A Forward-Looking Monetary Policy Reaction Function: Continuity and Change

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Just as consumers maximize their well-being (or "utility") subject to their budget constraints and businesses maximize profits subject to technological constraints, macroeconomic policymakers can, in principle, be viewed as maximizing policy goals, subject to feasibility constraints imposed by the behavior of the household, business, and external sectors of the economy. For example, the central bank (henceforth the Fed) can control some policy instrument quite precisely, either the volume of (some measure of) bank reserves or a price (some short-term interest rate). The policy instrument is manipulated to achieve the best feasible outcome in terms of the Fed's ultimate objectives or policy goals.

In practice, the relationship between policy instruments and policy goals is highly uncertain and may be quite complex. Any linking of policy instruments and policy goals, even a fixed nondiscretionary "rule," presumes, at least implicitly, some knowledge of how the macroeconomy works. Clearly, experts disagree on how best to model the economy. In addition, monetary policy affects the economy only after a lag. The policy decision made today has impacts months or even years in the future and therefore presumes, explicitly or implicitly, some forecast of future conditions. More fundamentally, economic policy may have several goals, each of which takes on a different importance at different times, and these goals can come into conflict.

Given the uncertainties, numerous factors have been offered as possible influences on monetary policy. Some have argued that policy depends importantly on the particular individual who is President of the United States or Chairman of the Fed, or on the political party in power. Others have argued that monetary policy depends on the stance of fiscal policy—as measured by the federal deficit, the debt, or government spending. (See Dwyer 1985 for a review of this literature.) It is widely believed that the Fed concentrates on stabilizing financial markets, such as the foreign exchange value of the dollar, securities prices, or interest rates.

This article develops a simpler approach; it finds that monetary policy has been influenced by both forecasts of and past experience with three broad factors—inflation, economic activity, and the monetary aggregates. The degree of influence of each factor has, however, varied within this common theme: in the past 22 years at least two specific shifts have occurred, resulting in three "policy regimes." The most important shifts stemmed from differences in the importance attached to the monetary aggregates, as well as from changes in the appropriate definition of "money." Other shifts may have occurred in policymakers' forecast horizon and in their preferred measure of economic activity. This study finds no impact on policy from the particular individual who is Chairman of the Fed or President of the United States, or from the political party holding the Presidency. It also finds no systematic reaction to various measures of fiscal policy, exchange rates, or stock prices.

Policy Goals, Instruments, and Regimes

The primary goals of monetary policy are fairly evident—low inflation and high levels of employment and economic growth. Monetary policy has tended to "lean against the wind"—tightening when inflation is high and easing when economic activity is low or falling. In addition, in its role as lender of last resort, the Fed is concerned with stability in the financial markets. This abstract objective could take several alternative concrete forms—stabilization of exchange rates, stock prices, interest rates (in particular, "even-keeling" during Treasury refundings), or even the growth of some monetary aggregate. This study looks for evidence of each of these motives. It finds clear evidence of a role for money growth, mixed evidence for interest-rate smoothing, and little evidence for the other potential objectives.

Attempts to describe the Fed's behavior, to characterize it as "tight" or "easy," depend importantly on which variable is assumed to be the *instrument* of monetary policy. If the Fed sets a short-term interest rate, the quantity of reserves (and money) will be determined endogenously by the public's demand for reserves. In that case, attributing demand-driven movements in reserves (or money) to monetary policy would result in spurious correlations. Similarly, if the Fed sets a reserve path, short-term interest rates are determined by the demand for those reserves, so that changes in interest rates cannot be attributed directly to policy. The validity of empirical efforts to model monetary policy hinges critically on whether the policy instrument has been correctly identified.

The terminology of the theory of monetary policy has become a morass. In an authoritative guide, Davis (1990, pp. 2–5) points out that policy instruments are on the opposite end of the spectrum from the "ultimate targets" of monetary policy. Examples of instruments "include open market operations, the discount rate, and in earlier periods, required reserve ratios and Regulation Q ceilings on deposit interest rates. Just one step along the spectrum beyond these instruments are 'operating targets,' measures that can be controlled with a rather high degree of precision through manipulation of the policy instruments." Examples of "potential operating targets include measures such as nonborrowed reserves, the nonborrowed monetary base, and short-term money market rates, most notably the federal funds rate."

Even though open market operations are a pure policy instrument, because the Fed has complete control over the quantity of securities it purchases or sells, the Fed's "operating target," which cannot be fixed exactly on a hourly, daily, or perhaps even weekly basis, is a better empirical measure of the monetary policy instrument. First, some open market operations are purely "defensive" in nature; they are conducted simply to offset shocks to the reserve market and have no implications for monetary policy. Second, the connotation of the word target in "operating target" can be misleading. Target is commonly used in association with both intermediate targets—such as monetary or credit aggregates or even nominal GNP—and the "ultimate targets" or policy goals. The essential dimension of the spectrum running from policy instruments to policy goals (or "ultimate targets") is the degree of precision with which the measure can be controlled by policy. Clearly, control

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of intermediate targets and policy goals is highly imprecise. In contrast, operating targets can be controlled with a very high degree of precision over periods as long as a quarter, a month, or even a week. Because the focus of this inquiry is not the daily or weekly behavior of the Fed but rather its behavior at a quarterly frequency—the same frequency as GNP data—referring to the "operating target" as a policy instrument seems to be a useful simplification. Similarly, a finding that financial market variables do not have an important influence on monetary policy at a quarterly frequency does not rule out the possibility that financial market variables could affect the daily, weekly, or even monthly timing within a calendar quarter.

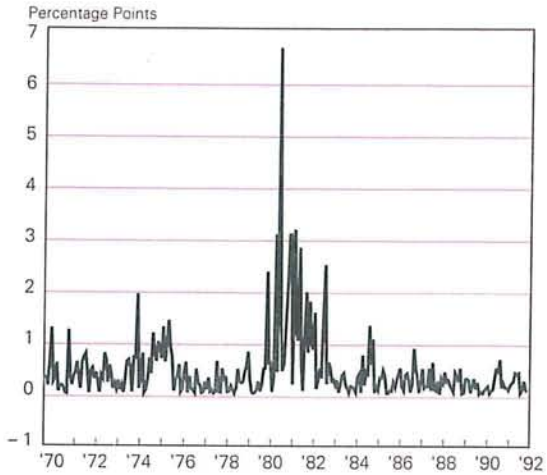
Over the post-World War II period, there have been numerous changes in the Fed's policy instrument. (See Meulendyke 1990 for a more complete account.) From World War II until the Treasury–Federal Reserve Accord in March 1951, the Fed pegged the yield of Treasury securities to minimize the cost of Treasury financing. After the Accord, throughout most of the 1950s and 1960s, Fed attention was focused on free reserves and short-term money market rates. (See Poole 1971, p. 154.) The acceleration of inflation in the late 1960s led to strong criticisms of the Fed's interest-rate targeting procedures: rising nominal short-term rates should not be construed as a restrictive policy in an environment of accelerating inflation and money growth. (See, for example, Friedman 1968.) In response to this dissatisfaction, the Fed retained the federal funds rate as the primary guide to day-to-day operations but, starting about 1970, formally adopted monetary growth as an intermediate target influencing the federal funds rate. (See DeRosa and Stern 1977; Ribe 1979; Meulendyke 1990, pp. 461–62.) In contrast to an ultimate target or policy goal, an intermediate target is of no intrinsic importance but its behavior is thought to be an indicator, ideally an early indicator or predictor, of the ultimate policy goal. In this case, money growth was used as a precursor of future inflation. The enhanced attention to money growth was formalized in a 1975 congressional resolution and embodied in The Full Employment and Balanced Growth Act of 1978, known as the Humphrey–Hawkins Act.

October 6, 1979 marks a clear and abrupt shift in monetary policy's operating procedures. Rising inflation, a falling dollar, and persistent overshooting of the M1 growth targets combined to cause a shift in emphasis to nonborrowed reserves, with an eye toward greater control of money growth. This shift in

Figure 1

Changes in the Federal Funds Rate, Absolute Values

January 1970 to June 1992



Source: Board of Governors of the Federal Reserve System.

policymakers' emphasis necessitated a much greater tolerance for changes in the federal funds rate. (See Bryant 1983, especially pp. 95–99.) For example, monthly changes in the federal funds rate have exceeded 200 basis points only eight times—all between October 1979 and August 1982. In the three-year period starting in October 1979, the average absolute monthly change (135 basis points) was nearly four times larger than the average absolute monthly change from 1970 to September 1979. The *average* monthly change in this period also exceeds the *largest* monthly change since 1982 (Figure 1).

A breakdown in 1982 of the link between M1 and economic activity, along with concerns that short-term interest rates had been too volatile, combined to produce still another change in the Fed's operating procedures. The M1 target was de facto abandoned at the July 1982 Federal Open Market Committee meeting, according to Frank E. Morris, who participated in that session. The decision stemmed from anticipated shifts in the demand for money, attributable to institutional changes that permitted the payment of interest on demand (NOW) and time (MMDA) deposits. The monetary aggregates did not quickly resume their "normal" relationship to the economy. M1

growth vastly exceeded its long-run targets in both 1985 and 1986, and in February 1987 M1 targets were formally abandoned because of uncertainties about M1's underlying relationship to the behavior of the economy and its sensitivity to economic and financial circumstances.

With the demotion and eventual dismissal of M1 targeting, M2 became the paramount monetary aggregate in Fed policy deliberations. At the same time, the relationship between M2 and economic activity has not been sufficiently close to warrant relatively tight short-term targeting such as occurred from October 1979 through 1982. In recent years, "In the absence of a reliable intermediate target, the [Federal Open Market] Committee has followed developments of the economy and prices directly and has observed a variety of economic statistics, in addition to the monetary aggregates, that point to future moves in the goal variables" (Meulendyke 1990, p. 471).

Acknowledging that shifts in policy regimes have occurred, the econometric challenge is to see whether the differences can be explicitly, formally modeled.

In short, two clear shifts in monetary policy operating procedures have occurred since 1970, when monetary growth targets were first formally adopted—the first in October 1979 and the second in mid 1982, associated with the payment of interest on and change in the definition of "money." In what follows, the period before October 1979 will be referred to as "regime one," the nearly three-year period after October 1979 as "regime two," and the period since mid 1982 as "regime three."

Different policy regimes can be studied empirically in two different ways. In a strict sense, different policy regimes, particularly those involving different policy instruments, are independent, essentially noncomparable episodes. Each regime can only be studied in isolation because each is technically a different form of behavior. In contrast, it can be more informative to try to incorporate these acknowledged differences in behavior into a common framework. Acknowledging that shifts have occurred, the econometric challenge is to see whether the differences can be explicitly, formally modeled. One of the primary uses of a model is as a base from which to measure change. "Structural change" cannot be defined, let alone measured, without some conception of an initial structure. Throughout most of the post-World War II period, the primary instrument of monetary policy has been some short-term interest rate such as the Treasury bill or federal funds rate. This article could be regarded as an investigation of whether a formal model can capture the variations in the policy instrument and in the factors influencing policy within a simple, underlying framework.

The Data

All "actual" data—GNP, unemployment, and "money"—have been taken from contemporaneous documents, as opposed to the latest revisions, in order to better represent the information available to policymakers at the time their policy decisions were made. The forecasts used are the ones prepared by the staff of the Board of Governors and presented at Federal Open Market Committee meetings. Because these forecasts are not publicly available until five years after the fact, the forecasts of a prominent commercial forecasting service have been spliced on to complete the sample for recent years.

The Results

Table 1 presents several versions of a federal funds rate reaction function, fit to the period 1970:III to 1992:II. The first equation is the simplest, relating the federal funds rate (RFF) to its previous level and to actual values of the inflation rate (P), the unemployment rate (UR), real GNP growth (Q), and the quarterly growth rate of the narrow money stock (M1,1). Each of these variables has the expected sign and is statistically significant at conventional levels of significance. However, the "fit"—a 116-basis-point standard error—is only slightly better than that (128 basis points) of a simple fourth-order autoregression of the federal funds rate on its own lagged values. The fit can be improved about 22 percent—to a 90-basis-point standard error—simply by allowing money growth to take on a different importance in the three different regimes; note also that money growth is measured by the one-quarter growth rate of

Table 1

Federal Funds Rate Reaction Function, with and without Forecasts and Varying Policy Regimes, 1970:III to 1992:II

Eq.	C	RFF(−1)	P(−1)	UR(−1)	FΔUR1	R1FΔUR1	Q(−1)	M1,1(−1)	R1M1,1(−1)	R2M1,1(−1)	R2ΔRFF(−1)	R3M2,4(−1)	s.e.r.	D.H.
Level, Actuals only														
1.	.08	.95	.13	−.23			.13	.11					116	−.01
	(.73)	(.05)	(.06)	(.10)			(.04)	(.03)						
2.	1.77	.76	.15	−.31			.08		.13	.43		.21	90	.26
	(.63)	(.05)	(.05)	(.08)			(.03)		(.04)	(.05)		(.04)		
Level, Actuals and Forecasts														
			FP4				R2,3FQ1							
3.	.30	.94	.30	−.29	−1.62			.10					99	−.24
	(.60)	(.04)	(.06)	(.09)	(.28)			(.02)						
4.	1.81	.76	.32	−.37	−1.20				.09	.36		.20	75	−.00
	(.52)	(.04)	(.07)	(.07)	(.23)				(.04)	(.04)		(.04)		
5.	1.84	.78	.31	−.41	−1.33				.09	.39	−.32	.21	70	.50
	(.48)	(.04)	(.06)	(.06)	(.21)				(.03)	(.04)	(.08)	(.04)		
6.	1.77	.77	.38	−.46		−1.33	.29		.10	.36	−.33	.14	66	.41
	(.45)	(.04)	(.06)	(.06)		(.25)	(.05)		(.03)	(.04)	(.08)	(.04)		
Change, Actuals and Forecasts														
											ΔRFF(−1)			
7.	1.23		.28	−.61		−2.19	.41		.20	.30	−.42	.10	75	2.93*
	(.49)		(.06)	(.08)		(.30)	(.06)		(.03)	(.04)	(.08)	(.04)		

Note: Standard errors are in parentheses. See Appendix Table 1 for mnemonic definitions.

*At the 5 percent level, the critical value of the normal distribution is 1.645, suggesting rejection of the null hypothesis of no serial correlation.

the narrow money stock (M1) until 1982 and by the four-quarter growth rate of the broader M2 measure since. Real growth, inflation, and the unemployment rate remain significant and of the expected sign.

The remaining equations all combine measures of actual, historical data with expectations or forecasts of future values. For example, equation 3 simply replicates equation 1—that is, it does not allow for different policy regimes—with two changes: (1) the actual inflation rate in the past quarter is replaced by the inflation rate expected to prevail over the next four quarters; and (2) last period's real GNP growth is replaced by the expected changes in the unemployment rate in the next quarter. (The expected change in the unemployment rate is fairly highly correlated (0.85) with expected growth of real GNP in the next quarter.) Actual values of the unemployment rate and the monetary growth rate are retained, as in equations 1 and 2. These replacements improve the fit of equation 1 by about 15 percent—a 99-basis-point standard error.

Equation 4 combines forecasts with actual data but also allows for differences in the response to monetary growth in different policy regimes; it is simply a replication of equation 2, except that forecasts of inflation and the change in economic activity replace their historical values. Equation 4, which allows for the differences in policy regimes and combines forecasts with actual data, fits the data much better than equation 1, which allows for neither of these refinements; its 75-basis-point standard error is 35 percent smaller than that of equation 1. All variables retain their expected sign and a high level of statistical significance.

Equations 5 and 6 explore whether different policy regimes entail more than just shifts in the emphasis placed on money growth and in the exact definition of "money" that was used. Specifically, equation 5 introduces the lagged change in the federal funds rate (ΔRFF) as a proxy for an interest-rate-smoothing motive, a financial market stability motive, or a constraint representing the cost of changing

the policy instrument. If one of these factors is at play, the Fed will be more reluctant, other things equal, to continue to change interest rates in the same direction as recent changes.

Under this interpretation, the sign of the lagged change should be negative: recent declines in rates ($\Delta RFF<0$) make the Fed more reluctant to reduce rates further. A significant interest-rate-smoothing effect has been previously identified in some (McNees 1986) but not all prior research. A careful reexamination of this evidence shows that (1) "smoothing" occurs at a quarterly but not at a monthly frequency, where mid-month changes in the federal funds rate introduce a positive serial correlation in the lagged change, and (2) its effect is not significant in all three regimes. More specifically, the negatively signed lagged change in the federal funds rate appears to gain most of its significance from "regime two"—the period from October 1979 through July 1982—when, as we have seen, great emphasis was placed on M1 growth. M1 growth in this period was quite erratic, inducing large changes in nonborrowed reserves which produced volatile swings in the federal funds rate (RFF). (See Figure 2.)

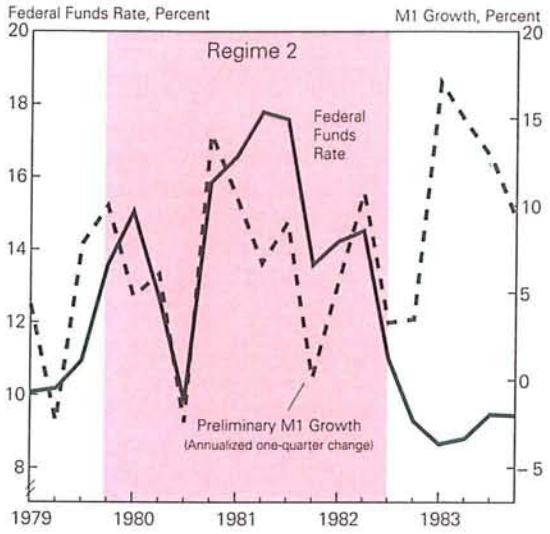
It seems plausible that some sort of interest-rate-smoothing motive was introduced to mitigate the interest rate swings that a single-minded pursuit of M1 growth would have dictated. Some analysts have argued that, within the prevailing institutional arrangements, an avid pursuit of M1 growth would have generated explosive changes in short-term rates. (See Board of Governors of the Federal Reserve System 1981.) Whether or not that argument is correct, the fact remains that an interest-rate-smoothing motive, represented by a negatively signed, lagged change in the federal funds rate, contributes some explanatory power and is statistically significant over both the entire sample period and "regime two" alone (as illustrated in equation 5). A separate, explicit interest-smoothing variable is not necessary to describe a fairly cautious approach to changing rates. A major role for the prior level and "small" responses to incoming data could display the same behavior even if no distinct "smoothing" variable could be identified.

Equation 6 emerged from an extensive search focused on whether the three different policy regimes entailed different responses to expected inflation, the actual unemployment rate, or the expected change in economic activity. The only reliable difference detected was a shift in the measure of the expected change in economic activity, from the expected

Figure 2

The Federal Funds Rate and Preliminary M1 Growth,

1979:I to 1983:IV



Source: Board of Governors of the Federal Reserve System.

change in the unemployment rate, in regime one, to expected real GNP growth, in regimes two and three. This shift is illustrated by a comparison of equations 5 and 6. The two equations are too similar to place much confidence in whether a shift from unemployment changes to GNP growth has actually occurred, however.

The intimidating appearance of equation 6 is due entirely to the attempt to capture variations in policy regimes; within any single regime, no more than four independent variables (plus the lagged level and/or change in the dependent variable) appear, thereby marginally conforming to Griliches's dictum that "any time series regression containing more than four independent variables results in garbage" (Griliches 1974, p. 335). Monetary policy can also be modeled as the change in the policy instrument, rather than its level. Policymakers may increase the interest rate when the economy is "too strong" and decrease it when it is "too weak," without any preconception of the equilibrium level of the interest rate. (See, for example, Fuhrer and Moore 1992.) The last equation in Table 1, equation 7, is estimated in

change, rather than level, form. The change in the federal funds rate is related to its own past value and to the same variables for inflation, economic activity, and money growth as are used in equation 6. The overall results are similar for the two formulations. The minor differences are that the interest-rate-smoothing variable—the negatively signed change—is significant in all regimes, while the role of M1 growth is larger in regime one, and the expected change in the employment rate is more important.

Figure 3

Reaction Function Residuals of Equation 6

1970:III to 1992:II

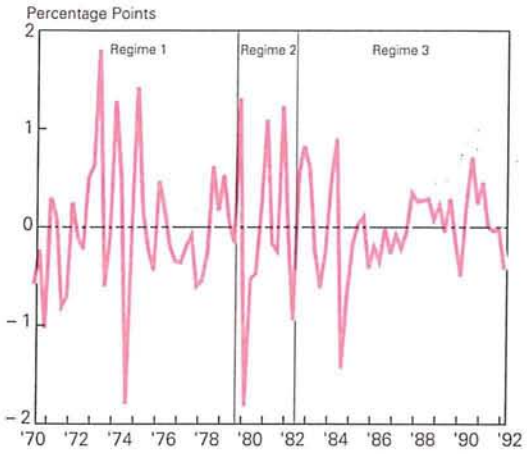


Figure 3 displays the within-sample residuals of equation 6. Table 2 presents simple statistics describing these residuals. It is immediately clear that the equation fits the more recent regime three better than the earlier regimes. Since 1982, only one residual has exceeded 100 basis points, and that observation may be associated with the extraordinary difficulties in the federal funds market around the time of the failure of Continental Illinois bank.

In contrast, the equation's fit is worst in regime two, when the policy operating target was nonborrowed reserves rather than the federal funds rate. Nevertheless, a comparison of rows 3 and 4 in Table 2 reveals that all of the deterioration was concentrated in the first half of 1980, the period when credit controls were imposed and relaxed. The residuals in the rest of regime two are no larger than in regime one or in the entire period. Given the large changes in the federal funds rate during this period, the failure to deteriorate can be viewed as a sign that the model adequately captured the change in behavior outside the credit controls period. Under this interpretation, October 1979 did mark a major change in Fed behavior, a vast increase in the importance attached to M1 growth, as originally suggested by Fair (1984). But the volatility of M1 growth was so great that the Fed simultaneously introduced an interest-rate-smoothing or a multiplier uncertainty constraint to dampen somewhat the unprecedented swings in short-term rates that did occur.

The model makes several large errors in regime one, particularly in the chaotic 1973:III–1975:II period, when wage and price controls were relaxed, the price of imported oil quadrupled, inflation fears exploded (culminating in the Whip Inflation Now summit), and the second leg of the deep 1973–75 recession kicked in. Four residuals exceeding 100 basis points occurred in this period and also in regime two.

The first equation in Table 3 repeats equation 6 in Table 1, to compare it with equations fit to various subperiods comprising different policy regimes. The coefficients are fairly stable, except that (1) expected inflation is similar in regimes one and three, but

Table 2

Summary Statistics: Within-Sample Residuals of Equation 6 across Regimes

Basis Points

Time Period of Equation 6	Number of Observations	Root Mean Squared Residual	Mean Absolute Residual	Mean Residual
Full Sample, 1970:III to 1992:II	88	62	45	0
Regime One, 1970:III to 1979:III	37	67	50	−1
Regime Two, 1979:IV to 1982:III	12	88	68	−4
Regime Two, excl. Credit Controls: 1979:IV to 1982:III, excl. 1980:I and II	10	65	51	0
Regime Three, 1982:IV to 1992:II	39	44	33	2

Table 3
Federal Funds Rate Reaction Function, 1970:III to 1992:II and Subperiods

Eq.	Sample Period	Regime(N)	C	RFF(−1)	FP4	UR(−1)	FΔUR1	R2,3FQ1	R1M1,1(−1)	R2M1,1(−1)	R2ΔRFF(−1)	R3M2,4(−1)	s.e.r.	D.H.
1.	70:III–92:II	R123 (88)	1.77	.77	.38	−.46	−1.33	.29	.10	.36	−.33	.14	66	.41
			(.45)	(.04)	(.06)	(.06)	(.25)	(.05)	(.03)	(.04)	(.08)	(.04)		
2.	70:III–79:III	R1 (37)	2.53	.64	.57	−.60	−1.24		.09				71	1.13
			(1.18)	(.12)	(.13)	(.15)	(.30)		(.04)					
3.	70:III–82:III	R12 (49)	1.52	.79	.35	−.42	−1.45		.12	.39	−.33		82	−.13
			(.94)	(.05)	(.08)	(.10)	(.29)		(.05)	(.04)	(.10)			
4.	79:IV–92:II	R23 (51)	1.90	.78	.31	−.44		.28		.37	−.32	.13	62	−.33
			(.50)	(.05)	(.08)	(.08)		(.05)		(.04)	(.08)	(.05)		
5.	82:IV–92:II	R3 (39)	1.16	.78	.45	−.35		.21				.11	45	1.02
			(.53)	(.06)	(.15)	(.08)		(.04)				(.05)		
6.	82:IV–92:II	R3 (39)	1.05	.83	.34	−.27	−.98					.12	53	.34
			(.63)	(.08)	(.19)	(.09)	(.38)					(.06)		

Note: Standard errors are in parentheses. See Appendix Table 1 for mnemonic definitions.

smaller in regime two when so much importance was attached to money growth; and (2) in regime three, as well as in regimes two and three combined, expected real GNP growth provides a better measure of the expected change in economic activity than the expected change in the unemployment rate. As shown in equation 6, the standard error increases 20 percent to 53 basis points when expected unemployment (FΔUR) replaces expected real GNP growth.

Policy reaction functions have often been used to test for the influence of particular individuals or political factors on policymaking. For example, both Froyen (1974, p. 187) and Potts and Luckett (1978, p. 532) found that "policy reaction functions differed from one administration to the next." Similarly, Blinder argues that empirical estimates of monetary reaction function may not be stable because "policymakers come and go" (1985, p. 687). Any such differences, it is important to recognize, could be attributable either to differences in the importance attached to policy goals or to differences in the economic forecasts or the implicit model of the economy that policymakers used to judge the feasibility and consistency of policy goals (Wood 1967, pp. 153–154; Abrams, Froyen, and Waud 1980, p. 31).

To test for such influences, a dummy variable for each Chairman of the Federal Reserve Board and each President of the United States was added to equation 6 of Table 1. The half-year (ED2) and full-year (ED1) periods just before presidential elections were also examined, to ascertain whether national elections had any impact on policy. The results, shown in Table 4, uniformly and clearly show no distinctive effect from any Fed Chairman or U.S. President. At conventional levels of statistical significance, none of these dummy variables is significant. Similarly, no evidence was found that the policymaking process differs in periods prior to presidential elections. This is not to suggest that a Fed Chairman has no influence on policy. It is important to note that both shifts in policy regime occurred during Volcker's tenure as Chairman. The insignificance of the dummy variable suggests only that no identifiable additional easing changes occurred under Volcker, above and beyond those already explicitly incorporated into the model.

The differences between these results and those previously reported could stem from different sample periods—the earlier studies covered the mid 1950s to the mid 1970s. Alternatively, the differences could come from the use here of expectational variables and the attention given to changes in policy regimes.

How Reliable Are These Results?

History shows that the life expectancy of any specific policy reaction function is limited. Previous research has suggested that the Fed first started to place weight on a monetary aggregate around 1970. Even though experts disagree on how best to charac-

Table 4
Individual and Election Year Influences on Monetary Policy

Fed Chairmen	Coefficient	Standard Error	t-Statistic
Burns	−.16	.27	−.59
Miller	.15	.33	.45
Volcker	−.42	.31	−1.36
Greenspan	.29	.23	1.23
U.S. Presidents			
Nixon	.14	.25	.58
Ford	−.09	.31	−.29
Carter	−.48	.28	−1.73
Reagan	.15	.27	.56
Bush	.14	.24	.60
Electoral Years			
ED1	−.11	.17	−.65
ED2	−.00	.22	−.02

Where ED1 = 1 in four quarters before Presidential elections,
= 0 elsewhere;
and ED2 = 1 in two quarters before Presidential elections,
= 0 elsewhere.
Note: Based on equation 6 in Table 1.

terize the change, everyone agrees that monetary policy was different after the October 6, 1979 change in operating procedures than it was before. Similarly, no one would dispute that the emphasis on the narrow monetary aggregate was reduced sometime in the mid 1980s. In light of this experience, it would be naïve to suppose that even a complete, correct description of current practice would hold stable for the foreseeable future.

In that spirit, it is interesting to compare these results with those obtained six years ago (McNees 1986). Equation 1 in Table 5 shows the former specification fit through 1986:II. (It differs very slightly from the previously published equation, because that equation used commercial forecasts rather than the official forecast.) Equation 2 in Table 5 presents the same equation fit with data through the present (1992:II). Note that none of the coefficients changed by more than its standard error, except for the intercept and the coefficient on M1 growth. It was clear in 1986 that M1 growth was no longer accorded the importance it had had in policymaking; the fact that this coefficient was declining was known at the time. It was not, however, entirely clear at that time what would replace the narrow money stock—simply replacing M1 with M2 would not have improved the fit through 1986:II. It took several years of experience with the new policy regime in order to measure the importance of M2. Even now, it appears that the shift was not only from a narrower to a broader monetary aggregate but a shift from quarterly growth rates to the less volatile four-quarter growth rate. Once the two modifications of the relevant monetary aggregates are made to the original equation, the coefficients appear quite stable, with four-quarter M2 growth having about the same impact after 1982 that quarterly M1 growth had prior to October 1979, as illustrated by equation 3 in Table 5.

The preferred equation developed in the current study—reproduced as equation 4 in Table 5 to facilitate comparison with the original equation—contains three additional modifications of the original equation: (1) the horizon of the inflation forecast has been extended from one to four quarters, (2) the measure of the expected change in economic activity has been shifted from the change in unemployment to the growth of real GNP, and (3) the interest-rate-smoothing motive, attributed to the lagged change in the federal funds rate, has been confined to regime two. The number of modifications to the original specification required to make it track the past six years serve as a clear illustration that policy reaction functions can be fragile. At the same time, it is of some interest to see that even in retrospect monetary policy seems to be driven by the same general factors—expected inflation, economic activity, and the behavior of a monetary aggregate.

Conclusion

It is difficult to decide whether the glass is half full or half empty. In a basic sense, the current version of the monetary policy reaction function is similar in spirit, though not in precise detail, to one originally specified nearly 10 years ago. The standard, common sense conclusion seems reconfirmed, that forecasts of inflation and economic activity, the actual level of activity, and the pace of money growth are the primary factors determining monetary policy. This broad conclusion is quite robust with respect to several factors:

- the sample period since 1970,
- the measure of economic activity,
- the horizon of the forecast,
- the importance of both actual and forecast data, and
- the irrelevance (at least at a quarterly frequency) of several factors often alleged to impinge on monetary policy, such as the stance of fiscal

Table 5

Federal Funds Rate Reaction Function, Original and Current Versions

	C	RFF(−1)	FP1	UR(−1)	FΔUR1	R23FQ1	M1,1(−1)	R2M1,1(−1)	R3M2,4(−1)	ΔRFF(−1)	s.e.r.	D.H.
1. Original equation, 1970:III–1986:II	1.18 (.71)	.91 (.05)	.23 (.06)	−.41 (.09)	−2.10 (.31)		.15 (.03)	.21 (.05)		−.35 (.10)	84	.71
2. Original equation, 1970:III–1992:II	2.17 (.53)	.91 (.04)	.17 (.04)	−.43 (.08)	−2.12 (.29)		.07 (.02)	.25 (.04)		−.29 (.09)	81	1.87*
							R1M1,1(−1)					
3. Original equation with new M regime 1970:III–1992:II	2.18 (.51)	.86 (.04)	.20 (.05)	−.47 (.08)	−1.76 (.27)		.13 (.04)	.38 (.04)	.18 (.04)	−.27 (.08)	75	1.09
			FP4		R1FΔUR1					R2ΔRFF(−1)		
4. Current equation, 1970:III–1992:II	1.77 (.45)	.77 (.04)	.38 (.06)	−.46 (.06)	−1.33 (.25)	.29 (.05)	.10 (.03)	.36 (.04)	.14 (.04)	−.33 (.08)	66	.41

Note: Standard errors are in parentheses. See Appendix Table 1 for mnemonic definitions.

*At the 5 percent level, the critical value of the normal distribution is 1.645. Since the Durbin-H statistic is greater than the critical value, we reject the null hypothesis of no serial correlation.

policy, exchange rates, stock prices, expected nominal (as opposed to real) GNP, and expected (as opposed to actual) money growth.

To the extent that this monetary policy reaction function is regarded as sensible and essentially stable, it raises questions about the appropriateness of macroeconomic models that take "money" to be the exogenous monetary policy instrument. Along with expected inflation and economic activity, a monetary aggregate does play a role in influencing the behavior of the Fed. But the role it plays appears to be that of an indicator or intermediate target to which policy responds rather than that of a policy tool.

At the same time, it is equally clear that the exact form of the quantitative relationship within this broad framework has undergone variations over time:

- The October 6, 1979 shift was toward greater attention to growth of the narrow monetary aggregate M1. This change was publicly known to have occurred at the time it was made, although only experience could show how much more importance money growth attained.
- The shift in the mid 1980s was from the narrow money aggregate to the broader M2 aggregate. This paper suggests this also entailed a shift in focus from quarterly to lower-frequency (annual) movements. Although this shift might have been inferred from systematic overshoots of the M1 target, it was not immediately clear just when the shift occurred; it was not officially acknowledged until February 1987 when the M1 growth target was abandoned.
- The 1986 study indicated the relevant horizon of the inflation forecast was one quarter. Reexamination of the data suggests a longer (four-quarter) horizon has always been more appropriate. Measured correctly, the response to expected inflation has been fairly stable and highly significant over time.
- The original investigation found the expected change in the unemployment rate to have more explanatory power than either expected or actual growth in GNP. The current results confirm this conclusion for regime one, but tentatively suggest a reversal in more recent years.
- Interpretation of the role of the lagged change in the federal funds rate is perhaps the least clear. It could refer to a financial market stability motive ("interest-rate smoothing") or to a multiplier uncertainty ("let's wait and see the impact of what we have just done"), or it could perhaps be just a statistical artifact. It is not clear whether this effect prevailed only during the volatile regime two period or has prevailed throughout the past 20 years.

With all these modifications, large and small, one can hardly suppose that the subject of modeling monetary policy has come to a close. With the continual shifts in some other macroeconometric relationships (such as money demand functions), it would be surprising to arrive at any other conclusion.

Appendix Table 1

Mnemonic	Description of Variable
RFF	Effective rate on federal funds, level.
P	Implicit price deflator for GNP (GDP after 1991:III), one-quarter annualized growth rate.
UR	Unemployment rate, level.
FΔUR1	Unemployment rate, forecast of the one-quarter change.
R1FΔUR1	FΔUR1 from 1970:III to 1979:III, 0 otherwise.
Q	Real GNP (GDP after 1991:III), one-quarter annualized growth rate.
M1,1	Preliminary narrow money stock, M1, one-quarter annualized growth rate.
R1M1,1	M1,1 from 1970:III to 1979:III, 0 otherwise.
R2M1,1	M1,1 from 1979:IV to 1982:III, 0 otherwise.
ΔRFF	Change in the federal funds rate.
R2ΔRFF	ΔRFF from 1979:IV to 1982:III, 0 otherwise.
R3M2,4	Preliminary money stock, M2, four-quarter growth rate from 1982:IV to the present, 0 otherwise.
FP1	Implicit price deflator for GNP (GDP after 1991:III), forecast of the one-quarter-ahead annualized growth rate.
FP4	Implicit price deflator for GNP (GDP after 1991:III), forecast of the four-quarter-ahead growth rate.
R2,3FQ1	Real GNP (GDP after 1991:III) forecast of the one-quarter-ahead annualized growth rate from 1979:IV to present, 0 otherwise.
s.e.r.	Standard error of the regression, basis points.
D.H.	Durbin-H statistic.

Note: "(−1)" refers to a one-quarter lag of the variable.

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