Interest rate volatility in historical perspective

Harvey Rosenblum and Steven Strongin

On October 6, 1979, the Federal Reserve changed its procedures for implementing monetary policy. Prior to that date, the Federal Reserve had sought to bring the rate of monetary growth in line with its desired target rate of growth through changes in the federal funds rate. Through its open market operations, the Fed supplied or absorbed whatever level of reserves was necessary to achieve the targeted federal funds rate. To influence the price of reserves (i.e., the federal funds rate), the Fed had to give up control over the quantity of reserves.

But after October 6, 1979, the Fed began controlling the quantity of reserves it supplied through open market operations (i.e., the level of nonborrowed reserves); in so doing, the Federal Reserve had to let market forces determine the price of reserves—the interest rate. Under these circumstances, the federal funds rate was free to move over a much wider range than before.

Since this change in the Fed's *method* of implementing monetary policy, much attention has been focused on the increased volatility of interest rates and the adverse economic consequences that seemed to have followed from the change. It is frequently asserted that the increased variability of interest rates stems primarily—and in the eyes of some observers, entirely—from the Fed's change in operating procedures. And indeed, by most conventional measures the degree of variability of interest rates (both long- and short-term rates) did increase markedly in the year or two following October 6, 1979 in comparison with the two years or so prior to that date.

But to use such a short span of time to analyze interest rate volatility and its impact may involve a myopic view that obscures the underlying fundamental causes and consequences of rate variability. Because interest rates respond to shifts in both supply and demand for credit, changes in interest rates and interest rate volatility may be due to factors other than Federal Reserve actions.

This article examines interest-rate volatility over the 86-year period from 1897-1982. When viewed over this longer time horizon, the interest-rate volatility of the last few years does not seem particularly unusual. What was unusual is that the sharply higher volatility followed a period of unusual tranquility, thus making the adjustment to the new environment all the more difficult for economic entities unprepared for the change in economic conditions. Further, the interest rate variability of the last few years is not vastly different from that of many other two- or three-year periods over recent decades. Thus, there is circumstantial evidence that the change in the Fed's operating procedures in October 1979 may have been only a minor factor contributing to the increased rate volatility, and that other factors were simultaneously contributing to the increased interest rate movements. However, no attempt is made in this paper to suggest what might have happened had there been *no* change in Fed operating procedures in October 1979.

Volatility since the mid-1950s

When the behavior of interest rates is examined over recent years, several observations are readily apparent. First, interest rates have tended to rise, on average, since World War II. Second, the level of interest rates has tended to fluctuate over a wider range during the later part of the postwar period than during the early part. Third, the peak level of rates in each cycle has tended to exceed the peak level of rates reached in the previous business cycle. This is seen in Figure 1, which shows the level for the federal funds rate

Harvey Rosenblum is vice president and economic advisor and Steven Strongin is a research economist in the Research Department of the Federal Reserve Bank of Chicago.

Figure 1

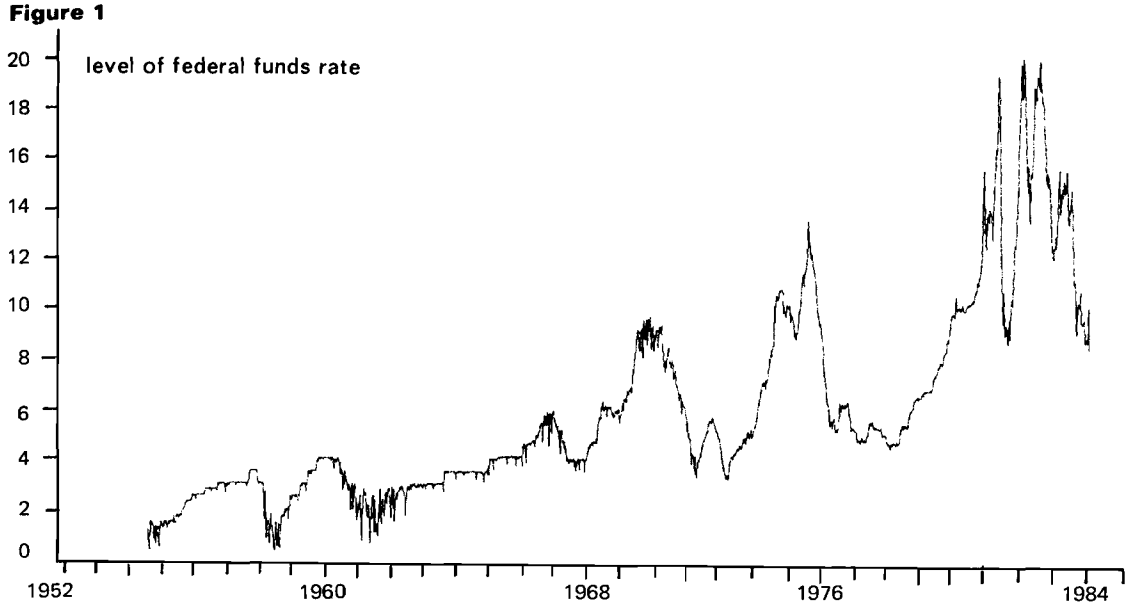
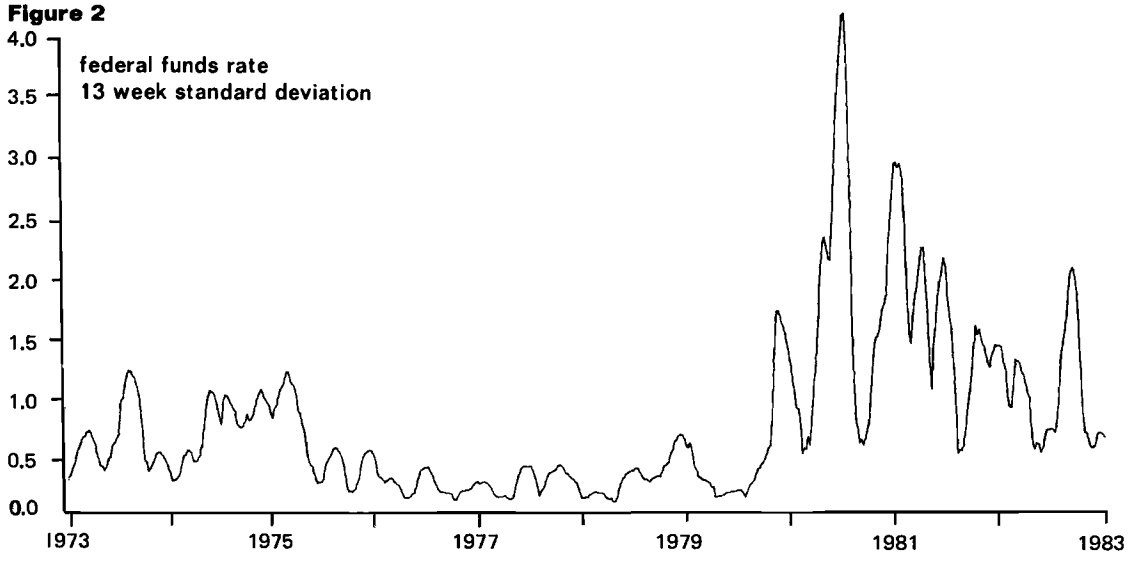


Figure 2



over the 1954-82 period. The pattern is very much the same for all short-term money market rates. The three-month Treasury bill rate and the 4-6 month prime commercial paper rate all show the same pattern.

The sharp increase in the variability of the federal funds rate is shown in Figure 2, which depicts the standard deviation[1] of the federal funds rate over the 1973-82 period. The stan-

[1]The graphs presented in this paper are based on moving calculation frames. For each week, a standard deviation or some other measure of volatility is calculated, using the data for that week and the previous 12 weeks. (Certain graphs are calculated with a one-year span and use the preceding 51 weeks.)

dard deviation did increase significantly immediately after the adoption of reserves targeting by the Federal Reserve in October 1979. However, several points are worth noting in Figure 2. First, in the first few months following the change in operating procedures, the standard deviation of rates rose quite sharply *in comparison with the standard deviation of rates in the two years prior to the operational shift.* But it was only slightly higher than that during the first two years of the 1973-82 period. Second, the truly significant spike in rate volatility, as measured by the standard deviation, centered on the Spring of 1980, when the Special Credit Restraint Pro-

Measuring Rate Volatility

To measure volatility a number of choices must be made.

- What data series should be used?
- What frequency of data should be used (daily, weekly, monthly, yearly, etc.)?
- Over what time period should the volatility measure be calculated?
- What statistical measure should be employed?

The choices made in this paper, and the reasons for them, are discussed below.

Two interest rates, the federal funds rate and the 4-6 month prime commercial paper rate, were used. The Federal funds rate was chosen because it is the rate which the Federal Reserve affects most directly through open market operations. The prime commercial paper rate was used because it provided the most consistent series over nearly a century, allowing a broader historical perspective. However, other rates, such as the U.S. Treasury bill rate, were tested and provided almost identical results in the periods for which they were available.

Weekly data were analyzed. This was a compromise between the need for a large number of observations that daily data would have provided, and the fact that very short-term fluctuations, such as interday or intraday fluctuations, are important primarily to floor traders or highly active speculators and are of little relevance to Federal Reserve policy.

The period over which volatility is calculated is crucial. Many previous examinations of volatility differ from this study with respect to period. Usually, the date of a particularly important event is chosen; volatility measures are then calculated for equal periods before and after, and the two numbers are compared.

This methodology has a serious bias toward finding a shift, because if there had been *any* change either in the before or after period then the analysis would falsely relate that change to the tested event. Another problem with this methodology is that it is impossible to tell which of the two periods was anomalous.

To avoid these problems, volatility calculations were made for each week using that week and either the previous 12 weeks (one quarter) or that week and the previous 51 weeks (one year). The volatility measures were then plotted against time, so that the reader may see when volatility was high or low and when it was changing without having to rely on the authors' perceptions of when major structural changes took place. It also becomes easier to spot short-term anomalies such as the Credit Restraint Program and to adjust one's perceptions accordingly.

The choice of volatility measure might at first seem crucial. Surprisingly, except for the very important distinction between measures which adjust for the level of interest rates (relative measures) and those that do not (absolute measures), very little difference could be found between measures. The two basic statistical measures chosen were standard deviation and range.

These two were picked because both are well known and reasonably easy to calculate. Many other measures were tested but, as mentioned above, no substantive differences were found.

Adjustments were made for level by calculating the natural logarithms of the interest rates, and then applying the same statistical measures as were used in investigating absolute volatility. This changes the measure to one of percentage changes. That is, an absolute change from 10% to 11%, measured by simple subtraction, is a change of the same magnitude (one percentage point) as a change from 1% to 2%. But when logs are taken, a change from 10% to 11% is the same as a change from 1% to 1.1%. Thus, by taking logs the standard deviation and range become relative volatility measures, measuring the volatility relative to the current level of interest rates.

gram was invoked by President Jimmy Carter. Third, interest rate volatility has subsided considerably since the demise of the Credit Restraint Program.

One problem with using the standard deviation as a measure of volatility is that it represents the *absolute* variation of rates about the mean. The probability of an absolute change in interest rates of 50 basis points[2] may be different when the level of rates averages 10 percent than when it averages 4 percent. As shown in Figure 1, the average level of interest rates has been much higher in the last few years than it was ten, twenty, or thirty years ago.

Measures of the *relative* variation of interest rates can correct for this problem (see Box). Indeed, when a relative measure of variation, the standard deviation of the natural log of the federal funds rate, is used, the increase in the volatility of the federal funds rate in the post October 1979 period does not appear as dramatic as when the standard deviation, an absolute measure of variation, is used. This can be seen in Figure 3. Note once again the dating of the spike in variability during Spring 1980.

An examination of the relative variability of the federal funds rate over the 1954-82 period, plotted in Figure 4, suggests that the volatility experienced during the last few years was neither unknown nor excessive by the standards of the period.

[2]A basis point is 0.01 percentage points. Thus a change of 50 basis points represents 50(.01)=0.5 percentage points.

A longer-run view of volatility

To provide a greater understanding of recent phenomena, Figure 5 places these events in a longer-term historical context, by plotting the relative volatility of the prime commercial paper rate from 1897 to 1982. The commercial paper rate is the only relatively consistent short-term interest rate series going back this far in time.

When viewed in this long-term context, the experience during the post October 6, 1979 period is neither unprecedented nor particularly unusual. There have been many spikes in rate volatility—the most significant ones having occurred in 1898, 1914, 1931, 1933, 1942, 1958 and 1980. Each of these episodes was followed by a return to a period of more "normal" variability.

To illustrate this point more clearly, Figure 6 divides the 1897-1982 period into three approximately equal subperiods of about 29 years each. Figure 6a shows that during the 1897-1925 period the nation experienced interest rate volatility not very different from that

Figure 3

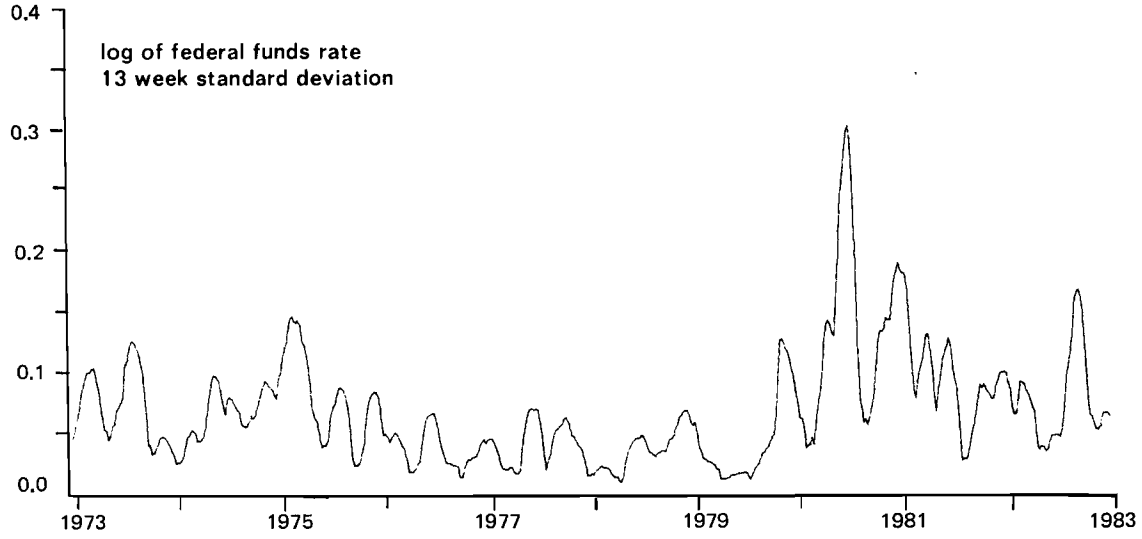


Figure 4

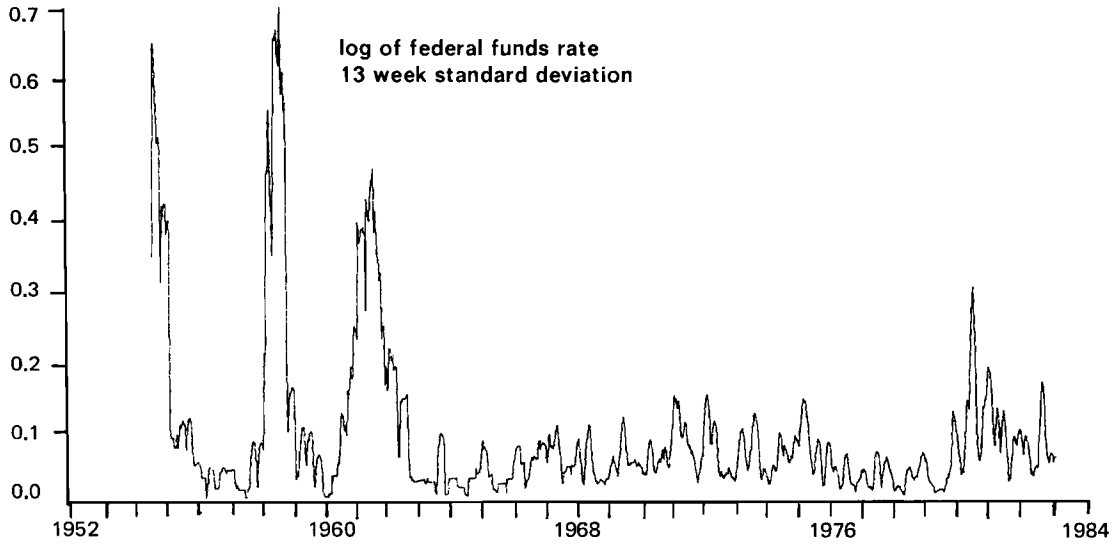
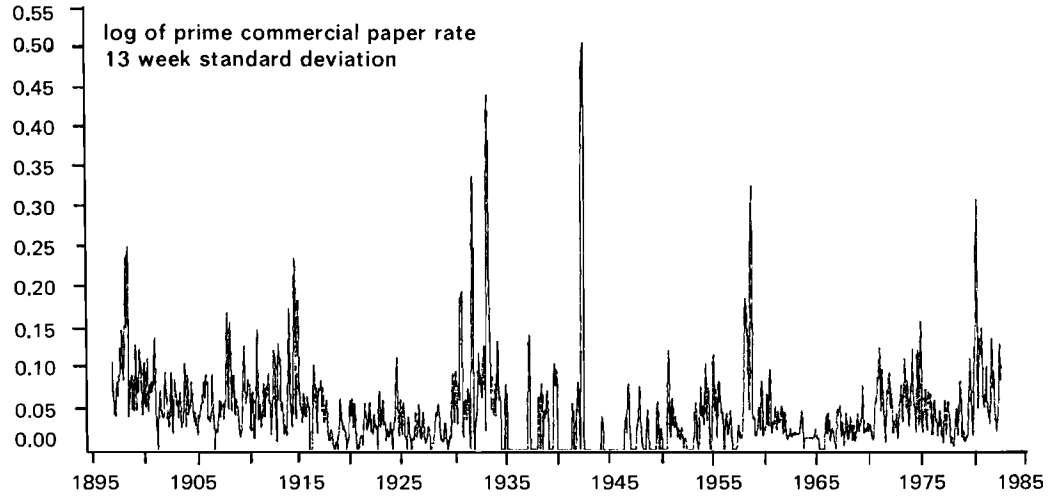


Figure 5



which has prevailed during the last three decades. This can be seen by comparing Figures 6a and 6c.

The period from the formation of the Federal Reserve in 1914 until the 1930s (Figures 6a and 6b) was a period of comparative interest rate tranquility. During the depths of the Great Depression, interest rates were at very low levels and changes in rates of only a few basis points were enough to cause large jumps in the measure of relative variation (Figure 6b). Similarly, during World War II and until the Federal Reserve-Treasury Accord in 1951, the Federal Reserve sought to peg rates at low and stable levels; again, any small variation in rates in a period such as this was sufficient to produce a sharp increase in relative measures of rate volatility. Finally, examination of the 1955-1982 period (Figure 6c) reveals that the first half of the 1970s had much greater relative rate volatility on average than the 1960s. During most of the second half of the 1970s, rate volatility subsided considerably, thus magnifying the relative impact of the increased volatility after October 6, 1979.

Figure 6a

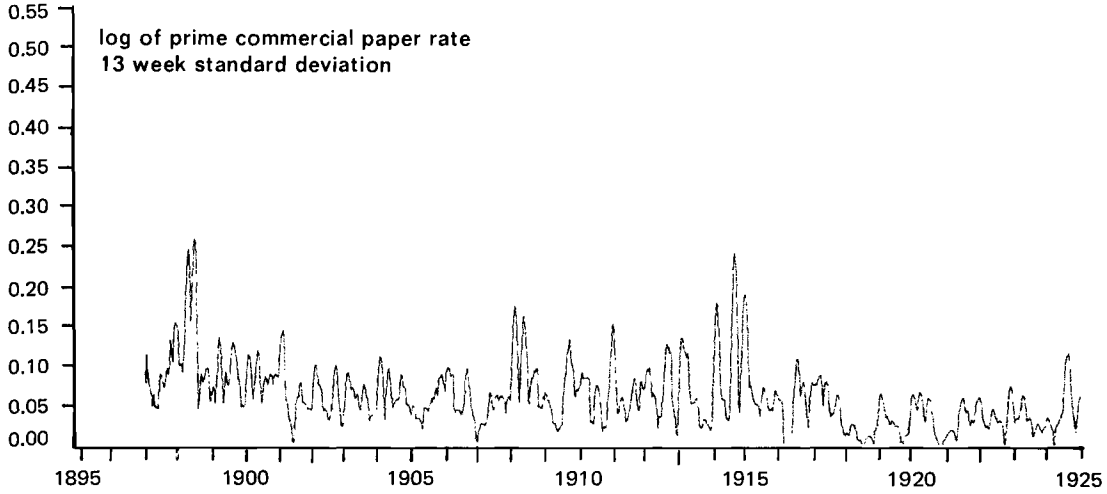


Figure 6b

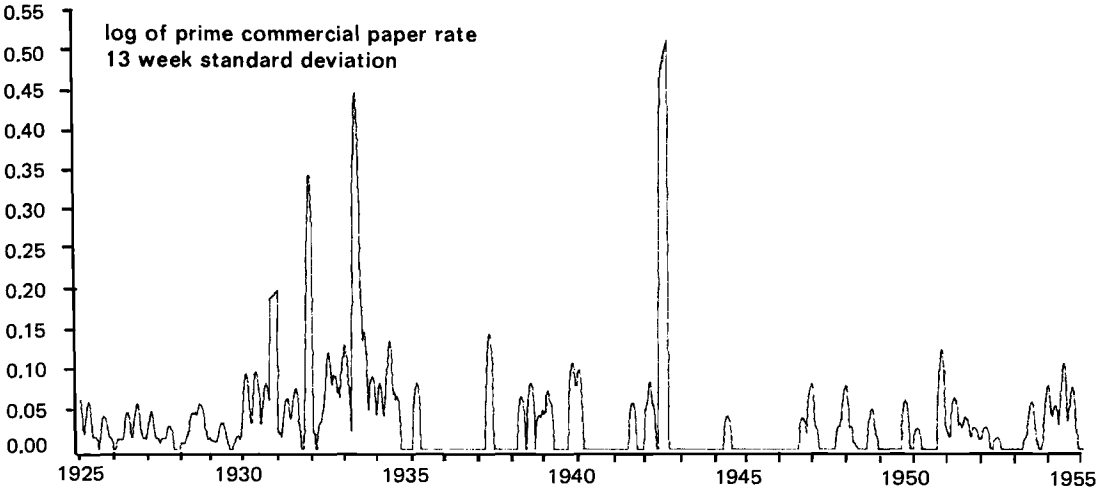
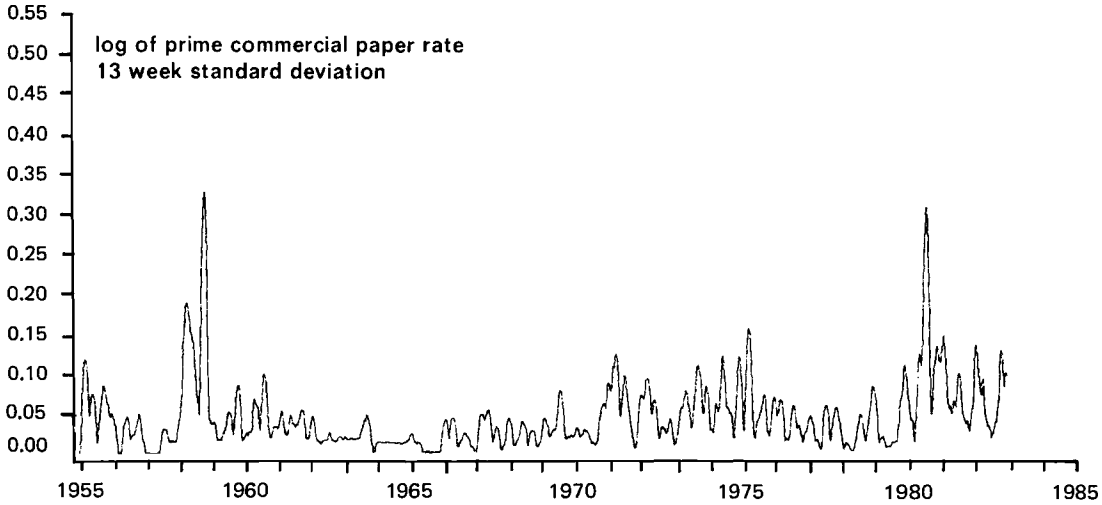


Figure 6c



Examination of rate volatility over a long time calls into question the usual methodology for analyzing current volatility. Most analyses of recent rate volatility have typically involved comparing an absolute measure of variation (generally an unadjusted standard deviation) during the period just before October 1979 (often January 1976-September 1979, a period of extremely low volatility) and the two- or three-year period immediately following October 6, 1979. Such a comparison leads to a significant overstatement of recent instabilities. Moreover, while there was a large increase in volatility shortly after the 1979 Fed changes, a substantial proportion of the increase is associated with the Special Credit Restraint Program during 1980. In fact, after the Credit Restraint Program was rescinded, rate volatility declined to more nearly normal levels.

Economic impact of rate volatility

Great care must be taken in interpreting any given measure of rate volatility. For example, if an absolute measure of rate volatility is used, 1981 shows nearly three times the volatility shown by rates in 1971. If a relative measure such as the log of the rate is used, the difference between rate volatility in 1971 and 1981 is inconsequential (see Figures 8b, 8c).

In terms of the economic impact of the rate movements involved, neither representation of rate volatility is necessarily more correct than the other. Rather, the "correctness" depends upon the nature of the problem being analyzed.

To assess the risk associated with holding a portfolio of fixed income securities during a period in which interest rates are changing, it is appropriate to look at the absolute measure of changes in rates.[3] Thus for any given initial security yield and holding period, a 50-basis point change in interest rates affects the value of that security by about twice as much as an interest rate change of 25 basis points.[4]

But from the point of view of monetary policy, which is transmitted to the economy through very short-term shocks or absorption of shocks in the money and credit markets, the relative or log measure of volatility is probably superior, especially when one is attempting to assess the "market's" uncertainty with respect to Fed behavior. The reason for this is fairly straightforward; the volatility of interest rates measured by an absolute measure increases as the level of rates rises. When rates are 5 percent, they simply cannot fall 11 percentage points, as they did during the Credit Restraint Program. Thus, as inflation has increased over the last 20 years, and with it the general level of interest rates, volatility has also trended up. Policy actions must be taken—and judged—in the environment in which they are made. The same willingness on the part of the Fed to smooth interest rates in terms of missing monetary growth targets will lead to much greater interest-rate volatility in a period characterized by 15 percent rates than in a period with 7 percent rates.

This does not change the fact that the economy is primarily affected by sustained absolute shifts in the level of interest rates. And these longer-term movements in rates have increased significantly. This particular aspect of rate volatility cannot be dismissed lightly. Indeed, to the extent that rate movements *persist* in one direction or the other for several weeks or months at a time, substantial changes in portfolio values and in actual and perceived levels of wealth will occur. Increases in interest rates produce declines in wealth which are generally followed by declines in spending; therefore longer-term rate movements that persist over substantial time periods can and do influence the level of economic activity.[5]

[3] As shown in Michael Hopewell and George G. Kaufman, "Bond Price Volatility and Term to Maturity: A Generalized Respecification," *American Economic Review*, September 1973, pp. 749-53, Equation (7), the percentage change in the price of a security, $\Delta P/P$, is proportional to the absolute change in the interest rate, Δi, times the duration, D, of the security.

[4] This relationship holds for small changes in rates; for larger rate movements, the proportionality or correspondence holds, but the proportionality factor does not remain constant because the relationship is nonlinear.

[5] Changes in interest rates also have an impact on income in that income associated with higher interest rates is redistributed from borrowers to savers. Since each of these groups may have different marginal propensities to spend and are likely to purchase a different basket of goods and services, income and employment of many economic groups will be affected by interest rate changes that persist for more than a few days or weeks.

To gain some insight into these longer-term rate movements, the range of values of a given interest rate over a period of time is used as a proxy for longer-term *swings* in interest rates. Two such measures are shown: the range of rates over thirteen-week (quarterly) and over one-year periods. Figure 7 shows the range of the federal funds rate over thirteen-week moving periods for the 1971-82 period. By this measure, the impact of the change in rates on portfolio values since October 1979 seems extraordinary, particularly as a measure of uncertainty. Prior experience would not have predicted the extent of this volatility and its effect on portfolio values. Although the extent of quarterly rate swings may have subsided to more "normal" levels in 1982, the impact of the rate swings during 1980 and 1981 on quarterly earnings statements of banks and other financial institutions was particularly severe for those institutions with asset-liability structures not hedged or immunized against *changes* in interest rates.

This view of rate volatility is shown in Figure 8b which shows a moving one-year range for the prime commercial paper rate over the 1897-1982 period. Once again, the episodes of high rate volatility occurred in the roughly two decade period prior to the formation of the Federal Reserve and during the 1973-75 period. The two years prior to October 1979 were periods of tranquility; and unprecedented, and presumably unanticipated, volatility followed beginning in 1980. The wealth and spending impacts must have been significant. Interest rate swings are measured over this period in relative terms in Figure 8c. This portrayal of rate volatility illustrates that interest rate swings, relative to the rates in existence at the time, were of the same order of magnitude on several occasions in the past. That is to say, if one had expected money market rates to reach 20 percent, then one should have expected, based on previous experience, that rates would move over an eight percentage point range (from 12 percent to 20 percent) within this period. In a sense, this experience is not very different than rate movements from 1.2 percent to 2.0 percent (a movement of only 80 basis points) during the 1930s, a period when similar relative rate swings occurred.

The longer-run perspective also provides further evidence that the episode of rate behavior shown in Figure 7 is not, then, necessarily due to the Fed's operating procedures adopted in October 1979. Significant changes in the magnitude of rate swings occurred in the past even before there was a Fed to have operating procedures. In fact a good case can be made that the episode of volatility illustrated in Figure 7 reflects an interaction between 1) higher inflationary expectations that had been developing since the mid-1960s, 2) the resultant higher

Figure 7

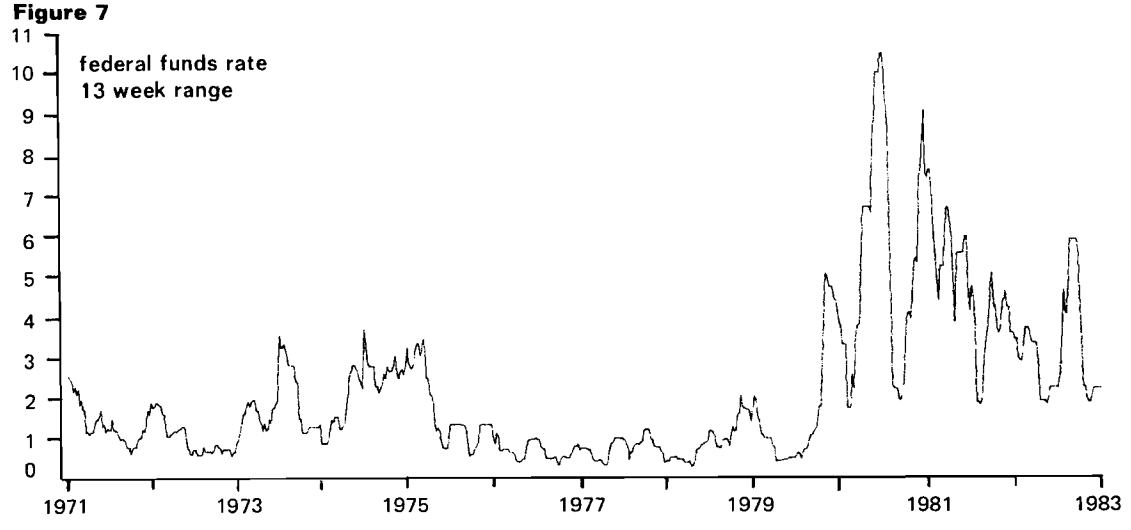


Figure 8a

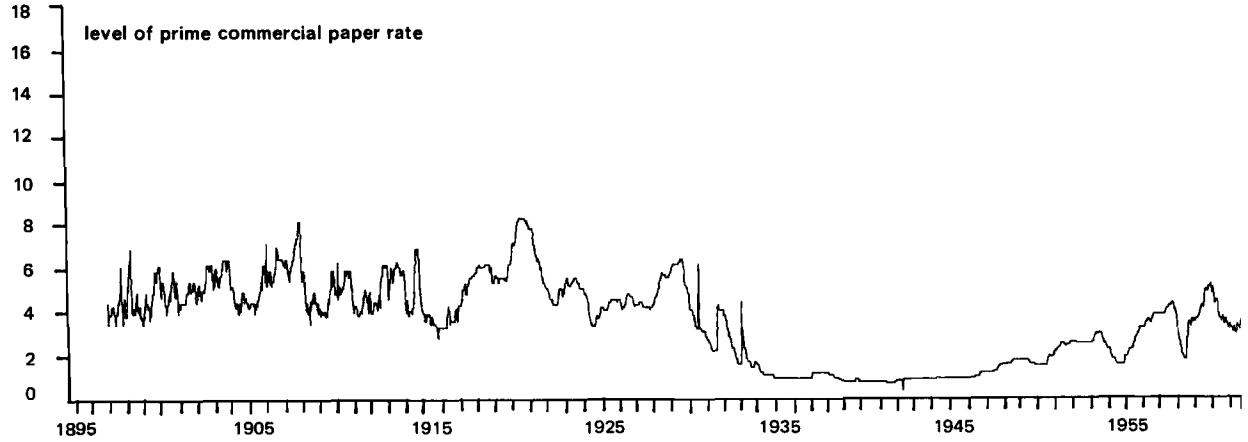


Figure 8b

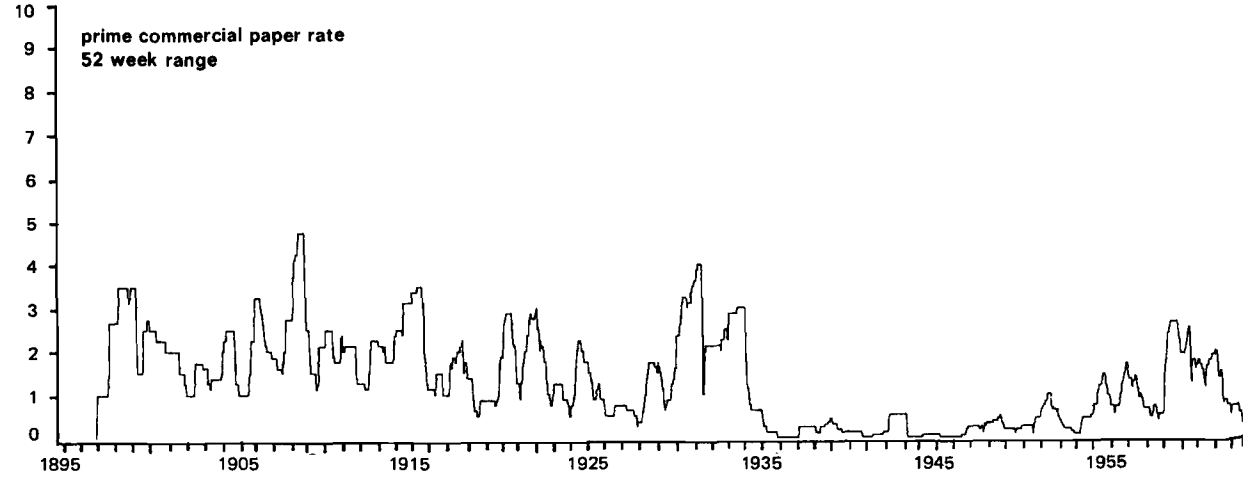
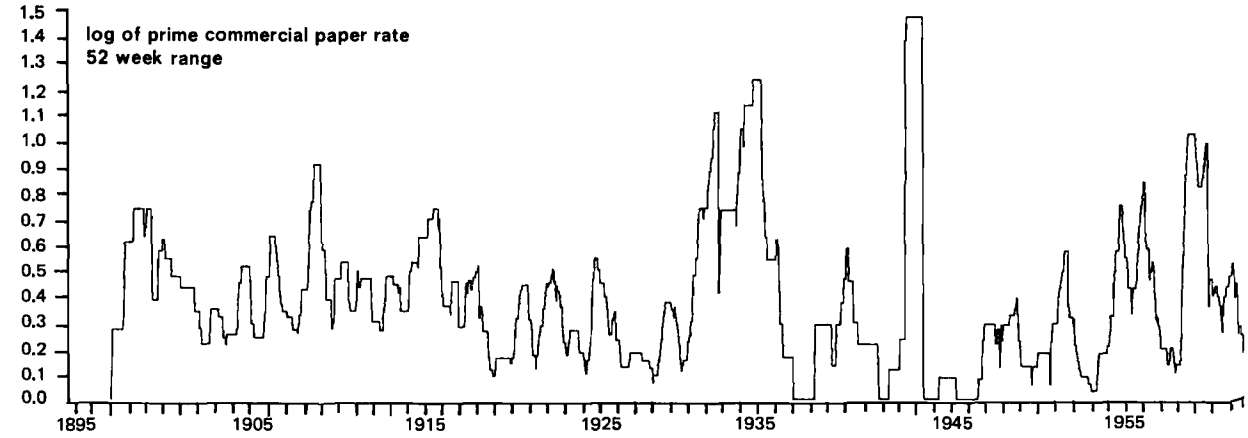
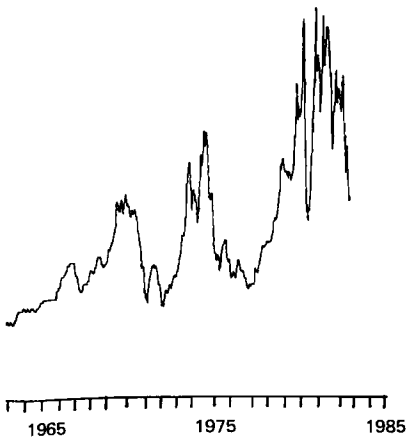
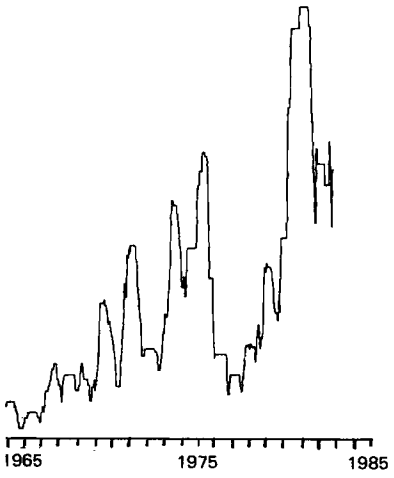
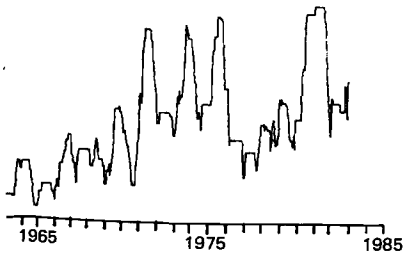


Figure 8c









interest rates, and 3) greater uncertainty about the Fed's commitment to attenuating these inflationary forces, particularly in the face of extremely large federal budget deficits.

Indeed, were it not for the high average level of interest rates—an inevitable result of the inflationary excesses of the late 1960s and early- to mid-1970s—it would not have been possible to have rate swings as large as they were in 1979-1981. Thus, with a lower average level of rates, the wealth effects stemming from the last few years' relative interest-rate volatility would have been less. But to achieve a sustained lower level of interest rates, it is first necessary to reduce inflation and with it, inflationary expectations, which was the goal of the Fed's October 6, 1979 operating procedures.

The relationship between the level of interest rates and the volatility (as measured by longer-term swings) of interest rates is illustrated clearly in Figures 8a, b, c. Clearly, there is a strong relationship between Figures 8a and b. However, Figure 8c, showing the relative measure, shows little, if any, relationship with the level of interest rates.

Summary

The charts presented here illustrate a mixed picture of interest-rate volatility. In a longer term historical context, the relative rate volatility of the last few years was not unprecedented, and depending on how and over what period it is measured, rate volatility in the last few years can be shown to be not at all unusual by the standards of even the last decade or so.

On the other hand, the high level of rates over this recent period has increased the absolute size of the range of rate movements and it is this measure that has the greatest impact on the value of security portfolios. Nevertheless, these rate movements and their associated wealth effects may have had less to do with the Federal Reserve's choice of operating procedures than with the extant level of interest rates—determined largely by past and anticipated rates of inflation.