

Does Interest Rate Volatility Affect Money Demand?

By C. Alan Garner

Some observers claim that volatile interest rates during the 1980s have adversely affected U.S. economic performance. According to this line of reasoning, the greater volatility of interest rates has contributed to the high average level of interest rates, thereby discouraging business investment and consumer purchases of durable goods. Moreover, interest rate volatility may have depressed capital spending directly by increasing the risk associated with investment decisions.

One channel by which interest rate volatility might affect economic performance and monetary policy decisions is through the demand for money. For example, Milton Friedman has argued that, "It is eminently plausible that uncertainty should raise the demand for cash balances, that is, reduce velocity."¹ If so, the

increased demand for money would be reflected in greater reluctance to hold securities, thus raising interest rates. Moreover, interest rate volatility could have important monetary policy implications because an increase in money demand caused by higher interest rate volatility could require the Federal Reserve to raise its target growth ranges for the monetary aggregates. However, the significance of interest rate volatility for money demand has not been confirmed by empirical studies.

This article finds little empirical evidence that interest rate volatility affects the demand for M1, the narrowest monetary aggregate. The first section documents the rise in interest rate volatility in the 1980s and discusses explanations for that rise. The second section discusses the theoretical reasons that have been offered to support the claim that higher interest rate volatility raises money demand and interest rate levels. The third section presents empirical evidence suggesting that greater interest rate volatility has not significantly affected the demand for M1.

¹ Milton Friedman, "Why a Surge of Inflation Is Likely Next Year," *The Wall Street Journal*, September 1, 1983.

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Recent volatility of interest rates

Regardless of the measure chosen, interest rates were highly variable in the early 1980s. The explanation may be partly one-time factors such as the unusually severe swings in real output and inflation during this period. However, another possible explanation, interest rate deregulation, suggests that higher interest rate volatility might continue in the future. Interest rate volatility also could be affected by policy actions such as the Federal Reserve's change of operating procedures in October 1979 and the special credit restraint measures adopted in 1980. Before examining these explanations in detail, this section first puts the recent volatility of interest rates in historical perspective.

The historical record

Different measures of interest rate volatility show divergent historical patterns. Two commonly used measures of interest rate volatility are the absolute and relative volatility of interest rates in the recent past. Absolute volatility is concerned with the variability of interest rates around their average level. Historical experience suggests that when the average level of interest rates rises, absolute volatility also rises. In contrast, relative interest rate volatility is concerned with the amount of interest rate variability in comparison with the average level of rates. If absolute volatility and the average level of rates rise proportionally, relative volatility does not change. These measures both show that interest rate volatility has been high in recent years but give differing impressions about its severity compared with earlier periods.

The absolute volatility of interest rates rose dramatically in the early 1980s. This rise is evident in Chart 1, which shows the behavior

from 1959 to 1984 of absolute interest rate volatility as measured by the eight-quarter moving standard deviation of the commercial paper rate.² By this measure, interest rate volatility was particularly low during the mid-1960s but then began an irregular rise that culminated in the unprecedented volatility of the early 1980s. Only in 1983 and 1984 did absolute interest rate volatility decline from these high levels.

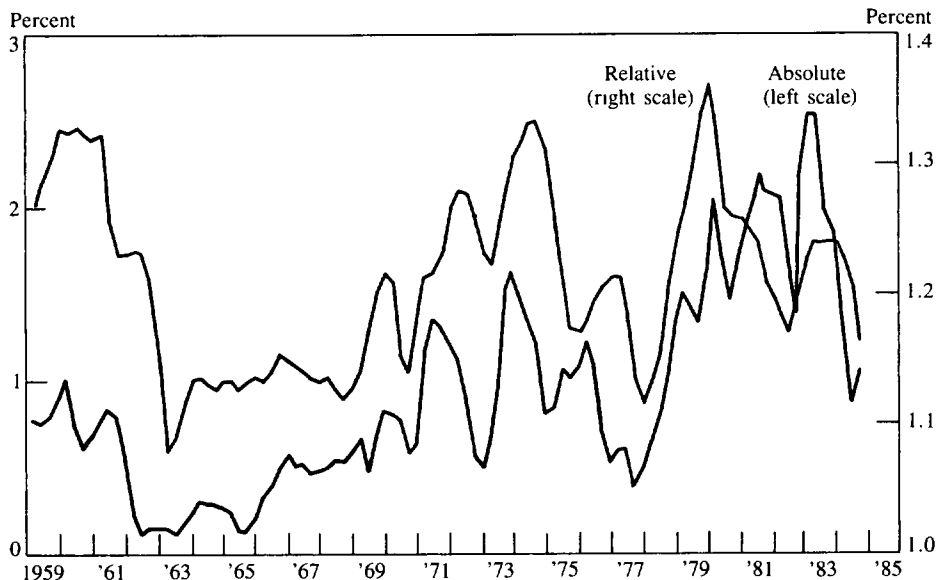
However, the relative volatility of interest rates increased much less in the 1980s. Chart 1 also shows the behavior of relative interest rate volatility as measured by the standard deviation of the logarithm of the commercial paper rate.³ The unusually low volatility of the mid-1960s again stands out, but the 1980s no longer appear to be a period of unprecedented turbulence. For example, relative interest rate volatility was roughly the same in 1960 and 1974 as in 1980. Two of the episodes of greatest interest rate volatility, 1974 and 1979-80, followed the major oil price shocks of the 1970s. Whereas absolute volatility did not peak until 1983, relative interest rate volatility remained well below historical peaks after 1980. Nevertheless, relative volatility has been high by historical standards in the 1980s.

Relative interest rate volatility is probably more relevant than absolute volatility to the economic decisions of firms and households. The reason is that the percentage increase in

² Variance, a measure of the dispersion of a set of numbers, is defined as the mean squared deviation of those numbers from their average value. The standard deviation is the square root of the variance. In this case, the standard deviation for any given quarter is computed from interest rate data for the preceding eight quarters.

³ For any given sample of numbers, suppose a second sample is obtained by multiplying each number in the original sample by some constant greater than one. The standard deviation of these numbers would increase by the constant multiplicative factor, whereas the standard deviation of the logarithms would be the same for both samples.

CHART 1
Absolute and relative interest rate volatility



wealth resulting from an interest rate decline depends on the relative rather than on the absolute amount of the decline. To show this, consider the effects on the price of a consol—a bond that never matures—of a decline by one-fifth in interest rates from alternative levels. If the annual coupon payment on a bond is \$100 and the interest rate is 10 percent, the bond's value equals \$1,000. A decline in the interest rate by one-fifth to 8 percent would raise the bond's value to \$1,250. Similarly, a bond paying \$50 per year in perpetuity would have a value of \$1,000 if the interest rate were 5 percent. The bond's value would rise to \$1,250 if the interest rate again fell by one fifth to 4 percent. In both cases, the same relative decline (but different absolute declines) in interest rates from their initial levels produces the same effect on bond value and the holder's wealth. For this reason, the relative volatility measure is a better indication of the economic effects of interest rate volatility.

It should be noted that interest rate volatility is not exactly the same thing as interest rate uncertainty. Uncertainty or unpredictability is generally what matters in economic theory because the risk of an unexpected gain or loss can influence economic decisions. An economic time series, in principle, could vary substantially from quarter to quarter and yet still be easy to predict. Nevertheless, volatility may be a good proxy for uncertainty because, in practice, volatile economic series are often hard to predict. In the following sections, therefore, volatility is interpreted implicitly as a measure of economic uncertainty.

Possible explanations for recent volatility

Several explanations have been offered for the high interest rate volatility of the 1980s. One is simply that the sharp swings in the economy during this period caused large fluctuations in interest rates. Real output fell dur-

ing the short recession in 1980, recovered briefly, and then dropped sharply during the contraction from July 1981 to November 1982. Output fluctuations, or expectations of output fluctuations, affect interest rates because the level of business activity influences demands for money and credit. Therefore, unusually large changes in real economic activity may have played a role in causing higher interest rate volatility in the early 1980s.

Similarly, sharp changes in actual and expected inflation may have contributed to higher volatility of interest rates. Inflation as measured by the GNP deflator fell from 9.6 percent in 1981 to 3.8 percent in 1983. Inflation expectations also declined, though somewhat less sharply. For example, the consensus five-year inflation expectation of decision-makers surveyed by Drexel Burnham Lambert dropped from 9.4 percent in October 1980 to 5.4 percent in July 1985.⁴ Lower inflation expectations reduce nominal interest rates because borrowers insist on lower rates when they expect less depreciation in the value of the dollars they will use for loan repayment. Lenders also are willing to accept lower nominal rates when they expect less inflation in the years ahead. Such large swings in actual and expected inflation as occurred in the early 1980s would be expected to cause large interest rate fluctuations.

The high relative interest rate volatility following the oil price shocks in 1974 and 1979 is probably due, in part, to the effects of these supply-side disturbances on real output, the inflation rate, and inflation expectations. Higher oil prices raised the cost of doing business for U.S. firms. Cost increases were

⁴ Richard B. Hoey and Helen Hotchkiss, *Decision-Makers Poll*, Drexel Burnham Lambert Incorporated, July 29, 1985.

passed on to the prices of goods and services, reducing sales and output. A higher inflation rate and fears of further oil price disturbances also increased the expected rate of inflation. In retrospect, the accompanying sharp movements in interest rates are hardly mysterious.

Another factor contributing to greater interest rate volatility in recent years is the deregulation of interest rates on bank deposits and certain kinds of credit. The Monetary Control Act of 1980 set in motion a process of deposit deregulation that has linked bank deposit rates more closely with rates on money market securities. Similarly, interest rate ceilings on consumer credit and mortgages have been removed or relaxed substantially. Before deregulation, lenders often changed such non-price loan terms as minimum downpayments and maximum maturities to equate the demand for and supply of credit. Some of the rationing of credit that occurred through nonprice means now takes place through higher interest rates because interest rate ceilings are less of a constraint. To have a given effect on the quantity of credit demanded, interest rates may have to rise much more in the deregulated environment than would have been expected from historical experience.⁵

A temporary but important source of interest rate volatility was the special credit restraint program in 1980. Policy measures such as special deposit requirements and voluntary limits on loan expansion were adopted to supplement the more general instruments of

⁵ See Raymond E. Lombra, "The Changing Role of Real and Nominal Interest Rates," *Economic Review*, Federal Reserve Bank of Kansas City, February 1984, pp. 12-25. In a deregulated financial environment, attempts to control broad monetary aggregates such as M2 and M3 closely on a short-term basis also could result in greater interest rate volatility. See Howard Roth, "Lasting Effects of Deregulation on Monetary Policy," *Economic Review*, Federal Reserve Bank of Kansas City, March 1985, pp. 17-29.

monetary policy. These special credit restraints were authorized partly by the Credit Control Act of 1969, which was invoked by President Carter. Interest rates dropped precipitously after the credit restraint program was initiated in March 1980. The Federal Reserve began phasing out credit controls in May and completed the phaseout in July. Interest rates rose substantially over the rest of the year as economic activity and inflation expectations strengthened. Although short in duration, this episode certainly contributed to the high interest rate volatility of the early 1980s.

Finally, another explanation for the high interest rate volatility during the early 1980s is the change in the Federal Reserve's operating procedures in October 1979. Previously, the Federal Reserve had implemented monetary policy by focusing on the federal funds rate. Although the funds rate changed from time to time, Federal Reserve policy actions substantially smoothed short-term interest rates. The change in operating procedures in October 1979 was part of a general policy strategy to curtail money growth and bring down inflation. The Federal Open Market Committee emphasized achieving a target path for nonborrowed reserves and was willing to tolerate wider swings in short-term interest rates. Increases and decreases in money demand, and correspondingly in the demand for bank reserves, were no longer accommodated in the short run but were allowed to affect the scarcity of reserves and, therefore, interest rates. As economists had anticipated, greater interest rate volatility accompanied the nonborrowed reserve operating procedures. But economists still do not agree on the importance of monetary policy operating procedures versus the other explanatory factors. In the fall of 1982, the Federal Reserve abandoned strict adherence to a nonborrowed reserve operating procedure. Since then, short-term interest rate

volatility has subsided somewhat, suggesting that the Federal Reserve's operating procedures may be an important determinant of interest rate volatility.

Effects on money demand, interest rate levels, and velocity

The continuing effects of deposit deregulation and the always uncertain economic outlook suggest that interest rate volatility could remain a concern. Policymakers particularly need to understand the effects of interest rate volatility on monetary variables, which serve as intermediate objectives of Federal Reserve policy, and on real economic activity, which is an ultimate policy goal. This section first explores the theoretically expected effects of interest rate uncertainty on money demand. Then it examines how a volatility-induced shift in money demand would affect the average level of interest rates, real economic activity, and monetary velocity.

Reasons interest rate volatility could affect money demand

Both the asset demand and transactions demand theories of money holding imply that greater interest rate uncertainty could increase desired money balances. An increase in the volatility of interest rates increases the risk of holding fixed-term interest-paying securities. To reduce this risk, firms and households may wish to hold larger money balances.

Interest rate uncertainty was introduced into money demand theory through the financial asset motive for holding money. Portfolio theories of money demand suggest that greater interest rate uncertainty should increase the demand for money. According to this theory, money is a desirable asset in financial portfolios even though it pays less interest than other

assets because money is less risky than other assets.⁶ Unlike bonds, the value of money does not change when interest rates fluctuate. If investors are risk averse, greater uncertainty about the return on interest-paying securities leads to an increased asset demand for money.⁷

The transactions demand for money also rises when interest rate volatility increases. The transactions theory of money demand emphasizes money's role as a medium of exchange. Firms and households need cash balances in order to buy and sell goods and services. The amount of money held to conduct transactions depends positively on the overall level of transactions and negatively on the rate of interest income foregone by holding cash instead of securities. In a recent study, a standard model of the transactions demand for money was modified to show how greater interest rate uncertainty could cause firms and households to desire larger risk-free cash balances.⁸ Interest rate uncertainty increases the transactions demand for money for the same reason it increases the asset demand for money: the incentive to hold money rises as the risk of holding alternative assets rises.

⁶ The choice of an optimal mix of money and bonds in an investor's portfolio is analyzed in James Tobin, "Liquidity Preference as Behavior Towards Risk," *Review of Economic Studies*, February 1958, pp. 65-86.

⁷ Some portfolio theories of money demand imply that the sensitivity of money demand with respect to a change in interest rates varies inversely with the level of interest rate volatility. See Carl Walsh, "The Effects of Alternative Operating Procedures on Economic and Financial Relationships," *Monetary Policy Issues in the 1980's*, Federal Reserve Bank of Kansas City, 1982. Such an effect, if it exists, could either augment or offset the interest rate volatility effect described in this article, depending on the general direction of interest rate movements.

⁸ Myron B. Slovin and Marie Elizabeth Sushka, "Money, Interest Rates, and Risk," *Journal of Monetary Economics*, September 1983, pp. 475-482.

Reasons to question the significance of the effects

Although monetary theory implies that greater interest rate uncertainty should raise desired money balances, the effects on M1 demand could be negligible in practice. Historical changes in volatility may not have been large enough relative to the costs of adjusting cash balances to produce a significant effect on money demand. For example, corporations might be reluctant to make additional investments in cash management systems in response to a small increase in interest rate volatility, particularly if that increase is expected to be temporary.

Another reason why interest rate uncertainty could have only a negligible effect on money demand is that narrowly defined money may not be a good alternative to long-term assets in financial portfolios. The major impact of interest rate volatility may be on financial instruments outside the M1 aggregate whose values do not fluctuate as interest rates change. For example, savings deposits are free of the risk to capital value caused by interest rate volatility and, in the past, paid an explicit return when the components of narrow money paid none. Now, new short-term assets such as money market deposit accounts and money market mutual funds have stable capital values and market-related rates of return. Because many investors prefer to hold these assets in their financial portfolios instead of demand deposits and NOW accounts, interest rate volatility might affect the demand for these short-term assets and have no significant effect on the demand for M1.

A further problem in testing interest rate uncertainty effects is that much of the actual volatility of nominal interest rates may be due to inflation rate uncertainty. The nominal interest rate can be decomposed into an

expected real rate of return and an expected rate of inflation. Therefore, variability of the nominal interest rate can reflect variability of either or both of these components. But the effect of inflation rate uncertainty on desired cash balances could be different than the effect of real interest rate uncertainty. Although it is generally agreed that uncertainty about real interest rates should raise money demand, economists do not yet agree on the direction of an inflation uncertainty effect.

Some empirical evidence indicates that inflation uncertainty lowers rather than raises money demand.⁹ One justification for a negative relationship is that an increase in inflation uncertainty makes all nominal assets riskier to hold because their value in terms of goods and services becomes less predictable. The greater risk could induce some investors to shift part of their wealth out of nominal assets, including money, into tangible assets such as commodity inventories. Moreover, investors might shift funds from cash balances to interest-paying financial instruments regarded as being better inflation hedges.¹⁰ Therefore, to the

⁹ Michael Smirlock, "Inflation Uncertainty and the Demand for Money," *Economic Inquiry*, July 1982, pp. 355-364. A negative inflation uncertainty effect was found for three Latin American countries by Mario I. Blejer, "The Demand for Money and the Variability of the Rate of Inflation: Some Empirical Results," *International Economic Review*, June 1979, pp. 545-549.

A theoretical model that permits either a positive or a negative effect of inflation uncertainty on money demand is presented in Benjamin Klein, "The Demand for Quality-Adjusted Cash Balances. Price Uncertainty in the U.S. Demand for Money Function," *Journal of Political Economy*, August 1977, pp. 691-715. Klein argued that a positive effect is plausible and presented supporting evidence based on annual U.S. data. Klein's empirical money demand results have been challenged by Stuart D. Allen, "Klein's Price Variability Terms in the U.S. Demand for Money," *Journal of Money, Credit, and Banking*, Part 1, November 1982, pp. 525-530

¹⁰ See C.F.J. Boonekamp, "Inflation, Hedging, and the Demand for Money," *American Economic Review*, December

extent that uncertainty about nominal interest rates reflects uncertainty about inflation, volatility of nominal interest rates could have a negative effect on money demand.

Effects on interest rate levels and velocity

If interest rate uncertainty does affect money demand, though, greater interest rate volatility could have broad macroeconomic consequences. Higher interest rate uncertainty would raise the average level of interest rates by increasing the demand for money. At the same time, long-term assets become less attractive because of the greater risk of price fluctuations caused by swings in interest rates. As a result, interest rate uncertainty could raise long-term interest rates by increasing their risk premiums.

In turn, a higher average level of long-term interest rates would depress real output and employment in several ways. Higher long-term interest rates discourage business fixed investment, residential construction, and interest-sensitive consumer spending. In addition, under a system of flexible exchange rates, higher U.S. interest rates also tend to attract foreign capital inflows, which cause the dollar to appreciate. A stronger dollar reduces real economic activity by decreasing U.S. exports

1978, pp. 821-833. Boonekamp's analysis of financial portfolio decisions shows that the effects of inflation uncertainty on money demand could be either positive or negative. A negative relationship is plausible for the 1959-73 period because the explicit yields on currency and demand deposits were zero, and because the implicit yields on demand deposits in terms of free banking services probably were adjusted slowly. As a result, the returns on money balances could not rise quickly to compensate firms and households for an increase in purchasing power risk. Because Treasury bills and commercial paper probably provided a better inflation hedge than the components of M1, rising inflation uncertainty would encourage some firms and households to shift funds from cash balances to money market securities.

and dampening production in import-competing industries.¹¹

Greater interest rate volatility also might decrease the velocity of money. Velocity, the rate of turnover of money, equals nominal GNP divided by the money supply. If higher interest rate volatility were to increase desired money holdings, velocity would decline. Consequently, the relationship between the money supply and nominal GNP would be different than if interest rate volatility had remained constant.

For these reasons, the effects of interest rate volatility on money demand are potentially important in formulating monetary policy. For example, policymakers might set target monetary growth ranges based partly on the expected behavior of velocity during the next year. Suppose that the Federal Reserve believes that 3 to 5 percent money growth would be consistent with desired economic performance. An unexpected increase in money demand and the accompanying unexpected decrease in velocity caused by higher interest rate uncertainty might require faster

money growth, say 5 to 7 percent, to achieve the desired economic results. Failure to take these effects of changes in interest rate volatility into account could lead to the pursuit of incorrect money growth objectives.

Empirical evidence

Further empirical testing is necessary to confirm or deny that economically important relationships exist between interest rate volatility and money demand. Although the empirical literature on money demand is large, few studies include interest rate volatility as an explanatory variable. Slovin and Sushka included a measure of absolute interest rate volatility in estimated money demand equations for the 1954-74 period and found that interest rate volatility had a significantly positive effect on the desired level of demand deposits. However, the effects on desired M1 balances should be considered as well because M1 occupies an important place both in economic theory and in recent monetary policy. Moreover, the sample period of the Slovin-Sushka study excluded the volatile years since 1974, and a measure of relative interest rate volatility is preferable to their absolute measure. Because spurious results are easy to obtain in time series relationships, the robustness of the Slovin-Sushka findings should be checked by examining more recent data, an M1 definition of the money supply, and a relative volatility measure.¹² Also, the possible role of inflation uncertainty should be investigated further.

¹¹ For evidence on the relationship between interest rate volatility and real output, see Paul Evans, "The Effects on Output of Money Growth and Interest Rate Volatility in the United States," *Journal of Political Economy*, April 1984, pp. 204-222; and John Tatom, "Interest Rate Variability: Its Link to the Variability of Monetary Growth and Economic Performance," *Review*, Federal Reserve Bank of St. Louis, November 1984, pp. 31-47.

Interest rate uncertainty may affect real economic variables even if interest rate volatility does not influence money demand. Interest rate uncertainty might reduce investment spending directly if business owners are risk averse. Moreover, shifts of funds between liquid nonmoney assets and long-term securities might increase the interest rates relevant to fixed investment and residential construction decisions. These risk-induced shifts between different nonmoney assets could increase the risk premiums in long-term rates and, thereby, reduce investment spending. As a result, failure to find a strong link between interest rate volatility and money demand does not mean policymakers should disregard the variability of interest rates.

¹² The absolute volatility measure described in the first section was also used in estimating money demand equations. This article does not report the empirical results for the absolute volatility measure because the conclusions regarding the sign and statistical significance of an interest rate volatility effect were the same as those obtained using relative volatility.

TABLE 1
Estimation results for money demand equations

Sample Period	c	y	rtd	rcp	dcred	mlag	rvol	\bar{R}^2
1959-73	2.9151* (2.85)	0.1882* (4.96)	-0.0407* (-2.95)	-0.0162* (-3.95)	—	0.6660* (6.54)	-0.0497* (-3.11)	0.99
1976-84	0.7240 (1.03)	0.1303* (2.61)	—	-0.0249* (-2.60)	-0.0227* (-4.62)	0.8700* (11.92)	0.0116 (0.37)	0.94

* Significant at the 5 percent level

Note: Numbers in parentheses are t-statistics. \bar{R}^2 is the multiple correlation coefficient corrected for degrees of freedom. The equation for the 1959-73 sample period was estimated by the Cochrane-Orcutt method to correct for first-order autocorrelation. Ordinary least squares was used for the 1976-84 period.

y = natural logarithm of real GNP
rtd = natural logarithm of the savings deposit rate
rcp = natural logarithm of the commercial paper rate
dcred = dummy variable representing 1980 credit controls
mlag = partial adjustment term equal to the natural logarithm of lagged real money balances, where lagged real money balances equal lagged M1 divided by the current GNP deflator
rvol = natural logarithm of relative interest rate volatility

Basic money demand equations

To determine the effect of interest rate volatility on desired cash balances, M1 demand equations were estimated with quarterly U.S. data. The estimated coefficient of the interest rate volatility measure provides evidence on the existence of an interest rate uncertainty effect. As is always true in empirical research, the statistical model of money demand must be specified carefully in order to obtain valid results.

The money demand equation is estimated for two sample periods because many economists believe the U.S. money demand relationship shifted around 1974. Table 1 contains estimates of money demand equations for two historical periods: 1959:Q3 to 1973:Q4 and 1976:Q1 to 1984:Q1. The 1959 starting date corresponds to the earliest availability of the Federal Reserve's current M1 series, and the

exclusion of 1974 and 1975 from either sample period reflects the possibility that the money demand relationship was shifting intermittently during these years.¹³

Money demand equations express the relationship between the real quantity of money and such fundamental determinants as real income and interest rates. The real quantity of money measures money balances in purchasing power terms and is defined as the M1 monetary aggregate divided by the GNP price deflator. Desired money balances are positively related to real income, measured by constant dollar GNP, because purchases and

¹³ For further justification of a divided sample period, see V. Vance Roley, "Money Demand Predictability," Research Working Paper No. 84-12, Federal Reserve Bank of Kansas City, December 1984. Money demand equations also were estimated for the 1974-81 and 1974-84 sample periods and yielded statistically insignificant interest rate volatility effects.

sales of goods and services rise with income, requiring larger transactions balances. Moreover, real income may serve as a proxy for real wealth, and higher real wealth would imply a larger asset demand for money balances.

Desired money balances are negatively related to interest rates because, as interest rates rise, firms and households have a greater incentive to reduce their cash balances and hold securities instead. For the 1959-73 period, two interest rates are used in the estimated money demand equations: the savings deposit rate and the 4 to 6 month commercial paper rate. In recent years, the proliferation of new deposits and the deregulation of old ones have made the savings deposit rate a poor measure of the opportunity cost of holding M1 balances. Therefore, the 4 to 6 month commercial paper rate is the only interest rate used for the 1976-84 period.¹⁴ Interest rate volatility is measured by the variable discussed previously, the relative volatility of the 4 to 6 month commercial paper rate.

Lagged money balances are included in the regression equations to represent the gradual adjustment of money demand toward the desired level. Explanatory variables such as real income, interest rates, and interest rate volatility are thought to determine desired money balances. But actual money balances may adjust only slowly to desired levels. Because of adjustment costs such as brokerage fees and the opportunity cost of the time required to transfer funds, firms and households may move their money balances gradu-

ally toward the target level so that only a fraction of the necessary change is made in any one quarter.¹⁵

The estimated equations for 1976-84 also include a dummy variable representing the effects on real money balances of the special credit restraint program in 1980.¹⁶ If credit controls were a temporary source of interest rate uncertainty, including the dummy variable could rob the relative volatility measure of explanatory significance. However, excluding the dummy variable could make the volatility measure appear too important because the credit restraint program probably affected the quantity of money apart from any uncertainty effects. Money demand equations were estimated with and without the credit control dummy variable, and the interest rate volatility coefficient was statistically insignificant in both cases.

The empirical results in Table 1 do not support the hypothesis that an increase in relative interest rate volatility raises the demand for money. Relative interest rate volatility (rvol) has a negative and statistically significant coefficient for the 1959-73 period, instead of the positive relationship implied by economic theory. For the 1976-84 period, the interest rate volatility coefficient has the expected positive sign but is not statistically different from zero.

¹⁵ The results in this article are based on a nominal money adjustment model in which the lagged money stock is deflated by the current value of the GNP deflator. Similar conclusions about interest rate volatility effects were obtained with a real adjustment model in which the lagged money stock is deflated by the lagged GNP deflator. For discussion of these models, see Stephen M. Goldfeld, "The Case of the Missing Money," *Brookings Papers on Economic Activity*, 1976:3, pp 683-730.

¹⁶ Credit controls are represented by a dummy variable equal to 1 in 1980:Q2, -1 in 1980:Q3, and 0 otherwise. Similar interest rate volatility conclusions are obtained when two separate dummy variables represent the effects of credit controls in 1980:Q2 and 1980:Q3.

¹⁴ Various interest rates were used in money demand equations for the 1976-84 sample period with no effect on the interest rate volatility conclusions. The Fitzgerald rate, a time deposit rate derived by the staff at the Board of Governors of the Federal Reserve System, was used along with the commercial paper rate in some regressions.

TABLE 2
Inflation volatility as a determinant of money demand

Sample Period	c	y	rtd	rtp	dcred	mlag	rvol	pvol	R ²
1959-73	3.4081* (3.31)	0.2074* (5.25)	-0.0127* (-3.07)	-0.0097* (-2.36)	—	0.6137* (5.94)	—	-1.2592* (-2.91)	0.99
1959-73	3.1554* (3.09)	0.2039* (5.24)	-0.0137* (-3.32)	-0.0125* (-2.79)	—	0.6371* (6.23)	-0.0249 (-1.39)	-0.8144 (-1.53)	0.99
1976-84	0.6625 (0.97)	0.1286* (2.49)	—	-0.0237* (-2.61)	-0.0226* (-4.57)	0.8759* (12.15)	—	-0.0238 (-0.09)	0.94
1976-84	0.8137 (1.08)	0.1393* (2.47)	—	-0.0269* (-2.40)	-0.0226* (-4.51)	0.8577* (10.53)	0.0197 (0.51)	-0.1259 (-0.36)	0.94

Note: Equations for the 1959-73 period were estimated by the Cochrane-Orcutt method, and those for the 1976-84 period by ordinary least squares. Variables and symbols are as defined in Table 1, except for the following:
pvol = natural logarithm of relative inflation rate volatility

The possible role of inflation uncertainty

One possible explanation of the negative interest rate volatility coefficient for the 1959-73 period is that the interest rate volatility measure actually captures an inflation uncertainty effect on money demand. Although an increase in inflation uncertainty could increase or decrease desired money balances in theory, previous research supports a negative effect. A measure of nominal interest rate volatility might be a good empirical substitute for inflation rate uncertainty if the real interest rate is relatively constant and nominal interest rate changes largely reflect changes in expected inflation. As a result, nominal interest rate volatility could have the same negative sign as inflation uncertainty in an estimated money demand equation.

To test this hypothesis, money demand equations that include relative inflation rate volatility as a measure of inflation uncertainty were estimated. The inflation rate volatility variable (pvol) is an eight-quarter moving

standard deviation of the logarithm of the inflation rate. The inflation rate for each quarter is the percentage change of the Consumer Price Index from its value four quarters ago. As shown in Table 2, for the 1959-73 sample period, the coefficient of the inflation rate volatility measure has a negative sign and is statistically significant when relative inflation rate volatility is included in place of interest rate volatility. When both interest rate and inflation rate volatility are included together in the money demand equation, neither is statistically significant. Moreover, a formal statistical test indicates that adding relative interest rate volatility to the equation containing the inflation rate volatility measure does not significantly increase the explanatory power of the equation.¹⁷ For the 1976-84 sample period,

¹⁷ An F-test was conducted with the null hypothesis that adding relative interest volatility to the money demand equation does not reduce the residual sum of squares. The F-statistic was 1.84, far less than the value of 4.01 needed to reject the null hypothesis at the 0.05 level

the inflation rate volatility measure is not statistically significant, whether included by itself or with the interest rate volatility variable.

These findings are consistent with the view that nominal interest rate volatility during the 1959-73 period was due largely to changing inflation expectations and that the negative interest rate volatility coefficient in Table 1 really represents an inflation uncertainty effect. More research is needed, however, before such a claim could be made with confidence. One problem is that an inflation uncertainty effect might be expected for the 1976-84 sample period, yet the inflation rate volatility coefficient is statistically insignificant. Possibly, the relative volatility of measured inflation is not an adequate proxy for inflation uncertainty during this period.¹⁸ Nevertheless, the inflation uncertainty hypothesis does provide a possible explanation for the seemingly anomalous interest rate volatility results of the 1959-73 period.

In summary, the empirical estimates presented here contrast sharply with the findings of Slovin and Sushka that greater interest rate volatility raises the demand for money. For the 1959-73 sample period, the coefficient of relative interest rate volatility was statistically significant and negative. However, this finding is more likely due to inflation rate uncertainty than to some undiscovered effect of real interest rate uncertainty. No evidence of any uncertainty effect was found for the 1976-84 sample, despite the turbulence of this period.

¹⁸ In part, the differences between the two samples could reflect structural change in the money demand relationship caused by deposit deregulation. For example, Super NOW accounts are a relatively new component of M1 paying a market-determined interest rate. Because this rate can rise to compensate depositors for greater purchasing power risk, money holdings should be less sensitive to changes in inflation uncertainty.

A few caveats

The evidence presented here provides little support for the hypothesis that interest rate volatility raises the demand for money. Nevertheless, three qualifying remarks are necessary. First, the economic experience of the early 1980s is difficult to interpret because of a large number of unusual circumstances that could either obscure an interest rate volatility effect or create the spurious appearance that one exists. Among these special circumstances were the nationwide extension of NOW accounts, the introduction of Super NOW and money market deposit accounts, the 1980 credit controls, the Federal Reserve's 1979 and 1982 changes in operating procedures, and unusually severe swings in inflation and real output. Such extreme or unique events may be difficult to represent by standard statistical techniques.

Second, caution must be exercised when extrapolating historical money demand results into the future. Deposit deregulation and technological change may have altered permanently the behavior of money demand, yet economists do not have enough observations under the new financial environment to determine the exact properties of the money demand relationship. Moreover, money demand might depend in some systematic way on the procedures and objectives of monetary policy. A change in the way policy is conducted could, therefore, produce money demand behavior different than would be expected from historical experience.

Third, relative volatility measures may not represent accurately all the movements of interest rate and inflation uncertainty. Although volatility and uncertainty are believed to be positively related, true economic uncertainty also could reflect such factors as the credibility of monetary and fiscal

authorities or the likelihood of institutional reforms. These influences often would not be captured by historical volatility statistics.

Additional research on the economic consequences of interest rate volatility is desirable. The U.S. evidence could be extended by considering different historical periods and other proxies for interest rate and inflation uncertainty. Similarly, the economic records of other countries might be examined for uncertainty effects on money demand and real output. Also worth exploring is the effect of interest rate volatility on the demand for short-term financial assets that are not part of M1.

Conclusion

Recent U.S. historical evidence does not

support the view that an increase in interest rate volatility raises the demand for M1. These findings have two major implications. First, money demand—at least, for the narrow M1 aggregate—is not a channel by which interest rate volatility affects real output and the aggregate price level. Policymakers should continue, nevertheless, to consider the effects of their procedures on interest rate volatility because this volatility still may affect real economic variables through such channels as bond risk premiums and direct effects on business investment spending. Second, policymakers need not take special account of interest rate volatility when setting the target M1 growth range because interest rate volatility apparently has not affected M1 demand in recent years.