Interest Rate Policy and the Inflation Scare Problem: 1979–1992

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U.S. monetary policy since the late 1970s is unique in the post-Korean War era in that rising inflation has been reversed and stabilized at a lower rate for almost a decade. The current inflation rate of 3 to 4 percent per year, representing a reduction of 6 percent or so from its 1981 peak, is the result of a disinflationary effort that has been long and difficult.

This article analyzes the disinflation by reviewing the interaction between Federal Reserve policy actions and economic variables such as the long-term bond rate, real GDP growth, and inflation. The period breaks naturally into a number of phases, with the broad contour of events as follows. A period of rising inflation was followed by disinflation which, strictly speaking, was largely completed in 1983 when inflation stabilized at around 4 percent per year. But there were two more "inflation scares" later in the decade when rising long-term rates reflected expectations that the Fed might once more allow inflation to rise. Confidence in the Fed was still relatively low in 1983, but the

The author is senior vice president and director of research at the Federal Reserve Bank of Richmond. This article originally appeared in this Bank's 1992 *Annual Report.* The article benefited greatly from discussions with Timothy Cook and Robert King as well as from presentations at the Bank of Canada, the Bank of England, the Bank of Italy, the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of St. Louis, the Graduate School of Business at the University of Chicago, the 1992 National Bureau of Economic Research Summer Institute, the Swedish Riksbank, the Swiss National Bank, and the University of Notre Dame. Comments by John Boschen, Michael Dotsey, Robert Hetzel, Peter Ireland, and George Moore were also very helpful. The analyses and conclusions are those of the author and do not necessarily reflect the views of the Federal Reserve Bank of Richmond or the Federal Reserve System.

central bank has acquired more credibility since then by successfully resisting the inflation scares.

I analyze the conduct of monetary policy using a narrative approach that pays close attention to monthly movements of long- and short-term interest rates. My approach is intended to complement existing studies such as the VAR-based analyses by Bernanke and Blinder (1992) and Sims (1992), and the more conventional studies of the period by Friedman (1988) and Poole (1988). The goal is to distill observations to guide future analysis of monetary policy with the ultimate objective of improving macroeconomic performance. Based on a familiarity with the Fed and the work of Fed economists, I interpret policy actions in terms of the federal funds rate rather than a measure of money. I view the article as a case study of the Federal Reserve's interest rate policy.

The Fed's primary policy problem during the period under study was the acquisition and maintenance of credibility for its commitment to low inflation.[1] I measure credibility by movements of inflation expectations reflected in the long-term interest rate. For much of the period the Fed's policy actions were directed at resisting inflation scares signaled by large sustained increases in the long rate. A scare could take well over a year of high real short-term interest rates to contain. Moreover, just the threat of a scare appears to have made the Fed tighten aggressively in one instance and probably made it more cautious when pushing the funds rate down to encourage real growth on a number of occasions.

Inflation scares are costly because resisting them requires the Fed to raise real short rates with potentially depressing effects on business conditions. Hesitating to react is also costly, however, because by revealing its indifference to higher expected inflation the Fed actually encourages workers and firms to ask for wage and price increases to protect themselves from higher expected costs. The Fed is then inclined to accommodate the higher inflation with faster money growth.

Inflation scares present the Fed with a fundamental dilemma the resolution of which has decided the course of monetary policy in the postwar period. Prior to the 1980s, the Fed generated an upward trend in the inflation rate by reacting to inflation scares with a delay. The more prompt and even preemptive reactions since the late 1970s have been a hallmark of the recent disinflation.

The plan of the article is as follows. First, I discuss the premises that underlie my interpretation of monetary policy. A chronological analysis of policy follows. Finally, I summarize the main empirical findings in a series of observations that sharpen our understanding of the conduct of monetary policy. A brief summary concludes the article.

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[1] See Rogoff (1987) for a discussion of credibility, reputation, and monetary policy.

1. PREMISES UNDERLYING THE INTERPRETATION OF POLICY

The first step in any study of monetary history is to choose an indicator of the stance of policy. For example, in their study of U.S. monetary history Friedman and Schwartz (1963) focus on the monetary base (currency plus bank reserves) because it summarizes monetary conditions whether or not a country is on the gold standard and whether or not it has a central bank. Focusing on the base allowed them to tie together a long period marked by many institutional changes, making possible their famous empirical findings about money, prices, and business conditions.

For my purposes, however, the base is not a useful indicator. Although the Fed could have used the base as its instrument by controlling it closely in the short run, it has not chosen to do so. Instead, the Fed has chosen to use the federal funds rate as its policy instrument. Hence this study, which seeks to investigate the short-run interactions between Fed policy and other economic variables, interprets policy actions as changes in the federal funds rate. The remainder of this section discusses the premises underlying my interpretation of policy.

Interest Rate Targeting

Throughout its history the Fed's policy instrument has been the federal funds rate or its equivalent. At times, notably from the mid to late 1970s, it has targeted the funds rate in a narrow band commonly 25 basis points wide (Cook and Hahn 1989). More often, it has targeted the funds rate indirectly, using the discount rate and borrowed reserve targets. Although the funds rate appears noisier under borrowed reserve targeting than under direct funds rate targeting, it is nevertheless tied relatively closely to a chosen funds rate target (Goodfriend 1983). Since a borrowing target tends to be associated with a particular spread between the funds rate and the discount rate, targeting borrowed reserves lets a discount rate adjustment feed through one-for-one to the funds rate. Forcing banks to borrow more reserves at a given discount rate also raises the funds rate (Goodfriend and Whelpley 1986). The Fed has used the borrowed reserve procedure to help manage the funds rate since October 1982 (Wallich 1984; Thornton 1988). Significant funds rate movements since then should be viewed as deliberate target changes.

It is less obvious that federal funds rate changes in the period of the New Operating Procedures from October 1979 to October 1982 should be interpreted as deliberate. Under those procedures, the Fed was to fix the path of nonborrowed reserves available to depository institutions so that increases in the money stock would force banks to borrow more reserves at the discount window and thereby automatically drive up the funds rate and other short-term interest rates.

Despite the widespread emphasis on automatic adjustment in the description of the post-October 1979 procedures, however, it was well recognized at the time that movements in the funds rate would also result from purely judgmental actions of the Federal Reserve (Levin and Meek 1981; Federal Reserve Bank of New York 1982–1984). These actions included: (1) judgmental adjustments to the nonborrowed reserve path taken at FOMC meetings that changed the initially expected reserves banks would be forced to borrow at the discount window (in effect, a funds rate target change by the FOMC), (2) judgmental adjustments to the nonborrowed reserve path between FOMC meetings, (3) changes in the discount rate, and (4) changes in the surcharge that at times during the period was added to the basic discount rate charged to large banks.

Cook (1989) presents a detailed breakdown of policy actions affecting the funds rate during this period showing that two-thirds of funds rate changes were due to judgmental actions of the Fed and only one-third resulted from automatic adjustment. Moreover, as we shall see below, the large funds rate movements in the nonborrowed reserve targeting period are overwhelmingly attributable to deliberate discretionary actions taken by the Fed to manage short-term interest rates. Therefore, it is more accurate to refer to the period from October 1979 to October 1982 as one of aggressive federal funds rate targeting than one of nonborrowed reserve targeting.

The Role of Money

The Federal Reserve was established with a mandate to cushion short-term interest rates from liquidity disturbances. Between the Civil War and the creation of the Fed, such disturbances caused short rates to rise suddenly and sharply from time to time. While generally trading in a range between 4 and 7 percent, the monthly average call loan rate reported by Macaulay (1938) rose roughly 5 percentage points in one month on 26 occasions between 1865 and 1914. Moreover, as a result of banking crises, sudden changes of over 10 percentage points occurred eight times during the same period. These episodes were distinctly temporary, ranging from one to four months, with many lasting for no more than one month. Such extreme temporary spikes are absent from interest rates since the founding of the Fed (Miron 1986; Mankiw, Miron, and Weil 1987).

In line with its original mandate, the Fed has routinely accommodated liquidity disturbances at a given targeted level of short-term interest rates. Furthermore, by giving banks access to the discount window, the Fed has been careful not to exert excessively disruptive liquidity disturbances when changing its interest rate target.[2] It follows that easing or tightening has mainly

[2] Total reserve demand is not very sensitive to interest rates in the short run. So whenever the Fed cuts nonborrowed reserves to support a higher federal funds rate target, it allows banks to satisfy a roughly unchanged reserve demand by borrowing the difference at the discount

been accomplished by changing the level of short rates to set in motion forces slowing the growth of money demand in order to allow a future reduction in money growth and inflation.

To view the Federal Reserve's policy instrument as the federal funds rate is thus to set money to the side, since at any point in time money demand is accommodated at the going interest rate. This does not say, however, that money can be left out of account altogether. The Fed, the markets, and economists alike recognize that trend inflation is closely connected to trend money growth and that achieving and maintaining price stability requires controlling money. During the period under study, money growth was often viewed as an important indicator of future inflation or disinflation by both the Fed and the markets.

Furthermore, we know from the work of McCallum (1981) and others that an interest rate policy just describes how changes in interest rates correspond to changes in the money stock. At a deeper level, then, there is an equivalence between talking in terms of interest rates or money. The important difference is that simple interest rate rules descriptive of policy have implications for how money and prices actually evolve over time (Goodfriend 1987; Barro 1989). We should keep this in mind when reviewing the current period for clues about how policy influences the inflation rate. Ultimately we seek to understand what it is about interest rate policy that turns one-time macroeconomic shocks into highly persistent changes in the growth of money and prices.

Interpreting Co-Movements Between Short and Long Rates

The Fed targets the funds rate in order to stabilize inflation and real economic growth as best it can. Output and prices, however, do not respond directly to weekly federal funds rate movements but only to longer-term rates of perhaps six months or more. Hence, the Fed targets the funds rate with the aim of managing longer-term money market rates. It exercises its leverage as follows. The market determines longer-term rates as the average expected level of the funds rate over the relevant horizon (abstracting from a time varying term premium and default risk). To see why, consider the pricing of a three-month bank loan. A bank could fund the loan with a three-month CD, or it could plan to borrow federal funds overnight for the next three months. Cost minimization and competition among banks keep the CD rate in line with the average expected future funds rate; competition in the loan market links loan rates to the CD rate and expected future funds rates. Finally, arbitrage among holders of money market securities links Treasury bill and commercial paper rates to CD rates of similar maturity.

window. The negative relation between nonborrowed reserves and the funds rate in part reflects the administration of the discount window, which creates a positive relation between bank borrowing and the spread between the funds rate and the discount rate. Christiano and Eichenbaum (1991) emphasize the importance of this mechanism in understanding the liquidity effect.

Since simplicity is crucial in communicating policy intentions, the Fed tries to manage its funds rate target to maintain an expected constancy over the near-term future. Target changes are highly persistent and seldom quickly reversed, so that a target change carries the expected level of the funds rate with it and thus longer-term money market rates too.[3] In this way, interest rate policy as practiced by the Fed anchors the short end of the term structure of interest rates to the current federal funds rate.

By the above argument, the interest rate on long bonds also must be determined as an average of expected future short rates. At best, the Fed affects short-term real interest rates temporarily, so average future short rates over the horizon of a 30-year bond should sum to a real interest rate that varies in a range perhaps 1 or 2 percentage points around 3 percent per year plus the expected trend rate of inflation.[4] From this perspective, we can view fluctuations in the long-term rate as driven by: (1) a component connected with the current funds rate target that anchors short maturity rates and (2) a component driven by expectations of inflation. Because the present discounted value of coupon payments far out in the future is smaller at higher interest rates, we should expect a given funds rate target change to exert a greater effect on the long bond at higher rates of interest.[5]

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[3] Goodfriend (1991) discusses evidence consistent with this view found in Fama (1984), Fama and Bliss (1987), Mankiw, Miron, and Weil (1987), Hardouvelis (1988), and Cook and Hahn (1989).

[4] Consider a bond paying nominal interest (i) taxable at rate (τ) when the expected inflation rate is (π^e). The real after-tax ex ante return on such a bond is then $r = (1 - \tau)i - \pi^e$, so the expected inflation rate over the life of the bond may be expressed as $\pi^e = [i - r/(1 - \tau)](1 - \tau)$.

Woodward (1990) reports market expectations of the after-tax real rate of interest on long-term bonds using quarterly data on British index-linked gilt-edged securities from 1982:2 to 1989:1. The ex ante post-tax real rate ranged from 1.5 percent to 3.2 percent per annum with a mean of 2.6 percent.

Assuming investors keep after-tax ex ante rates on long-term government bonds in the United States and United Kingdom roughly equal, we can set $r = 2.6$ in the above expression to infer long-term expected inflation in the United States. A tax rate in the United States of 0.2, for example, yields $\pi^e = [i - 3.2](.8)$. If we take i as the yield to maturity on a 30-year U.S. government bond, then π^e is the average per annum inflation rate expected over the 30-year horizon.

The tax rate in the above expression is the marginal rate that applies to the relevant marginal investor, e.g., individual, corporate, or foreign. The rate is difficult to determine. Its exact value, however, is not important for the analysis in the text. The analysis relies on the view that significant *changes* in the long-term nominal rate primarily reflect movements in inflation expectations, a view supported by the relatively narrow range of ex ante post-tax real rates reported by Woodward.

[5] A given federal funds rate target change will exert a greater effect on the long-term bond rate the shorter the average life of the security as measured by its duration. The duration of a coupon bond may be thought of as the term to maturity of an equivalent zero coupon bond that makes the same total payments and has the same yield. The duration of a 30-year coupon bond selling at par is approximately $1/r$, where r is the yield to maturity. See Moore (1989). Thus, the duration of the 30-year government (coupon) bond discussed in the text is only about 12.5 years at an interest rate of 8 percent and 7.1 years at a 14 percent interest rate.

It is useful to distinguish three sources of interaction between the federal funds rate and the long-term rate:

Purely Cyclical Funds Rate Policy Actions

The Fed routinely lowers the funds rate in response to cyclical downturns and raises it in cyclical expansions. I call such policy actions purely cyclical if they maintain the going trend rate of inflation. Even purely cyclical policy actions exert a pull on longer rates, however, so they are a source of positive co-movement between the funds rate and the long rate. But because cyclical actions strongly influence only the first few years of expected future short-term interest rates, only a relatively small fraction of purely cyclical funds rate changes are transmitted to the long rate.

Long-Run Inflation

Changes in the trend rate of inflation are a second source of positive co-movement between the funds rate and the long rate. The long rate moves automatically with inflation expectations. The funds rate does not, however, unless the Fed makes it do so. Nevertheless, the Fed often chooses to hold short-term real rates relatively steady in the presence of rising or falling inflation by moving the funds rate up or down to allow for a rising or falling inflation premium. Doing so causes short and long rates to move together.

Aggressive Funds Rate Policy Actions

The Fed occasionally takes particularly aggressive funds rate policy actions to encourage real growth or to stop and reverse a rising rate of inflation. Aggressive actions combine an effect on the long-term real rate with a potential change in the long-run rate of inflation. The real rate effect moves the long rate in the same direction as the funds rate, while the inflation effect moves the long rate in the opposite direction. Thus the net effect of aggressive actions on the long rate is somewhat complex.

Consider an aggressive reduction in the funds rate to encourage real growth. Initially, funds rate actions taken to fight recession pull the long rate down too. However, excessive easing that raises expected inflation can cause the long rate to reverse direction and begin to rise, even as the Fed continues to push short rates down. Thus we might expect to see the long rate move in the opposite direction from the funds rate near cyclical troughs. A funds rate tightening during the ensuing recovery exerts two conflicting forces. It tends to raise the long rate by reversing the cyclical funds rate decline, but it also reverses somewhat the expected rise in inflation, tending to lower the long rate. For a relatively brief recession with little excessive easing, the cyclical funds rate effect would dominate the inflation effect, so the long rate would tend to rise with the funds rate during the recovery. Thus, the long rate would move opposite from the funds rate for only a few months near a recession trough.

Now consider an aggressive increase in the funds rate intended to bring down the trend rate of inflation. Such a tightening potentially shifts both components of the long rate since short rates rise and expected long-run inflation may fall. One expects the first effect to dominate initially, however, because a large aggressive increase in short rates exerts an immediate significant upward pull on the long rate, while the public may not yet have confidence in the disinflation. If the Fed persists with sufficiently high short-term real rates, however, inflation and real growth eventually slow and the Fed can tentatively bring rates down somewhat. A declining long rate, at this point, would suggest that the Fed's disinflation has acquired some credibility.

Inflation Scares

I call a significant long-rate rise in the absence of an aggressive funds rate tightening an inflation scare since it reflects rising expected long-run inflation.[6] Inflation scares are of concern because higher inflation, if realized, would reduce the efficiency of the payments system, with negative consequences for employment, productivity, and economic growth. Moreover, scares are costly because they present the Fed with a difficult dilemma. Resisting them requires the Fed to raise real short rates with potentially depressing effects on business conditions. Failing to respond promptly, however, can create a crisis of confidence that encourages the higher inflation to materialize: workers and firms ask for wage and price increases to protect themselves from higher expected costs. In short, by hesitating, the Fed sets in motion higher inflation that it is then inclined to accommodate with faster money growth. The record of rising inflation and disinflation reviewed below contains examples of scares followed by higher money growth and inflation, as well as scares successfully resisted by the Fed.[7]

2. A REVIEW OF INTEREST RATE POLICY

This study focuses on the period of inflation fighting beginning in October 1979. Nevertheless, I begin my review by briefly describing conditions in the immediately preceding years. For the most part, data discussed throughout are shown in Figure 1 and are given in the tables included at the end of the article.

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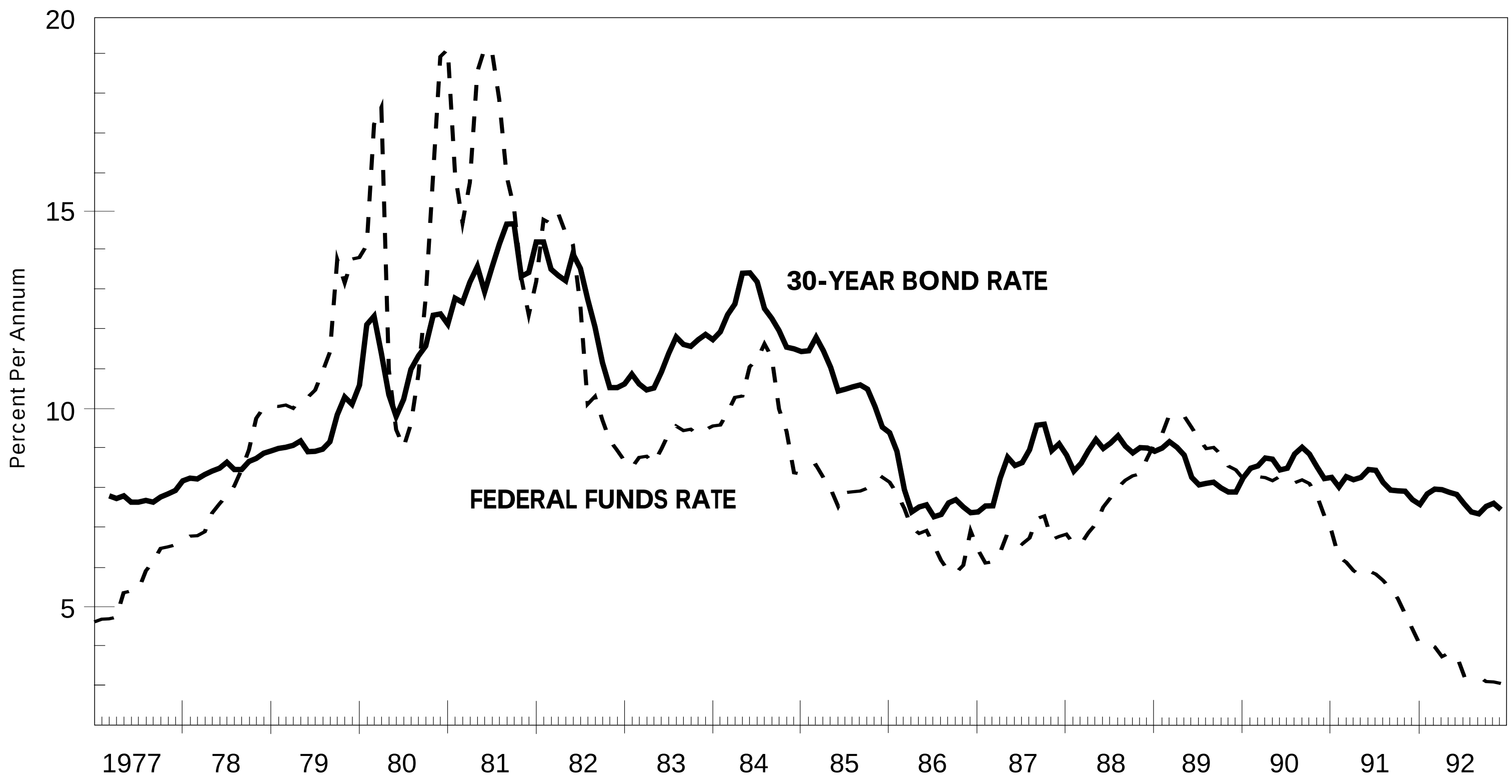
[6] Since short maturity rates are anchored to the federal funds rate target, they cannot convey as clear a signal of inflation expectations as the long rate. See Dotsey and King (1986) for an analysis of the informational implications of interest rate rules.

[7] An inflation scare may be consistent with either a positive or a negative association between money or prices, on one hand, and unemployment or real growth on the other, depending on the nature of the underlying macroshock that sets it off. For example, an investment boom tends to generate a positive association, and an oil price rise, a negative one.

Figure 1 Federal Funds Rate and 30-Year Bond Rate, January 1977–December 1992



Percent Change, 4Q to 4Q:

	1977	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
Real GDP	4.4	6.0	0.9	−0.2	−0.1	−1.1	6.7	4.5	3.3	2.2	4.5	3.3	1.6	−0.5	0.1	2.9
Implicit Price Deflator	7.3	8.4	8.7	10.1	9.4	4.4	4.0	4.3	3.6	2.6	3.3	4.2	4.4	4.5	3.4	2.4

Rising Inflation: The Late 1970s

Inflation was rising gradually in the late 1970s, with rates of 7.3 percent, 8.4 percent, and 8.7 percent in 1977, 1978, and 1979 as measured by fourth quarter over fourth quarter changes in the GDP deflator. The corresponding real GDP growth rates were 4.4 percent, 6.0 percent, and 0.9 percent. Rising inflation throughout the late 1970s carried the 30-year government bond rate from 7.8 percent in early 1977 to 9.2 percent by September 1979. Over the same period, the Fed steadily increased the federal funds rate from around 4.7 percent to 11.4 percent, raising short-term real rates from a range between 0 to -2 percent to between 0 and $+2$ percent. The negative short-term real rates at the beginning of the period suggest that initially the Fed was stimulating real growth, though the steady increase in real short rates represented a modest effort to resist inflation.

Aborted Inflation Fighting: October 1979 to July 1980

By the time Paul Volcker became Fed Chairman in August 1979, oil price increases following the Iranian revolution in November 1978 greatly worsened the inflation outlook. Oil prices were to double by early 1980 and triple by early 1981 from November 1978 levels, and by the fall of 1979 the Fed felt that more drastic action was needed to fight inflation. The announcement on October 6, 1979, of the switch to nonborrowed reserve targeting officially opened the inflation-fighting period.

The first aggressive policy actions in this period took the monthly average funds rate from 11.4 percent in September 1979 to 17.6 percent in April 1980. Cook (1989) reports that only 1 percentage point of this 6 point rise can be attributed to automatic adjustment. Virtually all of it represented deliberate policy actions taken by the Fed to increase short-term interest rates. It was the most aggressive series of actions the Fed had taken in the postwar period over so short a time, although the 5 percentage point increase from January to September of 1973 was almost as large.

For its part, the 30-year rate rose sharply from 9.2 percent in September to a temporary peak of 12.3 percent in March, after which it fell back to 11.4 percent in April. A closer look reveals the sources of this sharp rise in the long rate. The sharp 2.3 percentage point funds rate jump from September to October raised the long rate by 0.7 percentage points. The funds rate then held in a range between 13.2 percent and 14.1 percent through February. January 1980 later turned out to be an NBER business cycle peak, and evidence of a weakening economy caused the Fed to pause in its aggressive tightening. But with the funds rate relatively steady, the long rate jumped sharply by around 2 percentage points between December and February, signaling a serious inflation scare.

The scare was probably caused in part by the ongoing oil price rises, with the Soviet invasion of Afghanistan in December also playing a role. The

Fed's hesitation to proceed with its tightening, however, probably contributed to the collapse of confidence. In any case, the Fed reacted with an enormous 3 percentage point increase of the monthly average funds rate in March, only 1 percentage point of which was due to the automatic adjustment. The long rate hardly moved in response, suggesting that the positive effect on the long rate of the aggressive tightening was offset by a decline in expected inflation. Moreover, the long rate actually came down by 0.9 percentage points in April even as the Fed pushed the funds rate up another 0.4 percentage points, suggesting that the Fed had already begun to win credibility for its disinflationary policy.

When one considers that business peaked in January, there is reason to believe that inflation would have come down as the recession ran its course in 1980 if the Fed had then sustained its high interest rate policy. The imposition of credit controls in March, however, forced the Fed to abort that policy. Schreft (1990) argues persuasively that by encouraging a decline in consumer spending, the credit control program was largely responsible for the extremely sharp −9.9 percent annualized decline in real GDP in the second quarter of 1980. Supporting her view is the fact that personal consumption expenditures accounted for about 80 percent of the decline in real output, more than twice its average 35 percent contribution in postwar U.S. recessions.

Accompanying the downturn in economic activity was a sharp fall in the demand for money and bank reserves that, according to Cook (1989), caused a 4.2 percentage point automatic decline of the funds rate from April to July. The Fed enhanced the automatic easing with judgmental actions, e.g., reducing the discount surcharge, that reduced the funds rate by an additional 4.3 percentage points over this period.

The sharp interest rate decline coupled with the lifting of credit controls in July led to strong 8.4 percent annualized real GDP growth in the fourth quarter of 1980. Because the credit controls caused the Fed to interrupt its inflation-fighting effort, inflation rose through the year from an annual rate of 9.8 percent in the first quarter to 10.9 percent in the fourth quarter as measured by the GDP deflator.

Aggressive Disinflationary Policy: August 1980 to October 1982

It was clear in late summer and early fall of 1980 that inflationary pressures were as strong as ever. After being pulled down about 1.6 percentage points by the aggressive funds rate easing from April to June, the 30-year rate rose by about 40 basis points between June and July as the Fed continued to push the funds rate down another 40 basis points. The reversal signaled an inflation scare induced by the excessively aggressive easing, and the Fed began an unprecedented aggressive tightening. Of the roughly 10 percentage point rise in the monthly average funds rate from July to December 1980, Cook (1989) attributes only about 3 percentage points to the automatic adjustment. Thus, the run-up of the funds rate to its 19 percent peak in January 1981 marked a deliberate return to the high interest rate policy. As measured by the GDP deflator, which was rising at nearly a 12 percent annual rate in the first quarter of 1981, real short-term rates were a high 7 percent at that point.

As soon as the funds rate peak had been established, however, very slow growth in M1 and bank reserves automatically put downward pressure on the funds rate. According to Cook (1989), about 3.4 percentage points of the 4 percentage point drop in the funds rate between January and March was attributable to the automatic adjustment. Since the automatic adjustment had correctly signaled weakness in the economy in the second quarter of 1980, the Fed was initially inclined to let rates fall in early 1981. However, real GDP actually grew at a 5.6 percent annual rate in the first quarter, and when the strength of the economy became clear, the Fed took deliberate actions to override what it took to be a false signal that disinflation had taken hold. Reversing field, it ran the funds rate back up to 19 percent by June, using a series of deliberate tightening actions to supplement what Cook (1989) reports would only have been a 0.8 percentage point automatic funds rate rise.

It was not long before the aggressive disinflationary policy began to take hold. Annualized real GDP growth was −1.7 percent in the second quarter of 1981. The third quarter posted 2.1 percent real growth, but an NBER business cycle peak was reached in July and real growth fell to −6.2 percent in the fourth quarter of 1981 and −4.9 percent in the first quarter of 1982. Meanwhile, the quarterly inflation rate as measured by the GDP deflator fell from 11.8 percent in the first quarter of 1981 to the 4.5 percent range by early 1982.

The Fed brought the funds rate down from 19 percent at the business cycle peak in July to 13.3 percent in November and held the funds rate in the 13 to 15 percent range until the summer of 1982, when it brought short rates down another 4 percentage points to around 10 percent. The funds rate reduction through November 1981 was large in nominal terms, but when one considers that inflation had declined to the 4.5 percent range by early 1982, the funds rate decline actually represented a 1 or 2 percentage point rise in short-term real rates. Thus, one should still view policy as aggressively disinflationary in early 1982. As calculated by Cook (1989), automatic adjustments accounted for only 1 percentage point of the final 9 percentage point funds rate decline in the nonborrowed reserve targeting period, which ended formally in October of 1982. This last great decline should be seen as a deliberate funds rate easing calculated to achieve a sustained reduction in inflation without excessive harm to real growth.

The long rate provides a picture of the Fed's progress in reducing the trend rate of inflation. The 30-year rate rose about 5 percentage points from a trough in June of 1980 to its 14.7 percent peak in October 1981. About 2 percentage points of that rise represented a reversal of the decline in the second quarter of 1980. The remaining 3 point gain through October 1981 reflected a continuing inflation scare. The sharp rise in the long rate after the funds rate had reached its peak in early 1981 probably contributed to the Fed's inclination to persist with its 19 percent funds rate until August 1981. Moreover, the discernable declining trend in the long rate from October 1981 to August 1982 indicated that the policy was still exerting disinflationary pressure. When the Fed finally decided to relax its disinflationary policy by dropping the funds rate by over 4 percentage points in the summer of 1982, the long rate also fell by around 3.5 percentage points.

We can decompose this last decline in the long rate into a real component and an inflation-expectations component using evidence from earlier in the aggressive funds rate targeting period. The sharp 2.3 percentage point funds rate rise from September to October 1979 pulled the long rate up 0.7 percentage points; and the sharp 8.6 percentage point funds rate reduction between April and June 1980 pulled the long rate down 1.6 percentage points. Taking 25 percent as the fraction of aggressive funds rate policy actions transmitted to the long real rate, about 2.5 percentage points of the 3.5 percentage point fall in the long rate in the summer of 1982 reflected a reduction of inflation expectations.

Establishing Credibility: November 1982 to Spring 1986

Real GDP growth was still poor in the second half of 1982, running −1.8 percent and 0.6 percent in the third and fourth quarters, respectively. Consequently, the Fed continued to ease after relaxing its disinflationary policy, pushing the monthly average funds rate down to 8.5 percent by February 1983. November 1982 turned out to be an NBER business cycle trough, and real GDP growth was 2.6 percent in the first quarter of 1983. But the Fed kept the funds rate around 8.6 percent through May while the long rate remained steady at around 10.5 percent. It gradually became clear, however, that a strong recovery had begun. Real GDP grew at a spectacular 11.3 percent annual rate in the second quarter of 1983 and at rates of 6.1 percent, 7.0 percent, 7.9 percent, and 5.4 percent in the following four quarters.

The long rate rose from 10.5 percent in May 1983 to 11.8 percent in August, initiating an inflation scare only a year after the Fed had relaxed its disinflationary policy. The Fed reacted by raising the funds rate from 8.6 percent in May to 9.6 percent by August. Annualized quarterly inflation as measured by the GDP deflator was 4.8 percent or below throughout 1983 and 1984 with the exception of the first quarter of 1984, when it was 6 percent. Nevertheless, the long rate continued its rise in early 1984, moving up from the 11.8 percent level it had maintained since the previous summer to a 13.4 percent peak in June 1984. Amazingly, this was only about a percentage point short of its October 1981 peak, even though by 1984 inflation was 4 or 5 percentage points lower than in 1981.

The Fed tightened in an effort to resist the ongoing inflation scare, raising the funds rate to an 11.6 percent peak in August of 1984. The long rate began to decline in June 1984, indicating that the scare had been contained. The 7 percent real short rates needed to contain the scare ultimately brought quarterly real GDP growth down to the more normal 2 to 3 percent range in the second half of 1984. The Fed then lowered the funds rate rapidly by 3.2 percentage points from August to December and held it around 8 percent through 1985.

Meanwhile, the long rate fell about 6 percentage points from its June 1984 peak to the mid-7 percent range by the spring of 1986. By then, the long rate was 3 percentage points below where it had been at the start of the 1983 scare. The Fed's containment of the scare apparently made the public confident of another 3 percentage point reduction in the trend rate of inflation.

Maintaining Credibility: Spring 1986 to Summer 1990

Real GDP growth weakened considerably in the second quarter of 1986 to −0.3 percent from the strong 5.4 percent rate in the first quarter. With inflation appearing to have settled down in the 4 percent range, the Fed moved to encourage real growth by dropping the funds rate to the mid-6 percent range. Strong real growth in 1987 was accompanied by still another inflation scare in which the long rate rose 2 full percentage points from around 7.6 percent in March to 9.6 percent in October.

Although real GDP growth was very strong throughout the year, this time the Fed responded to the scare with only a relatively modest increase in the funds rate. As it happened, the scare eased somewhat after the October stock market crash, although the long rate remained above 8 percent. With real growth still reasonably strong in 1988, the Fed proceeded to raise the funds rate sharply from the 6 to 7 percent range in early 1988 to a peak of 9.9 percent in March 1989.

Though there was some evidence of a modest rise in inflation in 1988, the sustained funds rate tightening during the year is unique in that it was undertaken without a rise in the long rate. A preemptive tightening may have been needed to reverse the perception that policy had eased permanently following the stock market crash. At any rate, the result was an increase in credibility reflected in a further decline in the long rate in 1989. Though that fall was partially reversed in early 1990, a gently declining trend in the long rate was discernable by then, indicating growing confidence on the part of the public in the Fed's commitment to low inflation.

The 1990–91 Recession

The period of weak real growth in 1989 ending in an NBER business cycle peak in July 1990 may have been partly due to the high real short rates. Temporary oil price increases following the invasion of Kuwait, however, also helped account for the −1.6 percent real growth in the third quarter of 1990, −3.9 percent real growth in the fourth quarter, and −3.0 percent in the first quarter of 1991.

The Fed responded to the recession by bringing the funds rate down from slightly above 8 percent in the fall of 1990 to around 3 percent by the fall of 1992. It is remarkable that this sustained easing has not yet caused the long rate to rise, even though real short rates are now around zero. Real short rates were also about zero when excessive easing sparked the inflation scare in the summer of 1980, but they were around 4 percent when excessive easing triggered the summer 1983 scare, and around 3 percent at the time of the scare in the spring of 1987. The real short-rate floor at which easy monetary policy becomes excessive depends on such factors as the unemployment rate, government fiscal policy, and the strength of investment and consumption demand.[8] For example, the depressing effect of the credit control program on consumer spending may help account for the real rate getting as low as it did in 1980 before triggering a scare. Long rates, however, may also be more tolerant of aggressive funds rate easing when the public is more confident of the Fed's commitment to maintain a low trend rate of inflation.

3. OBSERVATIONS

The record of interest rate policy reviewed above contains a number of empirical findings that are important for interpreting and evaluating monetary policy. This section summarizes the main findings in a series of observations.

1. Inflation scares appear to be central to understanding the Fed's management of short-term interest rates. The gradual funds rate rise from January 1977 to October 1979 was undertaken in an environment of slowly rising long rates. The sharp long-rate rise in early 1980, during a four-month pause in the funds rate tightening, was probably an important factor inducing the Fed to undertake its enormous 3 percentage point tightening in March. Sharply rising long rates in the first nine months of 1981 indicated that the Fed had yet to win credibility for its disinflationary policy, and probably contributed to the Fed's maintaining very high real short rates for as long as it did. On the other hand, the declining long rate from October 1981 to October 1982 encouraged the Fed to ease policy by indicating the public's growing confidence in the disinflation.

   The serious inflation scare set off in the summer of 1983 largely accounts for the run-up of the funds rate to August 1984. The credibility acquired by the Fed in containing that scare yielded a 3 percentage point

[8] See, for example, the discussions in Campbell and Clarida (1987) and Poole (1988).

reduction in the long rate that allowed the funds rate to come down too. There was no inflation scare per se when the Fed raised the funds rate in 1988. Nevertheless, that series of actions may be understood as preemptive, taken to reverse a public perception that policy had permanently eased following the stock market crash. The current funds rate easing has yet to trigger a rise in the long rate, but the possibility of an inflation scare has probably limited the funds rate decline somewhat.

2. One might reasonably have expected the aggressive disinflationary policy actions taken in late 1979 to reduce long-term interest rate volatility by quickly stabilizing long-term inflation expectations at a low rate. Yet the reverse was true initially. Long rates turned out to be surprisingly volatile due to a combination of particularly aggressive funds rate movements and inflation scares. Amazingly, it took until 1988 for the unusual long-rate volatility to disappear.

3. One might also have expected the aggressive funds rate actions beginning in October 1979 to be accompanied by opposite movements in the long rate. Again, the result was just the reverse. The aggressive actions moved the long rate in the same direction, apparently influencing the long rate primarily through their effect on shorter maturity rates. Only at funds rate peaks and troughs did the long rate move in the opposite direction from the funds rate. The long rate appeared to be influenced by a change in expected inflation only after sustained aggressive funds rate actions.

4. The long rate reached its peak in October 1981, indicating that it took two years for policy to reverse the rise in the trend rate of inflation. It would be a mistake, however, to conclude that acquiring credibility necessarily takes so long. On the contrary, a close look reveals that the long rate had already turned down in April 1980 while the funds rate was still rising, suggesting that some credibility had been won by then. Credibility might even have been achieved sooner if the Fed had not hesitated temporarily between December 1979 and February 1980 to continue the aggressive funds rate tightening begun in October. In any case, the credit control program interrupted the disinflationary policy actions in May 1980 and high interest rates were restored fully only in early 1981. The automatic adjustment feature of the nonborrowed reserve operating procedure then caused a sharp decline in the funds rate between January and March of 1981 that was only fully reversed by June. Thus, three unfortunate interruptions account for the delay in the Fed's acquisition of credibility for its disinflationary policy.

5. Interestingly enough, the long rate was roughly in the same 8 percent range in the early 1990s as it was in the late 1970s, in spite of the 4 or 5 percentage point reduction in the inflation rate. Apparently, investors then perceived the 7 to 9 percent inflation rate as temporarily high, while, if anything, they perceive the current 3 to 4 percent rate as a bit below trend. The slowly declining long rate in the current period is indicative of the

steady acquisition of credibility, but the high long rate indicates a lingering lack of confidence in the Fed.

6. The Fed appears to have had remarkable latitude to push the federal funds rate down in the recent recession and recovery without triggering a rise in the long rate. On three occasions when trying to encourage real growth in the 1980s (summer 1980, summer 1983, and spring 1987) it could not push the funds rate more than 1 or 2 percentage points below the long rate before triggering an inflation scare; yet it pushed the funds rate 4 percentage points below the long rate in 1992.

   The greater flexibility to reduce short rates evident in the current recession is reminiscent of that in early postwar recessions when the Fed presumably had more credibility. The funds rate was pushed almost 3 percentage points below the long rate during the August 1957–April 1958 recession before the long rate began to rise. It was pushed more than 2 percentage points below the long rate in the April 1960–February 1961 recession without much of a rise in the long rate.[9]

7. The preceding observation suggests an attractive argument in favor of a congressional mandate for price stability. By reducing the risk of inflation scares, such a mandate would free the funds rate to react more aggressively to unemployment in the short run. Thus, a mandate for price stability would not only help eliminate inefficiencies associated with long-run inflation, it would add flexibility to the funds rate that might improve countercyclical stabilization policy as well.[10]

4. CONCLUSION

The article used institutional knowledge of Fed policy procedures, simple economic theory, and the inflation scare concept to analyze and interpret interest rate policy as practiced by the Fed since 1979. It focused on the primary policy problem during the period: the acquisition and maintenance of credibility for the commitment to low inflation. We saw that the Fed might have acquired credibility for its disinflation relatively quickly in early 1980 had it been able to sustain high interest rates then. After all, long-term rates were roughly equal to the inflation rate in 1979, indicating that the public believed inflation was only temporarily high at the time. Unfortunately, a series of interruptions delayed the actual disinflation for two years, probably raising the cost in terms of lost output of acquiring credibility.

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[9] Kessel (1965) contains a good description and analysis of the historical relation between long and short rates over the business cycle.

[10] Black (1990) discusses the benefits of price stability. Hetzel (1990, 1992) discusses a proposal that the U.S. Treasury issue indexed bonds to provide a better indicator of long-run inflation expectations.

Only a year after relaxing its disinflationary policy in 1982, the Fed's credibility was again challenged with a serious inflation scare that carried the long rate up from 10.5 percent to 13.4 percent. It took 11 months and 7 percent real short rates to contain the scare, indicating how fragile the Fed's credibility was in 1983 and 1984. The long-rate decline to the 7.5 percent range by the spring of 1986 reflected a big gain in credibility. Yet the Fed was tested by another scare in 1987 that ended with the stock market crash. The crash itself, however, then set in motion expectations of excessive easing that the Fed resisted with a 3 percentage point funds rate rise in 1988 and 1989, a tightening that probably weakened real growth somewhat in 1989 and 1990.

Reviewing the policy record makes one understand how fragile the Fed's credibility is and how potentially costly it is to maintain. Even after inflation had stabilized at around 4 percent in 1983, inflation scares and the Fed's reaction to them were associated with significant fluctuations in real growth. With that in mind, one cannot help but appreciate the potential value of a congressional mandate for price stability that would help the Fed establish a credible commitment to low inflation. In fact, there is evidence that an interest rate policy assisted by such a mandate would work well. The Bundesbank and the Bank of Japan follow interest rate policies resembling the Fed's and yet, for the most part, they have achieved better macroeconomic performance. Perhaps it is because they each enjoy a stronger mandate for price stability than does the Fed.

Table 1 Quarterly Changes in Real GDP and GDP Implicit Price Deflator, 1977:1–1992:4
Percent seasonally adjusted compound annual rates

Year/ Quarter	Real GDP	Implicit Price Deflator	Year/ Quarter	Real GDP	Implicit Price Deflator
1977			1985		
1	6.0	6.1	1	2.7	4.9
2	6.9	8.4	2	3.2	3.0
3	5.7	7.4	3	5.2	2.6
4	−0.8	7.3	4	2.3	3.9
1978			1986		
1	2.8	5.7	1	5.4	2.1
2	13.5	10.7	2	−0.3	2.1
3	3.1	8.3	3	2.3	2.9
4	4.8	8.8	4	1.3	3.3
1979			1987		
1	0.1	8.6	1	3.0	3.3
2	0.4	8.4	2	5.1	2.9
3	2.5	9.6	3	4.0	3.3
4	0.7	8.1	4	5.9	3.6
1980			1988		
1	1.7	9.8	1	2.6	3.6
2	−9.9	9.6	2	4.3	4.4
3	0.1	10.0	3	2.5	5.1
4	8.3	10.9	4	3.9	3.9
1981			1989		
1	5.6	11.8	1	3.2	5.4
2	−1.7	7.5	2	1.8	4.6
3	2.1	9.6	3	0.0	3.8
4	−6.2	8.8	4	1.5	3.7
1982			1990		
1	−4.9	4.5	1	2.8	4.4
2	1.6	5.5	2	1.0	4.8
3	−1.8	4.4	3	−1.6	4.7
4	0.6	3.4	4	−3.9	3.9
1983			1991		
1	2.6	4.8	1	−3.0	5.3
2	11.3	2.8	2	1.7	3.5
3	6.1	4.2	3	1.2	2.4
4	7.0	4.2	4	0.6	2.4
1984			1992		
1	7.9	6.0	1	2.9	3.1
2	5.4	4.1	2	1.5	2.7
3	2.2	4.5	3	3.4	2.0
4	2.7	2.6	4	3.8	1.7

Source: Bureau of Economic Analysis.

Table 2 Federal Funds Rate and 30-Year Government Bond Rate, January 1977–December 1992
Percent per annum

Year/ Month	Federal Funds Rate	30-Year Govt. Bond Rate	Year/ Month	Federal Funds Rate	30-Year Govt. Bond Rate	Year/ Month	Federal Funds Rate	30-Year Govt. Bond Rate	Year/ Month	Federal Funds Rate	30-Year Govt. Bond Rate
1977			1981			1985			1989		
J	4.61	—	J	19.08	12.14	J	8.35	11.45	J	9.12	8.93
F	4.68	—	F	15.93	12.80	F	8.50	11.47	F	9.36	9.01
M	4.69	7.80	M	14.70	12.69	M	8.58	11.81	M	9.85	9.17
A	4.73	7.73	A	15.72	13.20	A	8.27	11.47	A	9.84	9.03
M	5.35	7.80	M	18.52	13.60	M	7.97	11.05	M	9.81	8.83
J	5.39	7.64	J	19.10	12.96	J	7.53	10.45	J	9.53	8.27
J	5.42	7.64	J	19.04	13.59	J	7.88	10.50	J	9.24	8.08
A	5.90	7.68	A	17.82	14.17	A	7.90	10.56	A	8.99	8.12
S	6.14	7.64	S	15.87	14.67	S	7.92	10.61	S	9.02	8.15
O	6.47	7.77	O	15.08	14.68	O	7.99	10.50	O	8.84	8.00
N	6.51	7.85	N	13.31	13.35	N	8.05	10.06	N	8.55	7.90
D	6.56	7.94	D	12.37	13.45	D	8.27	9.54	D	8.45	7.90
1978			1982			1986			1990		
J	6.70	8.18	J	13.22	14.22	J	8.14	9.40	J	8.23	8.26
F	6.78	8.25	F	14.78	14.22	F	7.86	8.93	F	8.24	8.50
M	6.79	8.23	M	14.68	13.53	M	7.48	7.96	M	8.28	8.56
A	6.89	8.34	A	14.94	13.37	A	6.99	7.39	A	8.26	8.76
M	7.36	8.43	M	14.45	13.24	M	6.85	7.52	M	8.18	8.73
J	7.60	8.50	J	14.15	13.92	J	6.92	7.57	J	8.29	8.46
J	7.81	8.65	J	12.59	13.55	J	6.56	7.27	J	8.15	8.50
A	8.04	8.47	A	10.12	12.77	A	6.17	7.33	A	8.13	8.86
S	8.45	8.47	S	10.31	12.07	S	5.89	7.62	S	8.20	9.03
O	8.96	8.67	O	9.71	11.17	O	5.85	7.70	O	8.11	8.86
N	9.76	8.75	N	9.20	10.54	N	6.04	7.52	N	7.81	8.54
D	10.03	8.88	D	8.95	10.54	D	6.91	7.37	D	7.31	8.24
1979			1983			1987			1991		
J	10.07	8.94	J	8.68	10.63	J	6.43	7.39	J	6.91	8.27
F	10.06	9.00	F	8.51	10.88	F	6.10	7.54	F	6.25	8.03
M	10.09	9.03	M	8.77	10.63	M	6.13	7.55	M	6.12	8.29
A	10.01	9.08	A	8.80	10.48	A	6.37	8.25	A	5.91	8.21
M	10.24	9.19	M	8.63	10.53	M	6.85	8.78	M	5.78	8.27
J	10.29	8.92	J	8.98	10.93	J	6.73	8.57	J	5.90	8.47
J	10.47	8.93	J	9.37	11.40	J	6.58	8.64	J	5.82	8.45
A	10.94	8.98	A	9.56	11.82	A	6.73	8.97	A	5.66	8.14
S	11.43	9.17	S	9.45	11.63	S	7.22	9.59	S	5.45	7.95
O	13.77	9.85	O	9.48	11.58	O	7.29	9.61	O	5.21	7.93
N	13.18	10.30	N	9.34	11.75	N	6.69	8.95	N	4.81	7.92
D	13.78	10.12	D	9.47	11.88	D	6.77	9.12	D	4.43	7.70
1980			1984			1988			1992		
J	13.82	10.60	J	9.56	11.75	J	6.83	8.83	J	4.03	7.58
F	14.13	12.13	F	9.59	11.95	F	6.58	8.43	F	4.06	7.85
M	17.19	12.34	M	9.91	12.38	M	6.58	8.63	M	3.98	7.97
A	17.61	11.40	A	10.29	12.65	A	6.87	8.95	A	3.73	7.96
M	10.98	10.36	M	10.32	13.43	M	7.09	9.23	M	3.82	7.89
J	9.47	9.81	J	11.06	13.44	J	7.51	9.00	J	3.76	7.84
J	9.03	10.24	J	11.23	13.21	J	7.75	9.14	J	3.25	7.60
A	9.61	11.00	A	11.64	12.54	A	8.01	9.32	A	3.30	7.39
S	10.87	11.34	S	11.30	12.29	S	8.19	9.06	S	3.22	7.34
O	12.81	11.59	O	9.99	11.98	O	8.30	8.89	O	3.10	7.53
N	15.85	12.37	N	9.43	11.56	N	8.35	9.02	N	3.09	7.61
D	18.90	12.40	D	8.38	11.52	D	8.76	9.01	D	2.92	7.44

Source: Board of Governors of the Federal Reserve System.

REFERENCES

Barro, Robert J. "Interest Rate Targeting," *Journal of Monetary Economics,* vol. 23 (January 1989), pp. 3–30.

Bernanke, Ben, and Alan Blinder. "The Federal Funds Rate and the Channels of Monetary Transmission," *American Economic Review,* vol. 82 (September 1992), pp. 901–21.

Black, Robert P. "In Support of Price Stability," Federal Reserve Bank of Richmond *Economic Review,* vol. 76 (January/February 1990), pp. 3–6.

Campbell, John Y., and Richard H. Clarida. "The Dollar and Real Interest Rates," *Carnegie-Rochester Conference Series on Public Policy,* vol. 27 (1987), pp. 103–40.

Christiano, Lawrence, and Martin Eichenbaum. "Liquidity Effects, Monetary Policy, and the Business Cycle," Working Paper 70. Minneapolis: Federal Reserve Bank of Minneapolis, June 1991.

Cook, Timothy. "Determinants of the Federal Funds Rate: 1979–1982," Federal Reserve Bank of Richmond *Economic Review,* vol. 75 (January/February 1989), pp. 3–19.

__________, and Thomas Hahn. "The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s," *Journal of Monetary Economics,* vol. 24 (November 1989), pp. 331–51.

Dotsey, Michael, and Robert G. King. "Informational Implications of Interest Rate Rules," *American Economic Review,* vol. 76 (March 1986), pp. 33–42.

Fama, Eugene F. "The Information in the Term Structure," *Journal of Financial Economics,* vol. 13 (1984), pp. 509–28.

__________, and R. Bliss. "The Information in Long Maturity Forward Rates," *American Economic Review,* vol. 77 (1987), pp. 680–92.

Federal Reserve Bank of New York. "Monetary Policy and Open Market Operations in 1983," Federal Reserve Bank of New York *Quarterly Review,* vol. 9 (Spring 1984), pp. 39–56.

__________. "Monetary Policy and Open Market Operations in 1982," Federal Reserve Bank of New York *Quarterly Review,* vol. 8 (Spring 1983), pp. 37–54.

__________. "Monetary Policy and Open Market Operations in 1981," Federal Reserve Bank of New York *Quarterly Review,* vol. 8 (Spring 1982), pp. 34–53.

Friedman, Benjamin M. "Lessons on Monetary Policy from the 1980s," *The Journal of Economic Perspectives,* vol. 2 (Summer 1988), pp. 51–72.

Friedman, Milton, and Anna J. Schwartz. *A Monetary History of the United States.* Princeton: Princeton University Press, 1963.

Goodfriend, Marvin. "Discount Window Borrowing, Monetary Policy, and the Post-October 6, 1979 Federal Reserve Operating Procedure," *Journal of Monetary Economics,* vol. 12 (September 1983), pp. 343–56.

__________. "Interest Rate Smoothing and Price Level Trend-Stationarity," *Journal of Monetary Economics,* vol. 19 (May 1987), pp. 335–48.

__________. "Interest Rates and the Conduct of Monetary Policy," *Carnegie-Rochester Conference Series on Public Policy,* vol. 34 (Spring 1991), pp. 7–30.

__________, and William Whelpley. "Federal Funds: Instrument of Federal Reserve Policy," Federal Reserve Bank of Richmond *Economic Review,* vol. 72 (September/October 1986), pp. 3–11.

Hardouvelis, Gikas A. "The Predictive Power of the Term Structure during Recent Monetary Regimes," *Journal of Finance,* vol. 43 (1988), pp. 339–56.

Hetzel, Robert L. "Indexed Bonds as an Aid to Monetary Policy," Federal Reserve Bank of Richmond *Economic Review,* vol. 78 (January/February 1992), pp. 13–23.

__________. "Maintaining Price Stability: A Proposal," Federal Reserve Bank of Richmond *Economic Review,* vol. 76 (March/April 1990), pp. 53–55.

__________. "Monetary Policy in the Early 1980s," Federal Reserve Bank of Richmond *Economic Review,* vol. 72 (March/April 1986), pp. 20–32.

Kessel, Reuben A. *The Cyclical Behavior of the Term Structure of Interest Rates.* New York: National Bureau of Economic Research, 1965.

Levin, Fred J., and Paul Meek. "Implementing the New Operating Procedures: The View from the Trading Desk," in Stephen H. Axilrod, ed., *New Monetary Control Procedures.* Washington: Board of Governors of the Federal Reserve System, 1981.

Macaulay, Frederick R. *Bond Yields, Interest Rates, and Stock Prices.* Cambridge, Mass.: National Bureau of Economic Research, 1938.

Mankiw, N. Gregory, Jeffrey Miron, and David N. Weil. "The Adjustment of Expectations to a Change in Regime: A Study of the Founding of the Federal Reserve," *American Economic Review,* vol. 77 (June 1987), pp. 358–74.

McCallum, Bennett T. "Price Level Determinacy with an Interest Rate Policy Rule and Rational Expectations," *Journal of Monetary Economics,* vol. 8 (November 1981), pp. 319–29.

Miron, Jeffrey. "Financial Panics, the Seasonality of the Nominal Interest Rate, and the Founding of the Fed," *American Economic Review,* vol. 76 (March 1986), pp. 125–40.

Moore, George. "Forward-Looking Bond Yield Approximations." Washington: Board of Governors of the Federal Reserve System, September 1989.

Poole, William. “Monetary Policy Lessons of Recent Inflation and Disinflation,” *The Journal of Economic Perspectives,* vol. 2 (Summer 1988), pp. 73–100.

Rogoff, Kenneth. “Reputation, Coordination, and Monetary Policy,” *Carnegie-Rochester Conference Series on Public Policy,* Spring 1987, reprinted in Robert J. Barro, ed., *Modern Business Cycle Theory.* Cambridge, Mass.: Harvard University Press, 1989, pp. 236–64.

Schreft, Stacey L. “Credit Controls: 1980,” Federal Reserve Bank of Richmond *Economic Review,* vol. 76 (November/December 1990), pp. 25–55.

Sims, Christopher. “Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy,” *European Economic Review,* vol. 36 (1992), pp. 975–1000.

Thornton, Daniel. “The Borrowed-Reserves Operating Procedure: Theory and Evidence,” Federal Reserve Bank of St. Louis *Economic Review,* vol. 70 (January/February 1988), pp. 30–54.

Wallich, Henry C. “Recent Techniques of Monetary Policy,” Federal Reserve Bank of Kansas City *Economic Review,* vol. 69 (May 1984), pp. 21–30.

Woodward, G. Thomas. “The Real Thing: A Dynamic Profile of the Term Structure of Real Interest Rates and Inflation Expectations in the United Kingdom, 1982–89,” *Journal of Business,* vol. 63 (July 1990), pp. 373–98.

Price Stability Under Long-Run Monetary Targeting

Peter N. Ireland

Price-level stability is widely recognized as the principal goal of monetary policy (see, for example, Black 1990, Carlstrom and Gavin 1991, and Hoskins 1991). A program for price stability actually has two distinct objectives; achieving each objective has its own distinct benefits. The first objective is to reduce the expected rate of price inflation to zero. The second objective is to eliminate uncertainty about long-run changes in the price level. When these two objectives are met, monetary policy ceases to have disruptive effects in the real economy and in financial markets.

A simple model of the demand for money, such as the inventory model presented by Barro (1984), indicates that a rate of inflation that is expected to be positive provides consumers and firms with an incentive to engage in costly cash management activities in order to economize on their money holdings. In addition, because the federal income tax system is not completely indexed for changes in the price level, a positive rate of inflation causes some tax rates to increase automatically over time (Altig and Carlstrom 1991). Under zero inflation, costly cash management activities are unnecessary and unlegislated tax increases do not occur. These are the benefits of achieving the first objective of price stability.

The author, an economist at the Federal Reserve Bank of Richmond, would like to thank John Cochrane, Mike Dotsey, Marvin Goodfriend, Robert Hetzel, Tom Humphrey, Bennett McCallum, Yash Mehra, Stephen Stanley, and seminar participants at the Research Department, Federal Reserve Bank of Richmond, for helpful comments and suggestions. The opinions expressed herein are those of the author and do not necessarily represent those of the above-mentioned individuals, the Federal Reserve Bank of Richmond, or the Federal Reserve System.

Economic theory also indicates that uncertainty about long-run changes in the price level disrupts the functioning of capital markets. When there is long-run price-level uncertainty, lenders must worry that the real value of their savings will be depreciated by unexpected inflation. Similarly, borrowers must worry that the real value of their debt burdens will be increased by unexpected deflation. Fischer (1984) describes the problems that long-run price-level uncertainty causes for individuals who are saving for their retirement. Klein (1975) argues that long-run price-level uncertainty increases firms' dependence on short-term borrowing by making long-term debt financing riskier. Irving Fisher (1925, p. 65) points to these disruptive effects of long-run uncertainty as the greatest evil resulting from unstable prices:

> The chief indictment, then, of our present dollar is that it is uncertain. As long as it is used as a measuring stick, every contract is necessarily a lottery; and every contracting party is compelled to be a gambler in gold without his own consent.

Credit markets operate more efficiently when uncertainty about long-run changes in the price level is eliminated. This is the benefit of achieving the second objective of price stability.

This article demonstrates how a simple rule for monetary policy proposed by Milton Friedman (1960) provides for price stability. Friedman's *k-percent rule* requires that the nominal money supply, defined by the broad aggregate M2, grow at an annual rate of k percent, where k is a constant between three and five. Broaddus and Goodfriend (1984) interpret Friedman's k-percent rule as calling for a long-run monetary targeting procedure that eliminates the permanent changes away from trend in the money supply known as base drift. The most recent argument in favor of the k-percent rule is made by Hetzel (1989).

The ability of the k-percent rule to achieve the first objective of price stability, zero inflation, is seldom questioned. The ability of the k-percent rule to achieve the second objective of price stability, the elimination of long-run price-level uncertainty, is a more controversial issue. Thus, while this article shows how the k-percent rule can achieve both objectives of price stability, its argument focuses on the problem of long-run uncertainty that is also emphasized by Fisher (1925). Accordingly, the first section draws on time-series methods to obtain a working definition of long-run uncertainty. Section 2 derives a simple model of the price level that explains why economic theory gives no clear answer as to whether the k-percent rule can eliminate long-run price-level uncertainty: the model indicates that the answer hinges critically on the time-series properties of the demand for money. Section 3 goes on to examine the properties of M2 demand and concludes that the k-percent rule will, in fact, greatly reduce the degree of uncertainty concerning the long-run behavior of the price level. Section 4 concludes with a discussion, following Broaddus and Goodfriend (1984), of how the k-percent rule can actually be implemented.

1. LONG-RUN PRICE-LEVEL UNCERTAINTY

The idea of long-run price-level uncertainty can be formalized by reference to the time-series concepts of *trend stationarity* and *difference stationarity.* These concepts are introduced to economists by Nelson and Plosser (1982).

Denote the natural logarithm of an economic time series at time t by w_t. Suppose that this series fluctuates over time about a long-run trend according to

$$w_t = \alpha + \beta t + c_t, \tag{1}$$

where c_t is a stationary, mean zero deviation from trend. Since c_t is stationary, it can be represented as the linear combination of past and present identically and independently distributed (iid) innovations ϵ_t,

$$c_t = \theta(L)\epsilon_t, \tag{2}$$

where $\theta(L) = \theta_0 + \theta_1 L + \theta_2 L^2 + \cdots$ is a polynomial in the lag operator L (for details, see Sargent 1987, Ch. 11). Equations (1) and (2) define w_t as a *trend stationary* process, since it always tends to revert to the linear trend $\alpha + \beta t$.

Consider a second time series, with natural logarithm x_t at time t. Suppose that the first differences of x_t are stationary. Then

$$(1 - L)x_t = \gamma + d_t, \tag{3}$$

where d_t is a stationary, mean zero process with the representation

$$d_t = \phi(L)\delta_t, \tag{4}$$

δ_t is an iid innovation, and $\phi(L) = \phi_0 + \phi_1 L + \phi_2 L^2 + \cdots$. Equations (3) and (4) define x_t as a *difference stationary* process, since its first differences tend to revert to a constant mean γ.

Equations (1) and (2) imply that, with $\lambda(L) = (1 - L)\theta(L)$,

$$(1 - L)w_t = \beta + \lambda(L)\epsilon_t. \tag{5}$$

Similarly, equations (3) and (4) imply that

$$(1 - L)x_t = \gamma + \phi(L)\delta_t. \tag{6}$$

Equations (5) and (6) reveal that the first difference of both trend stationary and difference stationary processes can be expressed as the sum of a constant and a mean zero deviation.

Beveridge and Nelson (1981) demonstrate that any process that can be written in the form of equations (5) and (6) can be decomposed into a long-run, trend, or permanent component and a short-run, cyclical, or transitory component. For w_t and x_t, let w_t^t and x_t^t denote the trend components and let w_t^c and x_t^c denote the cyclical components.

The Beveridge-Nelson decomposition defines the trend components w_t^t and x_t^t to be random walks with drift (see part 1 of Appendix A for details), so that

$$E_{t-1}(w_t^t) = \beta + w_{t-1}^t \tag{7}$$

and

$$E_{t-1}(x_t^t) = \gamma + x_{t-1}^t \tag{8}$$

where $E_{t-1}(w_t^t)$ is the expectation, or forecast, of w_t^t conditional on $\{\epsilon_{t-1}, \epsilon_{t-2}, \epsilon_{t-3}, \ldots\}$ and $E_{t-1}(x_t^t)$ is the expectation, or forecast, of x_t^t conditional on $\{\delta_{t-1}, \delta_{t-2}, \delta_{t-3}, \ldots\}$. The variances of the trend components w_t^t and x_t^t conditional on $\{\epsilon_{t-1}, \epsilon_{t-2}, \epsilon_{t-3}, \ldots\}$ and $\{\delta_{t-1}, \delta_{t-2}, \delta_{t-3}, \ldots\}$ are given by

$$V_{t-1}(w_t^t) = \sigma_\epsilon^2(\lambda_0 + \lambda_1 + \lambda_2 + \cdots)^2 = \sigma_\epsilon^2[\lambda(1)]^2 \tag{9}$$

and

$$V_{t-1}(x_t^t) = \sigma_\delta^2(\phi_0 + \phi_1 + \phi_2 + \cdots)^2 = \sigma_\delta^2[\phi(1)]^2, \tag{10}$$

where σ_ϵ^2 is the unconditional variance of ϵ_t and σ_δ^2 is the unconditional variance of δ_t. The cyclical components w_t^c and x_t^c, meanwhile, are stationary, mean zero processes.

The conditional, or forecast, variance of the Beveridge-Nelson trend component serves as a working definition of long-run uncertainty, since it indicates exactly how much variation is expected in a series' long-run trend. From the definition $\lambda(L) = (1 - L)\theta(L)$, $\lambda(1) = 0$. Thus, equation (9) implies that the trend stationary process w_t has zero forecast variance in its long-run component. Since w_t always tends to revert to the linear trend $\alpha + \beta t$, there is never any uncertainty about its long-run behavior. In general, $\phi(1) \neq 0$, so equation (10) indicates that the difference stationary process x_t has a long-run component with positive forecast variance. Since x_t shows no tendency to revert to a linear trend, there is always some uncertainty about its long-run behavior.

Bordo, Choudhri, and Schwartz (1990) suggest that the Beveridge-Nelson decomposition can be used to measure the degree of long-run price-level uncertainty that is present under any given monetary policy. A monetary policy that makes the price level trend stationary will, in light of equation (9), completely eliminate long-run uncertainty. A monetary policy that makes the price level difference stationary, in contrast, fails to completely eliminate long-run uncertainty. In this latter case, the forecast variance $\sigma_\delta^2[\phi(1)]^2$ of the price level's trend component can be used to measure the degree of long-run uncertainty that remains.

2. A SIMPLE MODEL OF THE PRICE LEVEL

A simple model of the price level begins with the national income version of the equation of exchange,

$$M_t V_t = P_t Y_t, \tag{11}$$

where M_t is nominal money, V_t is the income velocity of money, P_t is the price level, and Y_t is real income. Taking logs in (11) and rearranging yields

$$p_t = m_t + v_t - y_t, \tag{12}$$

where lowercase letters denote the natural logarithms of the variables represented by the corresponding uppercase letters.

By definition, the income velocity of money is equal to nominal income divided by nominal money. Hence,

$$v_t = \ln(V_t) = \ln(P_t Y_t/M_t) = y_t - \ln(M_t/P_t). \tag{13}$$

Substituting equation (13) into equation (12) yields

$$p_t = m_t - \ln(M_t/P_t). \tag{14}$$

Monetary theory indicates that in the long run, nominal money is determined by supply, while real money is determined by demand (Friedman 1969, p. 8). Monetary theory, therefore, says that equation (14) can be written as

$$p_t = m_t^s - (m/p)_t^d, \tag{15}$$

where m_t^s is the log of the nominal money supply and $(m/p)_t^d$ is the log of real money demand. Equation (15) shows how the price level is determined by the interaction of money supply and money demand.

Monetary theory also indicates that the demand for real money $(m/p)_t^d$ depends on real income y_t and the opportunity cost R_t^* of holding real balances (McCallum and Goodfriend 1988):

$$(m/p)_t^d = f(y_t, R_t^*, \xi_t). \tag{16}$$

In equation (16), the opportunity cost R_t^* is defined as the difference between the rate of interest paid on nonmonetary assets and the rate of interest paid on monetary assets. Even when explicit interest payments on monetary assets are regulated or prohibited, as they were in the United States from 1933 through the early 1980s, interest payments may still be made implicitly in the form of services to depositors, and R_t^* must be measured so as to account for these implicit payments (Klein 1974; Dotsey 1983). The third term in the money demand function (16), ξ_t, captures variation in money demand that cannot be attributed to either changes in y_t or changes in R_t^*.

The neutrality of money implies that variations in the nominal money supply have no long-run effect on real income y_t or shifts in real money demand ξ_t. In addition, as noted by Moore, Porter, and Small (1990), competition in the banking system forces deposit rates to adjust one-for-one with changes in market rates of interest in the long run, so that if money is defined (as it is in Friedman 1960) by the broad aggregate M2, then changes in the nominal money supply will have no long-run effect on the opportunity cost R_t^*. In this case, changes in the growth rate of the money supply that translate into changes in the rate of inflation have no long-run effect on R_t^*; that is, money is not only neutral, but superneutral as well. Equation (16), along with these extra assumptions about the neutrality of money and competition in the banking system, therefore implies that long-run changes in the nominal money supply have no effect on long-run changes in real money demand. In equation (15), it is possible to consider the long-run behavior of m_t^s separately from the long-run behavior of $(m/p)_t^d$.

Milton Friedman's (1960) k-percent rule calls for steady long-run growth in the broad monetary aggregate. In terms of the time-series concepts introduced in section 1, the k-percent rule can be interpreted as a proposal to make the supply of M2 a trend stationary process, with an average annual growth rate of k percent. Suppose first that the demand for real M2 is a trend stationary process. Then equation (15) indicates that the k-percent rule will achieve the first objective of price stability, zero inflation, when k is set equal to the trend rate of growth in the demand for M2. Moreover, because the sum of two trend stationary processes is itself trend stationary, the k-percent rule will also achieve the second objective of price stability by completely eliminating long-run price-level uncertainty.

Now suppose that the demand for real M2 is difference stationary. In this case, the k-percent rule can still provide for zero expected inflation when k is set equal to the drift in real M2 demand. Since the sum of a trend stationary process and a difference stationary process is difference stationary, however, equation (15) indicates that the price level will be difference stationary. That is, considerable long-run uncertainty about the behavior of the price level may remain. Only the first objective of price stability will be achieved; the second objective will not be met.

As emphasized by Walsh (1986) and as shown by equation (15), the question of whether the k-percent rule will provide for price stability cannot be answered on theoretical grounds; instead, it is an empirical question. The k-percent rule can always achieve zero expected inflation, but it will eliminate long-run price-level uncertainty only if the demand for real M2 is trend stationary. Thus, the next section examines the time-series behavior of real M2 in order to determine whether real M2 is trend stationary or difference stationary and thereby to determine whether or not the k-percent rule can achieve both objectives of price stability.

3. THE TIME-SERIES PROPERTIES OF REAL M2

A number of empirical studies, including those by Moore, Porter, and Small (1990), Hafer and Jansen (1991), and Mehra (1991), document the existence of a stable econometric relationship between the demand for real M2 and its determinants, income and interest rates, based on a linearized version of equation (16):

$$(m/p)_t^d = a_1 y_t + a_2 R_t^* + \xi_t. \tag{17}$$

These studies also find evidence that income, and perhaps interest rates as well, are best described as difference stationary processes. Together, the stability of the demand function and the difference stationarity of the determinants imply that real M2 is itself difference stationary. Corroborating evidence is supplied by Nelson and Plosser (1982), who find that M2 velocity and national income are difference stationary. Equation (13), which can be rearranged to read

$$\ln(M_t/P_t) = y_t - v_t, \tag{18}$$

implies that if income and velocity are both difference stationary, then real M2 will be, in general, difference stationary as well.

These earlier studies draw their conclusions from the results of Dickey-Fuller (1979) tests of the null hypotheses that the relevant economic time series are difference stationary. One version of the Dickey-Fuller test uses the t-statistic on the OLS estimate of ρ_2 in the regression equation

$$z_t = \rho_0 + \rho_1 t + \rho_2 z_{t-1} + e_t. \tag{19}$$

If the null hypothesis that $\rho_2 = 1$ can be rejected in favor of the alternative that $\rho_2 < 1$, then there is evidence that the series z_t is trend stationary. If the null that $\rho_2 = 1$ cannot be rejected, then there is evidence that z_t is difference stationary. Under the null that $\rho_2 = 1$, the t-statistic has a nonstandard distribution; its critical values are given by Fuller (1976, p. 373). Also, if the regression errors e_t are autocorrelated, then the t-statistic must be adjusted as shown by Phillips and Perron (1988).

Table 1 presents the results of Dickey-Fuller tests for real M2 over two sample periods, a long period that runs from 1915 through 1990 and a postwar period that runs from 1947 through 1990. The data are annual; their sources are given in Appendix B. The Phillips-Perron adjustments to the t-statistics use

Table 1 Dickey-Fuller Tests for Real M2

1915–1990:

$$\ln(M2_t/P_t) = \underset{(0.0608)}{0.178} + \underset{(0.00209)}{0.00510}\,t + \underset{(0.0650)}{0.839}\,\ln(M2_{t-1}/P_{t-1})$$

DW = 1.27 DF = −2.97 lags = 3

1947–1990:

$$\ln(M2_t/P_t) = \underset{(0.175)}{0.439} + \underset{(0.00277)}{0.00663}\,t + \underset{(0.0895)}{0.788}\,\ln(M2_{t-1}/P_{t-1})$$

DW = 1.11 DF = −2.66 lags = 3

Notes: Standard errors of the OLS estimates are given in parentheses. DW is the Durbin-Watson statistic. DF is the Dickey-Fuller statistic, corrected for autocorrelated errors as suggested by Phillips and Perron (1988). The variance of the regression error is estimated as suggested by Newey and West (1987). The number of nonzero autocorrelations, lags, is chosen as suggested by Andrews (1991).

Newey and West's (1987) method to estimate the variance of the regression error along with Andrews' (1991) method (described in part 3 of Appendix A) to determine the number of nonzero autocorrelations that need to be allowed for.

For both sample periods, the Dickey-Fuller test fails to reject the null hypothesis that real M2 is difference stationary at the 10 percent significance level. These results, like those from earlier studies, can be interpreted as evidence that the k-percent rule will fail to eliminate long-run price-level uncertainty.

The results of the Dickey-Fuller tests have an alternative interpretation, however, that is more favorable for the k-percent rule. A statistical test can fail to reject its null hypothesis for two reasons. One reason is that the null is, in fact, true. The other is that although the null is false, the data do not contain enough information to allow the test to statistically reject it. The low power of Dickey-Fuller tests to distinguish between difference stationarity as the null and trend stationarity as the alternative is the subject of a number of recent papers, including those by Diebold and Rudebusch (1989), Christiano and Eichenbaum (1990), Stock (1991), DeJong et al. (1992), and Rudebusch (1992). These papers argue that Nelson and Plosser (1982) fail to reject the hypotheses that velocity and income are difference stationary not because the hypotheses are true, but because there is simply not enough information in the data to reject them.

Kwiatkowski, Phillips, Schmidt, and Shin (1992) suggest a way to determine why a Dickey-Fuller test fails to reject its null that a series is difference stationary. They recommend a direct test of the null hypothesis of trend stationarity that complements the Dickey-Fuller test. If their direct test rejects its null of trend stationarity, then there is good reason to believe that the Dickey-Fuller test fails to reject because the series is truly difference stationary. But if the direct test does not reject trend stationarity, then there is reason to conclude that the Dickey-Fuller test fails to reject because there is not enough information in the data. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, which is based on the properties of the residuals from the regression equation

$$z_t = \rho_0 + \rho_1 t + e_t, \tag{20}$$

is described in detail in part 2 of Appendix A.

Table 2 presents the results of the KPSS test for real M2. For neither sample period can the null of trend stationarity be rejected at the 10 percent significance level. These results suggest that the Dickey-Fuller tests do not reject the null of difference stationarity because there is not enough information in the M2 data for them to do so, not because M2 is necessarily difference stationary.

When applied to real M2, the Dickey-Fuller test is a test of the null hypothesis that the forecast variance of the Beveridge-Nelson trend component of real M2 is greater than zero (recall the discussion at the end of section 1). The KPSS test is a test of the null hypothesis that the forecast variance of the Beveridge-Nelson trend component of real M2 is equal to zero. Since

Table 2 Kwiatkowski-Phillips-Schmidt-Shin Tests for Real M2

1915–1990:

$$\ln(M2_t/P_t) = \underset{(0.0227)}{0.917} + \underset{(0.000513)}{0.0318}\, t$$

DW = 0.326 KPSS = 0.113 lags = 14

1947–1990:

$$\ln(M2_t/P_t) = \underset{(0.0160)}{1.96} + \underset{(0.000618)}{0.0304}\, t$$

DW = 0.357 KPSS = 0.0977 lags = 9

Notes: Standard errors of the OLS estimates are given in parentheses. DW is the Durbin-Watson statistic. KPSS is the Kwiatkowski-Phillips-Schmidt-Shin (1992) statistic. The variance of the regression error is estimated as suggested by Newey and West (1987). The number of nonzero autocorrelations, lags, is chosen as suggested by Andrews (1991).

these two tests indicate only that there is not enough information in the data to distinguish between their two hypotheses, a different approach is needed to assess the ability of the k-percent rule to achieve both objectives of price stability. Such an approach is developed by Bordo, Choudhri, and Schwartz (1990). Bordo, Choudhri, and Schwartz simply estimate the size of the forecast variance of the Beveridge-Nelson trend component of real M2. They use this point estimate, rather than a hypothesis test, to measure the amount by which the k-percent rule will reduce long-run price-level uncertainty.

Bordo, Choudhri, and Schwartz perform the following experiment. The degree of long-run price-level uncertainty that has actually prevailed in the United States during the two sample periods can be measured by the forecast variance of the Beveridge-Nelson trend component of the GNP deflator. Recall that equation (16), along with the assumptions about monetary neutrality and competition in the banking system discussed in section 2, implies that the Beveridge-Nelson component of real M2 is invariant to changes in monetary policy. Equation (15) expresses the log of the price level as the difference between the log of nominal money supply and the log of real money demand. Because the k-percent rule makes the money supply trend stationary, equation (15) implies that the degree of long-run uncertainty that would have prevailed if the k-percent rule had guided monetary policy during the sample periods can be measured by the forecast variance of the trend component of real M2. Thus, Bordo, Choudhri, and Schwartz estimate the amount by which the k-percent rule can reduce long-run uncertainty by comparing the forecast variance of the trend component of the actual GNP deflator to the forecast variance of the trend component of real M2.

Cochrane (1988) shows that the forecast variance of the Beveridge-Nelson trend component of a time series z_t can be estimated by $V_n(z)$, $1/n$ times the variance of the series' n-differences:

$$V_n(z) = (1/n)\,\mathrm{var}(z_t - z_{t-n}). \tag{21}$$

In equation (21), n is a large constant. Cochrane and Sbordone (1988) recommend using a value of 20 or 30 for n, but caution that n must not exceed half of the sample size T. Cochrane (1988) shows that $V_n(z)$ has an asymptotic variance that can be estimated by $(4n/3T)V_n(z)$.

Table 3 compares V_n for real M2 and the GNP deflator over both sample periods; $n = 30$ is used for the longer sample and $n = 20$ is used for the postwar data. The estimates indicate that the forecast variance of the trend component of real M2 is quite small, so that the long-run behavior of real M2 closely resembles that of a trend stationary process. In fact, the forecast variance of the trend component of real M2 is of an order of magnitude smaller than the forecast variance of the trend component of the GNP deflator.

Implementing the Bordo-Choudhri-Schwartz (BCS) experiment using the results from Table 3 indicates that long-run price-level uncertainty would have been reduced by 82 percent had the k-percent rule been used throughout the period from 1915 to 1990. The k-percent rule would have reduced uncertainty by more than 92 percent during the postwar years.

Taken together, the results presented in Tables 1–3 reveal that earlier studies overstate the case against the k-percent rule by suggesting that there is strong evidence that real M2 is difference stationary. In fact, the results indicate that Dickey-Fuller tests fail to reject their null hypothesis that real M2 is difference stationary because the data do not contain enough information to discriminate among various hypotheses, not because their null is necessarily true. The

Table 3 Forecast Variances of Beveridge-Nelson Trend Components, Real M2 and GNP Deflator

1915–1990:		
	$V_n(M2/P) =$ 0.000644 (0.000467)	$V_n(P) =$ 0.00358 (0.00260)
	$V_n(M2/P)/V_n(P) = 0.180$	
	$n = 30$	
1947–1990:		
	$V_n(M2/P) =$ 0.000273 (0.000213)	$V_n(P) =$ 0.00356 (0.00277)
	$V_n(M2/P)/V_n(P) = 0.0767$	
	$n = 20$	

Notes: $V_n(M2/P)$ is the forecast variance of the Beveridge-Nelson trend component of the log of real M2, estimated as $1/n$ times the variance of n-differences as suggested by Cochrane (1988). $V_n(P)$ is the forecast variance of the trend component of the log of the GNP deflator. Asymptotic standard errors are given in parentheses.

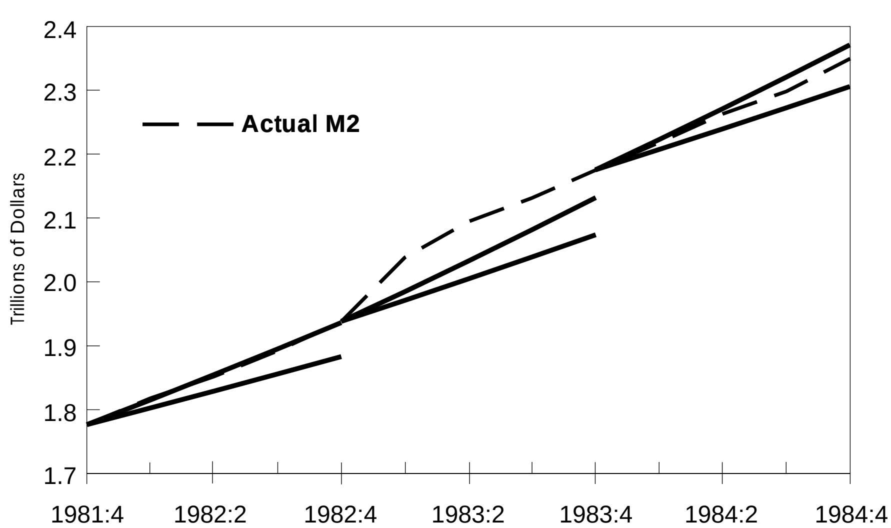
Dickey-Fuller and KPSS hypothesis tests indicate that it is not possible to draw firm conclusions about the trend stationarity or difference stationarity of real M2. Furthermore, the point estimates used in the BCS experiments suggest that adopting the k-percent rule will reduce long-run price-level uncertainty by at least 80 percent. These results provide good reason to believe that Friedman's k-percent rule can achieve both objectives of price stability by providing for zero expected inflation and by greatly reducing long-run price-level uncertainty.

4. IMPLEMENTING THE k-PERCENT RULE

Broaddus and Goodfriend (1984) recommend that the Federal Reserve implement the k-percent rule by adopting a long-run monetary targeting procedure. The differences between this alternative targeting procedure and the annual M2 targeting procedure that is presently used by the Federal Open Market Committee are illustrated in Figures 1 and 2.

Figure 1B shows that the long-run procedure starts from a single base (here, the base is chosen to be the actual level of M2 in the fourth quarter of 1981) and specifies a constant growth rate target from that base over many years, just as called for by the k-percent rule. Figure 1A shows that the annual procedure, in contrast, starts from a new base in each year and specifies a growth rate target from the new base over a single year only. According to

Figure 1A FOMC M2 Targets, 1981:4–1984:4



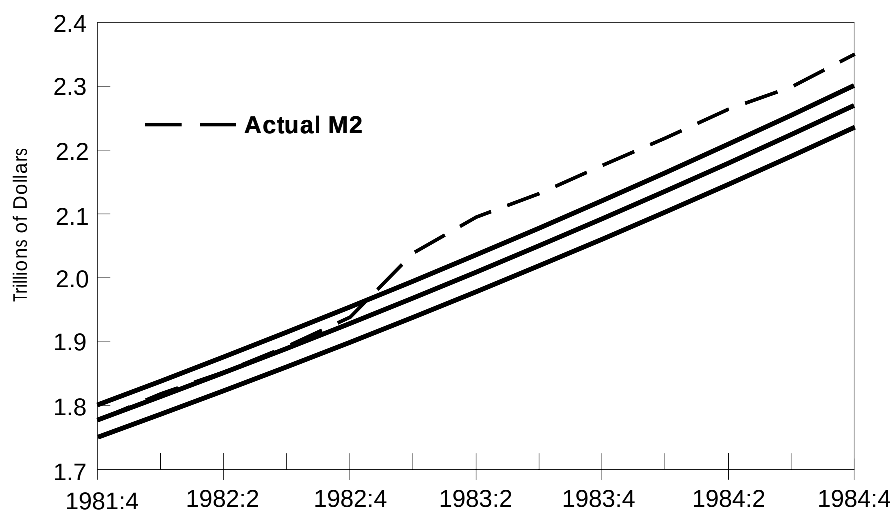
the annual procedure, the new base for each year is given by the actual level of M2, rather than the previous year's target level. As a result, the deviations of actual M2 from target at the end of each year are turned into permanent changes away from trend—known as base drift—in the nominal money supply.

One important feature of the long-run targeting procedure is that it eliminates base drift. While Figure 1A shows that M2 fell within the FOMC's target cone during 1984, so that the Federal Reserve was not required to make up for rapid M2 growth in the previous year, Figure 1B shows that under the Broaddus-Goodfriend targeting procedure, the Federal Reserve would have been required in 1984 to correct for its past mistake by bringing M2 back into its long-run target band.

Broaddus and Goodfriend's suggestion to eliminate base drift is criticized by Walsh (1986). Walsh uses a somewhat more elaborate model of the price level than the one used here in section 2 to demonstrate that if the demand for real money is difference stationary, then the k-percent rule will fail to completely eliminate uncertainty about the long-run behavior of the price level. Of course, this is exactly the same message that is contained in equation (15). Walsh goes on to point out that Nelson and Plosser's (1982) results imply that real M2 is, in fact, difference stationary. Thus, according to Walsh, the k-percent rule will not achieve an important objective of price stability.

The empirical results obtained here in section 3, however, indicate that Nelson and Plosser's conclusions about the time-series properties of real M2,

Figure 1B Alternative M2 Targets, 1981:4–1984:4



which are based in Dickey-Fuller tests, only reflect the fact that the data do not contain enough information to discriminate between alternative hypotheses. The KPSS tests show that there is as much evidence that real M2 is trend stationary as there is that it is difference stationary. In other words, the results show that Walsh is too quick to conclude that the elimination of base drift is inconsistent with the objectives of price stability.

Walsh also notes that if real M2 is difference stationary, then the forecast variance of its Beveridge-Nelson trend component is positive. In this case, there are permanent shocks to real M2 that prevent the series from reverting to a long-run trend. In principle, the permanent changes in the nominal money supply caused by base drift can act to offset these permanent shocks to real M2 and thereby prevent them from translating into long-run shocks to the price level.

The calculations associated with the Bordo-Choudhri-Schwartz experiment performed in section 3 show that the long-run component of real M2 has a small, but positive, forecast variance. This means that the k-percent rule can largely, but not completely, eliminate long-run price-level uncertainty. Walsh is correct, therefore, in noting that base drift could in theory act to offset the small permanent shocks to real M2, thereby improving on the k-percent rule by completely eliminating long-run uncertainty.

In practice, however, base drift has exacerbated, rather than offset, the effects of long-run variation in real M2 on the price level. If base drift offset the long-run effects of shocks to real M2, then Table 3 would show that the long-run forecast variance of the GNP deflator is smaller than the long-run forecast variance of real M2. Instead, Table 3 reveals that the long-run forecast variance of prices is of an order of magnitude larger than the long-run forecast variance of real M2. Thus, the long-run effects of base drift on the price level have been exactly the opposite of those predicted by Walsh. In fact, the Bordo-Choudhri-Schwartz experiment indicates that the k-percent rule, which eliminates base drift, will reduce the amount of long-run price-level uncertainty by at least 80 percent.

In addition to eliminating base drift, there is a second way in which the Broaddus-Goodfriend targeting procedure improves on the current annual targeting procedure. As can be seen in Figures 1 and 2, the long-run targeting procedure sets bounds around the monetary growth rate target in the form of a band of constant width. The annual procedure, in contrast, sets bounds around the target in the form of a cone. In this way, the long-run targeting procedure gives the Federal Reserve more room than does the annual procedure to pursue its short-term policy objectives throughout the entire year. Figure 2, for example, shows that while actual M2 dipped below the FOMC's target cone in the first and second quarters of 1989, potentially constraining short-run policy, actual M2 continued to stay well within the long-run target band throughout this period. By using the k-percent rule to guide monetary policy, therefore, the Federal Reserve would not only achieve its long-run goal of price stability, but would have considerably more room to pursue its short-run goals as well.

Figure 2A FOMC M2 Targets, 1988:4–1991:4

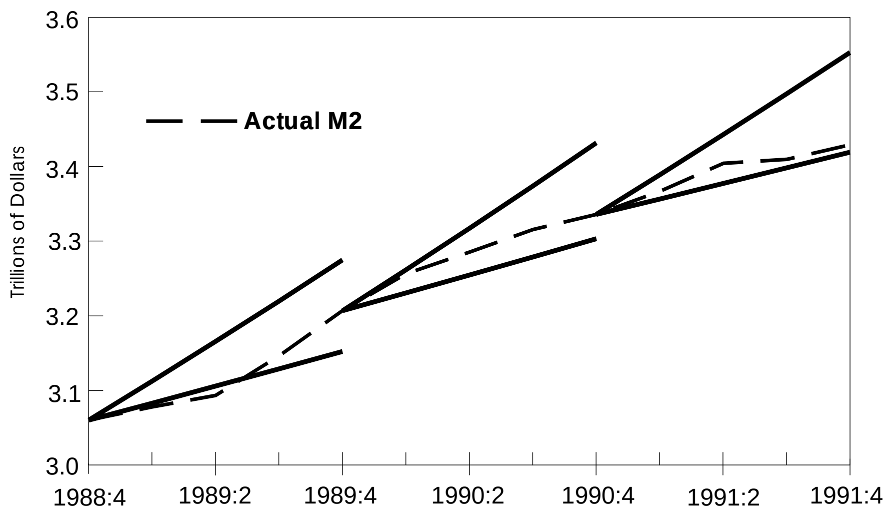
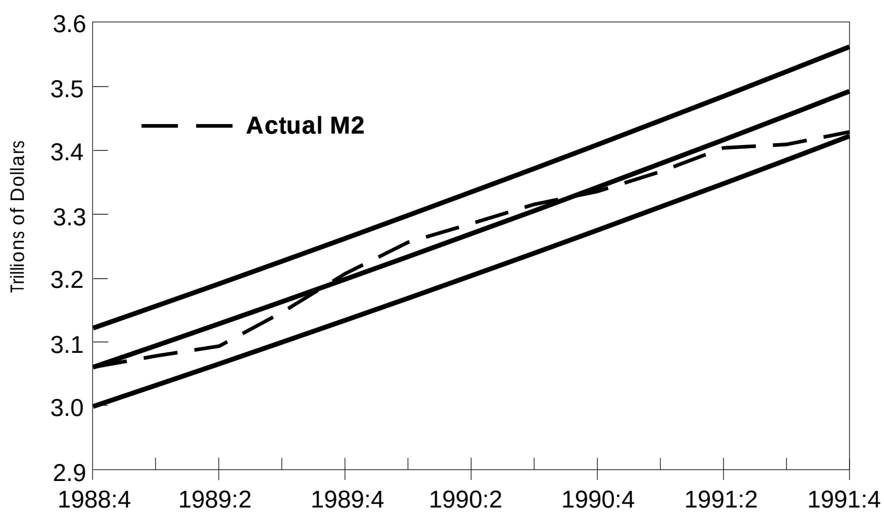


Figure 2B Alternative M2 Targets, 1988:4–1991:4



APPENDIX A: TECHNICAL ANALYSIS

1. The Beveridge-Nelson Decomposition

Let the trend stationary process w_t and the difference stationary process x_t be as defined by equations (1)–(4) in the text, so that

$$(1 - L)w_t = \beta + \lambda(L)\epsilon_t \tag{22}$$

and

$$(1 - L)x_t = \gamma + \phi(L)\delta_t. \tag{23}$$

When applied to w_t and x_t, the Beveridge-Nelson decomposition yields

$$w_t = w_t^t + w_t^c, \tag{24}$$

where

$$w_t^t = \beta + w_{t-1}^t + \sum_{j=0}^{\infty} \lambda_j \epsilon_t \tag{25}$$

and

$$w_t^c = -\sum_{k=0}^{\infty} \sum_{j=k+1}^{\infty} \lambda_j \epsilon_{t-k} \tag{26}$$

for w_t and

$$x_t = x_t^t + x_t^c, \tag{27}$$

where

$$x_t^t = \gamma + x_{t-1}^t + \sum_{j=0}^{\infty} \phi_j \delta_t \tag{28}$$

and

$$x_t^c = -\sum_{k=0}^{\infty} \sum_{j=k+1}^{\infty} \phi_j \delta_{t-k} \tag{29}$$

for x_t.

Equations (25) and (28) reveal that the Beveridge-Nelson decomposition defines the trend components w_t^t and x_t^t to be random walks with drift, so that equations (7) and (8) hold. Equations (9) and (10) also follow from (25) and (28). Equations (26) and (29), meanwhile, show that the Beveridge-Nelson cyclical components w_t^c and x_t^c are stationary, mean zero processes.

In addition to the Beveridge-Nelson decomposition, there may be other ways to write either w_t or x_t as the combination of a random walk and a stationary component. However, the random walk component defined by any such decomposition will have the same forecast variance as the Beveridge-Nelson trend component (see Cochrane 1988 for a proof of this fact). In this sense, the forecast variance of the Beveridge-Nelson trend component is a fairly general measure of long-run uncertainty.

Quah (1992) examines a broader class of decompositions, including those that define the trend component as an arbitrary ARIMA process instead of a pure random walk with drift. He shows that those decompositions (like the Beveridge-Nelson decomposition) that define the trend component as a random walk maximize the importance of the trend component in the series as a whole. Quah's result implies that if a given monetary policy completely eliminates long-run price-level uncertainty as defined by the Beveridge-Nelson decomposition, then it completely eliminates long-run price-level uncertainty as defined by *any* decomposition of the price level into long-run and short-run ARIMA components.

2. The Kwiatkowski-Phillips-Schmidt-Shin Test

Kwiatkowski et al. (1992) test the null hypothesis that the series z_t is trend stationary by estimating the regression equation

$$z_t = \rho_0 + \rho_1 t + e_t. \tag{30}$$

They apply Newey and West's (1987) method to estimate the variance of the residuals from this regression as

$$s^2(\tau) = T^{-1} \sum_{t=1}^{T} e_t^2 + 2T^{-1} \sum_{s=1}^{\tau} b(s,\tau) \sum_{t=s+1}^{T} e_t e_{t-s}, \tag{31}$$

where the sample size is T, the weighting function $b(s,\tau)$ is given by

$$b(s,\tau) = 1 - \frac{s}{1+\tau}, \tag{32}$$

and the lag truncation parameter τ is chosen according to the method developed by Andrews (1991), which is described in part 3 of this appendix.

With S_t defined as

$$S_t = \sum_{i=1}^{t} e_i, \tag{33}$$

the KPSS test statistic is

$$KPSS = \frac{1}{s^2(\tau)T^2} \sum_{t=1}^{T} S_t^2. \tag{34}$$

Kwiatkowski et al. show that this test statistic has a nonstandard distribution; its critical values are given in their Table 1 (p. 166).

3. Choosing the Lag Truncation Parameter

The Phillips-Perron (1988) correction to the Dickey-Fuller (1979) test statistic requires an estimate of the variance of the residuals from the regression equation

$$z_t = \rho_0 + \rho_1 t + \rho_2 z_{t-1} + e_t. \tag{35}$$

Similarly, the KPSS test requires an estimate of the variance of the residuals from the regression equation

$$z_t = \rho_0 + \rho_1 t + e_t. \tag{36}$$

In both cases, it is appropriate to use Newey and West's (1987) method to estimate the variance of e_t as

$$s^2(\tau) = T^{-1} \sum_{t=1}^{T} e_t^2 + 2T^{-1} \sum_{s=1}^{\tau} b(s,\tau) \sum_{t=s+1}^{T} e_t e_{t-s}, \tag{37}$$

where T is the sample size and the weighting function $b(s,\tau)$ is given by

$$b(s,\tau) = 1 - \frac{s}{1+\tau}. \tag{38}$$

In equation (37), the lag truncation parameter τ determines how many nonzero autocorrelations in e_t are allowed for. Use the residuals from (35) or (36) to estimate the regression equation

$$e_t = \pi e_{t-1} + u_t. \tag{39}$$

Andrews (1991) shows that the best choice for τ is given by

$$\tau = 1.1447(\alpha T)^{\frac{1}{3}} - 1, \tag{40}$$

where

$$\alpha = \frac{4\pi^2}{(1-\pi)^2(1+\pi)^2}. \tag{41}$$

APPENDIX B: DATA SOURCES

M2, 1915–1958: Friedman and Schwartz (1970). Table 1, Column 13.

M2, 1959–1990: *Economic Report of the President* (1992). Table B-65.

Implicit Price Deflator for Gross National Product, 1982=100, 1915–1928: Balke and Gordon (1989). Table 10.

Implicit Price Deflator for Gross National Product, 1982=100, 1929, 1933, 1939–1990: *Economic Report of the President* (1991). Table B-3.

Implicit Price Deflator for Gross National Product, 1982=100, 1930–1932, 1934–1938: U.S. Department of Commerce (1986). Table 7.3.

Federal Open Market Committee M2 Target Ranges, 1981:4–1984:4, 1988:4–1991:4: "Record of Policy Actions of the Federal Open Market Committee." Various issues (1981–1991) of the *Federal Reserve Bulletin.*

REFERENCES

Altig, David, and Charles T. Carlstrom. "Bracket Creep in the Age of Indexing: Have We Solved the Problem?" Working Paper 9108. Cleveland: Federal Reserve Bank of Cleveland, Research Department, June 1991.

Andrews, Donald W. K. "Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimation," *Econometrica*, vol. 59 (May 1991), pp. 817–58.

Balke, Nathan S., and Robert J. Gordon. "The Estimation of Prewar Gross National Product: Methodology and New Evidence," *Journal of Political Economy,* vol. 97 (February 1989), pp. 38–92.

Barro, Robert J. *Macroeconomics.* New York: John Wiley and Sons, 1984.

Beveridge, Stephen, and Charles R. Nelson. "A New Approach to Decomposition of Economic Time Series into Permanent and Transitory Components with Particular Attention to Measurement of the 'Business Cycle,' " *Journal of Monetary Economics,* vol. 7 (March 1981), pp. 151–74.

Black, Robert P. "In Support of Price Stability," Federal Reserve Bank of Richmond *Economic Review,* vol. 76 (January/February 1990), pp. 3–6.

Board of Governors of the Federal Reserve System. "Record of Policy Actions of the Federal Open Market Committee," *Federal Reserve Bulletin,* various issues, 1981–1991.

Bordo, Michael D., Ehsan U. Choudhri, and Anna J. Schwartz. "Money Stock Targeting, Base Drift, and Price-Level Predictability: Lessons from the U.K. Experience," *Journal of Monetary Economics,* vol. 25 (March 1990), pp. 253–72.

Broaddus, Alfred, and Marvin Goodfriend. "Base Drift and the Longer Run Growth of M1: Experience from a Decade of Monetary Targeting," Federal Reserve Bank of Richmond *Economic Review*, vol. 70 (November/December 1984), pp. 3–14.

Carlstrom, Charles T., and William T. Gavin. "A Conference on Price Stability," Federal Reserve Bank of Cleveland *Economic Review*, vol. 27 (Quarter 4, 1991), pp. 2–9.

Christiano, Lawrence J., and Martin Eichenbaum. "Unit Roots in Real GNP: Do We Know and Do We Care?" *Carnegie-Rochester Conference Series on Public Policy*, vol. 32 (Spring 1990), pp. 7–61.

Cochrane, John H. "How Big is the Random Walk in GNP?" *Journal of Political Economy*, vol. 96 (October 1988), pp. 893–920.

__________, and Argia M. Sbordone. "Multivariate Estimates of the Permanent Components of GNP and Stock Prices," *Journal of Economic Dynamics and Control*, vol. 12 (June/September 1988), pp. 255–96.

DeJong, David N., John C. Nankervis, N. E. Savin, and Charles H. Whiteman. "Integration Versus Trend Stationarity in Time Series," *Econometrica*, vol. 60 (March 1992), pp. 423–33.

Dickey, David A., and Wayne A. Fuller. "Distribution of the Estimators for Autoregressive Time Series With a Unit Root," *Journal of the American Statistical Association*, vol. 74 (June 1979), pp. 427–31.

Diebold, Francis X., and Glenn D. Rudebusch. "Long Memory and Persistence in Aggregate Output," *Journal of Monetary Economics*, vol. 24 (September 1989), pp. 189–209.

Dotsey, Michael. "An Examination of Implicit Interest Rates on Demand Deposits," Federal Reserve Bank of Richmond *Economic Review*, vol. 69 (September/October 1983), pp. 3–11.

Economic Report of the President. Washington: United States Government Printing Office, 1991.

Economic Report of the President. Washington: United States Government Printing Office, 1992.

Fischer, Stanley. "The Benefits of Price Stability," in *Price Stability and Public Policy.* Kansas City: Federal Reserve Bank of Kansas City, 1984.

Fisher, Irving. *Stabilizing the Dollar.* New York: Macmillan, 1925.

Friedman, Milton. *A Program for Monetary Stability.* New York: Fordham University Press, 1960.

__________. "The Optimum Quantity of Money," in *The Optimum Quantity of Money and Other Essays.* Chicago: Aldine Publishing Company, 1969.

Friedman, Milton, and Anna J. Schwartz. *Monetary Statistics of the United States: Estimates, Sources, and Methods.* New York: National Bureau of

Economic Research, 1970.

Fuller, Wayne A. *Introduction to Statistical Time Series.* New York: John Wiley and Sons, 1976.

Hafer, R. W., and Dennis W. Jansen. "The Demand for Money in the United States: Evidence from Cointegration Tests," *Journal of Money, Credit, and Banking,* vol. 23 (May 1991), pp. 155–68.

Hetzel, Robert L. "M2 and Monetary Policy," Federal Reserve Bank of Richmond *Economic Review,* vol. 75 (September/October 1989), pp. 14–29.

Hoskins, W. Lee. "Defending Zero Inflation: All for Naught," Federal Reserve Bank of Minneapolis *Quarterly Review,* vol. 15 (Spring 1991), pp. 16–20.

Klein, Benjamin. "Competitive Interest Payments on Bank Deposits and the Long-Run Demand for Money," *American Economic Review,* vol. 64 (December 1974), pp. 931–49.

__________. "The Impact of Inflation on the Term Structure of Corporate Financial Instruments: 1900–1972," in William L. Silber, ed., *Financial Innovation.* Lexington: D. C. Heath, 1975.

Kwiatkowski, Denis, Peter C. B. Phillips, Peter Schmidt, and Yongcheol Shin. "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure are We that Economic Time Series Have a Unit Root?" *Journal of Econometrics,* vol. 54 (October/December 1992), pp. 159–78.

McCallum, Bennett T., and Marvin S. Goodfriend. "Theoretical Analysis of the Demand for Money," Federal Reserve Bank of Richmond *Economic Review,* vol. 74 (January/February 1988), pp. 16–24.

Mehra, Yash P. "An Error-Correction Model of U.S. M2 Demand," Federal Reserve Bank of Richmond *Economic Review,* vol. 77 (May/June 1991), pp. 3–12.

Moore, George R., Richard D. Porter, and David H. Small. "Modeling the Disaggregated Demands for M2 and M1: The U.S. Experience in the 1980s," in Peter Hooper, Karen H. Johnson, Donald L. Kohn, David E. Lindsey, Richard D. Porter, and Ralph Tryon, eds., *Financial Sectors in Open Economies: Empirical Analysis and Policy Issues.* Washington: Board of Governors of the Federal Reserve System, 1990.

Nelson, Charles R., and Charles I. Plosser. "Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications," *Journal of Monetary Economics,* vol. 10 (September 1982), pp. 139–62.

Newey, Whitney K., and Kenneth D. West. "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica,* vol. 55 (May 1987), pp. 703–708.

Phillips, Peter C. B., and Pierre Perron. "Testing for a Unit Root in Time Series Regression," *Biometrika,* vol. 75 (June 1988), pp. 335–46.

Quah, Danny. "The Relative Importance of Permanent and Transitory Components: Identification and Some Theoretical Bounds," *Econometrica,* vol. 60 (January 1992), pp. 107–118.

Rudebusch, Glenn D. "Trends and Random Walks in Macroeconomic Time Series: A Re-Examination," *International Economic Review,* vol. 33 (August 1992), pp. 661–80.

Sargent, Thomas J. *Macroeconomic Theory,* 2d ed. Orlando: Academic Press, 1987.

Stock, James H. "Confidence Intervals for the Largest Autoregressive Root in U.S. Macroeconomic Time Series," *Journal of Monetary Economics,* vol. 28 (December 1991), pp. 435–59.

U.S. Department of Commerce, Bureau of Economic Analysis. *The National Income and Product Accounts of the United States, 1929–82: Statistical Tables.* Washington: United States Government Printing Office, 1986.

Walsh, Carl E. "In Defense of Base Drift," *American Economic Review,* vol. 76 (September 1986), pp. 692–700.

Should We Subsidize the Use of Currency?

Jeffrey M. Lacker

Three types of money are provided monopolistically by the government in the United States: coin, currency, and reserve balances with Federal Reserve Banks. Together, they make up the monetary base. Although it is common to think of government money as virtually costless to produce, the real resource costs are substantial, as shown in Table 1. In 1991 the cost of providing currency was $393.2 million, most of which was incurred in verifying and sorting deposits of used currency and replacing unfit notes with new currency.

Under current arrangements, banks can deposit used currency and withdraw fit currency at par. Thus currency costs are not borne directly by banks, but instead are funded out of general government revenues.[1] True, restrictions on banks' deposit and withdrawal of currency help limit Federal Reserve costs, but these costs are not borne by users. In contrast, all of the costs associated with the provision of reserve balances are recovered through "service fees," as mandated by the Monetary Control Act of 1980.[2]

The author is associate research officer of this Bank. For helpful comments on an earlier version, the author would like to thank Mike Dotsey, Marvin Goodfriend, Bob Hetzel, Tom Humphrey, Pete Ireland, Jim Reese, and John Weinberg. Thanks to Bruce Champ and Warren Weber for helpful conversations. The views expressed do not necessarily reflect those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] Costs associated with currency and coin operations directly reduce the Federal Reserve's payment to the U.S. Treasury. The Fed buys newly printed currency at cost from the Bureau of Engraving and Printing and newly minted coin at face value from the United States Mint.

[2] The Monetary Control Act of 1980 mandated fees for Federal Reserve services, including "currency and coin services" (12 USC §248a), but this phrase is interpreted to mean only coin wrapping and currency and coin transportation services, which are omitted from the tables. See Board of Governors (1980).

Table 1 Costs of Components of the Monetary Base, 1991
Millions of dollars

	Currency	Coin	Reserve Balances
Operating expenses	139.9	24.5	140.8
Replacement costs	253.3	44.0	0
Total	393.2	68.5	140.8
Recovered from fees	0	0	140.8
Unrecovered	393.2	68.5	0

Sources: See Appendix B.

This article examines whether the Fed should continue to subsidize the use of currency. In particular, I argue that the Fed should charge a currency deposit fee, effectively paying less than par when converting currency into reserve balances, and should remove the rationing constraints on currency deposits and withdrawals. This recommendation should not be surprising, since it follows from standard economic reasoning. The costs of a government-provided service should, in general, be paid by the users to ensure that use is efficient.

However, I argue that a partial subsidy is desirable, in the sense that the deposit fee should be less than marginal cost. The reasoning is again standard. There is likely to be a "market failure" that makes the private willingness to pay for fit currency less than the social benefits of fit currency. The market failure arises because currency generally trades at par, regardless of the quality of the note, due to the inconvenience of quality-adjusted currency prices. As a result, willingness to pay is less than the social benefits and the Fed should subsidize the provision of currency quality by charging less than marginal cost. In no case, however, should the deposit fee be zero; efficiency of the division of currency processing between banks and the Fed requires a strictly positive fee.

In what follows I focus solely on currency policy, even though coin use is similarly subsidized and the arguments against its free provision apply with equal force.

1. SOME BACKGROUND ON THE MANAGEMENT OF GOVERNMENT MONEY[3]

Depository institutions can hold reserve account balances at a Federal Reserve Bank. These reserves are book-entry demand deposits that can be transferred

[3] See Booth (1989) for a historical review of Federal Reserve currency and coin operations.

to other banks. Reserve account balances are also used for automated clearinghouse transactions in which recurring payments are made via prearranged wire transfers. Federal Reserve Banks charge fees for transfers of reserve balances and generally recover all of the associated costs.

A branch or office of a bank may withdraw currency and coin from a Federal Reserve Bank, deducting the par value of the withdrawal from its reserve balance. Deposits of currency and coin are credited at par. In both cases the bank pays for transportation, generally via an armored carrier service.

Incoming deposits of currency at Federal Reserve Banks are processed on high-speed equipment that removes wrong denomination and counterfeit notes and verifies the number of notes in the deposit. In addition, the equipment removes and destroys "unfit" notes that have become soiled in circulation.[4] The remaining "fit" notes are repackaged and stored. Withdrawals of currency are met with fit used notes and newly printed notes from the Bureau of Engraving and Printing. Banks are not allowed to request new notes, but must accept the mix that is sent to them. Coins are deposited and withdrawn in bags of standard size and are verified by weighing.

Banks can process, sort, and reuse currency themselves. Tellers count and sort currency, holding some for future use, and send unsatisfactory notes, suspected counterfeits or "excess" notes to the Fed. Banks with more than one branch sometimes process currency centrally at a "cash room," collecting currency from branches with net inflows, and disbursing it to branches with net outflows. Some banks sell currency directly to other neighboring institutions. Some private transfers of currency are intermediated by armored carrier companies. The same high-speed currency-processing equipment used by the Federal Reserve is available to private institutions, some of which, particularly larger institutions, run currency-processing operations similar to the Fed's (although they do not destroy worn currency).

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[4] The U.S. Treasury defines unfit currency as "currency which is unfit for further circulation because of its physical condition such as torn, dirty, limp, worn or mutilated." 31 CFR 100.5. Federal Reserve Banks have adopted more detailed definitions.

> "Paper currency tendered for redemption in order to be classed as fit for further circulation must be fairly clean so that its class, denomination, and genuineness can be determined without difficulty and must contain a sufficient amount of life or sizing to permit its being handled with facility. It should not contain heavy creases which break the fiber of the paper and indicate that disintegration has begun. A fit note when held by one end in one hand and pressed into a slightly concave shape lengthwise should sustain itself substantially on a line with the hand. It should not present a limp or rag-like appearance. If a note has retained a fair amount of the original strength or sizing, it is fit unless it is so badly soiled as to be offensive, or it is torn, perforated or otherwise mutilated. Mere creasing or wrinkling that has not broken nor seriously weakened the note does not make it unfit. So-called 'dog ears' or bent corners do not render notes unfit." (Federal Reserve Bank of Richmond, *Operating Circular No. 14,* March 30, 1990, p. 3)

Federal Reserve Banks place restrictions on the deposit and withdrawal of coin and currency by banks. The restrictions vary somewhat across Federal Reserve offices, but all follow a set of guidelines adopted by the Board of Governors (Board of Governors 1984). For example, some Federal Reserve Banks offer access to only one bank office per municipality. In large metropolitan areas this constraint can force a bank to consolidate cash from its branch network to its own cash room operation from which all deposits and withdrawals are made. In contrast, a bank operating in a suburban or rural environment can receive service at many of its branches. These constraints, called “access controls,” effectively mandate significant private processing for banks in certain geographical areas.

Another key restriction is the prohibition of “cross-shipping”—the “deposit of excess fit currency and re-order of the same denomination within 5 business days.” This restriction prevents a branch from depositing its incoming currency without sorting and then obtaining fit currency from the Fed to meet its withdrawal demand. Both access and cross-shipping constraints are explicitly aimed at limiting the volume of Fed currency processing. There is no empirical evidence on the extent to which these constraints reduce such processing volume, but anecdotal evidence suggests that it is quite substantial in some areas.

2. THE POLICY QUESTION

Currency, coin, and reserve account balances are the three components of the monetary base. The essential policy question concerns the terms on which the components of the monetary base can be exchanged for each other. Under current policy the Fed stands ready to exchange any component of the monetary base for any other component at a fixed relative price of one (par) plus transportation costs. The division of the base among currency, coin, and reserve account balances is thus demand determined, while the total monetary base is determined by monetary policy via open market operations.

As a consequence of the current policy and the fragmented structure of the U.S. depository industry, the Fed acts as an intermediary in the flow of currency. Some bank branches experience net inflows of currency deposits, accumulating currency which they wish to exchange for reserve account balances, either because their vault space is limited or because they want to convert excess reserves to loanable funds. Some bank branches experience net outflows of currency which they need to replace from reserve account balances. The Federal Reserve has a substantial inventory of currency, amounting to 21 percent of outstanding currency at the end of 1991, for example.[5]

[5] Out of $366 billion Federal Reserve notes outstanding on December 31, 1991, Federal Reserve Banks held $78 billion, leaving $288 billion in the hands of banks and the public (Board of Governors 1992, p. 246).

Table 2 Currency Costs, 1991
Millions of dollars, except where otherwise noted

Paying and receiving	41.2
High-speed processing	50.9
Other processing	4.4
Overhead	43.3
Total processing costs	139.9
Printing new currency	253.3
Total costs	393.2
Number of notes received from circulation, *millions*	19,613
Cost per note, *dollars.*	.0200

Sources: See Appendix B.

When a Federal Reserve Bank accepts a deposit of currency from a bank, in effect it *buys* notes in "straps" of 100 notes each. When a Federal Reserve Bank pays out currency to a bank, in effect it *sells* straps of currency. The objects sold by the Fed—verified straps of fit, genuine notes ("sorted straps")—are different from the objects bought by the Federal Reserve—unverified straps of fit and unfit notes, including some wrong denomination and counterfeit notes ("unsorted straps"). The two are distinctly different economic commodities, just as aluminum is different from bauxite and flour is different from wheat. Real resource costs must be incurred in receiving and storing unsorted straps, in processing currency, in printing new replacement notes, and in paying out currency withdrawals. From this point of view, Federal Reserve currency operations are a productive economic activity, consisting of the transformation of unsorted straps of mixed-quality currency into sorted straps of fit currency. Table 2 provides a breakdown of Federal Reserve Bank currency-processing costs.

The "price" of Federal Reserve processing is the difference between what the Fed charges for withdrawals of sorted straps of currency and what it pays for deposits of unsorted straps. Access and cross-shipping controls act as rationing devices to limit the demand for Federal Reserve processing. The policy issue, then, is a classic one. On what terms should a publicly provided service be offered? Should it be provided free of charge with quantitative restrictions to ration demand? Or should it be offered at a price without quantitative restrictions?

3. WHAT IS WRONG WITH THE CURRENT POLICY?

Under the current policy of rationed free provision—buying and selling currency at par with quantitative restrictions on deposits and withdrawals—banks' currency-handling decisions are likely to be socially inefficient. For example, a bank with a large branch network could operate a cash room, incurring the associated costs of processing. Alternatively, the bank could have branches deposit and withdraw directly to and from the Fed, avoiding the cost of processing altogether. By buying and selling currency at par, the Fed subsidizes central bank processing relative to private currency processing. Some currency processing now performed by the Fed is socially wasteful.

The quantitative restrictions embodied in access and cross-shipping constraints attempt to prevent overuse of Federal Reserve processing. For example, restrictions on the number of bank branches served in a given geographic locality prevent duplicative shipping to and from the Fed when direct currency transfers between branches would be less costly. Similarly, cross-shipping restrictions prevent some branches from having the Fed process currency that they could process at lower cost themselves.

However, quantitative restrictions are generally less efficient as a rationing device. If the Federal Reserve knew the costs of various alternative private currency-processing arrangements, it could design quantitative restrictions which would exactly replicate the effect of efficient prices. Unfortunately, the necessary information is costly to acquire, and implementable rules cannot be too complex or subjective. As a result, the simple rules in place are often unrelated to the real resource costs of currency processing.

For example, two banks might have neighboring branches that qualify for access, but if the banks merge only one branch would qualify. The real relative costs of currency processing would not have changed, but access controls would treat the two situations differently. Similarly, cross-shipping constraints affect banks unequally, depending on their typical net deposit flows. A branch with equal currency deposits and withdrawals is forced to process currency itself. By contrast, two neighboring branches with complementary currency flows—one receiving net inflows, the other meeting net outflows—have no incentive to sort and transfer currency together, since they can have the Fed process it free. Cross-shipping thus encourages private processing at branches with balanced currency flows but not at branches with net inflows or outflows.

4. PRICING WOULD BE BETTER THAN QUANTITATIVE RESTRICTIONS

An attractive alternative to rationing is to provide currency processing at a positive price without quantitative restrictions. One way to do this is to impose a fee for depositing currency.[6] Economic theory tells us that the price of a publicly

[6] An alternative method would be to charge a fee for withdrawals of sorted fit currency. Any combination of deposit and withdrawal fees are possible as long as the price at which the Fed sells currency is greater than the price at which the Fed buys it. I will restrict attention to a deposit fee.

provided good should be set equal to the marginal social cost of production.[7] This suggests that a currency deposit fee should be set equal to the marginal cost of Federal Reserve currency processing. As a rough guide to the likely magnitude of such a price, Table 2 shows that the average total cost of Federal Reserve currency operations is 2 cents per note. Under constant returns to scale, marginal cost would equal average cost implying a deposit fee of 2 cents per note.[8]

A deposit fee equal to the marginal cost of Fed processing would have the desirable property that banks' decisions about currency handling would no longer be biased towards Fed processing. If operating its own cash room is less costly to a bank than sending currency to the Fed, that is because private processing is socially less costly than Fed processing. Conversely, if Fed processing is less costly to the bank than processing currency itself, it is because Fed processing is socially less costly than private processing. The cost of acquiring sorted currency from the Fed, relative to the cost of obtaining privately sorted currency, would reflect actual relative resource costs. Appendix A describes a simple model that illustrates this point. The model shows that in the absence of any "market failure," setting the deposit fee equal to the Fed's marginal cost results in the socially optimal allocation of currency processing.

A currency deposit fee would allow the elimination of quantitative restrictions on currency deposits and withdrawals, and would let banks decide on the cost-minimizing pattern of use. Banks would determine whether it is less costly for a particular branch to obtain currency directly from the Fed, from other branches, or from central cash rooms. They would determine the cost-minimizing frequency of shipments and whether cross-shipping is the least costly arrangement. The potential overuse of Federal Reserve processing would be curbed, since banks would efficiently ration such processing themselves. In addition, and perhaps more important, the resulting volume of Fed currency processing would be allocated efficiently across banks. The substitution of a deposit fee for quantitative restrictions also would decentralize cost-minimization decisions and let banks assess whether Fed or private processing is more efficient.

5. WOULD THIS INTERFERE WITH PAR VALUE EXCHANGE OF CURRENCY?

One advantage of paper currency in retail transactions is that it trades at par value, which can be ascertained at a glance.[9] In contrast, in many commodity

[7] See Bös (1985), for a survey.

[8] Using three years of data by Federal Reserve office, Michael Dotsey (1991) estimates long-run cost functions for high-speed sorting and for currency paying and receiving. He finds economies of scale in both activities, with scale economy coefficients (elasticity of total cost with respect to output) of .92 and .84, respectively. This finding implies that marginal cost is about 1.7 to 1.8 cents per note.

[9] See Fama (1983) for a discussion.

money schemes it was costly to establish the value of money being tendered in exchange. For example, gold coins often would be weighed and assayed, with the coins valued on the basis of the quantity of the gold they contained. One would expect to see merchants offer discounts for less costly forms of payment. Gasoline retailers sometimes offer discounts for purchases by cash, check, or debit card, reflecting the costs of the float associated with credit card purchases.[10] If the Federal Reserve paid less than par for deposits of currency, then a merchant's currency deposit would be more costly for a bank to accept. Would banks impose new fees for currency deposits, passing along the cost of the deposit fee charged by the Fed? Would merchants then charge a premium for accepting payment in currency or offer a discount for non-cash payments? Perhaps, but it provides no reason not to charge for currency deposits at the Fed. The Fed charges for wire transfer payments and allows banks to decide whether to pass the charges on to their customers. Similarly, efficiency would be maximized by allowing banks to decide whether to pass on currency deposit fees.

Merchants and banks already face many costs of handling currency, but choose not to pass them on to consumers. For example, both currency and checks are accepted at par in retail transactions, despite the fact that their costs are very different. As it is, banks pay the cost of transporting currency to and from the Federal Reserve, a fee than can be as high as 4 cents per note—twice as high as the 2 cents per note deposit fee proposed above. Banks do not charge consumers directly for cash transactions, but often charge retail merchants for currency transactions. Retail businesses do not directly pass these costs along to customers offering cash; instead they incorporate them into their overall cost of doing business and assess customers only indirectly. In essence, we already have nonpar currency at the wholesale level, coexisting with par currency at the retail level. Such evidence suggests that currency would still generally exchange at par under a deposit-fee scheme.[11]

A distinct but related question concerns the variation in quality across notes. Par value exchange implies that old worn notes exchange one-for-one with crisp new notes of the same denomination, despite the inferiority of worn notes. If the Federal Reserve paid less than par for used currency deposits, then accepting unfit currency would be more costly for a bank than accepting fit. Would banks impose fees for deposits of unfit currency, passing along the cost of the deposit fee charged by the Fed? Would old, worn-out currency be discounted in retail transactions, trading at quality-dependent prices like used cars? Would the benefits of improved efficiency in currency processing be outweighed by the higher transactions costs of quality-dependent prices?

[10] See Barron, Staten and Umbeck (1992).

[11] Curtin (1983) reports evidence on the costs of different payment media to retail establishments and why so few offer cash discounts.

It seems unlikely that our currency would trade at quality-dependent prices under a deposit-fee scheme. First, it obviously would be cumbersome and inconvenient for the price of a note to vary with the note's physical condition. The quality of each note tendered in a transaction would have to be assessed individually and a value mutually agreed upon by both parties. Since quality is difficult to define objectively, this could be a contentious process. The number of computations required for a typical transaction would be larger, since the quality-adjusted price of notes would have to be calculated both for the notes tendered and for the notes given in change. Furthermore, merchants would have to keep track of each note's quality, either segregating notes or labeling them. For retail transactions it seems far more convenient for currency to trade at face value.

If everyone else is accepting currency at prices that do not depend on note quality, then your incentive to pay quality-dependent prices is minimal. You might be willing to pay for the lower inconvenience provided by a high-quality note while it is in your possession, but you will be unwilling to pay for the added convenience to the person that accepts it from you at par. Quality differentials would have to become relatively large to induce quality-dependent currency prices. Therefore, one reason we do not see quality-dependent currency prices is that the benefits—improved resource allocation resulting from more accurate relative prices—are less than the associated transactions costs.

Part of the reason quality differentials are not large enough to induce quality-dependent prices is that the Fed essentially supports the price of old currency relative to new currency. The Fed buys old currency at par, withdrawing unfit notes from circulation and replacing them at par with new notes. Worn notes are tendered to the Fed rather than exchanged at less than par. As a result, the range of quality of notes in circulation is not large enough to make quality-dependent pricing worthwhile. In most private durable goods markets, in contrast, producers supply new goods but do not intervene in the market for used goods. For example, automobile manufacturers sell new cars but do not generally intervene in the market for used cars.[12] The prices of used cars adjust to reflect the value of old cars relative to new cars. If automobile manufacturers supported the price of their used cars at close to the price of their new cars, they would be forced to buy many old cars. The quality of the stock of cars in use would be far higher on average and far more uniform, perhaps even trading "at par." Without manufacturer intervention, many consumers would pay large sums to have an old car replaced with a new one. Under current Fed policy, low-quality notes are rarely so bad that a consumer would be willing to pay more than a small fraction of its value to have it replaced with a new one.

The legal tender provision of the Coinage Act is another reason currency is likely to keep trading at par. The law prevents creditors from refusing to take worn currency at par. This probably would prevent merchants from offering discounts for high-quality notes.

[12] Supel and Todd (1984) first suggested this analogy.

6. WOULD THE QUALITY OF CURRENCY IN CIRCULATION DECLINE?

The preceding discussion raises some pertinent questions. How would a deposit-fee scheme affect the average quality of currency in circulation? By discouraging Fed processing, would it reduce the rate of destruction of unfit notes, increasing the average life of a note? More generally, what is the optimal quality of currency in circulation, and how can we attain the optimum?

As a benchmark, suppose that there is no "market failure" for currency quality, in the sense that the willingness of private individuals to pay for a higher-quality note is identical to its total social benefits. We could then let market forces determine the socially optimal level of currency quality, just as they determine the quality of any privately produced durable good. It would be crucial for the Fed to set the relative price of sorted and unsorted currency to reflect the real costs of transforming unsorted straps into sorted straps. In this case, private decisions would result in the socially optimal currency quality.

Figure 1, based on a model of currency processing described in Appendix A, illustrates the interaction between currency quality and the price of processing. The quality of currency in circulation is measured by the variable q, the fraction of notes in circulation that are fit rather than unfit.[13] The vertical axis displays the marginal benefits and marginal costs associated with each level of currency quality. The curve labeled MSC is the marginal social cost of Federal Reserve currency processing and includes the cost of processing notes plus the cost of printing new notes to replace the unfit notes destroyed. The curve labeled MSB is the marginal social benefit of higher-quality currency. The socially optimal currency quality is q^*, where MSC equals MSB. This currency quality maximizes social benefits minus social costs, or net social welfare.

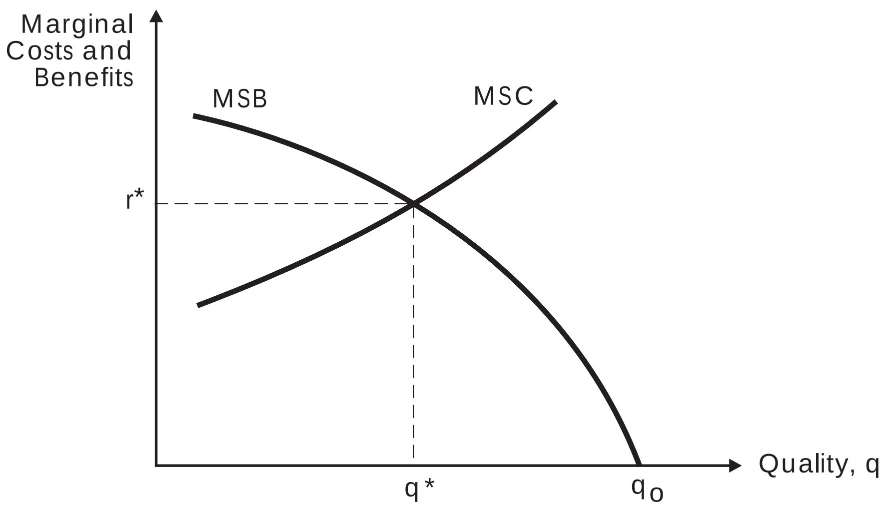
Underlying Figure 1 is the demand and supply for Fed processing. Banks choose how much currency to send to the Fed and to withdraw from the Fed based on the price of Fed processing—the difference between what the Fed charges for withdrawals of fit currency and what the Fed pays for unfit currency. A bank's demand for Fed-processed currency determines the quality of currency circulated by the bank. Fed processing volume determines the fraction of circulating unfit notes that are destroyed each period and replaced with new notes, and thus directly determines the quality of currency in circulation. A price for Fed processing thus is equivalent to a "price" for currency quality, since quality varies one-for-one with Fed processing volume.[14]

In the absence of market failure, private willingness to pay for currency quality corresponds exactly to the marginal social benefits of currency quality.

[13] For simplicity, think of currency as either fit or unfit, and suppose that over time fit notes randomly become unfit.

[14] More precisely, the "price" of currency quality is the price of Fed processing times the amount by which Fed processing volume must rise to increase quality by one unit.

Figure 1 Optimal Currency Quality, "No Market Failure" Case



In this case the optimal price of currency quality, r^*, is the marginal social cost of quality and it directly determines the optimal price of Federal Reserve currency processing. Facing r^*, banks bear the full social cost of higher currency quality, and so choose the socially optimal quality. Note that r^* includes the cost of printing new currency to replace the unfit currency in a deposit.

Would replacing the current system of quantitative restrictions with a deposit fee result in a decline in the quality of currency in circulation? Figure 1 shows that, by itself, imposing an optimal deposit fee reduces quality from q_0 to q^*. But the level of quality under free provision with quantitative rationing could be much less than q_0, or q^* for that matter. Therefore, what happens to currency quality depends upon how the level of quality under the current policy compares with the optimal level of quality. Is currency quality now too high or too low? One recent study of this question suggests that, if anything, currency quality is currently above the social optimum.[15]

[15] High-speed currency verification and sorting machines are capable of distinguishing between 16 different currency soil levels and are set to destroy all notes at or below a given soil level. The Federal Reserve System recently decided to reduce the threshold for destruction by one setting, from 9 to 8 for one-dollar bills and from 10 to 9 for other denominations. This decision was made after a study that documented the likely public reaction to the predicted change in currency quality and the effect on new currency printing cost. Extensive surveys revealed that lowering the threshold "would have a minimal impact on public acceptability of currency." The decision reflects the implicit judgment that the marginal social cost of the higher soil level setting is larger than the marginal social benefits of higher currency quality. See Federal Reserve System (1991).

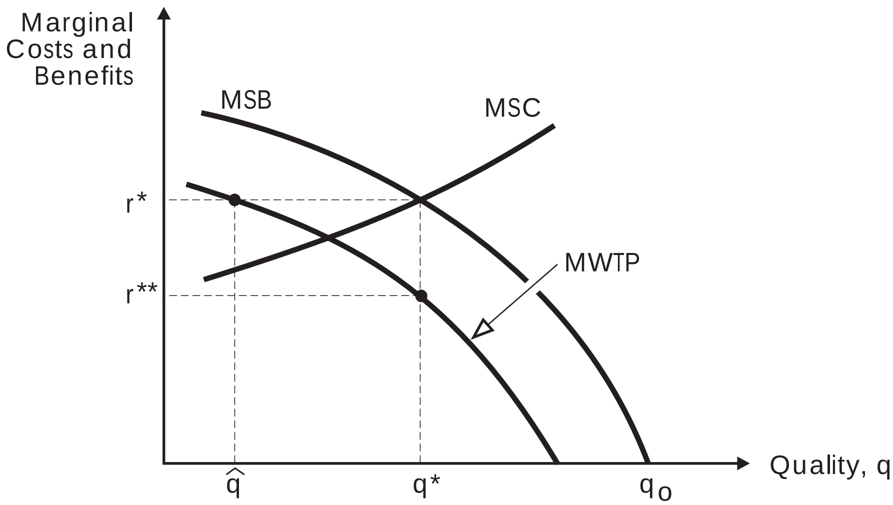
7. WHAT IF THERE IS A MARKET FAILURE FOR CURRENCY QUALITY?

The fact that currency trades at par can lead to a market failure that complicates the attempt to achieve the optimum level of currency quality. Banks choose the quality of currency to supply for withdrawals, but that currency is passed on and deposited at other banks. Because banks are small relative to the currency market, they neglect the effect of their currency outflow on the quality of other banks' currency inflows. Banks ignore the effect of their currency-processing decisions on the quality of currency in circulation, because they are not fully compensated for the social value of the currency quality they supply. At a more fundamental level, the source of the market failure is that the social benefits of quality-dependent note prices are smaller than the costs associated with the inconvenience of such prices. Because prices do not vary with note quality, people do not bear the full social costs and benefits of their decisions.

There are some settings in which suppliers of high-quality currency can obtain direct or indirect compensation for some of the social benefits associated with high quality. Some institutional currency users actually pay to obtain high-quality currency. For example, some banks pay to obtain higher-quality currency for loading into automated teller machines. Many banks, hotels and retail merchants prefer to use high-quality or even new currency in transactions with their customers. Since obtaining high-quality currency often involves some effort or expense, we can presume that the institution believes that its customers prefer high-quality currency, and that providing it to them will result in implicit remuneration such as enhanced goodwill or a higher probability of repeat business. Thus the institution may be partially compensated by its customers for the quality of currency disbursed, making them willing to pay a small premium to arrange for better-quality currency. The demand by these institutions for better-quality currency will reflect a portion of the social benefits of better quality, even though currency trades at par, without adjustment for quality.

For most transactions, however, such mechanisms of implicit compensation are generally lacking or incomplete. Therefore, the demand for fit sorted currency from the Fed, relative to the demand for unsorted currency, is likely to understate society's true demand for fit currency. If so, setting the price of currency processing equal to the Fed's full marginal cost will lead to suboptimal currency quality. Figure 2 illustrates the dilemma. It is based on a model (also described in Appendix A) in which private willingness to pay, the curve labeled MWTP, is less than marginal social benefits, the curve again labeled MSB. Charging the full marginal social cost, r^*, results in suboptimal currency quality, $\hat{q}$, because the demand for Fed processing does not reflect true social benefits. The optimal price is the one that attains the optimal level of Fed currency processing and is equal to the marginal willingness to pay at the optimal level of processing, r^{**} in Figure 2. This price is less than full marginal cost and

Figure 2 Optimal Currency Quality, "Market Failure" Case



subsidizes processing in order to counteract the divergence between the private and social marginal benefits of currency quality. The divergence is the direct result of the fact that currency generally trades at par, unadjusted for quality.

It is quite unlikely that the optimal price is zero. For this to occur, marginal private willingness to pay must be zero at the optimal quality. One component of private willingness to pay is the costliness of bank currency processing; banks are willing to pay to substitute Fed processing for their own. As long as bank processing is at all costly there will always be a positive willingness to pay for Fed processing.

8. AN ALTERNATIVE PRICING SCHEME

I have proposed a simple fee on all currency deposits, but other pricing schemes are also worth considering. One attractive idea is a two-tiered scheme, with a higher fee on deposits of fit currency and a lower fee on deposits of unfit currency.[16] This would provide an enhanced incentive for banks to sort currency themselves and deposit only the unfit, keeping the fit in circulation. If banks' currency-processing decisions are multidimensional, then a two-tiered scheme can bring us closer to the social optimum. A two-tiered, quality-dependent

[16] Cash Services Strategic Planning Task Force (1991).

pricing scheme thus could improve upon a simple deposit fee by inducing banks to make more efficient currency-processing choices.

Unfortunately, such a scheme would be quite costly to administer using existing technology. Currently, notes are fed through processing machines in continuous batches made up of many different deposits, and the number of unfit notes is recorded for the entire batch, but not for each bank's deposit. Measuring the fitness of a single deposit requires processing that deposit in isolation as a single batch, at a significantly larger cost. Measuring deposit fitness would be essential to a two-tiered pricing scheme, since banks would have an incentive to misrepresent their deposits as unfit. An additional social cost associated with a two-tiered scheme is that many depository institutions would be induced to acquire the costly devices the Fed uses to measure quality.

If the social benefits of more efficient currency processing outweigh the required administration and enforcement costs, a two-tiered pricing scheme would represent an improvement over a simple deposit fee. A two-tiered scheme probably is not significantly better than a simple deposit fee under current arrangements, however. The next generation of currency-processing equipment, to be deployed in the next five years, will have the capability of measuring individual deposit fitness at little additional cost. A two-tiered scheme could be worthwhile at that time.

9. PRECEDENTS

The position advocated here—paying less than par for worn money—may seem radical, but it is far from new. Historically, mints often bought foreign and worn domestic coin at the market price of the metal and then issued overvalued coins, with most of the difference accounted for by "brassage," the cost of minting.[17] When the Bank of England bought worn gold coins for reminting, "there was a small series of charges or profits made for weighing, melting, assaying, the turn of the scale, the difference of the assay reports, etc.," plus a charge for "demurrage," the interest lost while the gold was being coined.[18] Thus the deterioration of coin has been a perennial problem for monetary authorities, and has evoked changing policies as the technology underlying monetary arrangements has changed.[19]

There is a more immediate precedent, however. From 1863 to 1935 in the United States, national banks could issue their own notes, which circulated as

[17] See de Roover (1948) p. 241.

[18] Jevons (1875). The 19th century English economist was quite concerned about the quality of English currency and actually performed his own physical experiments to estimate the rate at which English gold sovereigns declined in weight. He also gathered information on the fraction of coins that were below "legal limit," meaning that they no longer qualified as legal tender and could only be sold by weight (at a loss).

[19] See, for example, Redish (1990).

currency. These notes were printed by the U.S. Treasury and shipped to the bank for issue. At first, notes could be redeemed at the issuing bank or at a "redemption agent" designated by the issuing bank, generally in New York. This made redemption costly, since by law the notes had to be redeemed at par. As a result, the condition of national bank notes in circulation deteriorated. In 1874, Congress authorized a "Redemption Agency" within the Treasury that would redeem national bank notes at various locations around the country, destroying worn and mutilated notes and sending back to the issuing bank the fit notes and, if necessary, newly printed replacement notes.

National banks were charged for all of the expenses associated with note issue and redemption. The banks were charged directly for the cost of the plates and dies used to print their notes. They were also assessed a 1 percent tax on outstanding notes (1/2 percent after 1900), out of which the other costs of producing new notes were paid. The costs of redemption were divided pro rata among banks on the basis of the amount of their notes redeemed. In addition, banks paid all of the costs of shipping their own notes.

By all accounts national bank notes functioned as hand-to-hand currency, and since they were collateralized by government securities, they were, in effect, government currency. The resource costs associated with national bank notes, arguably the model for Federal Reserve notes, were borne by private entities. The policy of charging national banks for the costs of note issue and redemption is thus directly analogous to my proposal to charge a fee for currency deposits.[20]

10. CONCLUDING REMARKS

A central bank fee for deposits of worn currency is an uncomfortable notion for many, but the proposal merely reflects standard economic reasoning. When the government provides a service for which there are privately provided substitutes, economic theory tells us that it should *not,* in general, be provided free. The current system of fees for wire transfers of reserve balances reflects just such reasoning and was designed to improve economic efficiency by providing the proper incentives to private decision makers.[21] The goal of a currency-processing fee is identical—to improve the efficiency of currency handling by providing private decision makers with the proper incentives.

The fact that currency processing plays a role in our monetary system can distract from the essential economics of the issue. Some express the view that

[20] There are some minor differences. The cost of printing notes was charged to the issuing national bank at the date of issue; under my proposal, the cost of printing notes would be charged to depositors of used notes. Under the national bank policy, the deposit of notes with the Treasury resulted in a charge to the issuing bank, not the depositing bank; under my proposal, the depositing bank would be charged.

[21] Board of Governors (1990).

par replacement of worn currency is somehow intrinsic to central banking or the monetary mechanism. But monetary policy concerns the size of the total monetary base, not the division of the base into its components; a deposit fee would merely add to the cost of exchanging currency for reserve account balances. Some express the view that par replacement is somehow required "to furnish an elastic currency," but again, this can be accomplished through variations in the size of the total monetary base; as long as the composition of the base is determined by demand, the currency supply will be sufficiently elastic.[22] Similar arguments were raised in objection to pricing other Federal Reserve services in the early 1980s, but are no longer taken seriously. Indeed, payments system efficiency is now a widely recognized public policy goal. A currency deposit fee would help.

APPENDIX A: A Model of Currency Processing

This appendix describes a simple model designed to capture the interaction between the price of Fed processing and the quality of currency in circulation. The heart of the model is the decision problem of a representative "bank" facing currency deposit and withdrawal flows. The bank chooses the quality of currency to supply, how much currency to process internally and how much currency to deposit and withdraw from the Fed. The Fed processes deposited currency, destroying unfit notes and replacing them with newly printed notes. The Fed sets fees for deposits and withdrawals, and these directly affect banks' processing decisions. Alternative fee policies affect currency quality, and I show how policy can achieve the socially optimal currency quality.

I consider two versions of the model. In the first version, the "no market failure case," currency prices depend on quality and affect consumers' demand for currency quality. In this case the optimal price of Fed currency processing is just the Fed's marginal cost. In the second version, the "market failure case," currency prices do not depend on quality, and the optimal price of Fed currency processing is less than marginal cost, but strictly greater than zero.

The model is an extension of the general equilibrium monetary model of Lucas (1980). It is essentially a model of bank processing embedded within a simple cash-in-advance framework. Articulating such a framework is useful because it allows us to evaluate Fed currency policy using the standard tools of welfare economics. In addition, such a framework forces us to be explicit about the benefits and costs of currency quality and ensures that the "demand," "supply," and "price" of currency quality are modeled in an internally consistent way.

[22] See Goodfriend and King (1988).

Many interesting aspects of currency policy are omitted here for the sake of clarity. Ignored are transportation costs, for example; they would modify the analysis in obvious ways. Also ignored is the fact that currency comes in distinct denominations that the public treats very differently; the model assumes a single denomination. Since the model is designed just to study the pricing of currency processing, the technology of public and private currency processing is taken as given.

Currency Processing

Currency, in this model, is either "fit" or "unfit." Currency is fit when first printed. While in circulation, a random fraction δ of fit notes deteriorate each period and become unfit. Thus, δ is both the probability that a given fit note becomes unfit in circulation in a given period and the fraction of fit notes that become unfit during the period.[23] The quality of the set of notes that circulate during period t will be denoted q_t, the fraction of the notes that are fit. Thus if notes of quality q_t begin circulating, their average quality at the end of the current period is $(1 - \delta)q_t$.

There are a large number of identical unit banks, and at the beginning of each period they each receive a deposit of M units of currency from the public. At the end of the period they each must meet a demand for withdrawal of M units of currency. A representative bank can deposit notes directly at the Fed without processing them, or it can process the notes themselves, sending unsatisfactory notes to the Fed. The bank then withdraws currency from the Fed in order to meet their own withdrawal demand of M notes. For every note deposited at the Fed they need to withdraw a note later from the Fed.[24]

Fed processing sorts all deposited notes into fit and unfit notes and destroys all unfit notes. The cost of Fed processing is $f(x_t^F)$ units of labor time, where x_t^F is the number of notes processed by the Fed at time t. The destroyed unfit notes are replaced with newly printed notes. The cost of printing x_t^N new notes at time t is $g(x_t^N)$ units of labor time.

Bank processing is less accurate than Fed processing. When a bank sorts notes, the satisfactory notes, call them "clean," are mostly fit but mistakenly include some unfit notes. The unsatisfactory notes, call them "dirty" notes, are mostly unfit but mistakenly include some fit notes. The dirty notes are all sent

[23] I am implicitly assuming that there are an infinite number of notes. Variables denoting quantities of notes should thus be interpreted as fractions of the total currency outstanding.

[24] It is possible to modify the model to allow for heterogenous banks, some of which experience net currency inflows each period and some of which experience net currency outflows. Private processing would then involve some shipment of currency from inflow banks to outflow banks. Such a model could be used to assess cross-shipping restrictions; banks with net deposit inflows could deposit at the Fed rather than ship to other banks, and banks with net currency outflows could withdraw from the Fed rather than buy from other banks, but banks would be unable to both deposit and withdraw from the Fed. If transportation costs are positive, cross-shipping has different effects on differently situated banks.

to the Fed. Let η be the fraction of unfit notes that the bank classifies as clean, and let ζ be the fraction of fit notes that the bank classifies as dirty. Thus η and ζ represent "error rates" in bank processing.[25] Table A–1 displays the amount of notes in each possible category, assuming that the bank processes x_t^B notes itself at time t, and the quality of notes deposited at the bank is $\hat{q}_t = (1-\delta)q_{t-1}$. The cost of bank processing is $h(x_t^B)$, where x_t^B is the number of notes processed.

The quality of the currency disbursed by the bank is determined by the quality of the currency it receives and by the amount of currency it processes itself. All of the notes withdrawn from the Fed are fit. The only unfit notes the bank supplies to customers are those mistakenly classified as clean. Therefore the quality of notes supplied by the bank, q_t, is given by

$$q_t = 1 - \eta(1 - \hat{q}_t)x_t^B/M. \tag{1}$$

This expression relates the quality of notes supplied this period to the amount of notes processed by banks and $\hat{q}_t$, the quality of notes deposited at banks. The more processing done by banks, the more unfit clean notes slip through without being sent to the Fed for destruction. Thus q_t is decreasing in x_t^B.

The amount of notes the bank deposits at the Fed is

$$\begin{aligned} x_t^F &= M - x_t^B + (1-\eta)(1-\hat{q}_t)x_t^B + \zeta\hat{q}_t x_t^B \\ &= M - [\eta + (1-\eta-\zeta)\hat{q}_t]x_t^B. \end{aligned} \tag{2}$$

The deposit consists of the notes the bank does not process, plus the notes that the bank processes but finds dirty. Note that the greater the volume of private processing, the smaller the volume of Fed processing.

Table A–1 Bank Note Processing During Period *t*

Note flow	Fit	Unfit
Deposit at the bank	$\hat{q}_t M$	$(1-\hat{q}_t)M$
Sent to the Fed	$\hat{q}_t(M - x_t^B)$	$(1-\hat{q}_t)(M - x_t^B)$
Processed by the bank	$\hat{q}_t x_t^B$	$(1-\hat{q}_t)x_t^B$
Clean	$(1-\zeta)\hat{q}_t x_t^B$	$\eta(1-\hat{q}_t)x_t^B$
Dirty, sent to the Fed	$\zeta\hat{q}_t x_t^B$	$(1-\eta)(1-\hat{q}_t)x_t^B$

M is the number of notes deposited at time t, $\hat{q}_t$ is the average quality of notes deposited at time t, x_t^B is the number of notes processed by the bank at time t.

[25] In the special case in which $\eta = \zeta = 0$, private processing is just as good as Fed processing at picking out unfit notes, and currency quality does not depend on the division of processing between banks and the Fed. In this case pricing has no effect on the quality of currency in circulation, although it does influence economic efficiency by affecting the division of processing between banks and the Fed. The exposition assumes that $\eta > 0$.

The number of new notes printed is equal to the number of unfit notes deposited at the Fed and is given by

$$\begin{aligned} x_t^N &= (1-\hat{q}_t)(M-x_t^B) + (1-\eta)(1-\hat{q}_t)x_t^B \\ &= (1-\hat{q}_t)(M-\eta x_t^B). \end{aligned} \tag{3}$$

The greater the volume of private processing, the larger the number of unfit notes escaping destruction each period, and so the smaller the number of new notes printed.

The General Equilibrium Environment

Currency deposit and withdrawal flows to and from the banking system are taken as given in the description of currency processing. These flows are determined within a general equilibrium model based on Lucas (1980). There are a large number of spatially separated locations. At each location there are representative banks like the one described above, along with a Federal Reserve Bank branch. In addition, there are a large number of households at each location. Each household consists of a pair of agents, a "shopper" that visits other locations and obtains goods, and a "worker" that stays at home to produce goods and sell them to visiting shoppers. (Households do not like to consume the goods produced at their own location.) The cost of reliably verifying a shopper's identity at another location is prohibitive, and this precludes the use of credit arrangements. Thus, shoppers carry currency to exchange for goods. At the same time the worker stays at home to sell goods to shoppers from other locations. The currency received by the worker cannot be used by the shopper during the same period; the shopper must use currency obtained earlier.

The worker produces a consumption good using a constant returns to scale technology in which one unit of labor time produces one unit of consumption good. (There is no capital.) The worker is endowed with L units of labor time, derives no utility from leisure, and so supplies labor inelastically. In addition to producing a consumption good for sale, the worker is employed outside of the house for a market wage of $w_t = 1$. Banks and Fed branches hire workers to process currency.

During the first part of each period, households deposit the currency accumulated the previous period at their local bank for safekeeping. Employment and household production then take place, and wages are credited to the household's bank account. At the end of the first part of the period, households withdraw currency for the shopper to use. In the second part of the period the shopper buys goods for currency, and the worker receives currency for goods. The shopper then returns home and consumption takes place. Currency is stored until the next period, and then deposited at the bank. All outstanding currency is deposited at banks at the beginning of each period; one can imagine that thieves are at large during the first part of each period, making privately held currency risky.

Handling currency is time consuming for the worker, and the quality of currency affects the amount of time required for currency handling. I assume that handling fit notes takes no time at all but that handling unfit notes takes time. Specifically, handling $(1-q_t)M$ unfit notes requires $\phi[(1-q_t)M]$ units of labor time, where $\phi(\,)$ is an increasing function. This time cannot be used to produce goods or work outside the house. Currency quality has no other effect on shoppers or workers. Therefore, we can define the value of currency quality as $v(q_t) = L-\phi[(1-q_t)M]$, the labor time available for productive activities, net of the time spent handling currency.[26] Currency deteriorates after it has been handled by the worker, but before it has been deposited at the bank the next period.

The number of notes in circulation is M and is held constant throughout the analysis. The Federal Reserve Banks perform the processing described earlier, perhaps collecting fees. Any deficit is covered by levying lump-sum taxes on households.

Optimal Currency Quality

The optimal currency quality maximizes the lifetime utility of a representative household subject to the resource constraints. Lifetime household utility is $\sum_{t=0}^{\infty} \beta^t u(c_t)$, where $u(c_t)$ is the utility of total consumption c_t at time t, and $0 < \beta < 1$. The economy is constrained each period by the L units of labor time per household available to be divided between bank and Fed processing, new note printing, handling unfit currency, and the production of consumption goods. For convenience, define the function $x^B(\hat{q}, q)$ as the number of notes processed by the representative bank when the quality of deposited currency is $\hat{q}$ and the quality of withdrawn currency is q. Define $x^F(\hat{q}, q)$ and $x^N(\hat{q}, q)$ similarly for Fed processing volume and the number of new notes printed. Using (1), (2), and (3), we have

$$
\begin{aligned}
x^B(\hat{q}, q) &= \frac{(1-q)M}{(1-\hat{q})\eta} \\
x^F(\hat{q}, q) &= M - [\eta + (1-\eta-\zeta)\hat{q}]\frac{(1-q)M}{(1-\hat{q})\eta} \qquad (4) \\
x^N(\hat{q}, q) &= (q-\hat{q})M.
\end{aligned}
$$

[26] The dependence of $v(q_t) = L - \phi[(1-q_t)M]$ on M is suppressed here because M, the total number of notes, is held constant throughout the analysis. Note that a nonneutrality is built into the environment here by having available labor time depend on the number of unfit notes; scaling up the number of notes at each date reduces available resources, independent of the price level. The optimal policy would seem to be making the number of notes as small as possible. This obviously runs up against the (unmodeled) constraint that the real value of a note be no greater than the smallest transaction. Since the money stock is held constant, this nonneutrality is inconsequential.

The following "social planner's problem" finds the optimal currency quality. Choose sequences $\{\hat{q}_t\}_{t=0}^{\infty}$, and $\{q_t\}_{t=1}^{\infty}$ to

$$\max \sum_{t=0}^{\infty} \beta^t u(c_t)$$

such that

$$\begin{aligned} c_t \leq L - \phi[(1-q_t)M] &- f[x^F(\hat{q}_t, q_t)] \\ &- g[x^N(\hat{q}_t, q_t)] - h[x^B(\hat{q}_t, q_t)] \\ \hat{q}_{t+1} = (1-\delta)q_t& \end{aligned} \tag{5}$$

This programming problem maximizes the representative household's discounted lifetime utility, subject to the constraint that consumption can be obtained with the labor not devoted to currency handling, currency processing or currency printing. The first-order condition for this optimization problem is

$$\begin{aligned} v'(q_t) - h'(x_t^B)x_2^B(\hat{q}_t, q_t) &- \beta(1-\delta)h'(x_{t+1}^B)x_1^B(\hat{q}_{t+1}, q_{t+1}) \\ &= f'(x_t^F)x_2^F(\hat{q}_t, q_t) + \beta(1-\delta)f'(x_{t+1}^F)x_1^F(\hat{q}_{t+1}, q_{t+1}) \\ &\quad + g'(x_t^N)x_2^N(\hat{q}_t, q_t) + \beta(1-\delta)g'(x_{t+1}^N)x_1^N(\hat{q}_{t+1}, q_{t+1}), \end{aligned} \tag{6}$$

where, for example, $x_1^B(\hat{q}_t, q_t) \equiv \partial x^B(\hat{q}_t, q_t)/\partial \hat{q}_t$, $x_2^B(\hat{q}_t, q_t) \equiv \partial x^B(\hat{q}_t, q_t)/\partial q_t$, and so on. The first term on the left side is the marginal social benefit of currency quality, the savings in productive resources from higher average currency quality. The second and third terms are the marginal reduction in private processing costs associated with higher currency quality—together these terms are generally positive because higher quality requires more Fed processing and thus less private processing. The right side is the marginal social cost of currency quality—marginal Fed processing costs plus marginal printing costs. The optimality condition, as usual, is that the total marginal social benefit should be equated to total marginal social cost. Note that an increase in q_t, quality at date t, increases total costs at date t, but reduces total costs at date $t+1$. The better the quality of currency at date t, the better the quality of the currency deposited at the beginning of period $t+1$.

I restrict attention to steady state equilibria. In a steady state equilibrium, all variables are constant over time. The condition for optimality in a steady state equilibrium can be written

$$\begin{aligned} v'(q^*) - h'(x^{B*})[x_2^B(\hat{q}^*, q^*) &+ \beta(1-\delta)x_1^B(\hat{q}^*, q^*)] \\ &= f'(x^{F*})[x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{q}^*, q^*)] \\ &\quad + g'(x^{N*})[x_2^N(\hat{q}^*, q^*) + \beta(1-\delta)x_1^N(\hat{q}^*, q^*)], \end{aligned} \tag{7}$$

where $x^{B*} = x^B(\hat{q}^*, q^*)$, $x^{F*} = x^F(\hat{q}^*, q^*)$, $x^{N*} = x^N(\hat{q}^*, q^*)$, and $\hat{q}^* = (1-\delta)q^*$. q^* is the optimal steady state currency quality.

The determination of the optimal currency quality is illustrated in Figure 1. The left side of (7) is plotted as a function of steady state quality q and is labeled MSB. The right side of (7) is labeled MSC. The intersection determines the optimal currency quality q^*.[27]

Optimal Price, No Market Failure Case

As a reference point, I first derive the optimal currency policy when there is no "market failure," in the sense that the willingness of a bank to pay for a higher-quality note is identical to the total social benefits of a higher-quality note. I assume that consumers are willing to pay a bank for the value to them of the quality notes they withdraw. In order for this to hold, consumers must believe that they will be paid for the quality of notes that they pass on to others, including banks. Therefore, I need to assume that workers pay shoppers for the quality of the currency received and that banks pay depositors for the quality of notes deposited.

Let $\hat{\rho}_t$ be the price paid by banks (over and above par) for fit notes in period t, so that deposits of M notes of quality $\hat{q}_t$ at t cost $\hat{\rho}_t \hat{q}_t M$.[28] Let ρ_t be the price paid to banks (over and above par) for quality notes withdrawn at t, so that a bank receives $\rho_t q_t M$ for withdrawals of M notes of quality q_t.

A shopper pays $\rho_t q_t$ per note for a withdrawal of notes of average quality q_t at t, and then exchanges the notes for consumption goods. Since a shopper is unaffected by currency quality, the premium for currency quality paid by the worker must equal the premium paid by the shopper at the bank. Thus the worker pays $\rho_t q_t$ per note for currency received from visiting shoppers. A fraction δ of the fit notes deteriorate and become unfit during period t, so the average quality of the notes is $(1-\delta)q_t$ at the beginning of period $t+1$. The bank will pay $\hat{\rho}_{t+1}(1-\delta)q_t$ for these notes at the beginning of next period. If the worker faces a market real interest rate of $r = \beta^{-1} - 1$, then the present value of selling the currency next period is $\beta\hat{\rho}_{t+1}(1-\delta)q_t$. Thus the "rental price" of notes with average quality q_t is $[\rho_t - \beta(1-\delta)\hat{\rho}_{t+1}]q_t$. This expression is exactly analogous to the user cost of a durable good, as one would expect. Given the rental price, the worker chooses a utility-maximizing note quality which satisifies[29]

$$v'(q_t) = \rho_t - \beta(1-\delta)\hat{\rho}_{t+1}. \tag{8}$$

[27] Certain mild conditions on the functions v, h, f, and g are required for there to be a unique interior optimal currency quality.

[28] Specifically, if banks pay p_t^u in real terms per unfit note and p_t^f per fit note, then p_t^u is par and $\hat{\rho}_t = p_t^f - p_t^u$. One could carry out the analysis in terms of the numbers of fit and unfit notes bought and sold by various parties, rather than in terms of the number of total notes and the quality of those notes. The latter parameterization allows us to separate quality choice from the choice of total money holdings.

[29] It is straightforward to derive this condition from the household's maximization problem, omitted here for brevity.

In other words, consumers equate the rental price of currency quality to the marginal real resource savings from currency quality.

I only consider currency policies that involve deposit and/or withdrawal charges—there is no quantitative rationing. The Fed pays p^D for deposits at all dates, which is equal to the par value of the currency minus any deposit charges. The Fed charges p^W for withdrawals of currency, par plus any withdrawal charges. Therefore, the bank pays a net amount of $(p^W - p^D)$ to send a note to the Fed for processing and then withdraw a note to replace it.

A typical bank essentially solves a static problem each period, maximizing receipts from currency sales minus outlays for purchased currency, processing costs, and Fed charges. If the bank buys currency of quality $\hat{q}$ and wants to supply currency of quality q (suppressing time subscripts), it must process $x^B(\hat{q}, q)$ notes itself, and send $x^F(\hat{q}, q)$ notes to the Fed. (These functions were defined above in [4].) The maximization problem for a typical bank during a typical period, therefore, is

$$\max_{q,\hat{q}} \rho q M - \hat{\rho}\hat{q}M - h[x^B(\hat{q}, q)] - (p^W - p^D)x^F(\hat{q}, q). \qquad (9)$$

The bank maximizes the value received from customers for supplying currency of quality q, minus the amount paid for currency deposits, minus the bank's processing costs, and minus the net cost of depositing and withdrawing currency from the Fed. The bank's decision problem reflects the social value to consumers of higher-quality currency through ρ, the market value of supplying higher-quality currency. The bank bears its own processing costs, but does not directly bear the cost of Fed processing and new note printing. The first-order condition for this problem is

$$\begin{aligned} \rho - \beta(1-\delta)\hat{\rho} - h'(x^B)[x_2^B(\hat{q}, q) + \beta(1-\delta)x_1^B(\hat{q}, q)] \\ = (p^W - p^D)[x_2^F(\hat{q}, q) + \beta(1-\delta)x_1^F(\hat{q}, q)]. \end{aligned} \qquad (10)$$

The bank equates the market value of an improvement in currency quality $[\rho - \beta(1-\delta)\hat{\rho}]$, plus the bank's marginal processing cost savings, to the marginal cost of Fed processing. Given $p^W - p^D$, the first-order condition (10) can be combined with (8) to determine the steady state equilibrium value of q consistent with bank profit maximization and consumer utility maximization.

$$\begin{aligned} v'(q) - h'(x^B)[x_2^B(\hat{q}, q) + \beta(1-\delta)x_1^B(\hat{q}, q)] \\ = (p^W - p^D)[x_2^F(\hat{q}, q) + \beta(1-\delta)x_1^F(\hat{q}, q)], \end{aligned} \qquad (11)$$

where $\hat{q} = (1-\delta)q$. This shows how the price of Fed currency processing, $p^W - p^D$, determines the equilibrium level of currency quality. Under standard assumptions, the left side of (11) is decreasing in q, so that an increase in $p^W - p^D$ causes equilibrium currency quality to decrease.

The optimal price of Fed processing, call it $\hat{r}^*$, is the value of $p^W - p^D$ that induces an equilibrium level of quality equal to q^*, the optimal quality. If

$q = q^*$, then the left side of (11) is equal to the left side of (7). Therefore, $\hat{r}^*$ must equate the right side of (11) with the right side of (7). This implies that,

$$\hat{r}^* \equiv f'(x^{F*}) + g'(x^{N*}) \frac{[x_2^N(\hat{q}^*, q^*) + \beta(1-\delta)x_1^N(\hat{q}^*, q^*)]}{[x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{q}^*, q^*)]}, \tag{12}$$

where $\hat{q}^* = (1-\delta)q^*$. Equation (12) states that in the absence of market failure the optimal price of Fed processing is the marginal cost of Fed processing plus the marginal cost of printing new notes. The latter is the marginal printing cost per note times the marginal number of notes printed per note processed by the Fed.

The determination of the optimal price of processing is illustrated in Figure 1. The curve labeled MSB again corresponds to the left sides of (7) and (11). For a given price of processing, banks and consumers act so as to equate MSB to $(p^W - p^D)\left[x_2^F(\hat{q}, q) + \beta(1-\delta)x_1^F(\hat{q}, q)\right]$, the right side of (11). The optimal "price" of currency quality, r^*, is just $\hat{r}^*$, the optimal price of Fed processing, multiplied by $x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{q}^*, q^*)$, the derivative of Fed processing volume with respect to steady state quality. If $p^W - p^D = \hat{r}^*$, then the equilibrium level of q is q^*, the optimal currency quality. Since there is no market failure in this case, marginal private willingness to pay is equal to marginal social benefits, and the optimal price is just marginal social cost.

Optimal Price, Market Failure Case

I now consider the case in which banks do not completely internalize the social benefits of currency quality. As discussed in the text, the market failure occurs because currency generally trades at par, with no adjustment for quality. Thus, banks and consumers do not obtain full compensation for the quality of the currency they pass on. I implement this case by assuming that $\rho = 0$, so that banks receive *no* compensation for the quality of the currency they supply. I show that even in this extreme case the optimal price is still strictly positive.

Banks solve the same profit-maximization problem as before, but with $\rho = 0$. The resulting first-order condition is just (10) with $\rho = 0$. As before, this condition can be combined with (7), the condition for the optimality of currency quality, to obtain an expression for the optimal price of Fed processing.

$$\begin{aligned} \hat{r}^{**} \equiv\ & f'(x^{F*}) + g'(x^{N*}) \frac{[x_2^N(\hat{q}^*, q^*) + \beta(1-\delta)x_1^N(\hat{q}^*, q^*)]}{[x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{q}^*, q^*)]} \\ & - \frac{v'(q^*)}{[x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{Q}^*, q^*)]} \\ & < \hat{r}^* \end{aligned} \tag{13}$$

Because of the third term, the optimal price is now smaller than $\hat{r}^*$, the optimal price in the no market failure case. Banks are not compensated for the direct value of currency quality to consumers, so the optimal price of Fed processing includes a subsidy proportional to $v'(q)$, marginal value of currency quality to consumers.

The determination of the optimal price of processing in this case is illustrated in Figure 2. Again, r^{**}, the optimal "price" of currency quality, is just $\hat{r}^{**}$ multiplied by $x_2^F(\hat{q}^*, q^*) + \beta(1-\delta)x_1^F(\hat{q}^*, q^*)$. Marginal private willingness to pay (MWTP) is the left side of (10) but with $v'(q)$ omitted; it now lies below the marginal social benefit curve because it does not include the value of currency quality to consumers. Optimality requires that the price of processing just equal MWTP at the optimal quality, q^*. Clearly, this requires that the price be below the price that is appropriate in the no market failure case, so we have $\hat{r}^{**} < \hat{r}^*$. In the market failure case the optimal price partially subsidizes processing. Without such a subsidy, banks will not send enough currency to the Fed for processing, and the quality of currency they supply will be below the optimum.

Note that the optimal price of Fed processing is still strictly positive in this case. Banks still weigh their own costs against Fed processing charges in deciding how much currency to process themselves. Fed pricing still must ensure that the division of processing between the Fed and the private sector is efficient.

APPENDIX B: DATA SOURCES

Table 1. Operating expenses for currency and coin are from Board of Governors of the Federal Reserve System, *1991 PACS Expense Report* (Board of Governors 1992): for currency, "total cost, currency service," p. 215; for coin, "total cost, coin service," p. 236. Operating expenses for reserve account balances are from the Pro Forma Income Statement for Federal Reserve Priced Services, by Service, 1991, in Board of Governors of the Federal Reserve System, *78th Annual Report,* 1991 (Board of Governors 1992), p. 235; operating expenses for funds transfer and net settlement ($69.3 million) plus commercial ACH ($49.5 million). Replacement costs for currency are calculated by multiplying 6,870,910,000, the number of new notes paid into circulation (*1991 PACS Expense Report,* p. 206), by $ .03686, the average cost of new notes delivered to the Federal Reserve in 1991. The latter was calculated by dividing the cost of currency printing in 1991, $261,316,379 (*78th Annual Report,* 1991, Statements of Revenues and Expenses and Fund Balance, "expenses for currency printing, issuance, retirement, and shipping," p. 239), by the number of notes delivered to the Federal Reserve Banks in 1991, 7,088,967,000 (Board of Governors database, provided by Ted Kelly, Federal Reserve Bank of Richmond).

Table 2. Board of Governors of the Federal Reserve System, *1991 PACS Expense Report* (Board of Governors, 1992): *processing costs,* pp. 199–218; *number of notes received,* p. 205. For *Printing costs,* see above.

REFERENCES

Barron, John M., Michael E. Staten, and John Umbeck. "Discounts for Cash in Retail Gasoline Marketing," *Contemporary Policy Issues,* vol. 10 (October 1992), pp. 89–102.

Board of Governors of the Federal Reserve System. *78th Annual Report,* 1991. Washington: Board of Governors, 1992.

__________. "The Federal Reserve in the Payments System," *Federal Reserve Bulletin,* vol. 76 (May 1990), pp. 293–98.

__________. "Currency Guidelines," *Federal Reserve Bulletin,* vol. 70 (February 1984), pp. 113–14.

__________. Press Release, December 31, 1980.

Booth, George. *Currency and Coin Responsibilities of the Federal Reserve: A Historical Perspective.* Cleveland: Federal Reserve Bank of Cleveland, 1989.

Bös, Dieter. "Public Sector Pricing," in Alan J. Auerbach and Martin Feldstein, eds., *Handbook of Public Economics.* New York: North-Holland, 1985.

Cash Services Strategic Planning Task Force. "A Proposal to Pilot Test the Market-Based Management of Currency Volumes." Federal Reserve Bank of San Francisco, internal memorandum, April 19, 1991.

Curtin, Richard T. "Payment Method Costs: Assessments by Retailers." Survey Research Center, University of Michigan, September 1983.

de Roover, Raymond. *Money, Banking and Credit in Medieval Bruges.* Cambridge, Mass.: The Medieval Academy of America, 1948.

Dotsey, Michael. "Cost Function for Federal Reserve Currency Handling," in Federal Reserve System, *A Comprehensive Assessment of U.S. Currency Quality, Age, & Cost Relationships.* September 1991.

Fama, Eugene F. "Financial Intermediation and Price Level Control," *Journal of Monetary Economics,* vol. 12 (1983), pp. 7–28.

Federal Reserve System. *A Comprehensive Assessment of U.S. Currency Quality, Age, & Cost Relationships.* September 1991.

Goodfriend, Marvin S., and Robert G. King. "Financial Deregulation, Monetary Policy, and Central Banking," Federal Reserve Bank of Richmond *Economic Review,* vol. 74 (May/June 1988), pp. 3–22.

Jevons, W. Stanley. *Money and the Mechanism of Exchange.* Henry S. King & Co.: London, 1875, reprinted New York: Garland, 1983.

Lucas, Robert E., Jr. "Equilibrium in a Pure Currency Economy," in John H. Kareken and Neil Wallace, eds., *Models of Monetary Economies.* Minneapolis: Federal Reserve Bank of Minneapolis, 1980.

Redish, Angela. "The Evolution of the Gold Standard in England," *Journal of Economic History*, vol. 50 (December 1990), pp. 789–805.

Supel, Thomas M., and Richard M. Todd. "Should Currency Be Priced Like Cars?" Federal Reserve Bank of Minneapolis *Quarterly Review*, vol. 8 (Spring 1984), pp. 6–7.

Bankers Acceptances

Robert K. LaRoche

A bankers acceptance, or BA, is a time draft drawn on and accepted by a bank. Before acceptance, the draft is not an obligation of the bank; it is merely an order by the drawer to the bank to pay a specified sum of money on a specified date to a named person or to the bearer of the draft. Upon acceptance, which occurs when an authorized bank employee stamps the draft "accepted" and signs it, the draft becomes a primary and unconditional liability of the bank. If the bank is well known and enjoys a good reputation, the accepted draft may be readily sold in an active market.

1. THE CREATION OF A BANKERS ACCEPTANCE

Acceptances arise most often in connection with international trade: U.S. imports and exports and trade between foreign countries.[1] An American importer may request acceptance financing from its bank when, as is frequently the case in international trade, it does not have a close relationship with and cannot obtain financing from the exporter it is dealing with. Once the importer and bank have completed an acceptance agreement, in which the bank agrees to accept drafts for the importer and the importer agrees to repay any drafts the bank accepts, the importer draws a time draft on the bank. The bank accepts

The author, former assistant economist at the Federal Reserve Bank of Richmond, would like to thank Lawrence Aiken of the Federal Reserve Bank of New York, Walker Todd of the Federal Reserve Bank of Cleveland, and Tim Cook and John Walter of the Federal Reserve Bank of Richmond. The views expressed in this article are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Richmond or the Federal Reserve System.

[1] Although acceptances may be created by entities other than banks—such acceptances are referred to as "trade acceptances"—the term "acceptance" in this article will refer to bankers acceptances only.

the draft and discounts it; that is, it gives the importer cash for the draft but gives it an amount less than the face value of the draft. The importer uses the proceeds to pay the exporter.

The bank may hold the acceptance in its portfolio or it may sell, or rediscount, it in the secondary market. In the former case, the bank is making a loan to the importer; in the latter case, it is in effect substituting its credit for that of the importer, enabling the importer to borrow in the money market. On or before the maturity date, the importer pays the bank the face value of the acceptance. If the bank rediscounted the acceptance in the market, the bank pays the holder of the acceptance the face value on the maturity date.

An alternative form of acceptance financing available to the importer involves a letter of credit. If the exporter agrees to this form of financing, the importer has its bank issue a letter of credit on its behalf in favor of the exporter. The letter of credit states that the bank will accept the exporter's time draft if the exporter presents the bank with shipping documents that transfer title on the goods to the bank. The bank notifies the exporter of the letter of credit through a correspondent bank in the exporter's country.

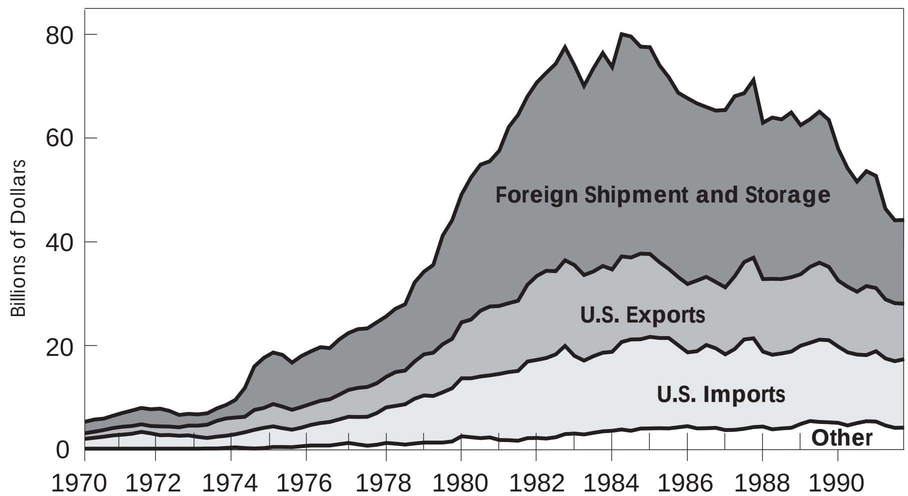
When the goods have been shipped, the seller presents its time draft and the specified documents to the accepting bank's correspondent, which forwards them to the accepting bank. If the documents are in order, the accepting bank takes them, accepts the draft, and discounts it for the exporter. At this point, the transaction is complete from the exporter's point of view; it has shipped the goods, turned over title to them, and received payment.

Once the bank has passed the shipping documents on to the importer, the situation is essentially the same as it was in the case where the bank simply accepted a draft drawn by the importer: The bank may hold the acceptance or rediscount it in the market, and the importer is responsible for paying the bank the face value of the acceptance on or before maturity. There is one subtle difference, however. The drawer of an accepted draft is secondarily liable on it, which means the drawer must pay the holder of the acceptance on maturity if the bank is unable to pay. In the current case, the drawer is the exporter. In the first case described, it was the importer.

An American exporter may seek acceptance financing in a case where it knows the buyer to be creditworthy and wants to extend it credit but needs cash in the interim. Around the time it ships the goods and after completing an acceptance agreement, the exporter draws a time draft on its bank, which accepts and discounts it. Once again, the bank may either hold the acceptance or rediscount it. On or before maturity, the exporter will have to pay the bank the face value of the acceptance. Ideally, the tenor of the acceptance, the time from acceptance to maturity, will coincide with the length of the credit extended by the exporter so that the exporter will be able pay the bank out of the proceeds of the sale.

Foreign importers and exporters trading with American firms may obtain acceptance financing in ways similar to those just described. Many acceptances

Figure 1 Bankers Acceptances Outstanding by Transaction Type
Quarterly averages of month-end figures



Notes: Figures are from the Board of Governor's *Annual Statistical Digest* and *Federal Reserve Bulletin.*

used to finance trade between foreign countries, however, are of a type known as "refinancing" or "accommodation" acceptances. A refinancing acceptance arises from a time draft drawn by a foreign bank on an American bank to finance a customer's transaction. Foreign banks that are not well known in the United States may seek this type of financing because they are unable to sell their own acceptances, or are unable to sell them at reasonable prices, in the U.S. market.

Acceptances are also created to finance the shipment of goods within the United States and to finance the storage of goods in the United States and abroad. Acceptances arising from the shipment and storage of goods in the United States, which are termed "domestic" shipment and storage acceptances, are included in Figure 1 under "other," which includes dollar exchange acceptances—acceptances created to provide banks in certain foreign countries with dollar exchange—until 1984 when they disappeared from the market. As Figure 1 shows, domestic shipment and storage acceptances have been a small part of the market in recent years. On average during 1991, they accounted for 10 percent of acceptances outstanding. Acceptances arising from imports into the United States accounted for 28 percent, those arising from exports from the United States accounted for 24 percent, and those arising from the storage of goods in or shipment of goods between foreign countries accounted for 38 percent.

2. BANKERS ACCEPTANCES AND THE FEDERAL RESERVE SYSTEM

Acceptances created to finance the activities listed above—U.S. imports and exports, foreign shipment and storage of goods, the shipment and storage of goods within the United States, and the provision of dollar exchange—are termed "eligible for discount" if they meet certain additional requirements laid out in the Federal Reserve Act. Eligibility for discount means that a Reserve Bank may rediscount them for accepting banks at the Federal Reserve's discount rate.

The Federal Reserve Act limits the ability to create eligible acceptances to Federal Reserve member banks and to branches and agencies of foreign banks that must hold reserves with the Federal Reserve.[2] Technically, the acceptances of other depository institutions are eligible only if they are endorsed by at least one member bank. In practice, the Federal Reserve has treated the acceptances of other depository institutions as eligible even without such an endorsement (Todd 1988, pp. 272–73).

The Federal Reserve Act places no limits on the types of goods that may be financed by eligible shipment acceptances (those arising from U.S. imports and exports and from the domestic and foreign shipment of goods). The Federal Reserve Act limits eligible storage acceptances, however, to those financing the storage of "readily marketable staples." In an early ruling, the Board of Governors interpreted the phrase to cover manufactured goods and raw materials that are nonperishable and have a "wide ready market" (*Federal Reserve Bulletin* 1916, p. 523). In the same ruling, the Board stated that cotton yarns and flour are covered. The Board later ruled that automobiles and automobile tires and parts are not (*Federal Reserve Bulletin* 1920, p. 65).

The Federal Reserve Act places on storage acceptances the added requirement that they be "secured at the time of acceptance by a warehouse receipt or other such document conveying title." Congress removed a similar documentary requirement for domestic shipment acceptances in 1982.

To be eligible for discount, acceptances must meet requirements concerning tenor. A dollar exchange acceptance must have a tenor of three months or less. Any other type of acceptance must have a tenor of six months or less.[3] However, the Federal Reserve has made it clear from early on that meeting these requirements on tenor does not guarantee eligibility. An acceptance will be eligible only if its tenor roughly corresponds to the time required for the completion of the underlying transaction.

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[2] There is another category of "eligible" acceptances, those eligible for purchase (described below). Even though there are two types of eligibility, acceptances that are eligible for discount are often simply called "eligible," while those that are not are called "ineligible."

[3] A Reserve Bank may not actually discount an eligible acceptance until it has 90 days or less left to run, unless it is a storage acceptance "drawn for an agricultural purpose," in which case it may be discounted when it has six months or less left to run.

In addition to allowing Reserve Banks to rediscount acceptances for accepting banks, the Federal Reserve Act allows them to purchase acceptances in the open market, but it does not specify what types of acceptances they may purchase. The Federal Open Market Committee determines which acceptances are "eligible for purchase." Acceptances that qualify are those

> with maturities of up to nine months at the time of acceptance that (1) arise out of the current shipment of goods between countries or within the United States, or (2) arise out of the storage within the United States of goods under contract of sale or expected to move into the channels of trade within a reasonable time and that are secured throughout their life by a warehouse receipt or similar document conveying title to the underlying goods. (Board of Governors 1992, *78th Annual Report,* p. 98)

Note that dollar exchange acceptances and acceptances arising from the storage of goods in foreign countries are not eligible for purchase and that domestic storage acceptances may be eligible for purchase only if secured throughout their life by documents conveying title to the goods; storage acceptances may be eligible for discount if they are secured at the time of acceptance by such documents.

The preceding rules on eligibility for purchase and for discount are those currently in force. The original Federal Reserve Act limited eligibility for discount to acceptances "based on the importation or exportation of goods."[4] Congress amended the Act in 1916 to include acceptances arising from the storage of readily marketable staples, from domestic shipments, and from the furnishing of dollar exchange. Until April 1974, when the current rules on eligibility for purchase went into effect, all acceptances that were eligible for discount, along with some others, were eligible for purchase.

The framers of the original Federal Reserve Act gave the Reserve Banks permission to discount and purchase bankers acceptances because they hoped to create a market for acceptances in the United States and to thereby stimulate American foreign trade by lowering the financing costs faced by American importers and exporters.[5] In the years before the Federal Reserve Act was passed, most international trade was financed with acceptances created under letters of credit (Warburg 1910, p. 9). The lack of an American market for acceptances meant that American firms engaging in foreign trade had to obtain financing from European banks, primarily those in London. Financing through London was thought to force American importers and exporters to pay more

[4] This included foreign shipment acceptances, as the Federal Reserve Board construed "importation" and "exportation" to include the movement of goods between foreign countries as well as between the United States and a foreign country.

[5] Hackley (1973, pp. 53–54), in making this point, quotes from speeches made by Congressman Phelan and Senator Swanson during their respective houses' debates on the Federal Reserve Act. Congressmen Borland, Bulkley, and Helvering expressed the same sentiment (U.S. Congress 1913, *Congressional Record,* pp. 4733, 4785, 4794, and 4798–99).

in commissions than they otherwise would have had to pay, and, since their obligations to the banks in London were denominated in pounds sterling, to expose them to exchange rate risk (Jacobs 1910, p. 13).[6]

The Federal Reserve Banks actively supported the nascent market in the first 18 years following the passage of the Federal Reserve Act. They did so mainly by purchasing acceptances in the open market and not by discounting acceptances offered by accepting banks, the means Congress had expected them to use. They posted buying rates on prime acceptances and bought all acceptances offered at those rates; at times, the posted rates were substantially below market rates. On average, from 1916 to 1931, the Reserve Banks held for their own portfolios over one-third of all outstanding acceptances; at times they held over half of them. They also purchased acceptances for foreign official institutions that held correspondent accounts with them. They endorsed these acceptances, thus freeing their foreign correspondents from the risk of default. Partly on the strength of the Reserve Banks' endorsement, their foreign correspondents purchased large numbers of acceptances. From 1925 to 1931, the foreign correspondents held on average about one-fifth of all acceptances outstanding.

With the support of the Reserve Banks and their foreign correspondents, the acceptance market quickly rose in prominence. As Figure 2 shows, from 1925 to 1931, acceptances financed on average about one-third of U.S. imports and exports. In 1931, the peak of their importance, they financed just under half.

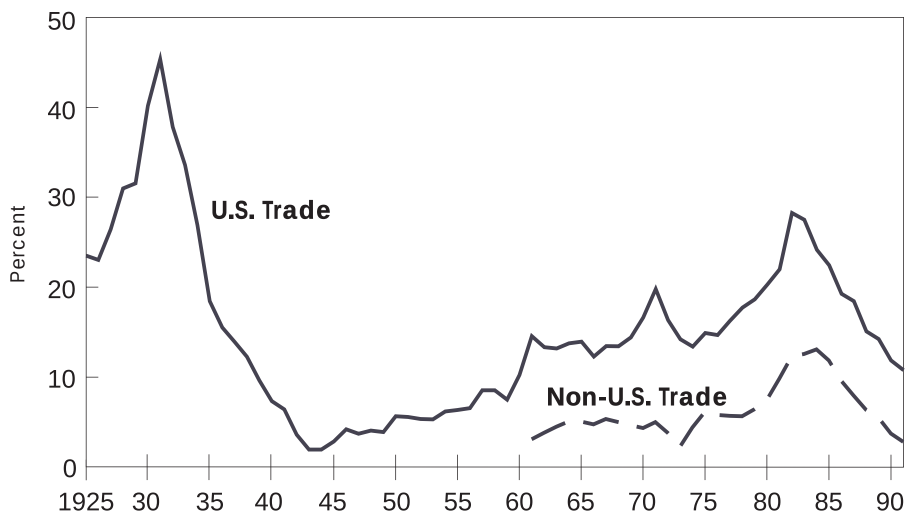
The support of the Reserve Banks and their foreign correspondents fell off dramatically in 1932. From the middle of 1934 until late 1946, they stayed out of the market for the most part. The decline in the acceptance market was equally dramatic, and by 1943 the fraction of America's foreign trade financed by acceptances had fallen to 3 percent.

The market began growing again following World War II, and the Reserve Banks' foreign correspondents resumed regular purchases in late 1946. The Federal Reserve re-entered the market in 1955 when the Federal Open Market Committee authorized the Federal Reserve Bank of New York to enter into repurchase agreements (RPs) in acceptances and to buy and sell acceptances at market rates as means of carrying out the Committee's monetary policy directives. The Federal Reserve sought to support the market, but not to the extent it had in the 1920s. Since 1955, the Federal Reserve and its foreign correspondents combined have not held more than 20 percent of the acceptances outstanding.

During the 1970s, the Federal Reserve decided that the acceptance market had matured to the point that it could stand on its own, and the System gradually

[6] Congressmen Phelan and Helvering quoted from Professor Jacobs during the House's debate on the Federal Reserve Act (U.S. Congress 1913, *Congressional Record,* pp. 4676, 4798–99).

Figure 2 Shares of U.S. and Non-U.S. International Trade Financed by Bankers Acceptances



Notes: Acceptance figures are from the Board of Governor's *Banking and Monetary Statistics, Annual Statistical Digest,* and *Federal Reserve Bulletin.* U.S. imports and exports are from the U.S. Bureau of the Census' *Historical Statistics, Statistical Abstract,* and FT900 release. Trade figures for the rest of the world are from the International Monetary Fund's *International Financial Statistics.* Shares financed are based on an average maturity of 90 days.

withdrew its support. In November 1974, it stopped endorsing acceptances for its foreign correspondents. In March 1977, it decided to stop outright purchases and sales of acceptances, and in 1984 it decided to stop entering into RPs in acceptances.

Even though the Federal Reserve Banks have stopped buying and selling acceptances for their own accounts, eligibility for purchase and eligibility for discount remain significant in that acceptances that are eligible for discount or purchase enjoy favorable treatment in certain areas. Acceptances must be eligible for purchase in order to be bought for the Federal Reserve's foreign correspondents, and they must be eligible for discount or purchase in order to be used as collateral for advances from the discount window. From 1973 to the end of 1990, eligibility for discount conferred an additional benefit: Acceptances outstanding in the market had to be eligible for discount in order to be exempt from reserve requirements.

The exemption from reserve requirements was a significant factor in the growth of the acceptance market in the late 1970s and early 1980s (Jensen and Parkinson 1986, pp. 5 and 8). The high interest rates in those periods raised the opportunity cost of holding reserves, which do not earn interest. This made it attractive for banks to finance eligible transactions by creating acceptances, discounting them, and rediscounting them in the market rather than by loaning out funds obtained by issuing large CDs, which were subject to reserve requirements.

The value of the exemption is evident in the experience of "working capital" or "finance" acceptances, which are acceptances that do not arise from specific transactions in goods. Of these acceptances, only dollar exchange acceptances are eligible for discount. In July 1973, the Board of Governors started treating ineligible acceptances discounted in the market as equivalent to deposits subject to reserve requirements. Judging by dealers' holdings of working capital acceptances, trading in them had been increasing for at least two years.[7] After the imposition of reserve requirements, trading declined steadily, and, aside from a brief and minor revival in the early 1980s, it has been dormant ever since.

At the end of 1990, the Board of Governors removed reserve requirements from "nonpersonal time deposits," which include ineligible acceptances and large CDs, and from Eurocurrency liabilities, which are net transfers from banks' overseas offices to their U.S. offices. This action bodes ill for eligible acceptances, since it puts CDs and Eurodollar liabilities on a more even footing with them. Even with favorable reserve-requirement status, eligible acceptances had been declining in importance for close to a decade. Judging by this experience, it seems unlikely that the Board's action will lead to a revival in ineligible working capital acceptances.

3. THE MARKET FOR BANKERS ACCEPTANCES

Borrowers

Borrowers in the acceptance market are for the most part firms engaged in U.S. imports and exports and foreign banks seeking to finance international trade not involving the United States. Over the last decade, as Figures 1 and 2 show, both types of borrowers have come to rely less and less on acceptances as a source of financing.

As a source of financing for importers and exporters, acceptances compete with commercial paper, Euro commercial paper, and bank loans. For borrowers with prime ratings, commercial paper is probably the cheapest alternative. Borrowers with less than prime ratings can take out bank loans, issue Euro commercial paper, issue commercial paper with credit enhancements, or issue

[7] Figures on dealers' holdings of acceptances can be found in the Federal Reserve Bank of New York's weekly report "Dealer Operations in Bankers' Acceptances."

asset-backed commercial paper. Borrowers of the latter type may find acceptance financing an attractive alternative.

Apparently, however, they increasingly do not. From 1983, when asset-backed commercial paper and Euro commercial paper were introduced, until 1991, outstandings rose to between $50 billion and $70 billion for asset-backed commercial paper and to $75 billion for Euro commercial paper. Over the same period, commercial and industrial loans made to U.S. businesses by onshore and offshore banks rose from $467 billion to $777 billion (McCauley and Seth 1992, p. 54). The volume outstanding of acceptances based on U.S. imports and exports fell over this period, however, from $31 billion to $24 billion, and the percentage of U.S. foreign trade financed by acceptances fell from 25 percent to 10 percent.

Foreign banks that have no presence in the United States may finance their own acceptances by drawing refinancing acceptances on American banks or by issuing Eurodollar liabilities. Jensen and Parkinson (1986, pp. 9–10) cite the narrowing of the spread between the rates on Eurodollar deposits and bankers acceptances, from nearly 100 basis points in the early 1980s to about 25 basis points in 1985, as a factor in the decline of refinancing acceptances in the first half of the 1980s. Since then, the spread has narrowed even more to under 10 basis points, and the decline in refinancing acceptances has continued, both in terms of volumes outstanding and in terms of the percentage of world trade financed.

Accepting Banks

Money center banks, large banks in seaboard states and in the principal grain trading cities, and U.S. branches and agencies of foreign banks create almost all acceptances. Branches and agencies of foreign banks have gained an increasing share of the market over the last decade or so. Their share has risen from about one quarter of all acceptances outstanding in the early 1980s to over 60 percent in 1990 and 1991.

The secondary market for acceptances is tiered, which means that the acceptances of banks with high credit ratings trade at lower rates of discount than the acceptances of banks with lower ratings. Traditionally, the acceptances of money center banks traded at lower rates of discount than those of regional banks and foreign banks. During the 1980s that changed. The spread between the rates of discount on the acceptances of regional banks and those of money center banks, which averaged around 10 basis points in the early 1980s, disappeared in late 1987. The spread between the rates of discount on the acceptances of foreign banks and those of money center banks, which was over 100 basis points when foreign banks were first entering the market, was around 5 basis points in 1990; indeed, the acceptances of some foreign banks traded at lower discounts than those of American money center banks (The First Boston Corporation 1990, p. 154).

Dealers

The number of principal dealers in bankers acceptances has been cut roughly in half in the last few years. Today, there are about a dozen, all of which are also primary dealers in government securities. Dealers in acceptances act as dealers in other money market instruments do, buying and selling acceptances and profiting from the spread between the prices at which they buy and sell. To facilitate their trading, they hold a number of acceptances in their own portfolios; a small number of these they hold until maturity. During 1991, dealers' daily positions in acceptances averaged a little over $1.5 billion.

Investors

Bankers acceptances are generally created in amounts over $100,000, so institutional investors dominate the market. On average in 1991, commercial banks held 21 percent of the acceptances outstanding; most of those were their own. Money market mutual funds held 13 percent, dealers held 3 percent, and the Federal Reserve's foreign correspondents held 3 percent. The remaining 60 percent were held by a variety of investors, of which, if relative holdings were like those in previous years, some of the largest were state and local governments, pension funds, and insurance companies (Jensen and Parkinson 1986, p. 4).

Investors consider acceptances to be safe investments because acceptances are "two-name" paper; that is, two parties, the accepting bank and the drawer, are obligated to pay the holder on maturity. Investors are willing to accept a slightly lower return on acceptances than they are on "one-name" paper such as commercial paper and certificates of deposit.

4. THE OUTLOOK FOR BANKERS ACCEPTANCES

Over the last decade or so a number of developments have diminished the attractiveness of bankers acceptances to both banks and borrowers. Asset-backed commercial paper and Euro commercial paper have been introduced, spreads between rates on Eurodollar deposits and rates on acceptances have fallen, and acceptances have lost their favorable reserve-requirement status. As these developments appear to be permanent, the acceptance market is unlikely to rebound and may even continue to decline in importance.

REFERENCES

Board of Governors of the Federal Reserve System. *78th Annual Report,* 1991. Washington: Board of Governors, 1992.

__________. *Annual Statistical Digest,* various issues. Washington: Board of Governors.

__________. *Banking and Monetary Statistics, 1914–1941.* Washington: Board of Governors, 1943.

__________. *Banking and Monetary Statistics, 1941–1970.* Washington: Board of Governors, 1976.

__________. *Federal Reserve Bulletin,* various issues. Washington: Board of Governors.

The First Boston Corporation. *Handbook of U.S. Government & Federal Agency Securities & Related Money Market Instruments,* 34th ed. Chicago: Probus Publishing Company, 1990.

Hackley, Howard H. *Lending Functions of the Federal Reserve Banks: A History.* Washington: Board of Governors of the Federal Reserve System, 1973.

International Monetary Fund. *International Financial Statistics,* various issues.

Jacobs, Lawrence Merton, *Bank Acceptances.* Washington: Government Printing Office, 1910.

Jensen, Frederick H., and Patrick M. Parkinson. "Recent Developments in the Bankers Acceptance Market," *Federal Reserve Bulletin,* vol. 72 (January 1986), pp. 1–12.

McCauley, Robert N., and Rama Seth. "Foreign Bank Credit to U.S. Corporations: The Implications of Offshore Loans," Federal Reserve Bank of New York *Quarterly Review,* vol. 17 (Spring 1992), pp. 52–65.

Ryan, Reade H., Jr. "Bankers' Acceptances," in Reade H. Ryan, Jr., ed., *Letters of Credit and Bankers' Acceptances 1988.* New York: Practicing Law Institute, 1988.

Todd, Walker F. "A Regulator's View of Bankers' Acceptances" in Reade H. Ryan, Jr., ed., *Letters of Credit and Bankers' Acceptances 1988.* New York: Practicing Law Institute, 1988.

United States Bureau of the Census. *Historical Statistics of the United States, Colonial Times to 1970.* Washington: Government Printing Office, 1975.

__________. *Statistical Abstract of the United States: 1991.* Washington: Government Printing Office, 1991.

__________. FT900 Supplement, May 21, 1992.

U.S. Congress. "The Currency," *Congressional Record,* vol. 50, Part 5 (September 10–12, 1913), pp. 4638–4859.

Warburg, Paul M. *The Discount System in Europe.* Washington: Government Printing Office, 1910.