because they are designed to control for credit quality differences across businesses. The test variables in each regression are the three business owner group variables (female, minority, and Hispanic), which are binary variables assigned a value of 1 if the business owner is a member of the group and 0 otherwise (for example, a business owned solely by an Hispanic woman would have these values: female = 1, minority = 0, and Hispanic = 1). Because we are trying to determine whether traditionally underserved groups have the same access to credit as white males do, the test variables are designed to compare businesses owned by underserved groups with businesses owned by white males.

The dependent variable is the decision on each business's most recent credit request, which is identified in the survey as approved or denied. This is a binary variable assigned a value of 1 if the credit request was approved and 0 if it was denied. When the dependent variable in a model is a binary variable, the standard (least-squares) regression model is inappropriate. A popular choice in this case, and the one we use here, is the logistic model. Other acceptable choices include the probit model and discriminate analysis.

Before estimating the regressions, we always test for pairwise collinearity among the control (credit quality) variables by estimating a correlation matrix. Previously, we discussed using sales as a credit quality variable. As an alternative to sales, we could use profits. However, profits and sales have a positive correlation of 0.84, which is large enough for the variables to be considered collinear. (Collinear means that the two variables closely resemble each other—changes in one are closely matched by changes in the other.) Collinearity is a problem in regressions because it causes the over-estimation of variances, which biases the test statistics against findings of significance. This creates the error of concluding that no relationship exists when, in fact, one does. The most common solution to the collinearity problem is to remove one of the variables from the regression model. We chose to report results using sales and excluding profits from the control variables because sales provided greater significance as a credit quality control variable. Replacing sales with profits in our tests does not qualitatively change the results we present. The largest remaining correlation is + 0.48, between total assets and total sales. Correlations of less than 0.50 between control variables in a regression are generally considered acceptable. The point being made here is that, before estimating any regression model, a lender must check the correlations between all the credit quality variables and usually remove one variable from each pair with a correlation of greater than 0.50.

Loan Denial Regression Results

Our test of the loan process consists of three logistic regressions that examine the impact of female, minority, and Hispanic ownership on credit decisions. The dependent variable is the respondent's answer to the question "What was the outcome of the most recent credit application by the business?"; this is coded as a dummy variable, with 1 indicating acceptance of the application and 0 indicating denial of the application. Each of the three test variables for the underserved groups (female, minority, and Hispanic) are set equal to 1 when the business is owned by members of the underserved group and 0 otherwise. When the business ownership group is white males, all three test variables are set equal to 0. The first of the three tests employs only the three test variables, the second employs the three test variables and the 18 credit quality control variables, and the third employs only the credit quality control variables.

The results of our tests are provided in Table 4. However, before we dive into the discussion of the regression results for compliance with the ECOA, we must discuss how to interpret them. For each control and test variable in a regression model, the computer program calculates two important pieces of information: a test statistic and a parameter estimate. The test statistic tells us how certain or confident we are that the parameter estimate is statistically different from 0, and the parameter estimate provides the size and direction of the relationship between the control or test variable and the dependent variable. A parameter estimate of 0 means that no relationship exists between a control or test variable and the dependent variable. However, parameter estimates in regressions are seldom exactly equal to 0, so we use tests to determine whether the parameter estimate is big enough for us to be confident that the real value of the parameter is different from 0. In our case, the test statistic that we report is a p-value. A p-value of less than 0.10 is generally accepted as evidence that the true parameter value is different from 0 (indicating a relationship between the test or control variable and the dependent variable), with the evidence becoming stronger as the p-value decreases in size.[9] We report p-values in parentheses beside each regression parameter estimate.

[9] Papers often discuss statistical significance levels of 10 percent (p-value ≤ 0.10), 5 percent (p-value ≤ 0.05), and 1 percent (p-value ≤ 0.01). A 10 percent significance level suggests 90 percent confidence that the parameter estimate is different from 0, while a 1 percent significance level suggests 99 percent confidence that the parameter estimate is different from 0. One problem in statistical analysis is that the sample may not have the same characteristics as the population. When we find, for example, that the percentage of minority-owned businesses with lines of credit differs in our sample from the percentage of white-male-owned businesses, we cannot be 100 percent certain that the percentages differ in the entire population of businesses. It is possible that our sample is different from the population. A confidence level tells us how certain we are that the differences observed in the sample are representative of the population. A significance level of 10 percent means that we are 90 percent certain that the observed difference is true of the whole population, while a 1 percent significance level indicates 99 percent confidence.

Table 4

Loan Process Model

	Univariate model	Full model	Control model
Intercept	2.09 (0.00)	–1.31 (0.13)	–1.85 (0.03)
Female	–0.40 (0.01)	–0.04 (0.83)	Omitted
Minority	–1.61 (0.00)	–0.87 (0.00)	Omitted
Hispanic	–0.33 (0.25)	0.00 (0.99)	Omitted
Size		0.13 (0.01)	0.15 (0.00)
Age		0.23 (0.03)	0.26 (0.01)
Equity		0.16 (0.02)	0.16 (0.02)
Leverage		–0.02 (0.65)	–0.02 (0.67)
Sales		0.04 (0.04)	0.04 (0.03)
Leases		–0.69 (0.00)	–0.63 (0.00)
Trade credit denied		–0.90 (0.00)	–0.91 (0.00)
Owner delinquent		–0.39 (0.07)	–0.51 (0.02)
Business delinquent		–0.68 (0.00)	–0.73 (0.00)
Accounts receivable		0.27 (0.14)	0.26 (0.15)
Inventory		–0.08 (0.68)	–0.05 (0.82)
Corporation		0.23 (0.19)	0.16 (0.34)
Business checking		1.23 (0.04)	1.49 (0.01)
Credit card		0.04 (0.81)	0.01 (0.94)
Line of credit		1.12 (0.00)	1.14 (0.00)
Vehicle loan		0.05 (0.75)	0.07 (0.66)
Equipment loan		0.12 (0.50)	0.15 (0.38)
MSA location		–0.40 (0.06)	–0.53 (0.01)
No. approved	1,695	1,462	1,462
No. denied	312	270	270
Model χ^2	1,625.66	1,181.09	1,194.92
Pseudo-R^2	5.65%	19.52%	18.59%

NOTE: p-values are in parentheses.

The first column of Table 4 verifies the summary statistics shown in Table 1. When no control variables are included, we find negative and statistically significant (p-value < 0.10) parameter estimates for female- and minority-owned firms and no significant impact (p-value > 0.10) for Hispanic-owned firms. The real value of this test is to verify that we have set up the logistic model correctly before we add the credit quality control variables.

The second column of Table 4 shows the impact of female, minority, and Hispanic ownership when credit quality is controlled for. Model χ^2 and pseudo-R^2 statistics suggest that our model has significant explanatory power in describing the credit evaluation process. The pseudo-R^2 statistic suggests that our model explains about 20 percent of the variation in the loan decision process. While this is reasonably good when this type of model is applied to such a large, diverse data set, it also means that much of the underlying loan process remains unexplained by the model.

Next, we look at the control variables to determine whether their parameter estimates are significantly different from 0 and have the expected sign. If the parameter estimates are significant and have the expected sign, our results our consistent with

the hypothesis that our empirical model describes the underlying loan decision process.[10] From the continuous variables, we again see, as expected, that larger, older businesses with more equity, more sales, and less leverage were more likely to have their loan requests approved. From the binary (yes/no) variables, we see, as expected, that previous credit problems make it more likely that a loan request will be denied and an existing relationship with a bank or other lender makes it more likely that a loan request will be approved.[11] With these controls in place, female ownership of a business does not have a significant impact on the loan decision process. Comparing this result to the average denial rates in Table 1 and the first column of Table 4 suggests that female-owned businesses are less likely to get loan requests approved because they are, on average, less credit worthy.[12] In contrast, despite these numerous credit quality controls, minority-owned businesses are significantly more likely to have loan applications rejected (as indicated by a negative sign on the parameter estimate and p-value of 0.00). This suggests that even after controlling for differences in credit quality, the fact that a business is minority owned (blacks, Asians, Pacific Islanders, Native Americans, or Alaska Natives) has a negative impact on the credit-granting decision. This result on minority-owned business applicants would suggest noncompliance with the ECOA and require corrective action by the lender.

The third column of Table 4 contains results for the model without the three test variables. These results are provided for two reasons. First, they allow us to see the additional explanatory power of race, ethnicity, and gender in our model, which is modest as the pseudo-R^2 rises from 18.59 percent to only 19.52 percent when the test variables are included. The female and Hispanic test variable parameters are insignificant, so only the minority variable contributes to the improved R^2. However, the small improvement in explanatory power indicates that, while minority-owned businesses are less likely to have loan applications accepted, race is not a primary factor in the loan decision process. Second, a comparison of the coefficients across columns 2 and 3 of Table 4 shows that the parameter estimates are consistent. This assures us that the significance of the coefficient on the minority variable is not due to a collinearity problem between control variables.[13]

Problems with Regression Results

In the previous section our results suggest that, after controlling for the credit evaluation process with our credit quality variables, businesses owned by females and Hispanics have similar access to credit as firms owned by white males. However, our results suggest that, even after careful control for the credit evaluation process, businesses owned by minorities have less access to credit than other businesses of similar credit quality. This result does not support complete lender compliance with the ECOA. But the result may come from one or more problems with the tests.

Let's retrace the steps we took to get to this point to see whether we can find any place where a problem may have occurred. The primary issue is whether traditionally underserved groups have the same access to credit as the majority. Our loan process data include loan applications from many businesses, including businesses owned by traditionally underserved groups—females, minorities, and Hispanics. Following the lead of previous studies on credit access, we define the majority group to be businesses owned by white males. Next, we determine that lenders make loans to applicants that the lender believes will have adequate future cash flow to repay the loan in accordance with the loan contract and have other indications of high credit quality. We identify a set of credit quality variables that we use in the lending decision process and make sure that each variable has an economic interpretation that warrants its inclusion as a credit quality indi-

[10] It may be that our model includes variables that are different from those used by actual lenders. However, if our control variables are highly correlated with the variables used by the lender, they will exhibit statistically significant parameter estimates and contribute to a higher model R^2.

[11] In addition to the control variables listed in Table 2, the reported tests also included binary variables for each one-digit SIC code to see whether firms in different industries experienced different lending decisions. The parameter estimates for these variables are not listed in Table 4, as none of them are significant at any conventional level. We also performed separate tests with controls for geographic region. These tests are not reported because none of the regional dummies was significant at any conventional level.

[12] For example, female-owned businesses are much smaller and younger than white-male-owned businesses. As we noted earlier, size and age are proxies for credit quality, so it appears that female-owned businesses are denied credit more frequently than white-male-owned businesses for rational economic reasons. Lenders should be careful not to use this "rational basis" argument too freely. The law states that even if an underwriting standard is nondiscriminatory on its face, it can be disallowed if it has a disparate impact on a protected class.

[13] We performed additional tests to determine the robustness of our results. In one, we examined the interaction between gender and ethnicity. Our results suggest that ethnic group is the dominant factor; however, some combinations of gender and ethnicity were quite small (for example, only 16 firms owned by Hispanic females had usable data), so our conclusions in this regard must be considered tentative.

cator. The summary statistics for the credit quality variables selected suggest that, within each demographic group, they have the expected relation to the accept/reject decision for the loan applications. Then we estimate a logistic regression model and find that the parameter estimates for credit quality variables have the expected signs, so the regression appears to work correctly. However, the final results on the test variables suggest that, while access to credit for female-owned businesses and Hispanic-owned businesses is similar to that of white-male-owned businesses, access to credit for minority-owned businesses appears to be lower.

This process is correct and well conducted, yet there are a couple of questions we can ask about our regressions. First, our full-model regression (Table 4, column 2) has a pseudo-R^2 statistic of only 19.52 percent. The pseudo-R^2 statistic describes how much of the credit evaluation process we are able to explain with our model, which means in our case that more than 80 percent of the process remains unexplained. It may be that we have failed to include information about the loan applicant that is relevant to the credit decision. Such a scenario is often referred to as an omitted variable problem and is a particular concern for self-monitoring by individual lenders. Specifically, if the model is developed correctly, as it was here, there is no indication of where to find the omitted variable(s). In addition, adding new variables to the model and testing their significance takes a great deal of time for data collection, if it is even possible, as there is a good chance that the data in question were not collected beforehand.

In our case, working with the survey data allowed us to include other variables easily, but we were unable to find any that could explain more of the credit evaluation process. That is, we were unable to find additional economic variables that added substantially to our ability to explain the lending process, let alone ones that helped to explain why minority-owned businesses are less likely to have a loan request approved than otherwise similar white-male-owned businesses. An issue related to the omitted variable problem is how to specify each variable. For example, we use total assets as our measure of firm size, but we specify the variable as the natural logarithm of total assets ($\ln(ta)$). Another common adjustment is to scale a dollar figure so that it is a percentage of the firm's total assets or sales (e.g., we specify inventory and accounts receivable as a percentage of total assets). In this case, we tried various variable definitions, and we report only the definitions for the best model (the model that explains the most about the credit evaluation process).[14]

A second possible problem with regression analysis for an individual lender is sample size. The minimum acceptable sample size for a statistical test on one variable is about 30 observations. However, for a regression model like ours with 18 control and 3 test variables, we should have at least 51 loan applications (30 plus the number of test and control variables) for each regression, with a balance between the underserved group and the majority. This is not a problem for our regression on minority-owned businesses, as Table 1 shows that our minority-owned sample contains 257 businesses. However, we can provide an example of the sample-size problem from the survey data. An additional survey variable allowed us to separate Native American–owned businesses from the full sample of minority-owned businesses. The Native American subsample contained only ten observations (eight approved and two denied), so regression analysis on this group of businesses using our model would not be appropriate. The small sample size of the Native American–owned businesses in the survey data demonstrates the potential for sample-size problems. It is easy to imagine that most small lenders would have difficulty achieving the necessary sample size for some underserved groups. There is no direct solution to this problem for an individual lender.

The two potential problems described above are not problems in our analysis. This means that our lender is left with the need to make adjustments to their credit analysis process so that minority-owned businesses get equal access to credit. This won't be easy because the answer won't be obvious. Remember, while the minority variable parameter estimate is statistically significant, having the minority variable in the regression model added only a little to the model's ability to explain the credit evaluation process. So a lender will need to adjust its process so that the marginal minority-owned business loan applicants get the same access to credit

[14] We also need to be careful not to try too many versions of a single variable. Our indicator of statistical significance (p-value ≤ 0.10) allows for possible error. For example, a p-value exactly equal to 0.05 means that we are 95 percent confident the true parameter value is not 0 but admit a 5 percent probability of being wrong. If we try more than one version of a particular variable and only one version exhibits a significant p-value, our probability of having made an error is significantly larger than indicated by the p-value. The problems related to trying multiple versions of the same variable and multiple combinations of control variables are grouped under the name "data snooping."

as the marginal white-male-owned businesses. In other words, a lender must make sure that, when giving "the benefit of the doubt" to marginal applicants, this benefit is given equally across all demographic groups.

A POSITIVE ROLE FOR BANK EXAMINERS AND REGULATORS IN THE SELF-MONITORING PROCESS

The process that we have discussed for self-monitoring is relatively straightforward and appears to address the issue of compliance with the ECOA. Unfortunately, compliance is not that simple, which is why we believe that there is an important role in the self-monitoring process for bank examiners and regulators. The reason is that some of the problems that exist in self-monitoring cannot be corrected by an individual lender.

First, many lenders, particularly smaller lenders, will encounter sample-size problems, just as we did in our example with respect to Native American–owned businesses. An individual lender's test sample is limited to the number of loan applications that the lender has processed, and for many small lenders this will provide an insufficient number of observations for regression analysis on some or all of the traditionally underserved groups. Bank examiners and regulators can do nothing to correct this problem on an individual lender basis. However, the newly collected demographic data, when combined with regulators and examiners' ability to monitor lending across the United States, will illuminate patterns not visible to individual lenders. If the need arises, regulators and examiners will be able to spread the word that a certain group or set of groups appears to be suffering from lending discrimination, despite controls for credit quality, allowing individual institutions to enhance their internal efforts.

Second, the only concern uncovered by our analysis is in providing equal access to credit for minority-owned businesses. However, outside research suggests that we missed some more subtle forms of limited access to credit for traditionally underserved groups. Cavalluzzo, Cavalluzzo, and Wolken (2002) use the same survey data that we use and show striking loan denial rate differences in less-competitive markets. In the least competitive banking markets, they find a denial rate for white-male-owned businesses of 27 percent accompanied by a 55 percent denial rate for minority-owned businesses. In addition, they show that in less-competitive banking markets, female-owned businesses are denied at a rate of 37 percent, whereas white-male-owned businesses are denied at a rate of 23 percent. They found these additional problems with equal credit access by using more advanced regression models[15] along with data on the level of local banking market competition. Data across lending markets is not directly available to individual lenders, so they would not be able to conduct this sort of analysis in their self-monitoring process. In addition, lenders in the less-competitive markets are typically the smaller lenders; so small sample sizes for the underserved groups are a likely problem. With a national (or regional) focus and access to cross-lender data, supervisors and regulators can see problems not visible to individual lenders.

Finally, as self-monitoring becomes prevalent, a number of lenders will begin to employ unfamiliar statistical tools (such as those described in this article). The examination process provides an opportunity for the lenders to ask knowledgeable sources about various statistical tools, models, and approaches to self-monitoring. Thus, the third role for regulators and examiners is to serve as sources of advice and information to lenders as they begin their self-monitoring efforts.

CONCLUSION

Reg B has been modified to allow lenders to collect demographic data on all loan applicants so they can self-monitor their compliance with ECOA requirements. Because this will be a new endeavor for most lenders, the purpose of this article is to discuss how individual lenders can self-monitor their compliance. We provided an example of this process using data from the 1993 Survey of Small Business Finances. In addition to describing the process, we discussed possible problems with our approach, particularly noting omitted variables and small sample size. We also discussed why regulatory oversight of self-monitoring is useful.

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Appendix

To provide empirical results for each step, we use a cross-section of small business lending decisions reported in the 1993 Survey of Small Business Finances that was conducted by Price Waterhouse for the Board of Governors of the Federal Reserve System. The survey contains usable responses (according to Price Waterhouse) for 4,637 firms.

An earlier version of this survey done in 1987 was the focus of a number of important studies, including the following: Petersen and Rajan (1994), which found that small businesses benefit from building close ties to a financial institution; Petersen and Rajan (1995), which found that concentration in the market for financial institutions adversely impacts the amount of institutional finance received by young firms; and Berger and Udell (1995), which found that borrowers with more established banking relationships pay lower interest rates and are less likely to pledge collateral. The survey done in 1993 was examined in Berger and Udell (1998), which showed how capital structure and sources of capital vary with firm size and age, and in Avery, Bostic, and Samolyk (1998), which compared the 1987 and 1993 surveys and found that personal guarantees by small business owners play a growing role in the allocation of credit.

The 2001 Recession: How Was It Different and What Developments May Have Caused It?

Kevin L. Kliesen

The U.S. business expansion that started in March 1991 and ended exactly a decade later lasted more than a year longer than the previous record-long 1961-69 expansion. On July 17, 2003, the arbiters of U.S. business cycles (the National Bureau of Economic Research [NBER]) declared that the 2001 recession ended some time in November 2001.[1] It was relatively short and, by some measures, shallow. Indeed, it bears some resemblance to the mild 1969-70 and 1990-91 recessions, which, respectively, followed the second- and third-longest expansions in U.S. history. Although the past two business cycles are consistent with the evidence that U.S. expansions have gotten progressively longer over time, and that recessions have become shorter, the mildness of the 2001 recession is perhaps surprising given the jarring economic developments that preceded it. In particular, the resiliency of the U.S. economy in the face of a boom and bust in U.S. equity markets and business outlays for capital equipment, as well as the economic disturbances caused by the fallout from the events of September 11, 2001, has been noted prominently by several policymakers and economists.

This article comprises two sections. The first section will discuss these developments in the context of the key differences between the 2001 recession and the "average" post-World War II recession. The second section will then attempt to ascertain, first, the extent to which forecasters were surprised by the recession and, second, what aspect of economic developments in the latter part of the 1990s and into 2000-01 surprised them. I accomplish the latter by examining forecast errors for real gross domestic product (GDP) growth and some of its major components from a macroeconometric forecasting model. Such an exercise may help determine whether some sector-specific shocks can be identified as potential causes for the recession.

COMPARING THE 2001 RECESSION WITH PREVIOUS POSTWAR RECESSIONS

According to the NBER's Business Cycle Dating Committee, which establishes and maintains the chronology of U.S. business cycles, the average recession (defined as the time from the peak to the trough) lasted 11 months during the post-World War II period.[2] The shortest of these downturns has lasted 6 months (1980), while the longest have lasted 16 months (1973-75 and 1981-82). Eliminating these extremes shows that recessions tend to average about 9 months. Hence, the 2001 recession, which ended in November 2001, was somewhat shorter than average.

The 2001 recession's relatively short duration is not the only unique characteristic that distinguishes it from other post-World War II recessions.[3] Another unique feature was its mildness, as seen by the decline in output (real GDP). Current national income and product account (NIPA) data indicate that real GDP rose 0.2 percent from the first quarter of 2001 (the peak quarter designated by the NBER Committee) to the fourth quarter of 2001 (the trough quarter according to the NBER). Economists have found that the severity of the recession importantly influences the magnitude of the recovery. That is, a deep recession tends to be followed by a strong recovery, but a mild recession tends to be followed by a mild recovery.[4] But does the length of the expansion say anything about the duration of the recession? Perhaps.

One notable characteristic of the 2001 recession

[1] See < http://www.nber.org/cycles/july2003.html > . In an article published in April 2003, this was also the date chosen by Chauvet and Piger (2003) using a type of Markov-switching model that was originally developed by Hamilton (1989).

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[2] See < http://www.nber.org/cycles > .

[3] Others who have noted the uniqueness of the 1991-2001 business cycle include Koenig, Siems, and Wynne (2002), Lansing (2003), and Nordhaus (2002).

[4] See Friedman (1964) or Balke and Wynne (1996).

Table 1

Economic Performance During Recessions Following the Three Longest Expansions and All Other Post-World War II Expansions

Expansion and contraction dates as determined by the NBER				Recession performance*		
Expansion dates	Expansion length (months)	Contraction dates	Contraction length	Real GDP	Nonfarm employment	Unemployment rate
3/91-3/01	120	3/01-11/01	8	–0.62	–1.34	2.10
2/61-12/69	106	12/69-11/70	11	–0.61	–1.47	2.70
11/82-7/90	92	7/90-3/91	8	–1.49	–1.63	2.80
A. Average, three longest	106.0		9.0	–0.91	–1.48	2.53
3/75-1/80	58	1/80-7/80	6	–2.19	–1.45	2.2
10/49-7/53	45	7/53-5/54	10	–2.72	–3.47	3.6
5/54-8/57	39	8/57-4/58	8	–3.71	–4.32	3.8
10/45-11/48	37	11/48-10/49	11	–1.67	–5.22	4.5
11/70-11/73	36	11/73-3/75	16	–3.40	–2.89	4.4
4/58-4/60	24	4/60-2/61	10	–1.59	–2.30	2.3
7/80-7/81	12	7/81-11/82	16	–2.86	–3.02	3.6
B. Average, all other post-1945	35.9		11.0	–2.59	–3.24	3.49
Percentage difference (A/B)	195.3		–18.2	–64.9	–54.3	–27.5
Test of correlation between long expansions and short recessions: Spearman rank-order test statistic				Test whether percentage differences (A/B) are statistically significant: Wilcoxon rank-sum test statistics		
–1.95				6	8	10

NOTE: November 2001 (fourth quarter) was the trough of the 2001 recession. A Spearman rank-order test statistic of 1.86 is significant at the 10 percent level. A Wilcoxon rank-sum test statistic of 6 is significant at the 2 percent level; a test statistic of 8 is significant at the 10 percent level.

*Percentage change from "local"-designated peak to trough for real GDP and nonfarm payroll employment. Unemployment rate is percentage point change from peak to trough.

was that it followed a record-long U.S. expansion. Indeed, the 1990-91 recession, which lasted 8 months, interrupted the nearly 18 years of continuous economic expansion that has been characterized as The Long Boom.[5] As seen by the critical value of the Spearman rank-order test statistic in Table 1 (significant at the 10 percent level), there is some evidence that long expansions tend to be followed by short recessions rather than long recessions.[6] The average of the three longest post-World War II economic expansions was 106 months, compared

[5] See Taylor (1998).

[6] The Spearman rank-order test ranks the expansions and contractions from longest to shortest. (Ties are assigned values of 0.5; for example, the two longest recessions of 16 months each receive a ranking of 1.5.) The null hypothesis is that there is no correlation between the ranking of expansions and contractions. See < http://www.nr.com > .

with nearly 36 months for all other post-World War II expansions. The average recession following the three longest expansions was 9 months, a little more than 18 percent shorter than all others.

Since the NBER uses monthly measures of economic activity to date peaks and troughs, their trough quarters do not always correspond to actual peaks and troughs of aggregate output.[7] Table 1 also shows that the actual peak-to-trough percentage decline in real GDP during the recessions following the three longest expansions was about 1 percent, versus 2.6 percent for all other post-World War II recessions. Moreover, the percentage decline in nonfarm employment and the percentage-point rise in the unemployment rate following the three longest expansions were about, respectively, 54 and 28 percent smaller than in the recessions that followed the other seven expansions. There is some statistical evidence that recession performance varies with the length of the business expansion. According to the Wilcoxon rank-sum test statistic reported in Table 1, the average percentage changes in real GDP and nonfarm payroll employment in recessions that followed the three longest recessions are significantly different from the average changes that followed all other expansions. The average change in the unemployment rate, however, is not statistically different in recessions following long or short expansions.[8]

The evidence presented in Table 1 suggests that recessions that follow long expansions tend (i) to be of shorter duration and (ii) to have smaller-than-average declines in output and payroll employment. The finding that recessions are milder after long expansions, which runs counter to Friedman (1964), might be that fewer imbalances accumulate over the course of long expansions, whereas expansions of a shorter duration end because of oil price shocks or an increase in inflation that exacerbates distortions to the price mechanism, thereby precipitating "tightening" actions by monetary policy policymakers. Over the final four quarters prior to the peak of the three longest expansions reported in Table 1, the consumer price index (CPI) inflation rate averaged about 4.5 percent; over the final four quarters of the remaining expansions, the inflation rate averaged 6.3 percent.

Table 2 details how several other important economic indicators fared during the 2001 recession relative to their postwar average. First, because of its relative mildness, the decline in nonfarm employment was well below average and the civilian unemployment rate rose by less than normal. Second, growth of real disposable personal income was stronger than normal, which helped to keep consumer spending growth at elevated rates. Strong growth of real disposable personal income reflected above-average growth of nonfarm labor productivity. The latter development also helped to restrain aggregate price pressures. Third, in contrast with previous recessions in which the stock market had started to rally before the trough, equity prices continued to fall throughout the 2001 recession, which helped to put downward pressure on business fixed investment (by raising the equity cost of capital).[9] Fourth, the decline in private inventory investment was the largest of any post-World War II recession. Finally, real exports during the 2001 recession fell by a much-greater-than-average amount. In particular, exports of capital goods to several important Asian markets fell sharply.

Ultimately, recessions occur because of economic developments that are of sufficient magnitude to alter expenditures by households and firms, thereby reducing aggregate demand, output, and employment. Accordingly, the causal factors behind various recessions may differ. Many economists have documented the role of international disturbances, technology shocks, energy price shocks, and actions taken by monetary policymakers to restrain an unanticipated rise in the general price level.[10]

The next section of the paper will discuss some of the developments that unfolded over the course of 1999 to 2001 that either mitigated or exacerbated the severity of the recession. The paper employs a well-known macroeconometric forecasting model to look at several developments that appear to have had a hand in shaping economic developments prior to and during the 2001 recession. Large forecast errors may reveal the unanticipated shocks that hit the U.S. economy during this period. Among the developments that will be discussed are the boom and bust in U.S. equity markets, the sharp decline

[7] For example, the NBER declared that the 2001 peak occurred in March (2001:Q1); however, real GDP actually peaked one quarter earlier (2000:Q4).

[8] The Wilcoxon rank-sum test is a nonparametric test. In this instance, the sum of the ranks for the percentage change in real GDP, nonfarm employment, and the unemployment rate are ranked from smallest to largest (N = 10) and classified as whether they occurred in the three longest recessions or the remaining seven recessions. The test statistic is simply the sum of the ranks of the longest recessions. See < http://www.stat.auckland.ac.nz/ ~ wild/ChanceEnc/ > .

[9] Equity prices are measured as end-of-period values, rather than quarterly averages.

[10] For example, see Fuhrer and Schuh (1998) or Zarnowitz (1992).

Table 2

Growth of Various Economic Series During Post-World War II Recessions (Percent Change)

	Averages excluding the 2001 recession			
	Average	High	Low	2001 recession
Real GDP	**–1.96**	–0.14	–3.40	**0.20**
PCE	**0.41**	3.28	–1.29	**2.18**
Durables	**–3.66**	16.35	–9.45	**10.15**
Nondurables	**–0.06**	2.69	–2.43	**1.14**
Services	**2.17**	3.59	–0.24	**1.13**
Fixed Investment	**–6.94**	–0.76	–16.26	**–6.16**
Nonresidential investment	**–7.59**	–2.99	–14.57	**–8.01**
Equipment & software	**–9.65**	–3.50	–18.44	**–7.32**
Structures	**–4.26**	4.09	–11.11	**–9.88**
Residential investment	**–6.31**	10.63	–30.18	**–0.93**
Inventory investment	**–0.56**	2.94	–3.18	**–3.61**
Government	**1.24**	5.95	–7.59	**3.64**
Exports	**–0.76**	10.00	–12.45	**–10.04**
Imports	**–4.54**	5.70	–13.96	**–6.04**
Nonfarm employment	**–2.20**	–0.79	–4.23	**–0.98**
Unemployment rate	**2.49**	3.50	0.90	**1.43**
S&P 500	**11.59**	22.89	–14.55	**–1.06**
CPI inflation	**3.93**	14.44	–2.20	**0.89**
Industrial production	**–7.30**	–3.37	–11.26	**–4.19**
Nonfarm productivity	**0.89**	3.68	–0.61	**2.23**
Real disposable personal income	**–0.24**	3.22	–3.31	**0.37**

NOTE: Period for the 2001 recession is 2001:Q1 to 2001:Q4. Percent changes are from NBER-designated peak quarters to NBER-designated trough quarters. Change in the unemployment rate is in percentage points.

in business capital expenditures for computers and software, the economic fallout from the events surrounding September 11, and the significant decline in the real value of U.S. exports.

WERE FORECASTERS SURPRISED BY THE RECESSION?

Finding the causes of the 2001 recession, or any recession, is often extremely difficult.[11] In the literature, finding the proximate cause (or shock) that precipitated a downturn in economic activity has taken many forms.[12] This article uses a large-scale macroeconometric forecasting model to identify structural changes in the U.S. economy. Specifically, I examine quarterly forecasts that are published in the last month of each quarter in the *Blue Chip Economic Indicators* (*BCEI*).[13] These are known as the *Blue Chip Econometric Detail* (*BCED*).[14]

[11] See Boldin (1994).

[12] These have included the identification of shocks, using vector auto regression (VAR) or real business cycle models, to changes in the major components of real GDP relative to trend. See Walsh (1993), Blanchard (1993), Hansen and Prescott (1993), and Hall (1993).

[13] The *BCED* are published in March (Q1), June (Q2), September (Q3), and December (Q4).

[14] Because no model is used to produce the Blue Chip Consensus forecast, the *BCED* uses Macroeconometric Advisers' macroeconometric model to produce detailed quarterly forecasts of output, prices, interest rates, profits, productivity, and other economic series. The *BCED* forecasts are based on the Blue Chip Consensus forecast.

Forecasters were surprised by the onset of the recession. Table 3 shows that, up until the September 11, 2001, terrorist attacks, Blue Chip forecasters generally believed that the odds of the U.S. economy falling into a recession within the next 12 months were fairly low. Although the percentage of those expecting a recession to develop within a year's time reached a high of 38 percent in April 2001, nearly nine in ten forecasters as of September 10, 2001, did not believe that the United States was in a recession. According to Figure 1, which plots the estimate of real GDP growth for the quarter in which the *BCED* is published (current-quarter forecast), Blue Chip forecasters were surprised by the strength of aggregate economic growth over the first two quarters of 2000, as seen by the relatively large current-quarter forecast errors for those two quarters. Over four of the next five quarters, though, forecasters over-estimated the strength of real economic growth—as seen by the real-time estimates of quarterly real GDP growth published in the *BCED*.[15] After September 11, forecasters expected a decline in output in the fourth quarter of 2001, as published in the December 2001 (2001:Q4) forecast. However, as seen by the relatively large negative forecast error (forecast less actual), this did not occur.

The difficulty with these macroeconomic analyses after the fact is that history is constantly being rewritten—especially, in this case, through the annual revisions that occur to the NIPA data published by the Bureau of Economic Analysis. NIPA data published in real time in Figure 1 showed that actual real GDP growth turned negative in only one quarter during this period: the third quarter of 2001. But, as seen in the boxed insert, the 2002 revisions were especially significant: With their publication in July 2002, real GDP was estimated to have declined in the first, second, and third quarters of 2001. Hence, one reason why the 2001 recession may have caught forecasters by surprise is that the real-time data offered little support for such a conclusion, which is why many forecasters viewed the NBER's decision in November 2001 to date the peak of the 1991-2001 business expansion in March 2001 as somewhat of a surprise (Table 3).

IDENTIFYING AND EVALUATING FORECAST SURPRISES

The abrupt switch from negative (under-predicted) to mostly positive (over-predicted) real GDP forecast errors in the third quarter of 2000 suggests when the shock may have occurred. To help sort through this issue, Table 4 lists the current-quarter forecast from the *BCED*, the real-time estimate as published in the subsequent *BCED*, and the current-quarter forecast error (the difference between the two). In addition to the growth of real GDP, I look at the growth of real personal consumption expenditures (PCE), real business (nonresidential) fixed investment, real residential fixed investment (RFI), and real net exports (in billions of 1996 chain-type dollars), nonfarm labor productivity, and the GDP chain-type price index. This section will discuss the pattern of forecast errors for these major econ-

Table 3

Recession Probabilities According to Blue Chip Forecasters, 2000-01 (Percent)

	Question posed: "What Are the Odds a Recession Will Begin Within…"	
Date	**12 months**	**24 months**
May 2000	18	33
June 2000	18	33
July 2000	19	31
August 2000	18	31
September 2000	16	29
November 2000	23	N/A
April 2001	38	N/A
May 2001	32	N/A

	Question posed: "Has the U.S. Slipped Into a Recession?"	
Date	**Yes**	**No**
February 2001	5	95
June 2001	7	93
July 2001	13	87
August 2001	15	85
September 10, 2001	13	87
September 19, 2001	82	18

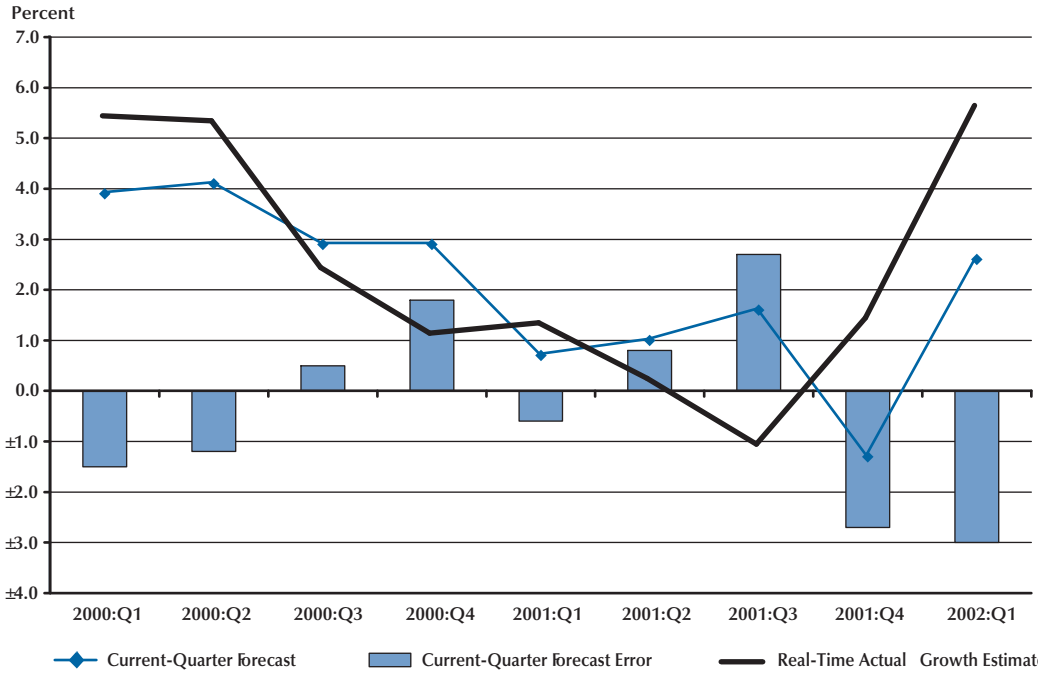
NOTE: On November 26, 2001, the NBER Business Cycle Dating Committee determined that the business cycle peak occurred sometime in March 2001.

SOURCE: *BCEI,* various issues.

[15] See footnote to Table 4 for a description of the timing of the current-quarter forecast and the real-time estimates.

Figure 1

Real GDP Growth: Current-Quarter Forecast and Forecast Error and Real-Time Actual Growth Estimate



omic variables in the context of the macroeconomic developments noted above. From this discussion, it is hoped that some identification of the likely shocks that caused the 2001 recession will emerge.

Consumer Spending

As seen in Table 2, real PCE usually increases slightly (about 0.5 percent) during the average postwar recession. This was true for the 2001 recession as well, but the increase in real PCE was relatively large (2.2 percent). On average, the pattern of consumer expenditures by type of good and service during a recession is quite different: Spending on consumer durables typically falls about 3.75 percent, while spending on services increases by a little less than 2.25 percent. Real expenditures on nondurable goods is about unchanged. Even though consumer expenditures on durables tends to fall sharply, the relative income inelasticity of consumer demand for services, combined with the fact that household spending on services (current dollars) is now a little more than 59 percent of PCE (versus roughly 41 percent in 1960), probably explains why total spending does not appreciably decline.[16]

On average, consumer expenditures on durable goods peak about two quarters prior to the business cycle peak; they then bottom out about one quarter after the trough. After showing relatively weaker growth in 2000 and early 2001, consumer durable goods purchases rose strongly well into the 2001 recession. The 10.2 percent increase for real consumer durables during the 2001 recession was surpassed only by the 1948-49 recession. Table 4 shows that forecasters generally were surprised by the strength of real PCE growth prior to and into the recession, which suggests that a shock to consumer spending was not a precursor to the recession. Indeed, this can be seen by the cumulative current-quarter forecast errors, which summed to a little more than –3 percentage points by 2001:Q1 (the NBER business cycle peak).

Part of this strength in consumer expenditures was manifested after the terrorist attacks on September 11: To counteract the expected drop in

[16] The share of consumer expenditures (current dollars) on nondurables has declined from about 46 percent in 1960 to about 30 percent currently. The other category, consumer durables, has varied much less, between 11 and around 14 percent.

Changing History: The 2001 Annual Revision to the NIPAs

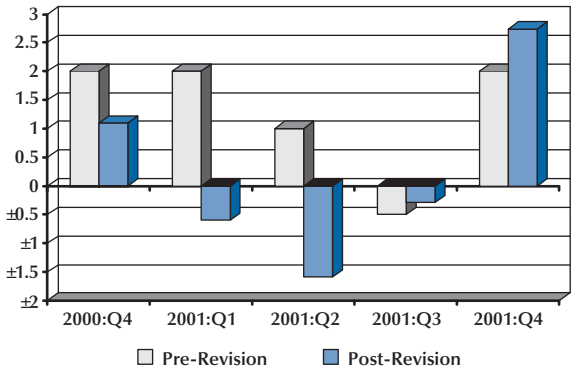
Each year, typically in late July, the Bureau of Economic Analysis releases revised estimates of the national income and product accounts (NIPAs). These revisions usually incorporate updated source data, but sometimes they also incorporate methodological changes.[1] Examples of the latter include the decision in October 1999 to classify business purchases of software as a fixed investment (rather than treat them, as before, as an intermediate expense). These annual revisions can dramatically alter the growth of NIPA data over the previous three-year period and, hence, perceptions of the economy's strength on the part of financial markets and policymakers.

Prior to the July 2002 annual revision, some economists were puzzled by the decision of the NBER Business Cycle Dating Committee to date the peak of the 1991-2001 expansion as March 2001. This was especially true given that real GDP growth remained positive during the first two quarters of 2001, only to turn negative during the third quarter of 2001, when the September 11 terrorist attacks shut down financial markets and a significant part of the nation's transportation system for several days. The economic importance of the terrorist attacks was seen in a survey of business economists by the National Association for Business Economics in February 2002.[2] According to this survey, the terrorist attacks were cited as the most important reason for the expansion's demise, which may explain why there was considerable disagreement between the NBER Business Cycle Dating Committee and other economists regarding the date of the recession's onset. Indeed, in the November 26, 2001, press release announcing the business cycle peak, the Committee said that "before the attacks, it is possible that the decline in the economy would have been too mild to qualify as a recession. The attacks clearly deepened the contraction and may have been an important factor in turning the episode into a recession."[3]

Figure B1

Real GDP Growth: Pre- and Post-July 2002

Percent Change, Annualized Growth



But the revised NIPA data released in July 2002 seemed to confirm the wisdom of the Committee's decision. The revision showed that the economy actually contracted during the first three quarters of 2001 (see figure), which correlates with the Committee's decision to date the peak as March 2001. Moreover, this annual revision seems to confirm the wisdom of the Committee's decision to not look at the behavior of real GDP growth when dating peaks and troughs. In fact, the NBER has stated that monthly nonfarm payroll employment "is probably the single most reliable indicator."

[1] See Fixler and Grimm (2003).

[2] Allyn (2002).

[3] See < http://www.nber.org/cycles/november2001/ > .

Table 4

Current-Quarter Forecasts and Forecast Errors for Major NIPA Series

	2000:Q1	2000:Q2	2000:Q3	2000:Q4	2001:Q1	2001:Q2	2001:Q3	2001:Q4	2002:Q1
Real GDP									
Current-quarter forecast	3.9	4.1	2.9	2.9	**0.7**	1.0	1.6	–1.3	2.6
Real-time estimate	5.4	5.3	2.4	1.1	**1.3**	0.2	–1.1	1.4	5.6
Current-quarter error	–1.5	–1.2	0.5	1.8	**–0.6**	0.8	2.7	–2.7	–3.0
Current-quarter cumulative error	–1.5	–2.7	–2.2	–0.4	**–1.0**	–0.2	2.5	–0.2	–3.2
Real PCE									
Current-quarter forecast	4.8	3.8	3.5	3.3	**2.1**	1.7	2.4	1.9	1.0
Real-time estimate	7.5	2.9	4.5	2.8	**2.9**	2.5	1.1	6.0	3.2
Current-quarter error	–2.7	0.9	–1.0	0.5	**–0.8**	–0.8	1.3	–4.1	–2.2
Current-quarter cumulative error	–2.7	–1.8	–2.8	–2.3	**–3.1**	–3.9	–2.6	–6.7	–8.9
Real BFI									
Current-quarter forecast	11.5	7.1	13.0	9.3	**3.3**	–6.0	–6.5	–16.5	–0.4
Real-time estimate	25.2	14.6	7.8	–0.6	**2.1**	–14.6	–9.3	–13.1	–8.2
Current-quarter error	–13.7	–7.5	5.2	9.9	**1.2**	8.6	2.8	–3.4	7.8
Current-quarter cumulative error	–13.7	–21.2	–16.0	–6.1	**–4.9**	3.7	6.5	3.1	10.9
Real RFI									
Current-quarter forecast	10.0	1.5	–13.2	–2.9	**–6.2**	–0.3	–3.3	–8.1	–2.0
Real-time estimate	5.2	0.0	–10.5	–3.4	**2.9**	5.8	2.5	–5.0	14.6
Current-quarter error	4.8	1.5	–2.7	0.5	**–9.1**	–6.1	–5.8	–3.1	–16.6
Current-quarter cumulative error	4.8	6.3	3.6	4.1	**–5.0**	–11.1	–16.9	–20.0	–36.6

sales, automobile manufacturers implemented special financing incentives, as light vehicle (passenger cars and light trucks) sales surged to a near-record pace of 21.1 million units (seasonally adjusted annual rate) in October. As a result, real consumer expenditures on motor vehicles and parts contributed 1.88 percentage points to fourth-quarter real GDP growth (2.7 percent), the largest contribution since the first quarter of 1971 (3.66 percentage points). Also helping to bolster real PCE growth was an upswing in purchases of non-automotive household durables.

What kept consumer spending relatively strong during the recession? Two factors stand out. First, these discretionary consumer purchases likely were boosted by the run-up in household wealth during the 1990s. Second, short-term interest rates were falling sharply prior to the onset of the recession, which helped to spur purchases of household durables (Figure 2). Typically, short-term interest rates, as viewed by yields on 3-month Treasury bills, peak about two months prior to the NBER peak. This time around, as seen in the upper portion of Figure 2, short-term interest rates peaked about four months prior to the onset of the recession (March 2001). A low, stable inflation rate may have been key in spurring subsequent aggressive reductions in the FOMC's intended federal funds rate target after the onset of the recession in 2001.

Table 4 cont'd

Current-Quarter Forecasts and Forecast Errors for Major NIPA Series

	2000:Q1	2000:Q2	2000:Q3	2000:Q4	2001:Q1	2001:Q2	2001:Q3	2001:Q4	2002:Q1
Real net exports									
Current-quarter forecast	–360.1	–384.6	–418.6	–427.3	**–440.3**	–417.5	–412.2	–410.0	–439.4
Real-time estimate	–372.9	–408.6	–425.0	–442.9	**–411.9**	–410.5	–408.1	–418.5	–443.7
Current-quarter error	12.8	24.0	6.4	15.6	**–28.4**	–7.0	–4.1	8.5	4.3
Current-quarter cumulative error	12.8	36.8	43.2	58.8	**30.4**	23.4	19.3	27.8	32.1
Nonfarm productivity									
Current-quarter forecast	1.6	2.8	2.0	1.3	**–0.8**	1.7	2.1	1.9	4.1
Real-time estimate	2.4	5.3	3.8	2.4	**–0.1**	2.5	2.7	3.5	8.6
Current-quarter error	–0.8	–2.5	–1.8	–1.1	**–0.7**	–0.8	–0.6	–1.6	–4.5
Current-quarter cumulative error	–0.8	–3.3	–5.1	–6.2	**–6.9**	–7.7	–8.3	–9.9	–14.4
GDP price inflation									
Current-quarter forecast	2.0	2.3	2.2	2.2	**2.4**	2.4	1.8	1.5	1.4
Real-time estimate	2.7	2.6	1.9	1.9	**3.2**	2.2	2.1	–0.3	1.0
Current-quarter error	–0.7	–0.3	0.3	0.3	**–0.8**	0.2	–0.3	1.8	0.4
Current-quarter cumulative error	–0.7	–1.0	–0.7	–0.4	**–1.2**	–1.0	–1.3	0.5	0.9

NOTE: The *Blue Chip Econometric Detail* estimates are published in the March, June, September, and December issues of *BCEI* dated the 10th of each month. For example, in the March issue, the current quarter forecast would be the forecast for real GDP growth in the first quarter. The real-time estimate of first-quarter real GDP growth was published in the June issue. The forecast error is defined as forecasted growth less actual growth.

SOURCE: *BCED*, various issues.

Residential Construction

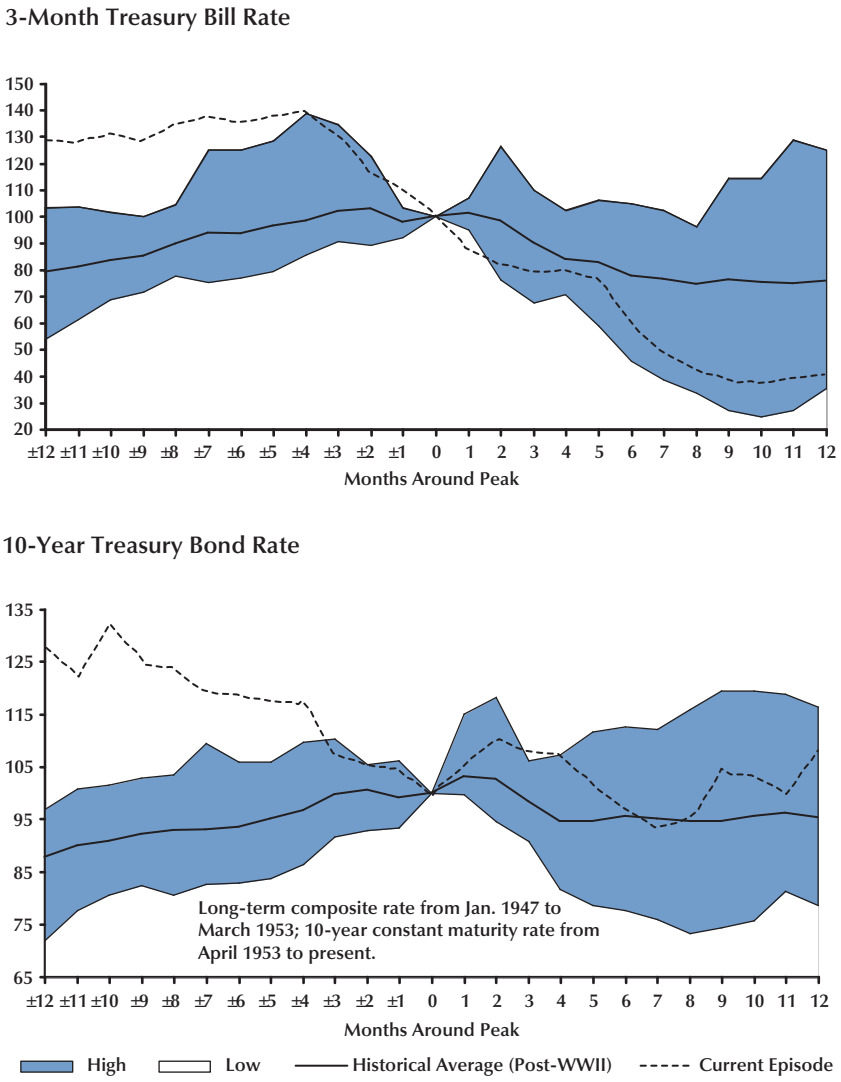
Real RFI typically turns down about 11 months before the business cycle peak, as rising interest rates (Figure 2) slow the pace of housing starts and new home sales. In similar fashion, the growth of real RFI was weakening significantly prior to the 2001 recession. Hence, one potential cause of the 2001 recession may have been a shock to the residential housing sector. Table 4 shows that forecasters generally were surprised by the magnitude of the decline in housing construction in 2000. By the fourth quarter of 2000, the cumulative forecast error for real RFI was a little more than 4 percentage points.

The unexpected decline in housing investment prior to the March 2001 business cycle peak may have resulted from rising interest rates. Conventional mortgage interest rates rose from about 6.75 percent in December 1998 to about 8.5 percent in April 2000; over the same period, the 12-month percent change in the core PCE chain-type price index rose only from 1.6 percent to 1.9 percent. The rise in nominal and real interest rates corresponded with a more restrictive monetary policy: From June 1999 to May 2000, the FOMC increased its intended federal funds target from 4.75 percent to 6.50 percent.[17] Moreover, as seen in the bottom portion of Figure 2, long-term Treasury rates were at historically high levels

[17] From June 1999 to June 2000, the real federal funds target rate, defined as the nominal rate less the 12-month change in the core PCE, rose about 150 basis points, nearly as much as the 175-basis-point increase in the nominal rate.

Figure 2

Movements of Short- and Long-Term Interest Rates During the 2001 Recession Relative to Previous Post-World War II Recessions



NOTE: The range of previous cycles denoted by the shaded areas excludes the 2001 recession and recovery.

(relative to previous postwar periods) prior to the 2001 business cycle peak.

Ironically, an unexpected decline in RFI may have helped trigger the onset of the recession; it also was an important factor tempering the severity of the 2001 recession. This can be seen in Table 4 as an abrupt switch from cumulative positive forecast errors for RFI growth to large cumulative negative forecast errors. In contrast with the typical pattern of growth after the business cycle peak, RFI strengthened in late 2000 and into the first two quarters of the recession. Referring back to Figure 2 helps to explain why. Yields on 10-year government securities usually top out about one month after the peak, but this time long-term rates peaked 10 months before the March 2001 business cycle peak. With mortgage interest rates also falling sharply, and real income growth remaining relatively strong (see Table 2), the housing sector benefited significantly.

International Trade

Another factor that may have helped push the economy into a recession was an unexpected decline in real net exports. During the 2001 recession, as seen in Table 2, real exports of goods and services fell about 10 percent, which was substantially larger than the average post-World War II recession decline of roughly 0.75 percent. There were two factors working against U.S. exports leading up to the recession. The first of these was an appreciation of the trade-weighted value of the U.S. dollar. After falling nearly 5 percent from August 1998 to August 1999, the real value of the U.S. dollar began to rise shortly thereafter.[18] By October 2000, the dollar was up nearly 13 percent from a year earlier. In addition to a price effect (an appreciation of the trade-weighted value of the dollar), growth of U.S. exports was tempered by a worldwide slowdown in economic activity, as world output growth slowed from 4.7 percent in 2000 to 2.3 percent in 2001.[19] The decline in exports during the 2001 recession relative to 1998-2000 was most pronounced in non-automotive capital goods and consumer goods and travel and transportation services. The largest percentage-point declines in U.S. real exports were generally for those destined for Asia: South Korea (–58.4 percent), Taiwan (–37.3 percent), and Japan (–37.1 percent).

Table 4 shows that the Blue Chip forecasting model (*BCED*) significantly underestimated the decline in real net exports during 2000. In real dollars, the average quarterly error was about $15 billion, or about 3.5 percent of the average value of real net exports over these four quarters.[20] The current-quarter cumulative forecast error was nearly $59 billion, or a little more than 14 percent of the average forecasted value of real net exports over these four quarters—although the Blue Chip model subsequently over-predicted the decline in real net exports during the recession.

Business Investment

Swings in business inventories typically account for a large percentage of the decline in output during a recession. As with most downturns, an unintended accumulation of business inventories relative to sales also preceded the 2001 recession. What was different this time is that the imbalance between inventories and sales was outside the range of previous downturns. As seen in Table 2, the peak-to-trough decline in real private inventory investment was 3.6 percent, which surpassed the previous largest decline of 3.2 percent seen during the 1948-49 recession. But since forecasters were generally surprised by the strength of consumer spending during the recession, it appears that the decline in business inventories may have been more of a reflection of faster-than-expected growth of household expenditures (unexpectedly drawing down inventories) rather than planned reductions in inventories that filtered back into production cuts at manufacturers. However, it is also clear that the response to September 11 by automotive manufacturers led to a sizable decline in auto inventories in the fourth quarter of 2001.[21]

The largest component of business investment is fixed investment (expenditures on capital goods and structures). BFI is also one of the most volatile indicators of business activity, and it usually accounts for a large percentage of the decline in output during the average recession. Table 2 shows that the 2001 recession was fairly typical in terms of business capital spending. For example, real BFI fell 8 percent in the 2001 recession, only modestly more than the average downturn (7.6 percent). Although the decline in real equipment and software expenditures (7.3 percent) was somewhat smaller than average (9.7 percent), the decline in business structures (9.9 percent) was significantly larger than average (4.3 percent).

The pattern of BFI spending before the business cycle peak was consistent with previous episodes in that, on average, growth of BFI turns negative about one quarter prior to the peak. As seen in Table 4, this was true prior to the 2001 recession. But as Figure 3 shows, this only held true for business expenditures on information processing equipment and software (hereafter high-tech equipment). Business investment in commercial structures and industrial equipment reached its peak concurrent with the NBER-dated business cycle peak; on the other hand, spending on transportation equipment

[18] This refers to the Federal Reserve Board's trade-weighted major currency index. The U.S. dollar is measured against currencies of the euro area (12 countries) and 6 additional countries. The real value uses the foreign consumer price indices to deflate the spot exchange rates.

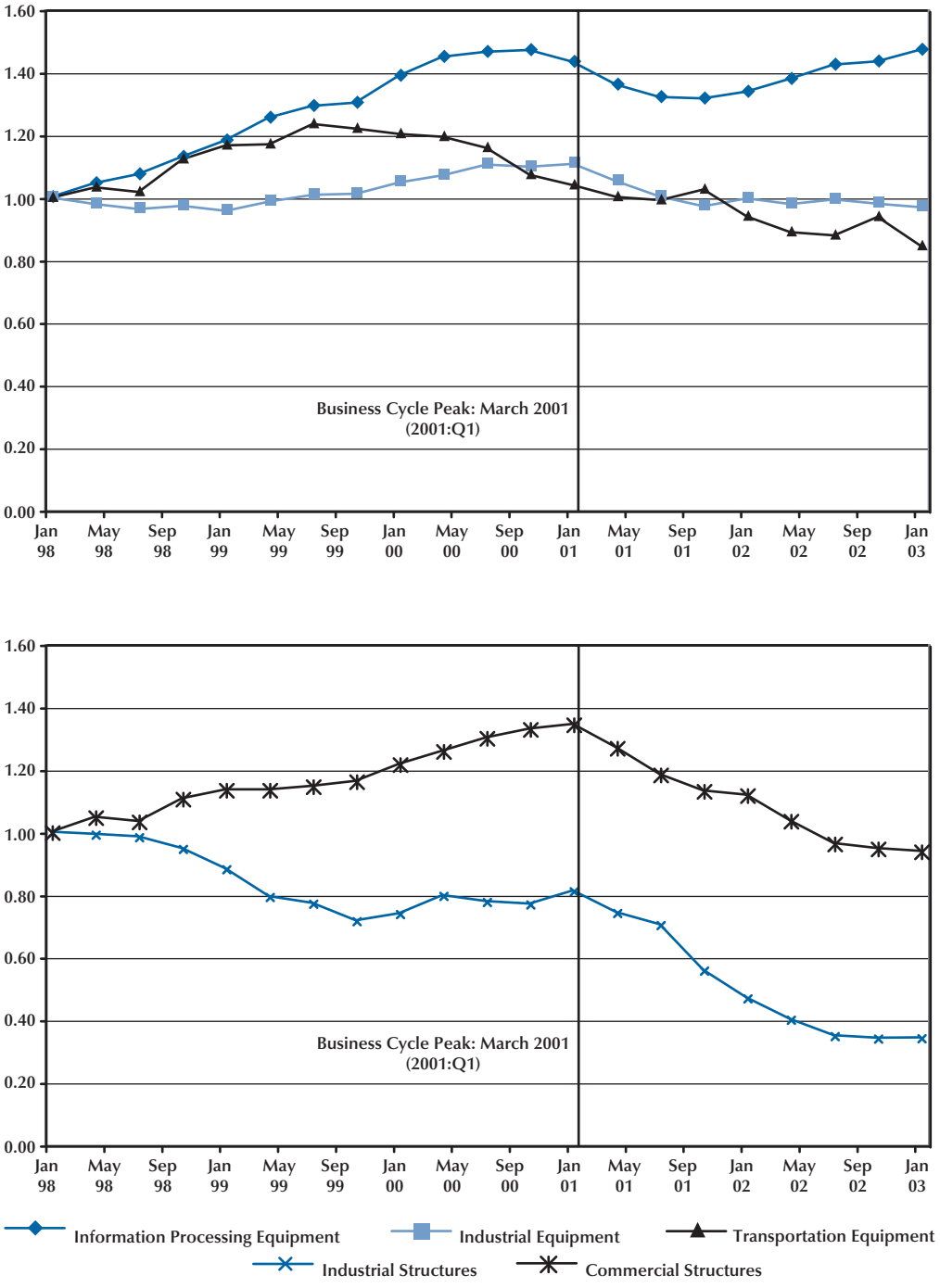
[19] International Monetary Fund (2003).

[20] The percentage error for real net exports is the current-quarter error divided by the actual value for that quarter.

[21] The real change in private inventories was –$98.4 billion in the fourth quarter of 2001. Of this, $33.5 billion was attributed to the change in real private automotive inventories.

Figure 3

Components of Real Business Fixed Investment
Index, 1998:Q1 = 1.0



peaked much earlier (1999:Q3) and industrial structures, although rebounding modestly from 2000:Q2 through 2001:Q1, remained below its level seen three years earlier. The weakness in business commercial structures may have been exacerbated by overbuilding. In the third quarter of 2000, the national commercial office vacancy rate (first reported in 1986:Q1) fell to a record low of 7.7 percent, while vacancy rates for industrial structures were little changed since the start of the business expansion in March 1991 (averaging around 8 percent). By 2003:Q1, the commercial vacancy rate had risen to a nine-year high of 16.4 percent and real fixed investment in commercial structures continued to decline.[22]

Table 4 shows that Blue Chip forecasters significantly under-predicted the strength of real BFI over the first half of 2000: The forecast error over this two-quarter period averaged 10.6 percentage points. Hence, perhaps the most significant shock that led to the 2001 recession was the unexpected decline in real BFI. Although the pace of BFI growth was clearly slowing, forecasters responded to these large negative errors by raising their projected growth over the second half of 2001. The result was the opposite: relatively large positive errors. Although fairly sizable negative *cumulative* forecast errors continued into 2001:Q1, the persistent overestimation by forecasters of the strength of BFI spending caused these cumulative errors to become significantly positive by 2002:Q1. It thus appears that forecasters were surprised not only by the sudden decline in BFI, but by the persistence of the decline.

One factor that may have spurred tremendous growth of business expenditures on commercial structures and real information processing equipment and software late in the expansion was the sharp rise in equity prices, which lowered the cost of capital to firms.[23] Presumably, the converse holds as well: Declines in equity prices raise the cost of capital and slow the growth of capital expenditures. Thus, although equity prices topped off well before the peak in high-tech or commercial structures, falling stock prices beginning in 2000 probably caused firms to reassess the feasibility of many planned outlays and, ultimately, delay or cancel several projects.[24] This is consistent with the growth of real BFI after the first quarter of 2000. Evidently, falling long-term rates were not a significant enough inducement to cause firms to increase planned outlays (see Figure 2). Hence, the timing of the declines in real BFI and the Nasdaq stock price index suggests some causation—if one believes the aforementioned cost-of-capital story that helped fuel the investment boom. It is also consistent with the timing of the large positive fixed investment forecast errors over the second half of 2000.

For computer equipment and software, an additional factor might have been precautionary capital expenditures by firms to eliminate Y2K computer glitches. But the largest potential Y2K-related investment contribution to real GDP growth probably occurred during the 1997-99 period, when expenditures on these goods were estimated to have contributed about 0.37 percentage points to real output growth, whereas total high-tech expenditures continued to increase strongly into the first half of 2000.[25]

Productivity and Prices

As seen in Table 2, nonfarm labor productivity rose 2.2 percent, more than a percentage point faster than during the average postwar recession. Strong labor productivity growth also helped to keep real disposable personal income growth positive during the recession (0.37 percent), rather than declining slightly as is typically the case. Hence, helping to underpin the strength of real consumer spending during the recession was relatively strong growth of nonfarm labor productivity. Table 4 shows that the relatively strong labor productivity growth was quite a surprise to forecasters. Over this nine-quarter period, forecasters underestimated quarterly labor productivity growth rates in each quarter. By 2002:Q1 the cumulative forecast error was 14.4 percentage points, an average of 1.6 percentage points per quarter. Recent empirical work on the

[22] The source for the national industrial vacancy rate is CB Richard Ellis; this measure of industrial vacancy rates begins in the first quarter of 1981.

[23] Caballero and Hammour (2002) argue that the rapid increase in stock prices in the latter part of the 1990s arose in part from the "emerging information technology sector" (investment boom) and the onset of fiscal surpluses. They argue that the fiscal surpluses may have arisen from the stock market boom and also helped fuel further investment by increasing aggregate saving. Tevlin and Whelan (2003) find that accelerated rates of depreciation and rapid rates of declines for prices of equipment explain much of the high-tech investment boom in the 1990s. They also argue that conventional models that do not use a disaggregated approach (high-tech and non-high-tech investment) thus could not account for the boom—nor, presumably, the bust.

[24] The Nasdaq and S&P 500 reached a peak in the first quarter of 2000; the Wilshire 5000 peaked in the third quarter of 2000.

[25] See Kliesen (2003).

sources of this productivity shock suggests much of it stemmed from the high-tech investment boom of the 1990s.[26]

Faster than expected productivity growth also helped to minimize growth of unit labor costs and aggregate inflation pressures. Although forecasters were surprised by the persistence of strong productivity growth, their inflation forecast errors were much smaller: From 2000:Q1 to 2002:Q1, the cumulative GDP inflation forecast error was 0.9 percentage points, or about zero when averaged over this period. By contrast, the cumulative real GDP forecast error was –3.2 percentage points.

CONCLUSION

When viewed across the expanse of post-World War II recessions, the 2001 recession was both relatively mild and of comparatively short duration. The 2001 recession and recovery was also unusual in several respects. First, in contrast to the typical downturn, spending on consumer durable goods and new residential housing continued to grow throughout the recession. The strength of these relatively interest-sensitive sectors reflected the steep declines in short- and long-term interest rates that started well before the onset of the recession—another distinguishing difference. Second, the 2001 recession was also notable for the sharp decline in exports and business investment in structures and inventories. Further, the declines in business capital spending were probably magnified by the sharp declines in equity prices during the recession, which helped to raise firms' financial cost of capital.

Identifying a cause of the recession is difficult. Using real-time forecast errors from Macroeconomic Advisers' forecasting model, which incorporates the Blue Chip Consensus forecast, it appears that shocks to investment by businesses and households were important factors. Another significant factor appears to be the unexpected declines in real net exports in 2000, which likely exacerbated the shock to the capital goods sector. Offsetting these shocks were unexpectedly large increases in labor productivity growth. This productivity shock helped to keep growth of real disposable income at an elevated rate during the recession.

[26] See Jorgenson, Ho, and Stiroh (2002) and Oliner and Sichel (2002).

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A Reconstruction of the Federal Reserve Bank of St. Louis Adjusted Monetary Base and Reserves

Richard G. Anderson and Robert H. Rasche, with Jeffrey Loesel

This paper summarizes the results of a benchmark reconstruction of the adjusted monetary base and adjusted bank reserves data of the Federal Reserve Bank of St. Louis. With this revision, these series include monthly figures from December 1917 to the present and biweekly figures from February 1984 to the present.[1] 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 as follows:

- 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.[2] 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 RAM from September 1935 to October 1980 have been changed to correct calculation errors. The changes are discussed in detail below.
- As of January 1994, the previously published RAM was replaced with the Anderson and Rasche (2001) adjustment that interprets a bank's implementation of a retail-deposit sweep program as being equivalent to a reduction in its statutory reserve requirement. This change increases the adjusted monetary base and adjusted reserves by approximately $18 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.[3] Given this shift in monetary policy analysis, some readers of this article may question the value of reconstructing the St. Louis measure of the adjusted monetary base. We briefly address that question here.[4]

In a recent paper, Nelson (2002b) attributes the

[1] The data in this article end as of September 2002.

[2] Figures on the adjusted monetary base for 1917 to 1935 have been available on the Federal Reserve Bank of St. Louis Research Division web site (< research.stlouisfed.org >) since publication of Anderson and Rasche (1999). They have not previously been combined with later figures in a consistent format.

Richard G. Anderson is a vice president and economist and Robert H. Rasche is a senior vice president and director of research at the Federal Reserve Bank of St. Louis. Jeffrey Loesel is a research associate at the Committee for Economic Development, in Washington, D.C. The reconstructed RAM for 1936-80 shown in this article largely was built by Jeffrey Loesel, then of Swarthmore College, during an internship at the Federal Reserve Bank of St. Louis. Marcela Williams, William Bock, and Michelle Meisch provided research assistance. Views expressed are those of the authors and not necessarily those of the Federal Reserve Bank of St. Louis, the Board of Governors of the Federal Reserve System, or the Committee for Economic Development.

[3] The monetary base, or "outside money," continues to appear in theoretical structural models, e.g., Sargent (1987, Chap. I to 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.

[4] Interested readers may consult Nelson (2002a,b) for further analysis.

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 gross domestic product (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 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, 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, inflation will follow. Hence, observations on the monetary base may be useful in understanding ex post, if not ex ante, the effects of central bank actions.[5]

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.[6] It is true 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 by controlling the growth of the monetary base is more difficult and generally less successful than by controlling 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 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 that emphasizes that monetary policy actions induce substitution by households and firms among a large number of assets.[7] 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.[8]

The recent nearness-to-zero of policy-target rates in the United States and Japan has further stimulated discussion of the role of the monetary

[5] Allan Meltzer's recent history of the Federal Reserve System (Meltzer, 2003), for example, cites several episodes, such as 1920-21, 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 Nelson (2002b, footnote 32). Meltzer's analysis uses the St. Louis adjusted monetary base figures developed in Anderson and Rasche (1999).

[6] See, for example, McCallum (2001).

[7] See Brunner and Meltzer (1963, 1968) and Friedman and Schwartz (1963, 1982).

[8] Meltzer (2001a) 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 United Kingdom.

base as a policy indicator.[9] 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 as those liabilities of the monetary authorities that households and firms use as media of exchange and that depository institutions use to satisfy statutory reserve requirements and to settle interbank debts.[10] 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 base are averages of daily figures. Previously, some monthly figures were averages of daily figures (before 1959 and after early 1989), but some were not: 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 our monetary base figures replicable from published data.[11] With respect to its impact on the time-series behavior of the monetary base, this change is largely a technical revision. From January 1959 through 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 series.

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 could be measured easily because these deposits are liabilities of the Federal Reserve Banks and, hence, appear on Reserve Bank balance sheets. Unfortunately, at least for measurement of the monetary base, balance sheet figures are hard to come by: 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.[12] 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."[13] Although this proxy satisfies our criterion to provide a monthly average of daily figures, it differs from our ideal deposit figure by 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

[9] See McCallum (1993, 2003) and Meltzer (2001b).

[10] 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.

[11] The following publications are from the Board of Governors of the Federal Reserve System: For months prior to January 1991, figures are from *Banking and Monetary Statistics* (1943 [1976], 1976) and various issues of the *Annual Statistical Digest*. Beginning January 1991, figures are from the weekly H.4.1 data release and the *Federal Reserve Bulletin* table "Reserves of Depository Institutions and Reserve Bank Credit." In the January 2003 issue of the *Bulletin*, this is Table 1.11, p. A5. Additional details regarding data sources are contained in the appendix to this article.

[12] See the January 2003 issue of the *Federal Reserve Bulletin*, Table 1.18, p. A10, "Federal Reserve Banks: Condition and Note Statements." Deposits held by depository institutions at Federal Reserve Banks are shown in line 25.

[13] See the January 2003 issue of the *Federal Reserve Bulletin*, Table 1.11, p. A5, "Reserves of Depository Institutions and Reserve Bank Credit." Reserve balances are shown in line 25 and service-related balances are shown in line 22.

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 with published monthly figures of 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.

ADJUSTING 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.[14] RAM measures how 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 τ, affect monetary base demand.[15] If the reserve-requirement regime in effect during the current period, t, is the same as the regime during the base period, τ, 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 through October 1980, values are calculated from aggregate weekly figures.[16] Beginning October 1980, values are calculated from the weekly figures of individual banks, 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.[17] Beginning January 1991, the calcula-

[14] 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).

[15] 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 zero 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.

[16] 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.

[17] Since 1981, RAM has become more complicated: 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 that 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. 57-58).

tions 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.[18] 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)[19]:

- 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 and bank reserves, was

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

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

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

which displays one month prematurely the effect of changes in reserve-requirement ratios. Our new calculation, which supercedes previously published figures, contains no lags:

$$RAM(1935)_t = \sum_j \left(r_{j,\tau} - r_{j,t}\right) D_{j,t}.$$

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.[20]

For the period 1935-49, 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 1). 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, 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 τ had been in effect, the RAM adjustment for period t relative to period τ is

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

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

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

[19] The first segment, RAM(1922), is unchanged from the figures in Anderson and Rasche (1999).

[20] 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.

Table 1

Supplemental and Marginal Reserve Requirements, 1969-80

Date	Change in requirements
October 1969–August 1978	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 related foreign offices plus certain loans by related foreign branches to U.S. residents and (Regulation D) on borrowings by domestic banking offices from foreign banks. Ratios: • 10 percent effective October 16, 1969; • increased to 20 percent, January 7, 1971; • reduced to 8 percent, June 21, 1973; • reduced to 4 percent, May 22, 1975; • reduced to zero, August 24, 1978. Originally, the requirements applied only to amounts 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 March 14, 1974 (thereby increasing the total requirement). Smaller loans and loans at banks with smaller aggregate amounts were excluded.
June 1973–December 1974	"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 October 3, 1973, and for (c) from July 12 through October 3, 1973; 11 per cent from October 4 through December 26, 1973; and 8 per cent from December 27, 1973, through September 18, 1974. Beginning September 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 December 12, 1974, the remaining marginal reserve on this type of obligation issued to mature in less than 4 months was removed." (*Annual Report* of the Board of Governors of the Federal Reserve System for 1976, Table 13)
August 1978	For the maintenance period beginning August 24, 1978, requirements were • reduced to zero percent from 4 percent on net Eurocurrency liabilities of domestic banks to their own foreign branches; • reduced to zero percent from 1 percent on deposits that foreign branches of domestic banks lend to U.S. residents; • reduced to zero percent from 4 percent on borrowings of domestic banks from unrelated banks abroad.

Table 1, cont'd

Supplemental and Marginal Reserve Requirements, 1969-80

Date	Change in requirements
November 1978	Effective with the maintenance period beginning November 2, 1978, a 2 percent supplementary reserve requirement on time deposits of $100,000 or more, obligations of affiliates, and ineligible acceptances was imposed.
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	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 was imposed 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 maturities of less than a year, Eurodollar borrowings, repurchase agreements against U.S. government and federal agency securities, and federal funds borrowings from nonmember institutions.
	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.
	For Eurodollar borrowings, loans made by foreign offices of member banks to U.S. residents, and for 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 percent.
	For repurchase agreements against U.S. government and federal agency securities, the marginal requirement increased to 8 percent from zero percent.
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 zero percent from 5 percent; and the supplementary reserve requirement on large time deposits, implemented November 1978, was reduced to zero percent from 2 percent.

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

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

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

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

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 requirements was zero during the base period, τ.

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 indices 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 as follows:

$$f_1 = \frac{MB_{1935:8} + RAM(1935)_{1935:8}}{MB_{1935:8} + RAM(1922)_{1935:8}}$$

$$f_2 = \frac{MB_{1972:12} + RAM(1972)_{1972:12}}{MB_{1972:12} + RAM(1935)_{1972:12}}$$

$$f_3 = \frac{MB_{1975:1} + RAM(1975)_{1975:1}}{MB_{1975:1} + RAM(1972)_{1975:1}}$$

$$f_4 = \frac{MB_{1980:10} + RAM(1991)_{1980:10}}{MB_{1980:10} + RAM(1975)_{1980:10}}.$$

Then, the adjusted monetary base is calculated as

$$AMB_t$$
$$= \prod_{i=1}^{4} f_i * \left(MB_t + RAM(1922)_t\right), \quad t = 1917{:}12, \ldots, 1935{:}8$$
$$= \prod_{i=2}^{4} f_i * \left(MB_t + RAM(1935)_t\right), \quad t = 1935{:}8, \ldots, 1972{:}12$$
$$= \prod_{i=3}^{4} f_i * \left(MB_t + RAM(1972)_t\right), \quad t = 1972{:}12, \ldots, 1975{:}1$$
$$= f_4 * \left(MB_t + RAM(1975)_t\right), \quad t = 1975{:}1, \ldots, 1980{:}10$$
$$= \left(MB_t + RAM(1991)_t\right), \quad t = 1980{:}10, \ldots$$

For the adjusted monetary base, the splice factors f_1, f_2, f_3, f_4 have values of 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.[21] 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 the Board's *Banking and Monetary Statistics, 1941-1970* (1976, Table 1.1B, p. 20). For December 1917 through December 1946, our figures are from Friedman and Schwartz (1970, Table 1, pp. 16-37).[22]

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.

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 1918-32 based on the

[21] See the January 2003 issue of the *Federal Reserve Bulletin*, Table 1.21, p. 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).

[22] 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, Chap. 12); for discussion of later periods, see Anderson and Kavajecz (1994).

seasonal patterns identified in Anderson and Rasche (1999) and, as in that article, include for 1933-49 the seasonally unadjusted figures.

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, and 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 2. Some of the terms are simple 0-1 dummy variables, while others, such as the "ramp" and "temporary change" adjustment, are more complex.[23] The fitted model's intervention terms are used to remove outliers from the data prior to estimation of seasonal factors; this is done by means of the enhanced X-11 routines. In addition, the fitted model is used to forecast the series 24 months into the future prior to estimation with X-11.[24] 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 2. 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 the other spans December 1999 to February 2000.[25] 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 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 the relatively higher volatility of reserves. 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.[26]

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 with 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 so that the final seasonally adjusted biweekly levels average to the seasonally adjusted monthly levels for historical data.[27]

[23] The "ramp" intervention term fits a straight line 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.

[24] 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 with 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.

[25] Although our two ramp adjustments resemble a linear spline, we do not force the end of the first segment to be attached to the beginning of the second segment.

[26] In our estimation, we do not include variables for the shift from lagged to near-contemporaneous reserve accounting in February 1984 and the shift from contemporaneous to lagged reserve accounting in July 1998.

[27] For future periods, we project separately the future monthly and biweekly seasonal adjustment factors.

Table 2

ARIMA Models Used in Seasonal Adjustment of the Adjusted Monetary Base and Adjusted Reserves

Intervention variables used in ARIMA models

AO: Additive outlier at date t_0

$$AO_t^{(t_0)} = \begin{cases} 1 & \text{for} \quad t = t_0 \\ 0 & \text{for} \quad t \neq t_0 \end{cases}$$

LS: Level shift at date t_0

$$LS_t^{(t_0)} = \begin{cases} -1 & \text{for} \quad t < t_0 \\ 0 & \text{for} \quad t \geq t_0 \end{cases}$$

TC: Temporary change at date t_0, with decay at rate α back to the previous level ($0 < \alpha < 1$)

$$TC_t^{(t_0)} = \begin{cases} 0 & \text{for} \quad t < t_0 \\ \alpha^{t-t_0} & \text{for} \quad t \geq t_0 \end{cases}$$

RP: Ramp between date t_0 and date t_1

$$RP_t^{(t_0,t_1)} = \begin{cases} -1 & \text{for} \quad t \leq t_0 \\ (t-t_0)/(t_1-t_0) & \text{for} \quad t_0 < t < t_1 \\ 0 & \text{for} \quad t \geq t_1 \end{cases}$$

A. Model for the adjusted monetary base

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

Intervention variables (I)	Parameter estimate	Standard error
Constant	0.0001	0.00292
*TC*1981.*Jan*	–0.0104	0.00236
*RP*1999.*Sep*-1999.*Dec*	0.0143	0.00001
*TC*1999.*Dec*	0.0193	0.00387
*RP*1999.*Dec*-2000.*Feb*	–0.0249	0.00281
*TC*2000.*Jan*	0.0133	0.00347
*TC*2001.*Sep*	0.0347	0.00327
*TC*1952.*Apr*	–0.0103	0.00297
*AO*1954.*Jan*	0.0080	0.00229
*AO*1975.*May*	–0.0091	0.00227
φ_1	0.2247	0.04059
φ_2	0.1890	0.04152
φ_3	0.0489	0.04096
θ	0.6672	0.03090

Table 2, cont'd

ARIMA Models Used in Seasonal Adjustment of the Adjusted Monetary Base and Adjusted Reserves

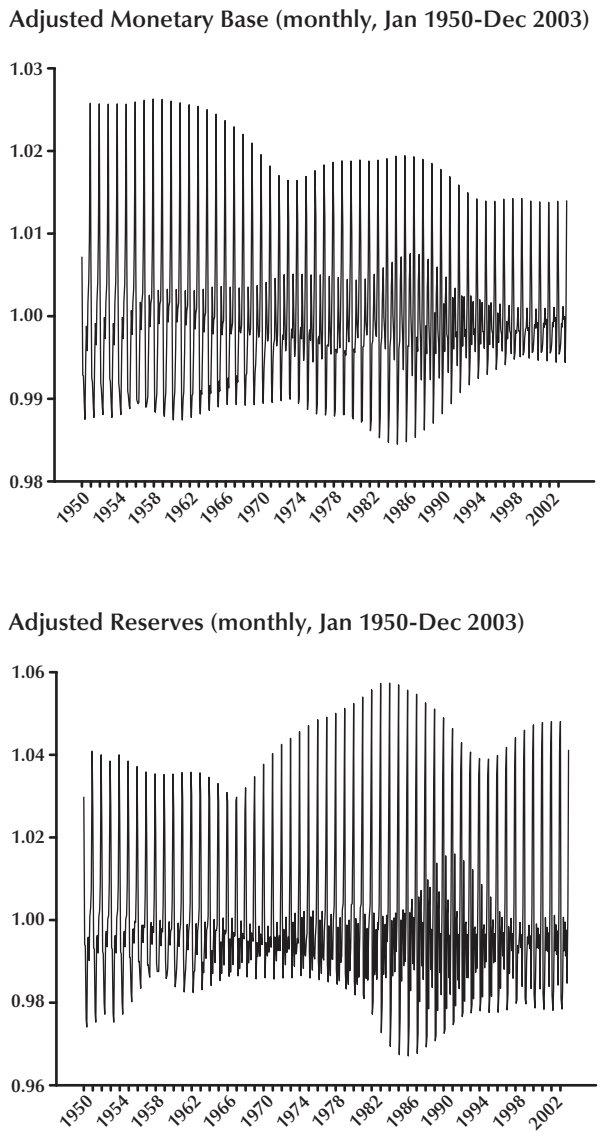
B. Adjusted reserves

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

Intervention variables (I)	Parameter estimate	Standard error
Constant	0.0001	0.00292
*RP*1999.*Sep*-1999.*Dec*	0.0886	0.00467
*RP*1999.*Dec*-2000.*Feb*	–0.1257	0.00547
*AO*1951.*Apr*	0.0282	0.00797
*LS*1980.*Dec*	–0.0375	0.00866
*LS*1982.*Mar*	–0.0333	0.00866
*TC*1982.*Jul*	–0.0304	0.00836
*LS*1984.*Aug*	–0.0316	0.00866
*AO*1985.*Dec*	0.0426	0.00776
*AO*1986.*Feb*	–0.0259	0.00774
*LS*1986.*June*	0.0318	0.00879
*TC*1986.*Nov*	0.0314	0.00842
*LS*1986.*Dec*	0.0515	0.00879
*AO*1987.*May*	0.0326	0.00778
*LS*1989.*Feb*	–0.0522	0.00951
*TC*1989.*Mar*	0.0364	0.00917
*AO*1990.*Feb*	–0.0350	0.00784
*AO*1990.*Dec*	0.0320	0.00783
*AO*1991.*Dec*	0.0322	0.00795
*LS*1992.*Mar*	0.0427	0.00890
*LS*1992.*Sep*	0.0347	0.00870
*AO*1999.*Sep*	0.0407	0.00895
*TC*2001.*Sep*	0.2086	0.00980
*LS*2001.*Oct*	–0.0705	0.01000
φ_1	0.2159	0.04152
φ_2	0.1305	0.04046
θ_1	0.3867	0.03828
θ_2	0.6104	0.03294

Figure 1

Seasonal Factors for the Adjusted Monetary Base and Adjusted Reserves



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.[28] The Anderson-Rasche variant of RAM(1991) must be estimated from panel data on individual banks because each bank has complete discretion regarding when (and whether) 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 (2001) is that many banks, previously constrained by statutory reserve requirements, have been able 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.[29] In that analysis, banks that are constrained by statutory reserve requirements are referred to as *economically bound*, or *e-bound*; banks not so-constrained are referred to as *economically non-*

[28] Retail-deposit sweep programs function as follows: 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 point, see also Anderson (2002).

[29] For a bank to be included in our panel data set, 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 categories mentioned in the text are implemented in our analysis by means of 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).

Table 3

The Five Segments of the Reserve Adjustment Magnitude

Date span	Date of base period statutory reserve requirements	Description
RAM(1922): August 1917–August 1935	July 1922	On July 1, 1922, St. Louis was classified as a reserve city, rather than a 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): September 1935–December 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): December 1972–January 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): January 1975–October 1980	January 1975	Time deposits became subject to a graduated system of requirements that also depended on deposit maturity.
RAM(1991): November 1980 to 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 percent reserve requirement.

bound, 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.

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 programs, 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 becomes 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 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 by means of 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, $D_{30Sep2002}$ denotes their aggregate net transaction deposits (including deposits involved in retail-deposit sweep programs), RR_b denotes 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).[30] Then, in the absence of figures on individual banks, we extend $RAM(1991)_t$ forward, for periods $t > 26Dec2001$, with 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 reserves at all banks;

$$\delta_D = \frac{D_b}{AggD_b},$$

where D_b is the transaction deposits of e-bound banks during the benchmark reserve maintenance period; and

$$\delta_R = \frac{RR_b}{AggRR_b},$$

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 PREVIOUS AND REVISED ADJUSTED MONETARY BASE

Differences between our revised series and the previously published figures are shown for the monetary base and adjusted reserves, respectively, in Figures 2 and 3. For clarity, the time series are separated into three segments—1936-58, 1959-79, and 1980-2002. Note that the vertical scales differ.[31] In each figure, the charts in panel A compare the levels of the series and the charts in panel B compare the compound annual growth rates.

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 1936-68, 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 large revi-

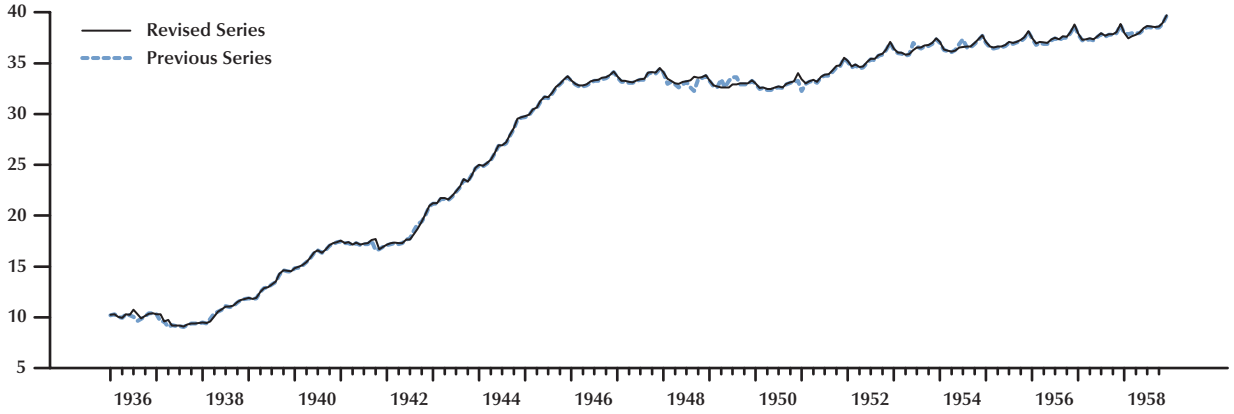
[30] The low-reserve tranche and reserve-exemption amounts are subject to statutory reserve-requirement ratios of 3 percent and zero, respectively. For the reserve maintenance period ending January 9, 1991, the low-reserve tranche was $41.1 million and the reserve-exemption amount was $3.4 million. For the benchmark reserve maintenance period ending September 30, 2002, the amounts were $42.8 million and $5.5 million.

[31] 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 1947.

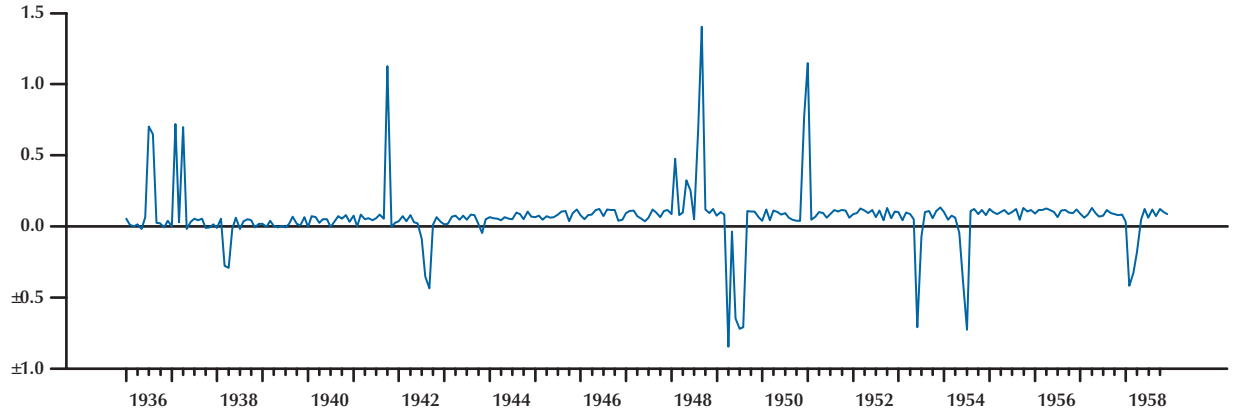
Figure 2

Adjusted Monetary Base, Revised and Previous Series

A.
Levels, Part 1 (billions of dollars, not seasonally adjusted, monthly, 1936-58)



Revised Series Minus Previous Series, Part 1 (billions of dollars, not seasonally adjusted)



sions to some monthly growth rates during 1936-37, late 1941, and late 1961. (Once again, note the differences in vertical scale.)

SUMMARY

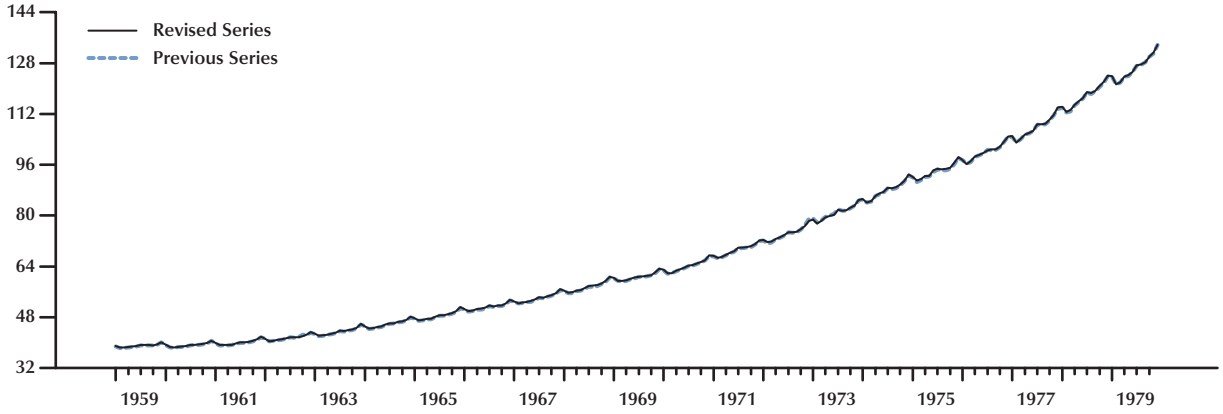
This analysis has summarized the results of an extensive reconstruction of the Federal Reserve Bank of St. Louis adjusted monetary base and adjusted reserves. Minor revisions have been made to the monetary (source) base such that it is now measured for all periods, as closely as is feasible, as an average 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 in 1991. Seasonal adjustment factors also have been updated.

Figure 2 cont'd

Adjusted Monetary Base, Revised and Previous Series

A.

Levels, Part 2 (billions of dollars, not seasonally adjusted, monthly, 1959-79)



Revised Series Minus Previous Series, Part 2 (billions of dollars, not seasonally adjusted)

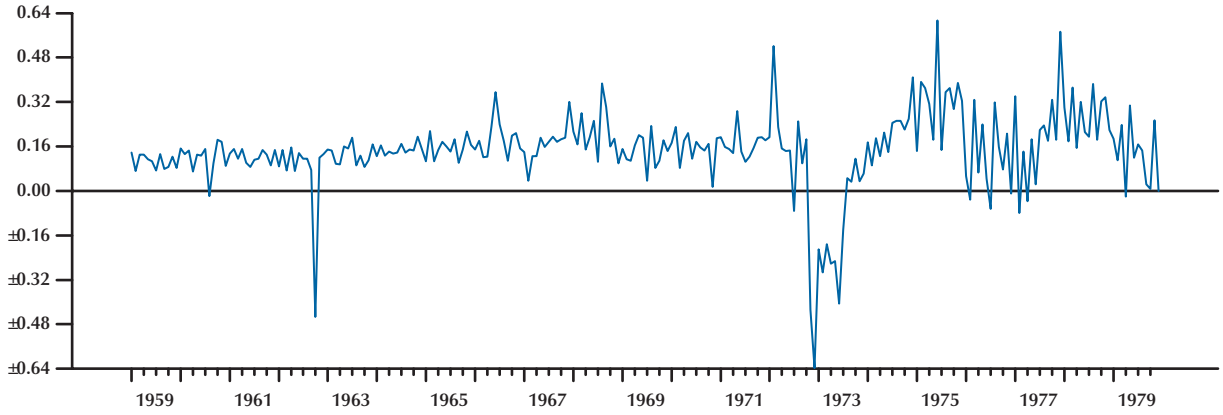
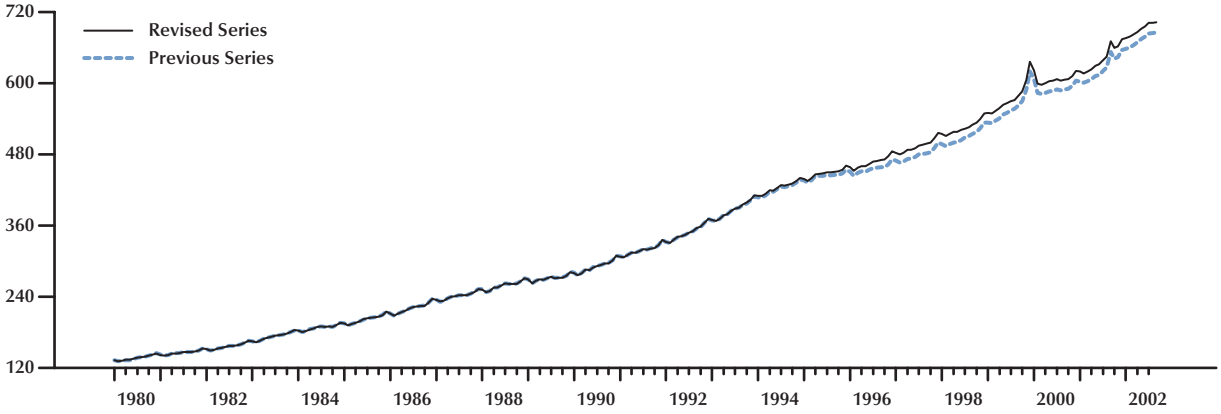


Figure 2 cont'd

Adjusted Monetary Base, Revised and Previous Series

A.

Levels, Part 3 (billions of dollars, not seasonally adjusted, monthly, 1980-2002)



Revised Series Minus Previous Series, Part 3 (billions of dollars, not seasonally adjusted)

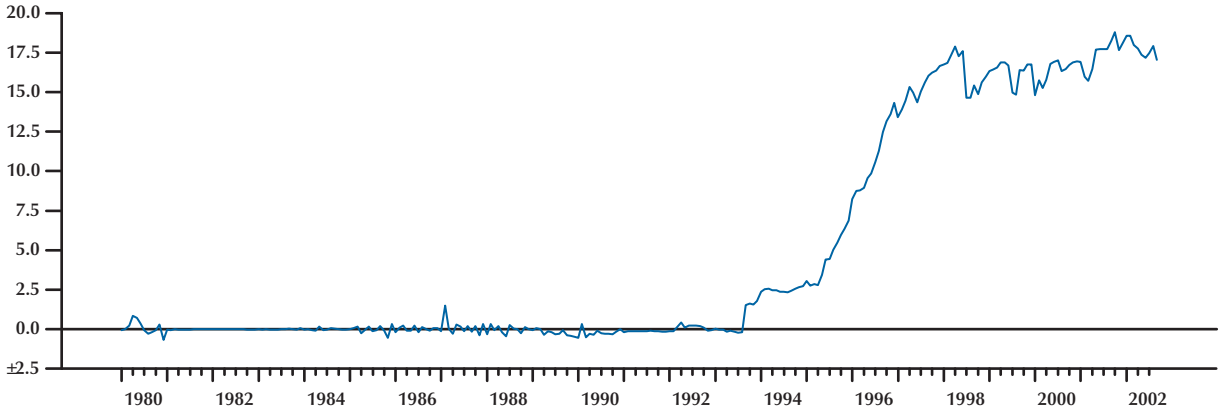
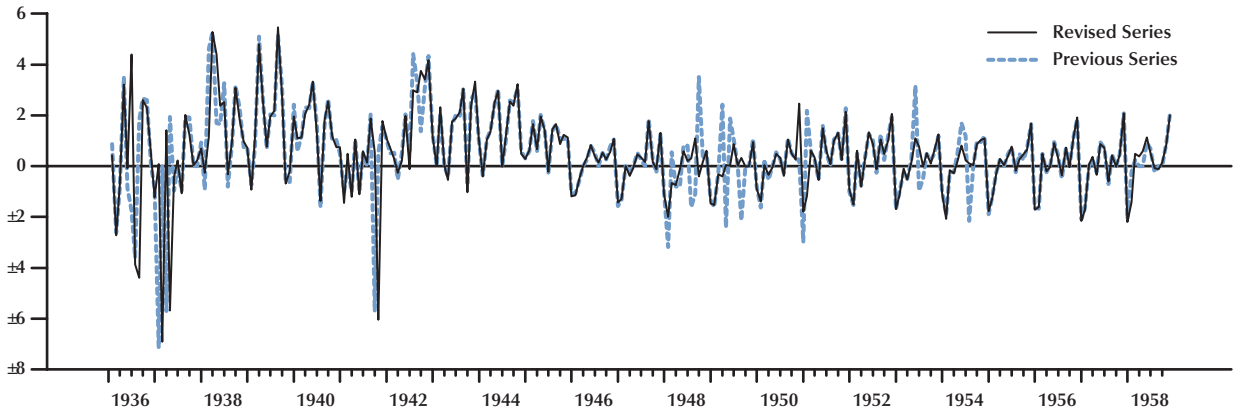


Figure 2 cont'd

Adjusted Monetary Base, Revised and Previous Series

B.

Growth Rate, Part 1 (monthly, compound annual rate, 1936-58)



Revised Series Minus Previous Series, Part 1 (monthly, compound annual rate)

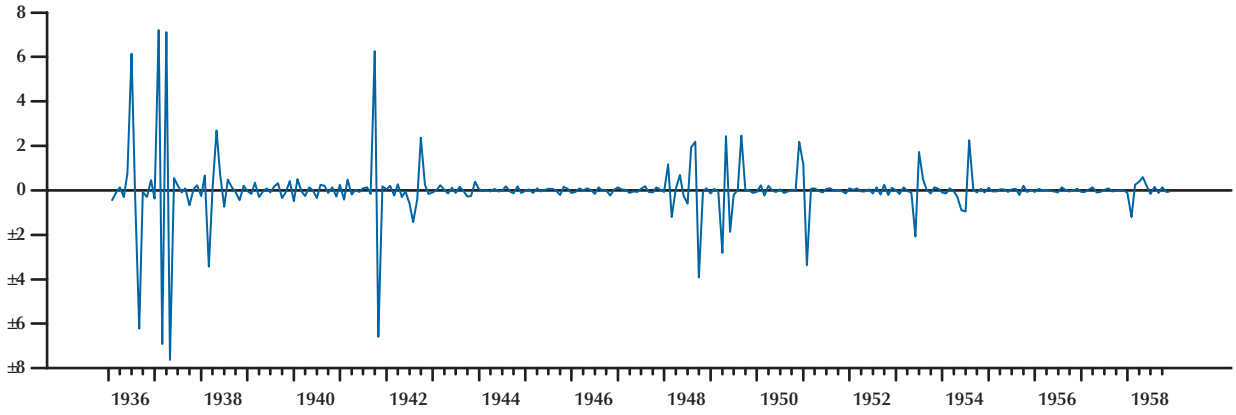
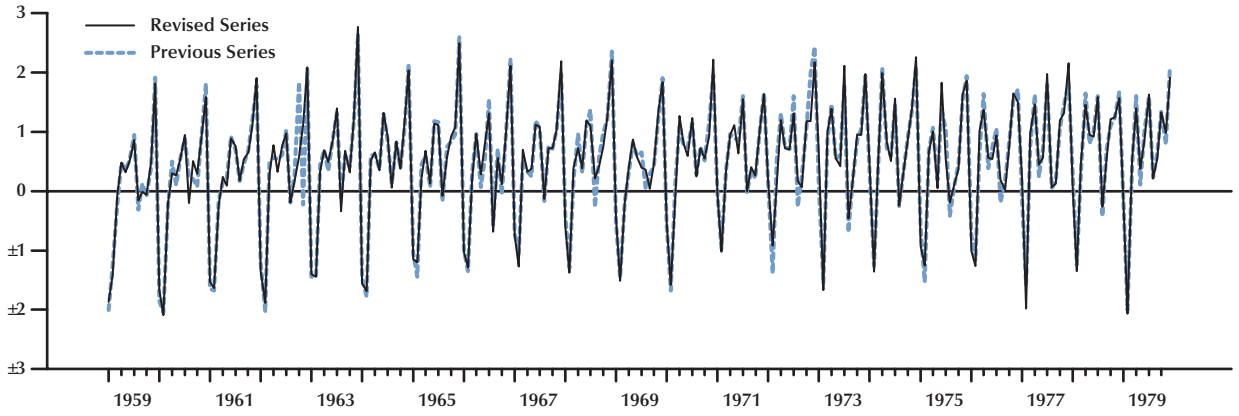


Figure 2 cont'd

Adjusted Monetary Base, Revised and Previous Series

B.

Growth Rate, Part 2 (monthly, compound annual rate, 1959-79)



Revised Series Minus Previous Series, Part 2 (monthly, compound annual rate)

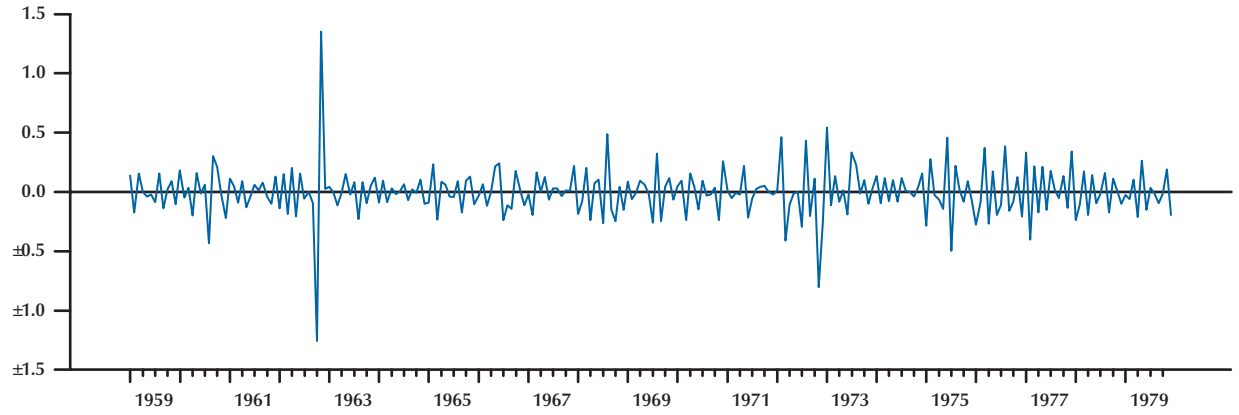
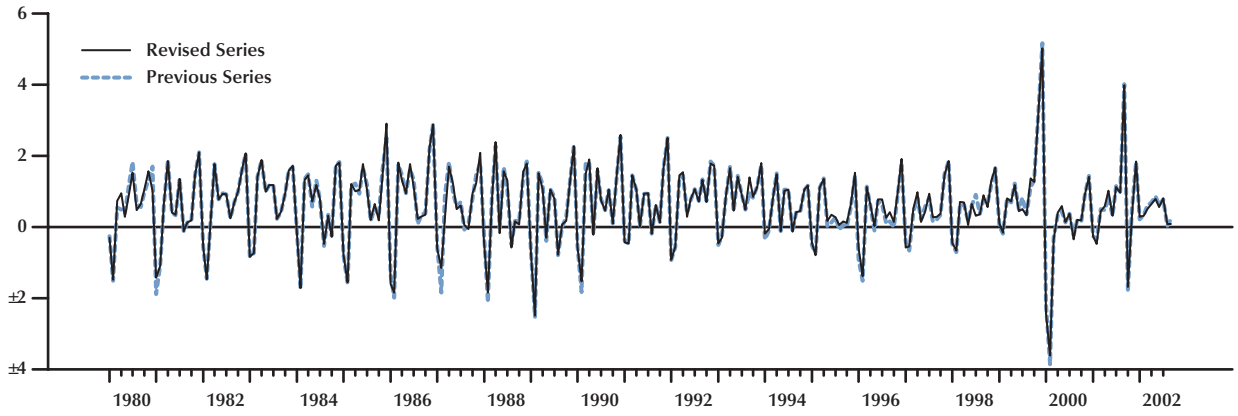


Figure 2 cont'd

Adjusted Monetary Base, Revised and Previous Series

B.
Growth Rate, Part 3 (monthly, compound annual rate, 1980-2002)



Revised Series Minus Previous Series, Part 3 (monthly, compound annual rate)

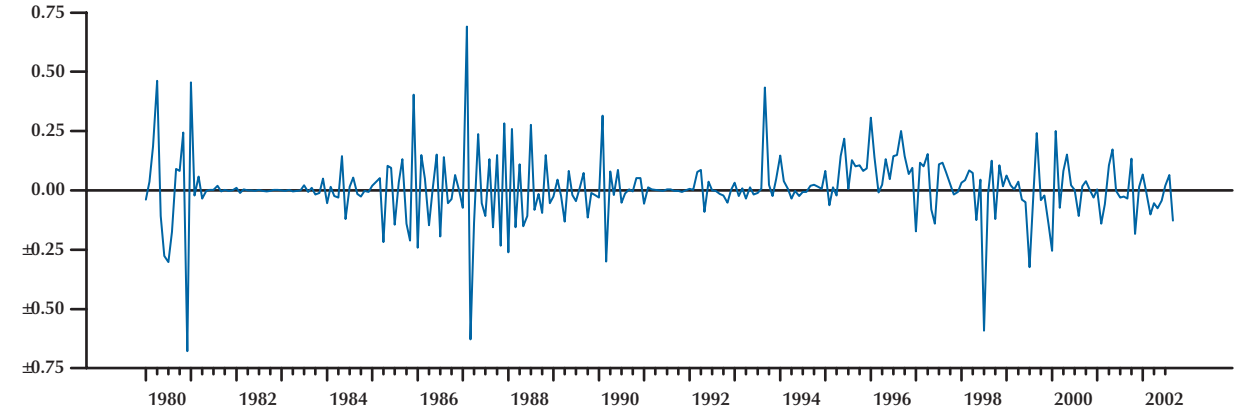
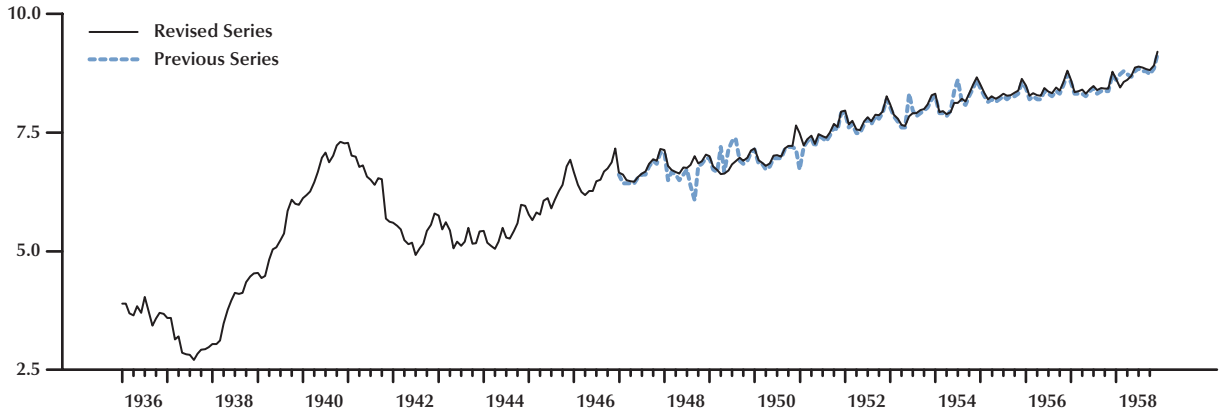


Figure 3

Adjusted Reserves, Revised and Previous Series

A.
Levels, Part 1 (billions of dollars, not seasonally adjusted, monthly, 1936-58)



Revised Series Minus Previous Series, Part 1 (billions of dollars, not seasonally adjusted)

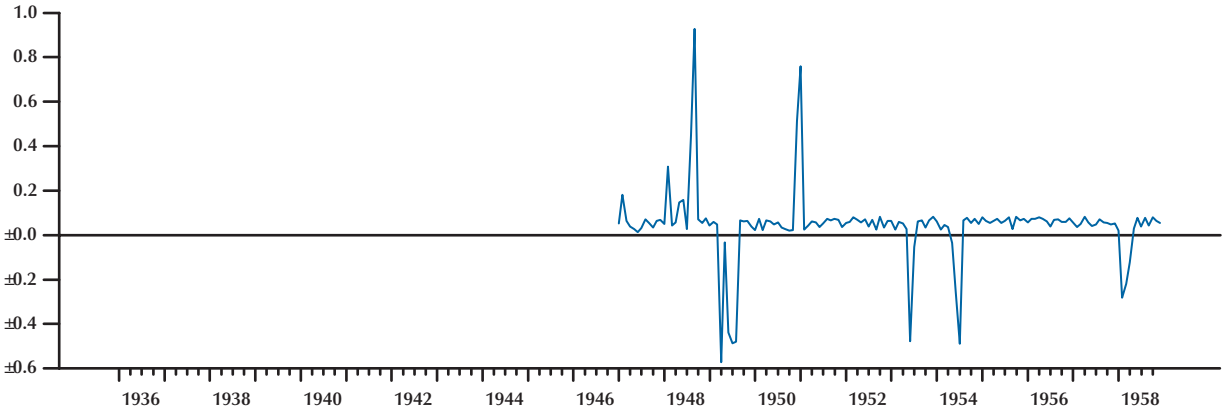
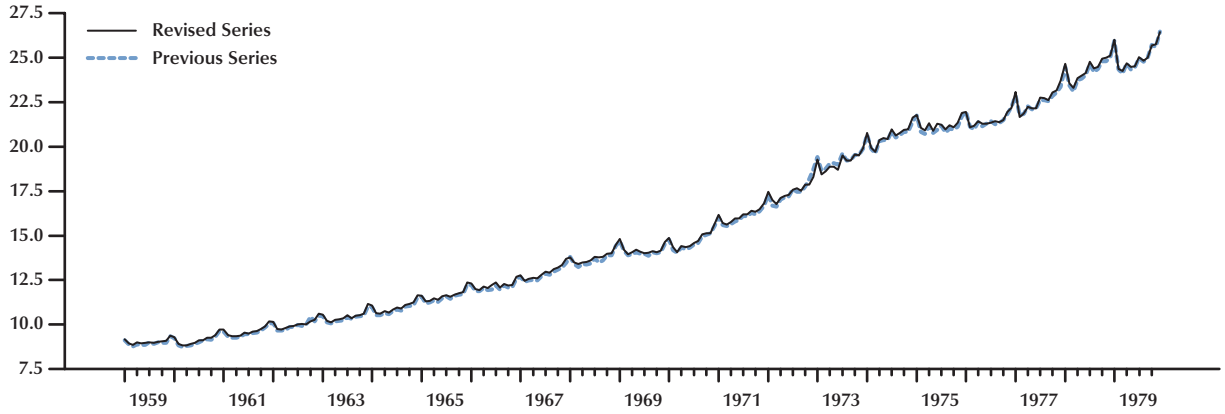


Figure 3 cont'd

Adjusted Reserves, Revised and Previous Series

A.
Levels, Part 2 (billions of dollars, not seasonally adjusted, monthly, 1959-79)



Revised Series Minus Previous Series, Part 2 (billions of dollars, not seasonally adjusted)

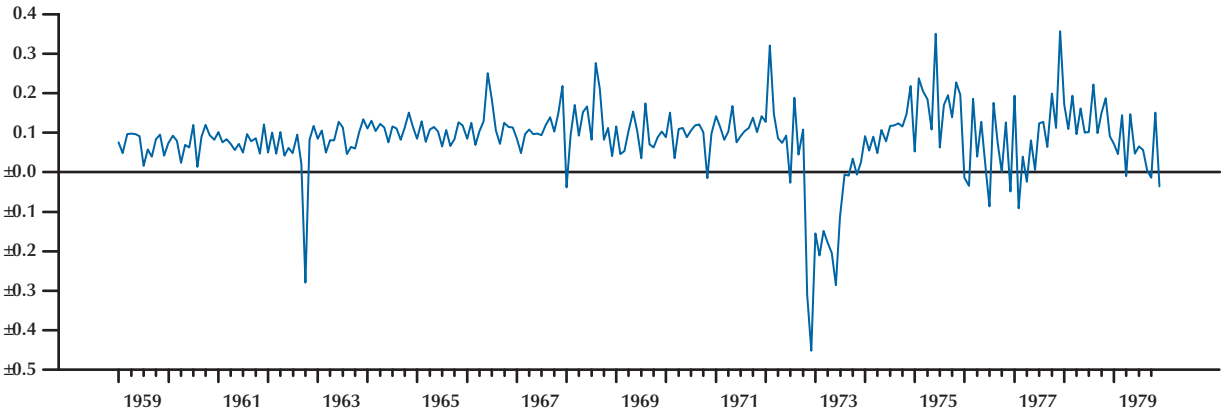
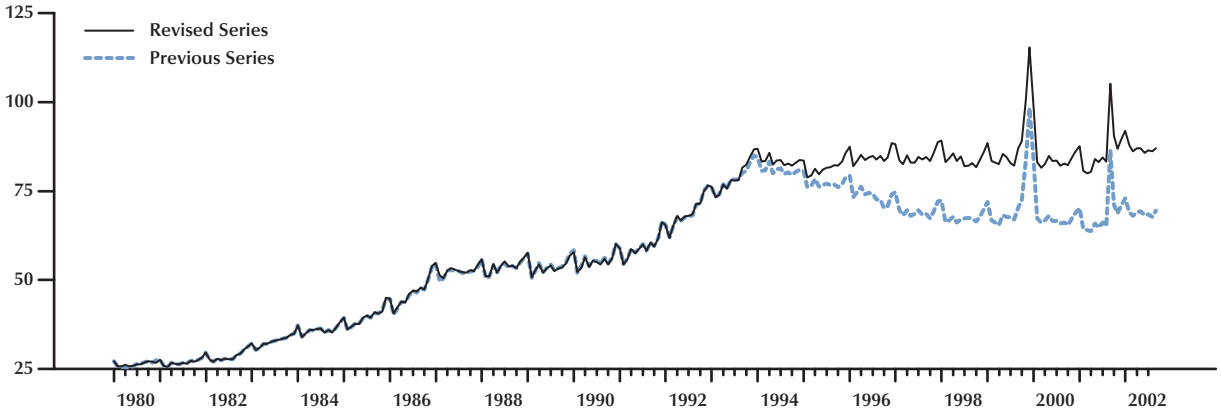


Figure 3 cont'd

Adjusted Reserves, Revised and Previous Series

A.

Levels, Part 3 (billions of dollars, not seasonally adjusted, monthly, 1980-2002)



Revised Series Minus Previous Series, Part 3 (billions of dollars, not seasonally adjusted)

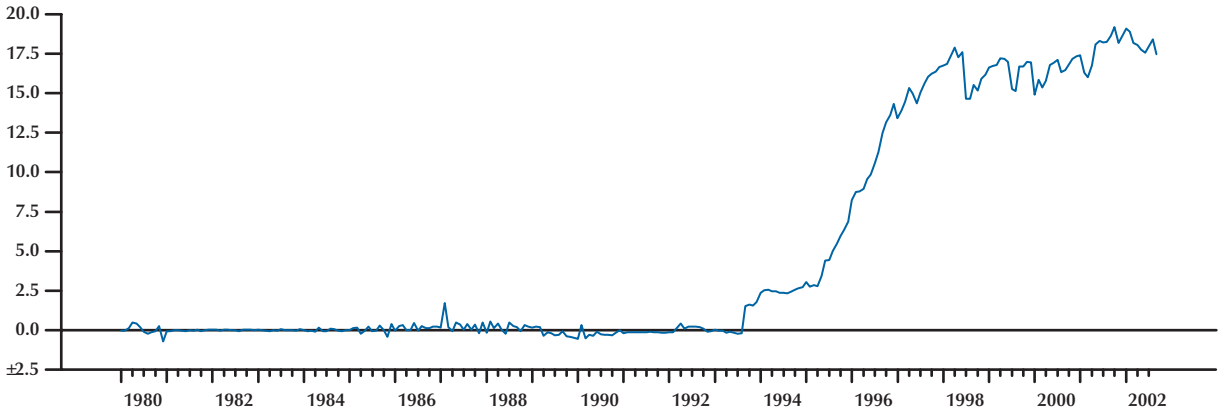
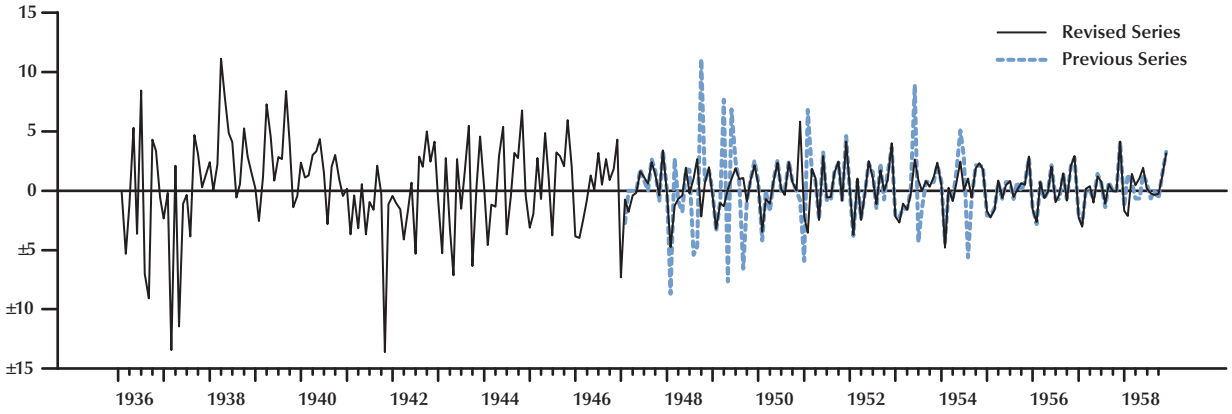


Figure 3 cont'd

Adjusted Reserves, Revised and Previous Series

B.

Growth Rate, Part 1 (monthly, compound annual rate, 1936-58)



Revised Series Minus Previous Series, Part 1 (monthly, compound annual rate)

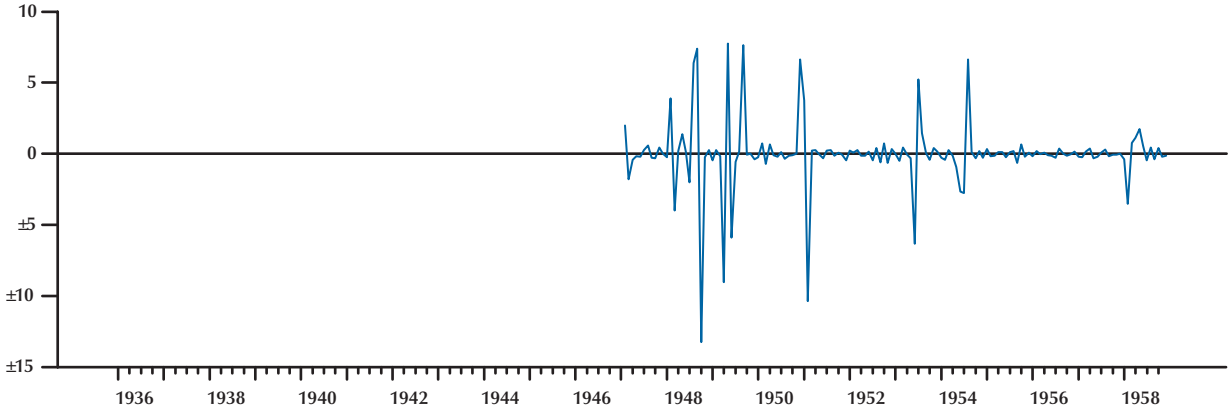
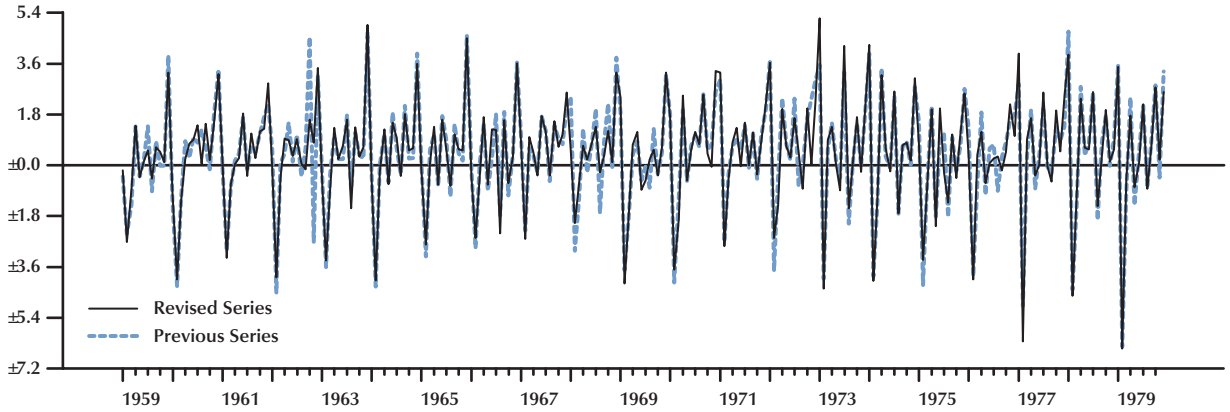


Figure 3 cont'd

Adjusted Reserves, Revised and Previous Series

B.

Growth Rate, Part 2 (monthly, compound annual rate, 1959-79)



Revised Series Minus Previous Series, Part 2 (monthly, compound annual rate)

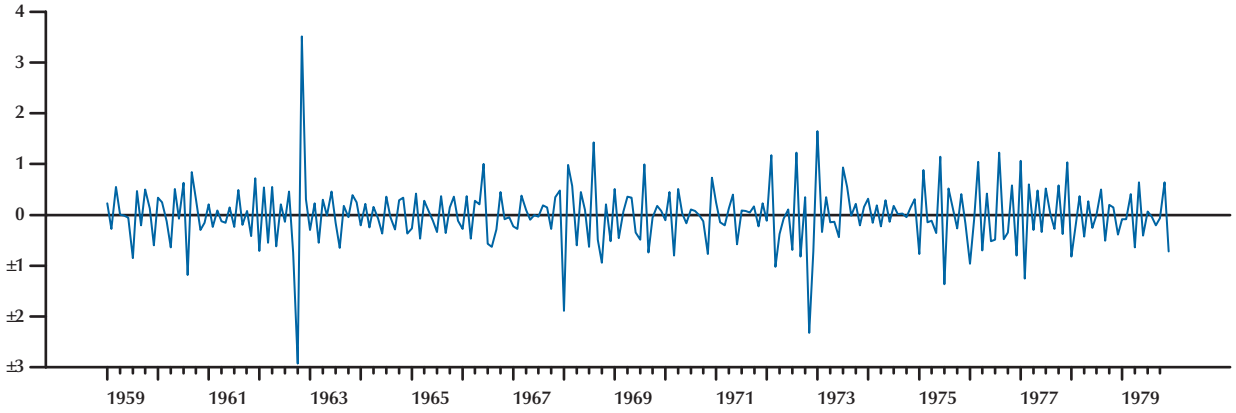
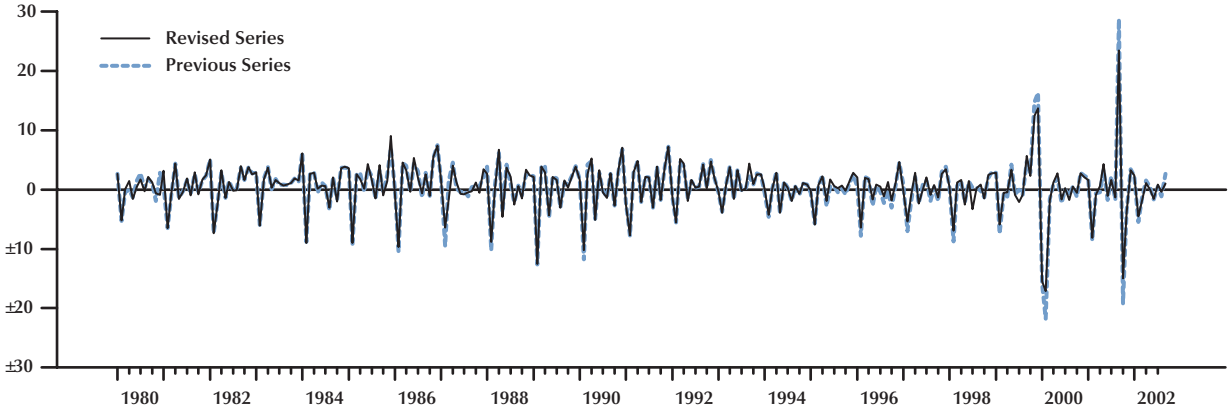


Figure 3 cont'd

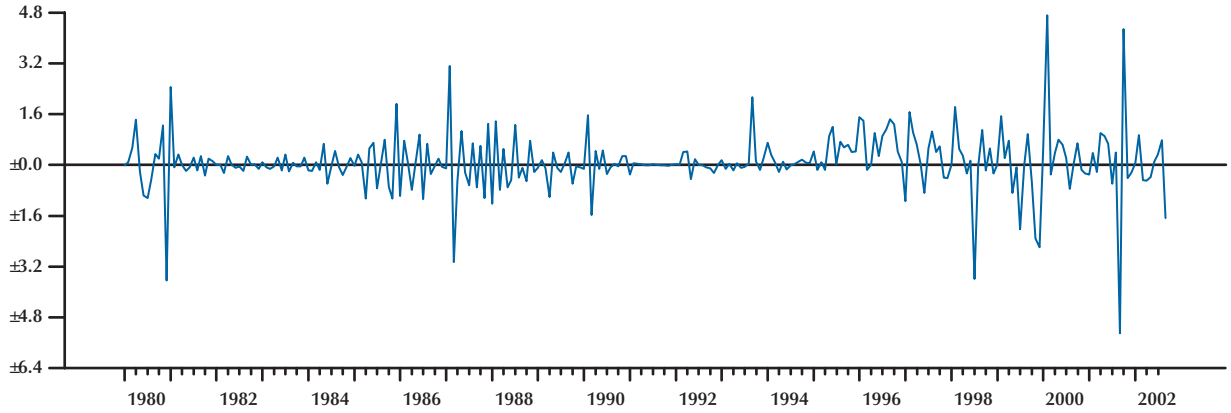
Adjusted Reserves, Revised and Previous Series

B.

Growth Rate, Part 3 (monthly, compound annual rate, 1980-2002)



Revised Series Minus Previous Series, Part 3 (monthly, compound annual rate)



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Appendix

NOTES ON DATA SOURCES AND CALCULATION OF THE SOURCE BASE AND RAM

The Monetary (Source) Base

The Federal Reserve Bank of St. Louis monetary (source) base is defined as those liabilities of the monetary authorities (U.S. Treasury and the Federal Reserve) that (i) the nonbank public uses as media of exchange and (ii) 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 (i) currency in circulation outside the Treasury and Federal Reserve Banks, plus (ii) the deposits held by depository institutions at the Federal Reserve Banks. Monthly observations on the Federal Reserve Bank of 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 as follows:

- December 1917–December 1958: Figures through 1941 are from *Banking and Monetary Statistics, 1914–1941* (Board of Governors, 1943 [reprinted 1976], Table 101, pp. 369-71, the column "Money in circulation"). Later figures are from *Banking and Monetary Statistics, 1941–1970* (Board of Governors, 1976, Table 10.1B, pp. 526-35, the column "Currency in circulation").
- January 1959 to date: *Banking and Monetary Statistics, 1941-1970* (noted above), various issues of the *Annual Statistical Digest*, the Board of Governors H.4.1 release (< www.federalreserve.gov/releases/h41/ >), and the *Federal Reserve Bulletin* (January 2003, Table 1.11, p. A5, line 17).

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

- 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 to date: *Annual Statistical Digest*, the Board of Governors H.4.1 release (< www.federalreserve.gov/releases/h41/ >), and the *Federal Reserve Bulletin* (January 2003, Table 1.11, p. A5, line 17).

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.[32] Rather, only Wednesday and end-of-month figures are published. Ideally, if these figures were available, we would measure the monetary base as period averages of the deposits of depository institutions at the Reserve Banks (*Federal Reserve Bulletin*, January 2003, Table 1.18, p. A10, line 25). Instead, we measure the monetary base by the sum of "reserve balances at the Reserve Banks" (*Federal Reserve Bulletin*, January 2003, Table 1.11, p. A5, line 25) plus, beginning August 1981, "service-related balances and adjustments" (*Federal Reserve Bulletin*, January 2003, Table 1.11, p. A5, line 22). 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 held at the Reserve Banks by nonmember institutions for settling interbank payments (as described by Friedman and Schwartz, 1963, p. 748). 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 (1996a).

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

For monthly figures, our sources are as follows:

- December 1917–December 1970: Figures through 1941 are from *Banking and Monetary Statistics, 1914–1941* (Board of Governors, 1943 [reprinted 1976], Table 101, pp. 369-71, the column "Member bank reserve balances, Total"). Later figures are from *Banking and Monetary Statistics, 1941–1970* (Board of Governors, 1976, Table 10.1B, pp. 526-29, the column "Member bank reserves, Total" and pp. 530-35, the column "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 for 1981-83 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 to date: Board of Governors H.4.1 release and Table 1.18 of the *Federal Reserve Bulletin*. These figures are the sum of reserve balances plus service-related balances and adjustments.
- For biweekly figures, our sources are the Board of Governors *Annual Statistical Digest* issues from 1984 through 1990 and the H.4.1 release 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

[32] 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 (*Federal Reserve Bulletin*, January 2003, Table 1.18, p. A10).

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, we use unpublished figures from the archives of the St. Louis Fed's Research Division.[33] We measure $RAM^{deposits}$ as the difference between a counterfactual required-reserve figure calculated from the *Banking and Monetary Statistics* deposit figures and the reserve-requirement regime in effect during September 1935, minus the level of required reserves that we calculate from the *Banking and Monetary Statistics* deposit figures.[34] Note that $RAM^{deposits}_{1935}$ is zero for August 1935–July 1936. For all months in this segment, RAM^{other}_{1935} 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 $RAM^{deposits}_{1935}$, 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 Governors 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 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.[35] During this period, the Board of Governors expanded its practice of imposing special and marginal reserve requirements (see Table 3).[36] 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, $RAM^{deposits}_{1972}$ varies from zero (the value for

[33] Different requirement ratios are applied to a bank's total time (and savings) deposits under $5 million compared with over $5 million. Aggregate time deposits in these categories, aggregated across banks, are unpublished figures.

[34] From January 1936 through December 1967, our calculated required-reserve figures differ from the *Banking and Monetary Statistics* 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.

[35] 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.

[36] 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 preexisting regular requirement.

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^{other}_{1972} 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 to 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. $RAM^{deposits}_{1975}$ is positive for all months after January 1975, beginning with 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^{other}_{1975} is positive and averages approximately $225 million. With the imposition of supplementary reserve requirements on large time deposits in November 1978, RAM^{other}_{1975} 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.[37]

[37] 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).

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