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7 A Historical Analysis of Monetary Policy Rules

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This paper examines several eras and episodes of U.S. monetary history from the perspective of recent research on monetary policy rules.[1] It explores the timing and the political economic reasons for changes in monetary policy from one policy rule to another, and it examines the effects of different monetary policy rules on the economy. The paper also defines—using current information and the vantage point of history—a quantitative measure of the size of past mistakes in monetary policy. And it examines the effects that these mistakes may have had on the economy. The history of these changes and mistakes is relevant for monetary policy today because it provides evidence about the effectiveness of different monetary policy rules.

The Rationale for a Historical Approach

Studying monetary history is, of course, not the only way to evaluate monetary policy. Another approach is to build structural models of the economy and then simulate the models stochastically with different monetary policy rules.

1. In this paper a monetary policy *rule* is defined as a description—expressed algebraically, numerically, graphically—of how the *instruments* of policy, such as the monetary base or the federal funds rate, change in response to economic variables. Thus a constant growth rate rule for the *monetary base* is an example of a policy rule, as is a contingency plan for the monetary base. A description of how the *federal funds rate* is adjusted in response to inflation or real GDP is another example of a policy rule. A policy rule can be normative or descriptive. According to this definition, a policy rule can be the outcome of many different institutional arrangements for monetary policy, including gold standard arrangements in which there is no central bank. The term *regime* is usually used more broadly than the specific definition of a policy rule used in this paper. E.g., the term "policy regime" is used by Bordo and Schwartz (1999) to mean people's expectations as well as the institutional arrangements.

A model economy provides information about how the actual economy would operate with different policies. One monetary policy rule is better than another monetary policy rule if it results in better economic performance according to some criterion such as inflation or the variability of inflation and output.[2] This model-based approach has led to practical proposals for monetary policy rules (see Taylor 1993a), and the same approach is now leading to new or refined proposals. The model-based approach has benefited greatly from advances in computers, solution algorithms, and economic theories of how people forecast the future and how market prices and wages adjust to changing circumstances over time.

Despite these advances, the model-based approach cannot be the sole grounds for making policy decisions. No monetary theory is a completely reliable guide to the future, and certain aspects of the current models are novel, especially the incorporation of rational expectations with wage and price rigidities. Hence, the historical approach to monetary policy evaluation is a necessary complement to the model-based approach. By focusing on particular episodes or case studies one may get a better sense about how a policy rule might work in practice. Big historical changes in policy rules—even if they evolve slowly—allow one to separate policy effects from other influences on the economy. Because models, even simple ones, are viewed as black boxes, the historical approach may be more convincing to policymakers.[3] Moreover, case studies are useful for judging how much discretion is appropriate when a policy rule is being used as a guideline for central bank decisions.

Overview

I begin the analysis with a description of the framework I use to examine the history of monetary policy rules. I focus entirely on interest rate rules in which the short-term interest rate instrument of the central bank is adjusted in response to the state of the economy. When analyzing monetary policy using the concept of a policy rule, one must be careful to distinguish between instrument changes due to "shifts" in the policy rule and instrument changes due to "movements along" the policy rule. To make this distinction, I assume a particular functional form for the policy rule. The functional form is the one I suggested several years ago as a normative recommendation for the Federal Reserve (Taylor 1993a). According to this policy rule, the federal funds rate is adjusted by specific numerical amounts in response to changes in inflation and

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2. Examples of this approach include the econometric policy evaluation research in Taylor (1979, 1993b), McCallum (1988), Bryant, Hooper, and Mann (1993), Sims and Zha (1995), Bernanke, Gertler, and Watson (1997), Brayton et al. (1997), and many of the papers in this conference volume.

3. In fact, the historical approach is frequently used in practice by policymakers, although the time periods are so short that it may seem like real-time learning. If policymakers were using a particular type of policy and found that it led to an increase in inflation, or a recession, or a slowdown in growth, then they probably would, at the next opportunity, change the policy, learning from the unfavorable experience.

real GDP. This functional form with these numerical responses describes the actual policy actions of the Federal Reserve fairly accurately in recent years, but in this paper I look at earlier periods when the numerical responses were different and examine whether economic performance of the economy was any different.

I examine several long time periods in U.S. monetary history, one around the end of the nineteenth century and the others closer to the end of the twentieth century. The earlier period from 1879 to 1914 is the classical international gold standard era; it includes 11 business cycles, a long deflation, and a long inflation. The later period from 1955 to 1997 encompasses the fixed exchange rate era of Bretton Woods and the modern flexible exchange rate era, including 7 business cycles, an inflation, a sharp disinflation, and the recent 15-year stretch of relatively low inflation and macroeconomic stability. The change in the policy rule over these periods has been dramatic. The type of policy rule that describes Federal Reserve policy actions in the past 10 or 15 years is far different from the ones implied by the gold standard, by Bretton Woods, or by the early part of the flexible exchange rate era.

It turns out that macroeconomic performance—in particular, the volatility of inflation and real output—was also quite different with the different policy rules. Moreover, the historical comparison gives a clear ranking of the policy rules in terms of economic performance. To ensure that this ranking is not spurious—reflecting reverse causation, for example—I try to examine the reasons for the policy changes. I think these changes are best understood as the result of an evolutionary learning process in which the Federal Reserve— from the day it began operations in 1914 to today—has searched for policy rules to guide monetary policy decisions and has changed policy rules as it has learned.

I then consider three specific episodes when "policy mistakes" were made. I define policy mistakes as big departures from two *baseline* monetary policy rules that both this historical analysis and earlier models-based analysis suggest would have been good policy rules. According to this definition, policy mistakes include (1) excessive monetary tightness in the early 1960s, (2) excessive monetary ease and the resulting inflation of the late 1960s and 1970s, and (3) excessive monetary tightness of the early 1980s. I contrast these three episodes with the more recent period of low inflation and macroeconomic stability during which monetary policy has followed the baseline policy rule more closely. I think the analysis of these three episodes and the study of the gradual evolution of the parameters of monetary policy rules from one monetary era to the next gives evidence in favor of the view that a monetary policy that stays close to the baseline policy rules would be a good policy.[4]

4. Judd and Trehan (1995) first brought attention to the difference between the interest rates implied by the policy rule I suggested in Taylor (1993a) and actual interest rates in the late 1960s and 1970s during the Great Inflation.

7.1 From the Quantity Equation of Money to a Monetary Policy Rule

The quantity equation of money ($MV = PY$) provided the analytical framework with which Friedman and Schwartz (1963) studied monetary history in their comprehensive study of the United States from the Civil War to 1960. As they state in the first sentence of their study, "This book is about the stock of money in the United States." A higher stock of money (M) would lead to a higher price level (P) other things—namely, real output (Y) and velocity (V)—equal, as they showed by careful study of episode after episode. In each episode they demonstrated why the money stock increased (gold discoveries in the nineteenth century, for example) or decreased (policy mistakes by the Federal Reserve in the twentieth century, for example), and they focused on the roles of particular individuals such as William Jennings Bryan and Benjamin Strong. But the quantity equation of money transcended any individual or institution: with the right interpretation it was useful both for the gold standard and the greenback period and whether a central bank existed or not.

The idea in this paper is to try to step back from the debates about current policy, as Friedman and Schwartz (1963) did, and examine the history of monetary policy via an analytical framework. However, I want to focus on the short-term interest rate side of monetary policy rather than on the money stock side. Hence, I need a different equation. Instead of the quantity equation I use an equation—called a monetary policy rule—in which the short-term interest rate is a function of the inflation rate and real GDP.[5] The policy rule is, of course, quite different from the quantity equation of money, but it is closely connected to the quantity equation. In fact, it can be easily derived from the quantity equation. To a person thinking about current policy, the quantity equation might seem like an indirect route to a interest rate rule for monetary policy, but it is a useful route for the study of monetary history.

7.1.1 Deriving a Monetary Policy Rule from the Quantity Equation

First imagine that the money supply is either fixed or growing at a constant rate. We know that velocity depends on the interest rate (r) and on real output or income (Y). Substituting for V in the quantity equation one thus gets a relationship between the interest rate (r), the price level (P), and real output (Y). If we isolate the interest rate (r) on the left-hand side of this relationship, we see a function of two variables: the interest rate as a function of the price level

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5. Two useful recent studies have looked at monetary history from the vantage point of a monetary policy rule stated in terms of the interest rate instrument rather than a money instrument. These are Clarida, Galí, and Gertler (1998), who look at several other countries in addition to the United States, and Judd and Rudebusch (1998), who contrast U.S. monetary policies under Greenspan, Volker, and Burns. Clarida et al. (1998) show that British participation in the European Monetary System while Germany was tightening monetary policy led to a suboptimal shift of the baseline policy rule for the United Kingdom. Two earlier influential studies using the Friedman and Schwartz (1963) approach to monetary history and policy evaluation are Sargent (1986) and Romer and Romer (1989).

and real output. Shifts in this function would occur when either velocity growth or money growth shifts. Note also that such a function relating the interest rate to the price level and real output will still emerge if the money stock is not growing at a fixed rate, but rather responds in a systematic way to the interest rate or to real output; the response of money will simply change the parameters of the relationship.

The functional form of the relationship depends on many factors including the functional form of the relationship between velocity and the interest rate and the adjustment time between changes in the interest rate and changes in velocity. The functional form I use is linear in the interest rate and in the logarithms of the price level and real output. I make the latter two variables stationary by considering the deviation of real output from a possibly stochastic trend and by considering the first difference of the log of the price level—or the inflation rate. I also abstract from lags in the response of velocity to interest rates or income. These assumptions result in the following linear equation:

$$(1) \qquad\qquad r \; = \; \pi \; + \; gy \; + \; h(\pi \; - \; \pi^*) \; + \; r^{\mathrm{f}},$$

where the variables are r = the short-term interest rate, π = the inflation rate (percentage change in P), and y = the percentage deviation of real output (Y) from trend and the constants are g, h, π^*, and r^{f}. Note that the slope coefficient on inflation in equation (1) is $1 + h$; thus the two key response coefficients are g and $1 + h$. Note also that the intercept term is $r^{\mathrm{f}} - h\pi^*$. An interpretation of the parameters and a rationale for this notation is given below.

7.1.2   Interpreting the Monetary Policy Rule

Focusing now on the functional form for the policy rule in equation (1), our objective is to determine whether the parameters in the policy rule vary across time periods and to look for differences in economic performance that might be related to any such variations across time periods. Note how this historical policy evaluation method is analogous to model-based policy evaluation research in which policy rules (like eq. [1]) with various parameter values are placed in a model and simulations of the model are examined to see if the variations in the parameter values make any difference for economic performance. Equation (1) is useful for this historical analogue of the model-based approach because it can describe monetary policy in different historical time periods when there were many different policy regimes. In each regime the response parameters g and $1 + h$ would be expected to differ, though in most regimes they would be positive. To see this, consider several types of regimes.

Constant Money Growth. We have already seen that the quantity equation with fixed money growth implies a relationship like equation (1). To see that the parameters g and $1 + h$ are positive with fixed money growth consider the demand for money in which real balances depend negatively on the interest rate and positively on real output. Then, in the case of fixed money growth, an

increase in inflation would lower *real* money balances and cause the interest rate to rise: thus higher inflation leads to a higher interest rate.[6] Or suppose that real income rises thus increasing the demand for money; then, with no adjustment in the supply of money, the interest rate must rise. In other words, the monetary policy rule with positive values for g and $1 + h$ provides a good description of monetary policy in a fixed money growth regime. However, the monetary policy rule also provides a useful framework in many other situations.

International Gold Standard. Important for our historical purposes is that such a relationship also exists in the case of an international gold standard. The short-run response $(1 + h)$ of the interest rate to the inflation rate in the case of a gold standard is most easily explained by the specie flow mechanism of David Hume. If inflation began to rise in the United States compared with other countries, then a balance-of-payments deficit would occur because U.S. goods would become less competitive. Gold would flow out of the United States to finance the trade deficit; high-powered money growth would decline and the reduction in the supply of money compared with the demand for money would put upward pressure on U.S. interest rates. The higher interest rates and the reduction in demand for U.S. exports would put downward pressure on inflation in the United States.[7] Similarly, a reduction in inflation in the United States would lead to a trade surplus, a gold inflow, an increase in the money supply, and downward pressure on U.S. interest rates.

Fluctuations in real output would also cause interest rates to adjust. Suppose that there were an increase in real output. The increased demand for money would put upward pressure on interest rates if the money supply were unchanged. Amplifying this effect under a gold standard would be an increase in the trade deficit, which would lead to a gold outflow and a decline in the money supply.

These interest rate responses would occur with or without a central bank. If there were a central bank, it could increase the size of the response coefficients if it played by the gold standard's "rules of the game." Interest rates would be even more responsive, because a higher price level at home would then bring about an increase in the "bank rate" as the central bank acted to help alleviate the price discrepancies. The U.S. Treasury did perform some of the functions of a central bank during the gold standard period; it even provided liquidity during some periods of financial panic, though not with much regularity or predictability. However, there is little evidence that the U.S. Treasury per-

6. Note that this effect of inflation on the interest rate is a short-term "liquidity effect" rather than a longer term "Fisherian" or "expected inflation" effect. The expected inflation effect would occur if the growth rate of the money supply increased or if π^* (the target inflation rate in the policy rule) increased.

7. Short-term capital flows would of course limit the size of such interest rate changes. One reason why U.S. short-term interest rates did not move by very much in response to U.S. inflation fluctuations (as shown below) may have been the mobility of capital.

formed "rules of the game" functions as the Bank of England did during the gold standard era.

Leaning against the Wind. The most straightforward application of equation (1) is to situations where the Fed sets short-term interest rates in response to events in the economy. Then equation (1) is a central bank interest rate reaction function describing how the Federal Reserve takes actions in the money market that cause the interest rate to change in response to changes in inflation and real GDP. For example, if the Fed "leaned against the wind," easing money market conditions in response to lower inflation or declines in production and tightening money market conditions in response to higher inflation or increases in production, then one would expect g and $1 + h$ in equation (1) to be positive. However, "leaning against the wind" policies have not usually been stated quantitatively; thus the size of the parameters could be very small or very large and would not necessarily lead to good economic performance.

Monetary Policy Rule as a Guideline or Explicit Formula. Finally, equation (1) could represent a guideline, or even a strict formula, for the central bank to follow when making monetary policy decisions. As in the previous paragraph, decisions would be cast in terms of whether the Fed would raise or lower the short-term interest rate. But equation (1) would serve as a normative guide to these decisions, not simply a description of them after the fact. If the policy rule called for increasing the interest rate, for example, then the Federal Open Market Committee (FOMC) would instruct the trading desk to make open market sales and thereby adjust the money supply appropriately to bring about this increase. In this case, the parameters of equation (1) have a natural interpretation: π^* is the central bank's target inflation rate, r^f is the central bank's estimate of the equilibrium real rate of interest, and h is the amount by which the Fed raises the ex post real interest rate $(r - \pi)$ in response to an increase in inflation. In the case that $g = 0.5$, $h = 0.5$, $\pi^* = 2$, and $r^f = 2$, equation (1) is precisely the form of the policy rule I suggested in Taylor (1993a). Others have suggested that g should be larger, perhaps closer to one (see Brayton et al. 1997). Thus an alternative baseline rule considered below sets $g = 1$. These are the parameter values that define the baseline policy rules for historical comparisons in this paper.

7.1.3   The Importance of the Size of the Coefficients

To summarize, a constant growth rate of the money stock, an international gold standard, an informal policy of leaning against the wind, and an explicit quantitative policy of interest rate setting all will tend to generate positive responses of the interest rate to changes in inflation or real output, as described by equation (1). And we expect that g and $1 + h$ in equation (1) would be greater than zero in all these situations. However, the magnitude of these coefficients will differ depending on how monetary policy is run.

In the case of the gold standard or a fixed money growth policy, the size of

the coefficients depends on many features of the economy. Under a gold standard, the size of the response of the interest rate to an increase in inflation will depend on the sensitivity of trade flows to international price differences. It will also depend on the size of the money multiplier, which translates a change in high-powered money due to a gold outflow into a change in the money supply. The interest rate elasticity of the demand for money is also a factor.

With a policy that keeps the growth rate of the money stock constant, the response of the interest rate to an increase in real output will depend on both the income elasticity of money demand and the interest rate elasticity of money demand. The higher the interest rate elasticity of money demand (or velocity), the smaller would be the response of interest rates to an increase in output or inflation.

The size of these coefficients makes a big difference for the effects of policy. Simulations of economic models indicate, for example, that the coefficient h should not be negative; otherwise $1 + h$ will be less than one and the real interest rate would fall rather than rise when inflation rose. As a result inflation could be highly volatile. As I show below there is evidence that h was negative during the late 1960s and 1970s when inflation rose in the United States. Hence, policymakers need to be concerned about the size of these coefficients.

A recent example of this concern demonstrates the usefulness of thinking about monetary history from the perspective of equation (1). Consider Alan Greenspan's (1997) recent analysis of the size of the interest rate response to real output with a constant money growth rate. In commenting on a money growth strategy, Greenspan reasoned: "Because the velocity of such an aggregate [M1] varies substantially in response to small changes in interest rates, target ranges for M1 growth in [the FOMC's] judgement no longer were reliable guides for outcomes in nominal spending and inflation. In response to an unanticipated movement in spending and hence the quantity of money demanded, a small variation in interest rates would be sufficient to bring money back to path but not to correct the deviation in spending" (1997, 4–5). In other words, in Greenspan's view the interest rate elasticity of velocity is so large that the interest rate would respond by too small an amount to an increase in output. In terms of equation (1) the parameter g is too small, according to Greenspan's analysis, under a policy that targets the growth rate of M1.

7.2   The Evolution of Monetary Policy Rules in the United States: From the International Gold Standard to the 1990s

Figures 7.1 and 7.2 illustrate the historical relation between the variables in equation (1). They show the interest rate (r), the inflation rate (π), and real GDP deviations (y) during two different time periods: 1880–1914 versus 1955–97. The upper part of each figure shows real output, an estimate of the trend in real output, and the percentage deviation of real output from this trend. Our focus is on the deviations of real output from trend rather than on the
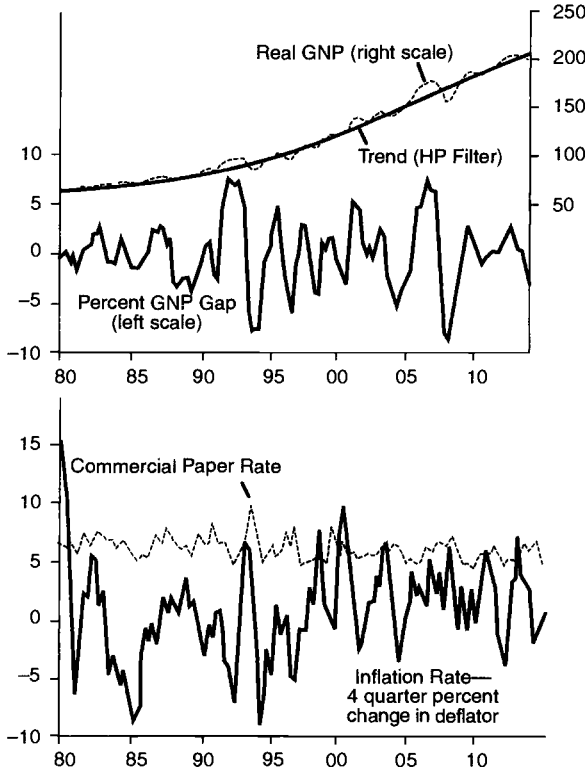
Fig. 7.1   The 1880–1914 period: short-term interest rate, inflation, and real output

Source: Quarterly data on real GNP, the GNP deflator, and the commercial paper rate are from Balke and Gordon (1986). Real output data are measured in billions of 1972 dollars and the trend is created with the Hodrick-Prescott filter.

average output growth rate in the two periods. The lower part of each figure shows a short-term interest rate (the commercial paper rate in the earlier period and the federal funds rate in the later period) and the inflation rate (a four-quarter average of the percentage change in the GDP deflator). Recall that the earlier period coincides with the classical international gold standard, starting with the end of the greenback era when the United States restored gold convertibility and ending with the suspension of convertibility by many countries at the start of World War I.

7.2.1   Changes in Cyclical Stability

The contrast between the display of the data in figure 7.1 and figure 7.2 is striking. First, note that business cycles occur much more frequently in the earlier period (fig. 7.1) than in the later period (fig. 7.2), and the size of the
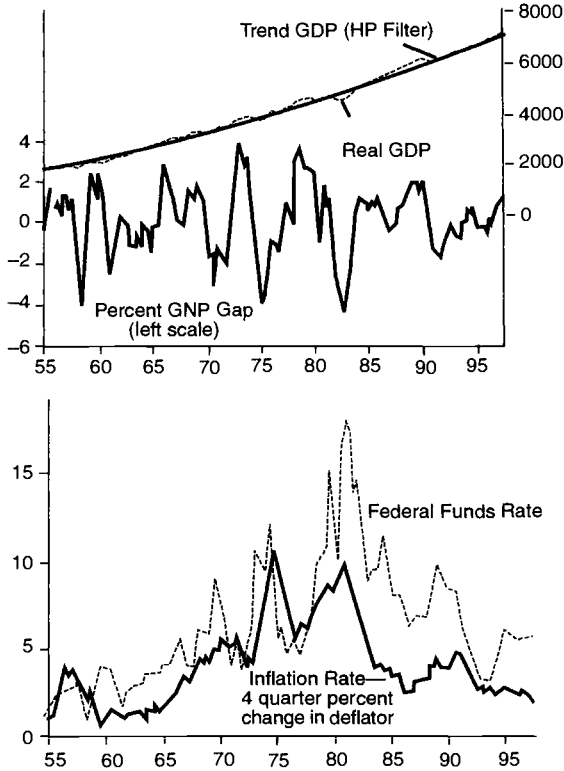
Fig. 7.2   The 1955–97 period: short-term interest rate, inflation, and real output
Source: Quarterly data are from the DRI data bank. Real output is measured in billions of 1992 dollars and the trend is created with the Hodrick-Prescott filter.

fluctuations of inflation and real output is much greater. From 1880 to 1897 there was deflation on average. From 1897 to 1914 prices rose on average. But throughout the whole period there were large fluctuations around these averages. The later period is not of course uniform in its macroeconomic performance. The late 1960s and 1970s saw a large and persistent swing in inflation, while the years since the mid-1980s have seen much greater macroeconomic stability.

One way to highlight the greater macroeconomic turbulence in the earlier years is to consider the period from 1890 to 1897, which saw three recessions. These years were so bad that they were called the "Disturbed Years" by Friedman and Schwartz (1963). One cannot avoid the temptation to contrast 1890–97 with 1990–97. If we had the same business cycle experience in the later years, we would have had a recession in 1990–91 slightly longer than the one we actually had. But we would have also had another recession starting in January 1993 just as President Clinton started in office and yet another recession start-

ing in 1995. The trough of that third recession of the 1990s would have occured in June of 1997. Even allowing for measurement error due to overemphasis of goods versus services in the earlier period, it appears that the earlier period was less stable.[8] To be sure, if one ignores the long swing of average deflation and then inflation, the fluctuations in inflation were much less persistent during the gold standard period, as emphasized in a comparison by McKinnon and Ohno (1997, 164–71). But this long-term deflation and inflation should count as part of the sub-par inflation performance during this period.

7.2.2   Changes in Interest Rate Responses

A second, and even more striking, contrast between the two periods is the response of the short-term interest rate to inflation and output. While the short-term interest rate is procyclical during both the earlier period and the later period, the elasticity of its response to output is clearly much less in the earlier period than in the later period. Cagan (1971) first pointed out the increased cyclical sensitivity of the interest rate to real output fluctuations, and it is more evident now than ever. The short-term interest rate is also much less responsive to fluctuations in the inflation rate in the earlier period. It appears that the gold standard did lead to a positive response of interest rates to real output and inflation, but this response is much less than for the monetary policy in the post–World War II period.

The huge size of these differences is readily visible in figures 7.1 and 7.2. But to see how the responses changed during the post–World War II period it is necessary to go beyond these time-series charts. Some numerical information about the size of these differences is provided in table 7.1. The table shows least squares estimates of the coefficients on real output (the parameter g in eq. [1]) and the inflation rate (the parameter $1 + h$ in eq. [1]) for different time periods.[9]

The far right-hand column shows the results for each of the two full periods. Observe that the estimated values of g and $1 + h$ are about 10 times larger in the Bretton Woods and post–Bretton Woods eras than in the international gold standard era. It is clear that the gold standard implied much smaller response coefficients for the interest rate than Federal Reserve policy has implied in later periods.

8. Romer (1986) demonstrated that biases in the pre–World War I data tend to overestimate the volatility in comparison with later periods.

9. As explained above this equation is actually a reduced form of several structural equations, especially in the gold standard and Bretton Woods periods. I have purposely tried to keep the statistical equations as simple as the theoretical policy rule in eq. (1). No attempt has been made to correct the estimates for serial correlation of the errors in the equation. I want to allow for the possibility that monetary policy mistakes are serially correlated in ways not necessarily described by simple time-series models. In fact, this serial correlation is very large, especially in the gold standard period when the equations fit very poorly. Hence, the "t-statistics" in parentheses are not useful for hypothesis testing. See Christiano, Eichenbaum, and Evans (1997) for a comprehensive analysis of estimation and identification issues in the case of reaction functions.

Table 7.1   **Monetary Policy Rules: Descriptive Statistics**

	International Gold Standard Era		
Variable	1879:1–91:4 Coefficient	1897:1–1914:4 Coefficient	1879:1–1914:4 Coefficient
Constant	6.458 (70.5)	5.519 (47.3)	5.984 (75.0)
π	0.019 (1.01)	0.034 (1.03)	0.006 (0.32)
y	0.059 (2.28)	0.038 (1.89)	0.034 (1.52)
R^2	0.15	0.07	0.02

	Bretton Woods and Post–Bretton Woods Eras		
	1960:1–79:4 Coefficient	1987:1–97:3 Coefficient	1954:1–97:3 Coefficient
Constant	2.045 (6.34)	1.174 (2.35)	1.721 (5.15)
π	0.813 (12.9)	1.533 (9.71)	1.101 (15.1)
y	0.252 (4.93)	0.765 (8.22)	0.329 (3.16)
R^2	0.70	0.83	0.58

Note: These are ordinary least squares estimates of the coefficients of the variables in eq. (1). The left-hand-side variable (r) is measured by the commercial paper rate for the years 1879–1914 and by the federal funds rate for the years 1954–97. The variable π is measured by the average inflation rate over four quarters, and the variable y is measured by the percentage deviation of real output from a trend. Numbers in parentheses are ratios of coefficients to standard errors. See figs. 7.1 and 7.2 for data sources.

Note also that the size of these coefficients has increased gradually over time. Compared with the 1960s and 1970s the coefficients on real output tripled in size by the 1987–97 period while the coefficient on inflation doubled in size. They are now close to the values of the rule I suggested in Taylor (1993a). Hence, when viewed over the past century we have seen an evolution of the monetary policy rule as I have defined and characterized it empirically here. The monetary policy rule had very low interest rate responses during the gold standard era. It had higher responses during the 1960s and the 1970s, and it had still higher responses in the late 1980s and 1990s.

7.2.3   A Graphical Illustration of the Importance of the Size of the Inflation Response

Figure 7.3 shows how dramatically the monetary policy rule has changed from the 1960–70s to the 1980–90s. The two solid lines show two monetary policy rules corresponding to the two periods. The slopes of the solid lines measure the size of the interest rate responses to inflation in the policy rule. I abstract from output fluctuations in figure 7.3, by assuming that the economy is operating at full employment with real GDP equal to potential GDP ($y = 0$). The dashed line in figure 7.3 has a slope of one and shows a constant real interest rate of 2 percent. If the actual long-run real interest rate is 2 percent,
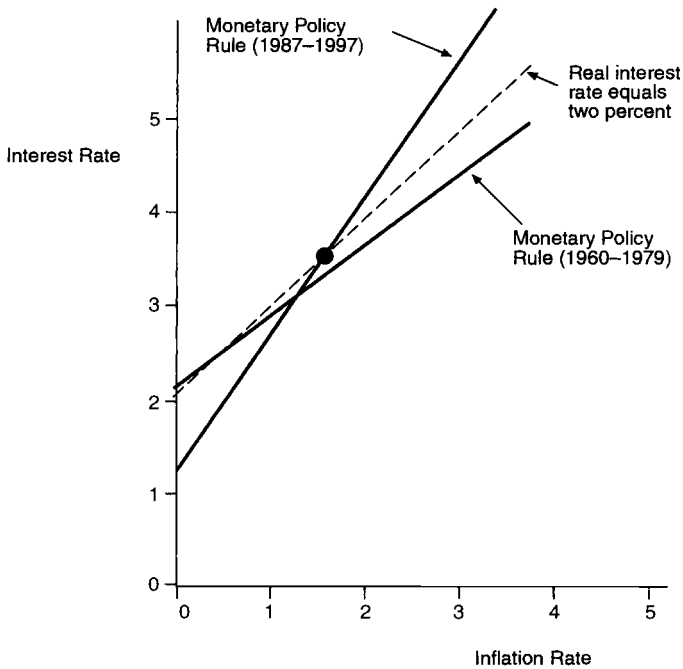
Fig. 7.3   Two estimated monetary policy rules: 1960–79 versus 1987–97

then the intersection of the dashed line and the policy rule line gives the long-run average inflation rate.

Observe that the slope of the policy rule has gone from below one to above one. A slope below one would lead to poor economic performance according to variety of models. With the slope less than one, an increase in inflation would bring about a *decrease* in the real interest rate. This would increase demand and add to upward pressures on inflation. This is exactly the wrong policy response to an increase in inflation because it would lead to ever increasing inflation. In contrast, if the slope of the policy rule were greater than one, an increase in inflation would bring about an *increase* in the real interest rate, which would be stabilizing.

These theoretical arguments are illustrated in figure 7.3. For a long-run equilibrium, we must be at the intersection of the policy rule line and the dashed line representing the long-run equilibrium real interest rate. If the slope of the policy rule line is greater than one, higher inflation leads to higher real interest rates and the inflation rate converges to an equilibrium at the intersection of the policy rule line and the dashed real interest rate line. For example, if the equilibrium real interest rate is 2 percent as in figure 7.3, the equilibrium inflation rate is about 1.5 percent for the recent, more steeply sloped, monetary policy rule in figure 7.3. However, if the slope of the policy rule line is less

than one, higher inflation leads to a lower real interest rate, which leads to even higher inflation; the inflation rate is unstable and would not converge to an equilibrium. In sum, figure 7.3 shows why the inflation rate would be more stable in the 1987–97 period than in the 1960–79 period.

7.3   Effects of the Different Policy Rules on Macroeconomic Stability

Can one draw a connection between the different policy rules and the economic performance with those policy rules? In particular, within the range of policy rules we have seen, is it true that more responsive policy rules lead to greater economic stability? Making such a connection is complicated by other factors, such as oil shocks and fiscal shocks, but it is at least instructive to try.

7.3.1   Three Monetary Eras

As the analysis summarized in table 7.1 indicates, three eras of U.S. monetary history can be clearly distinguished by big differences in the degree of responsiveness of short-term interest rates in the monetary policy rule.

First, during the period from about 1879 to about 1914 short-term interest rates were very unresponsive to fluctuations in inflation and real output. Second, during the period from about 1960 to 1979 short-term interest rates were more responsive, but still small in the sense that the response of the nominal interest rate to changes in inflation was less than one. Third, during the period from about 1986 to 1997 the nominal interest rate was much more responsive to both inflation and real output fluctuations.

These three eras can also be distinguished in terms of overall economic stability. Of the three, there is no question that the third had the greatest degree of economic stability. Figure 7.1 shows that both inflation and real output had smaller fluctuations during this period. The period contains both the first and second longest peacetime expansions in U.S. history. Moreover, inflation was low and stable. And, of course, this is the period in which the monetary policy rule had the largest reaction coefficients, giving support to model-based research that this was a better policy rule than those implied by the two earlier periods.

The relative ranking of the first and second periods is more ambiguous. Real output and inflation fluctuations were larger in the earlier period. But while inflation was more variable, there was much less persistence of inflation during the gold standard than in the late 1960s and 1970s. However, the different exchange rate regimes are another monetary factor that must be taken into account. It was the gold standard that kept the long-run inflation rate so stable in the earlier period. Bretton Woods may have provided a similar constraint on inflation during the early 1960s, but as U.S. monetary policy mistakenly became too easy, it was not inflation that collapsed, it was the Bretton Woods system. And after the end of Bretton Woods this external constraint on inflation was removed. With the double whammy of the loss of an external constraint

and an inadequately responsive monetary policy rule in place, the inevitable result was the Great Inflation.

If one properly controls for the beneficial external influences of the gold standard on long-run inflation during the 1879–1914 period, one obtains an unambiguous correlation between monetary policy rule and macroeconomic stability. The most economically stable period was the one with the most responsive policy rule. The least economically stable (again adjusting for the gold standard effects) was the one with the least responsive policy rule. The late 1960s and 1970s also rank lower than the most recent period in terms of economic stability and had a less responsive monetary policy rule.

7.3.2   Explaining the Changes in the Policy Rules

In any correlation analysis between economic policy and economic outcomes there is the possibility of reverse causation. Could the lower responsiveness of interest rates in the two earlier periods compared with the later period have been caused by the greater volatility of inflation and real output? If one examines the history of changes in the monetary policy rule I think it becomes clear that the answer is no. The evolution of the monetary policy rule is best understood as a gradual process of the Federal Reserve learning how to conduct monetary policy. This learning occurred through research by the staff at the Fed, through the criticism of monetary economists outside the Fed, through observation of central bank behavior in other countries, and through direct personal experience of members of the FOMC. And, of course, there were steps backward as well as forward.[10]

This learning process occurred as the United States moved further and further away from the classical international gold standard. Under the gold standard, increases and decreases in short-term interest rates were explained by the interaction of the quantity of money supplied (determined by high-powered money through the inflow and outflow of gold) and the quantity of money demanded (which rose and fell as inflation and output rose and fell). A greater response of the short-term interest rate to rising or falling price levels and to rising or falling output would probably have reduced the shorter run variability of inflation and output. For example, lower interest rates during the start of the deflation period may have prevented the deflation. But because of the fixed exchange rate feature of the gold standard, the U.S. inflation rate was constrained to be close to the inflation rates of other gold standard countries; the degree of closeness depended on the size and the duration of deviations from purchasing power parity.

The Federal Reserve started operations at the same time as the classical gold standard ended: 1914. From the start there was therefore uncertainty and dis-

10. If economists' research on the existence of a long-run trade-off between inflation and unemployment helped lead to the Great Inflation in the 1970s, then this research should be counted as a step backward. The effect of economic research and other factors that may have led to the Great Inflation are discussed in De Long (1997) and in my comment on De Long's paper.

agreement about how monetary policy should be conducted without the constraints of the gold standard and fixed exchange rates. The Federal Reserve Act indicated that currency—best interpreted now as the monetary base or high-powered money—was to be elastically provided. But how was the Fed to determine the degree of this elasticity?

The original idea was that two factors—each pulling in an opposite direction—were to be balanced out. One was the gold standard itself; with a gold reserve requirement limiting the amount of Federal Reserve liabilities, the supply of money was limited. This was a long-run constraint on the supply of money; it worked through gold inflows and gold outflows and the gradual adjustment of the U.S. price level compared with foreign price levels. The other factor, which worked more quickly, was "real bills" or "needs of trade" doctrine under which the supply of money was to be created in sufficient amounts to meet the demand for money. Clearly, the needs-of-trade criterion was not effective on its own because it did not put a limit on the amount of money creation. Therefore, with the suspension of the gold standard and with the real bills criterion ineffective in determining the supply of money, the Federal Reserve began operations with no criteria for determining the appropriate amount of money to supply. Hence, ever since this uncertain beginning, the Fed has been searching for such criteria. From the perspective of this paper, we can think of the Fed as searching for a good monetary policy rule.

This search is evident in many Federal Reserve reports. Early on, the idea of "leaning against the wind" was discussed as a counterbalance to the needs-of-trade criterion. For example, the Fed's annual report for 1923 stated that "it is the business of the [Federal] Reserve system to work against extremes either of deflation or inflation and not merely to adapt itself passively to the ups and downs of business" (quoted in Friedman and Schwartz 1963, 253). But there was no agreement about how much leaning against the wind there should be. As discussed above, leaning against the wind would result in a policy rule of the type in equation (1), but the parameters of the policy rule could be far from optimal. That the Fed was unable throughout the interwar period to find an effective policy rule for conducting monetary policy is evidenced by the disastrous economic performance during the Great Depression when money growth fell dramatically.

The search for a monetary policy rule was postponed during World War II and in the postwar period by the overriding objective of keeping Treasury borrowing costs down. (Effectively the Fed set $g = 0$ and $h = -1$ so that r was a constant stipulated by the U.S. Treasury.) However, after the 1951 Treasury–Federal Reserve Accord, the Fed once again needed a policy rule for conducting monetary policy. Leaning against the wind—now articulated by William McChesney Martin—again became a guideline for short-run decisions about changes in the money stock. But the idea was still very vague. As stated by Friedman and Schwartz (1963) in discussing the mid-1950s when William McChesney Martin was chairman, "There was essentially no discus-

sion of how to determine which way the relevant wind was blowing. . . . Neither was there any discussion of when to start leaning against the wind. . . . There was more comment, but hardly any of it specific about how hard to lean against the wind" (631–32).

The experience of new board member Sherman Maisel indicates that the search was still going on 10 years later in the mid-1960s. According to Maisel in his candid memoirs, "After being on the Board for eight months and attending twelve open market meetings, I began to realize how far I was from understanding the theory the Fed used to make monetary policy. . . . Nowhere did I find an account of how monetary policy was made or how it operated" (1973, 77). Maisel was particularly concerned about various money market conditions indexes such as free reserves that came up in Fed deliberations, because of the difficulty of measuring the impact of these changes on the economy. He states, "Money market conditions cannot measure the degree to which markets should be tightened or for how long restraint should be retained" (82). And when referring to a decision to raise the short-term interest rate in 1965, he states, "It became increasingly clear that an inflationary boom was getting underway and that monetary policy should have been working to curb it" (81). However, he argued that the actions taken to raise interest rates were insufficient to curb the inflation. In retrospect he was correct. Interest rates did not go high enough. With no quantitative measure of how high interest rates should go, the chance of not raising them high enough was great.

The increased emphasis on money growth in the 1970s played a very useful role in clarifying the serious problems of interest rate setting without any quantitative guidelines. And money growth targets had a very useful role in the disinflation of the 1979–81 period because it was clear that interest rates would have to rise by large amounts as the Fed lowered the growth rate of the money supply. But after the disinflation was over, money growth targets again receded to being a longer run consideration in Federal Reserve operations as the demand for money appeared to be less stable. Moreover, as noted earlier, according to Greenspan's (1997) analysis, keeping money growth constant does not give sufficient response of interest rates to inflation or real output when the aim is to keep inflation low and steady.

The importance of having a policy rule to guide policy became even more important when the Bretton Woods system fell apart in the early 1970s. Until then the long-run constraints on monetary policy were similar to those of the international gold standard. If the Fed did not lean hard enough against the wind, the higher inflation rate would start to put pressure on the exchange rate and the Fed would have to raise interest rates to defend the dollar. But without the dollar to defend, this constraint on monetary policy was lost. After Bretton Woods ended there was an even greater need for the Fed to develop a monetary policy rule that was sufficient to contain inflation without the external constraint. This need was one of the catalysts for the rational expectations econometric policy evaluation research in the 1970s and 1980s.

This brief review of the evolution of policy indicates that macroeconomic events, economic research, and policymakers at the Fed have gradually brought forth changes in the monetary policy rule in the United States. I think this gradual evolution makes it clear that the causation underlying the negative correlation between the size of the policy response of interest rates to output or inflation and the volatility of output or inflation goes from policy to outcome, not the other way around.

If we apply this learning hypothesis to the changes in the estimated policy rule described above, it suggests that the Federal Reserve learned over time to have higher response coefficients in a policy rule like equation (1). What led the Fed to change its policy in such a way that the parameter h changed from a negative number to a positive number? Experience with the Great Inflation of the 1970s that resulted from a negative value for h may be one explanation. Academic research on the Phillips curve trade-off and the effects of different policy rules resulting from the rational expectations revolution may be another.[11]

7.4   "Policy Mistakes": Big Deviations from Baseline Policy Rules

The historical analysis thus far in this paper has not assumed that any particular policy rule was better than the others. However, that was the conclusion of the analysis: a comparison of policy rules and economic outcomes points to the rule the Fed has been using in recent years as a better way to run monetary policy than the way it was run in earlier years. That conclusion of the historical analysis bolsters the very similar conclusion of the model-based research summarized in the introduction to this paper.

Once one has focused on a particular policy rule, however, there is another way to use history to check whether the policy rule would work well. With a preferred policy rule in hand, one can look at episodes in the past when the instrument of policy—the federal funds rate in this case—deviated from the settings given by the preferred policy rule. We can characterize such deviations as "policy mistakes" and see if the economy was adversely affected as a result of these mistakes.[12]

Figures 7.4, 7.5, and 7.6 summarize the results of this historical "policy mistake" analysis. They show the actual federal funds rate and the value of the federal funds rate implied by two policy rules. The gap between the actual

11. Chari, Christiano, and Eichenbaum (1998) argue that the Fed was too accommodative to inflation (h was too low) in the 1970s because high expectations of inflation raised the costs of disinflation, rather than because the Fed still had something to learn about the Phillips curve trade-off or about the effects of different policy rules. I find the learning argument more plausible in part because it explains the end of the inflation and the change in the policy rule.

12. We are, of course, looking at these past episodes with the benefit of later research and experience. The term "mistake" does not necessarily mean that policymakers of the past had the information to do things differently.
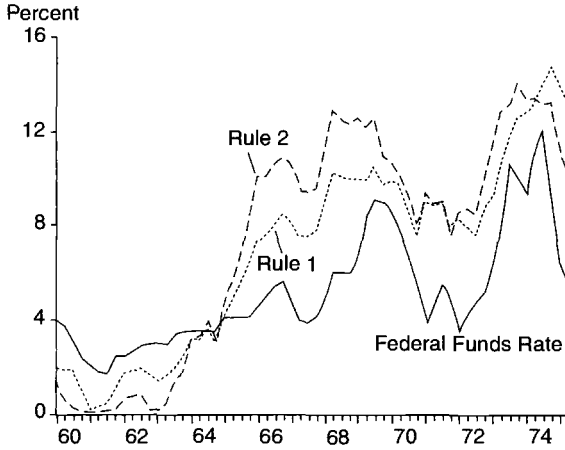
Percent

Fig. 7.4   Federal funds rate: too high in the early 1960s; too low in the late 1960s

Note: Rules 1 and 2 are given by the monetary policy rule in eq. (1) with $g = 0.5$ and 1.0, respectively.
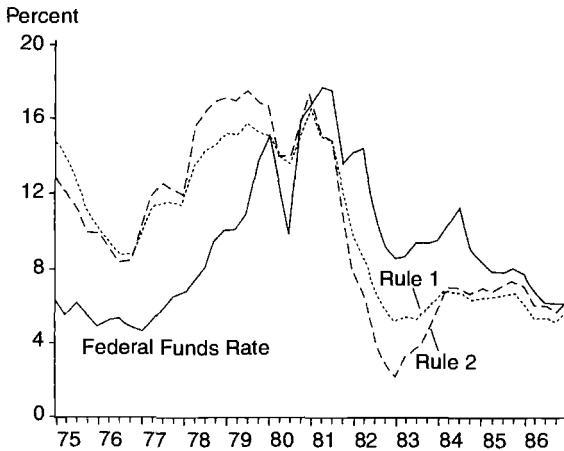
Percent

Fig. 7.5   Federal funds rate: too low in the 1970s; on track in 1979–81; too high in 1982–84

Note: See note to fig. 7.4.

federal funds rate and the policy rules is a measure of the policy mistake. One of the monetary policy rules I use is the one I suggested in Taylor (1993a), which is equation (1) with the parameters g and h equal to 0.5. This is rule 1 in figures 7.4, 7.5, and 7.6. As mentioned above, more recent research has suggested that g should be closer to 1.0, giving a more procyclical interest rate. This variant is rule 2 in the figures.
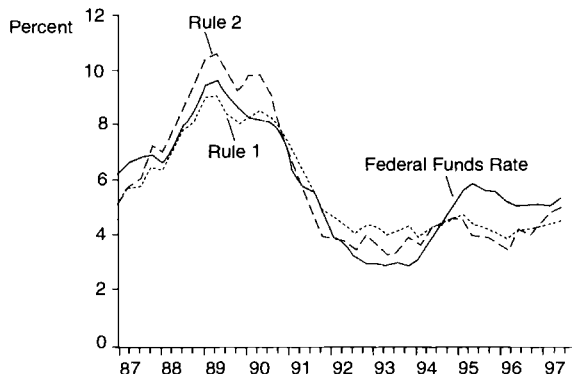
Fig. 7.6   Federal funds rate: on track in the late 1980s and 1990s
Note: See note to fig. 7.4.

The gap between the actual federal funds rate and the policy rule is particularly large in three episodes shown in figures 7.4 and 7.5, especially in comparison with the relatively small gap in the late 1980s and 1990s shown in figure 7.6.

The first episode occurred in the early 1960s when the mistake was making monetary policy too tight. Regardless of whether g is 0.5 or 1.0 the actual federal funds rate is well above the policy rule. The gap between the funds rate and the baseline policy was between 2 and 3 percentage points and this gap lasted for about three and a half years.[13]

It is interesting to note that Friedman and Schwartz (1963, 617) also concluded that monetary policy was overly restrictive during this period. They cite several reasons why policy may have been too tight. First, the Fed was concerned about the balance of payments and an outflow of gold. Second, in looking back at the previous recovery, it appeared to the Fed that policy had eased too soon after the recession. What was the result of this policy mistake? The recovery from the 1960–61 recession was weak and the eventual expansion was slow for several years from about 1962 to 1965. In fact, the economy did not appear to catch up to its potential until 1965. The New Economics introduced by President Kennedy and his economic advisers was addressed at this prolonged period with real output below potential.

The second episode started in the late 1960s and continued throughout the 1970s—a mistake with so much serial correlation it would pass a unit root test! In this case the monetary policy mistake was being way too easy. As shown in figures 7.4 and 7.5, the gap between the funds rate and the baseline policy

13. With its high output response, rule 2 brings the interest rate below zero for several quarters, so the interest rate is set to a small positive number in the chart.

started growing in the late 1960s. It grew as large as 6 percentage points and persisted in the 4 to 6 percentage point range until the late 1970s when Paul Volcker took over as Fed chairman. The excessive ease in policy began well before the oil price shocks of the 1970s, thus raising doubts that these shocks were the cause of the 1970s Great Inflation.

What caused this monetary policy mistake? Economic research of the 1960s suggested that there was a long-run trade-off between inflation and unemployment; this research probably reduced some of the aversion to inflation by the Federal Reserve. At the least the belief by some in a long-run Phillips curve made defending low inflation more difficult at the Fed. Note that the mistake began well before the Friedman-Phelps hypothesis was put forward. Moreover, as the quotes from Maisel's memoirs above make clear, the Fed's use of money market conditions caused them to understate the degree of tightness. De Long (1997) argues that the overly expansionary policy was due to a great fear of unemployment carried over from the Great Depression, though he does not attempt to explain why this mistake occurred when it did. While the causes of this mistake may be uncertain, there is little doubt that it was responsible for bringing on the Great Inflation of the 1970s. In my view this mistake is the second most serious monetary policy mistake in twentieth-century U.S. history, the most serious being the Great Depression. If a policy closer to the baseline were followed, the rise in inflation may have been avoided.

The third episode occurred after the disinflation of the early 1980s. The increase in interest rates in 1979 and 1980 was about the right magnitude according to either of the policy rules. But both rule 1 and rule 2 indicate that the funds rate should have been lowered more than it was in the 1982–84 period. During this period the interest rate was well above the value implied by the two policy rules. However, it should be emphasized that this period occurred right after the end of the 1970s inflation, and interest rates higher than recommended by the policy rules may have been necessary to keep expectations of inflation from rising and to help establish the credibility of the Fed. In effect the Fed was in a transition between policy rules. In my view this period has less claim to being a "policy mistake" than the other two periods.

7.5   Conclusions

The main conclusions of this paper can be summarized as follows. First, a monetary policy rule for the interest rate provides a useful framework with which to examine U.S. monetary history. It complements the framework provided by the quantity equation of money so usefully employed by Friedman and Schwartz (1963). Second, a monetary policy rule in which the interest rate responds to inflation and real output is an implication of many different monetary systems. Third, the monetary policy rule has changed dramatically over time in the United States, and these changes are associated with equally dra-

matic changes in economic stability. Fourth, an examination of the underlying reasons for the monetary policy changes indicates that they have caused the changes in economic outcomes, rather than the reverse. Fifth, a monetary policy rule in which the interest rate responds to inflation and real output more aggressively than during the 1960s and 1970s or than during the international gold standard—and more like the late 1980s and 1990s—is a good policy rule. Sixth, if one defines policy mistakes as deviations from such a good policy rule, then such mistakes have been associated with either high and prolonged inflation or drawn-out periods of low capacity utilization, much as simple monetary theory would predict.

Overall the results of the historical approach in this paper are quite consistent with the results of the model-based approach to monetary policy evaluation. But in an important sense this paper has only touched the surface; many other issues could be explored with a historical approach. For example, two difficult problems with monetary policy rules such as equation (1) have been mentioned by Alan Greenspan (1997): both potential GDP and the real rate of interest are uncertain. Uncertainty about the level of potential GDP (and the natural rate of unemployment) is a problem faced by monetary policymakers today regardless of whether they use a policy rule for guidance. Looking back at previous episodes and seeing the results of mismeasuring either potential GDP or the real rate of interest might help reduce the probability of making the next monetary policy mistake.

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Comment   Richard H. Clarida

It is a pleasure to discuss this paper by John Taylor. In it, he proposes to use the Taylor rule as an analytical framework for the interpretation of monetary history, much as Friedman and Schwartz employed the quantity equation. I agree with the approach that he is trying to promote, I concur in general with the inferences he draws from it, and I believe that this way of interpreting monetary history can be, and in my work with Jordi Galí and Mark Gertler (1998a, 1998b) has already been, applied in fruitful ways that complement the application emphasized in this paper.

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The basic idea is straightforward, and much of the paper is devoted to justifying its application. A baseline, or reference, time path of the short-term (federal funds) interest rate is constructed using a Taylor (1993) rule of the form

$$r_t = r^f + \pi^* + h(\pi_t - \pi^*) + gy_t,$$

where r^f is the long-run equilibrium real interest rate, π^* is the long-run equilibrium rate of inflation, and y_t is the output gap. After the baseline is constructed, the actual time path of the short-term interest rate is compared to the baseline path. Episodes (i.e., sequences of observations) in which the funds rate is persistently higher than the baseline path are interpreted as episodes of excessively "tight" monetary policy, while episodes in which the funds rate is consistently below the baseline are interpreted as episodes in which monetary policy is too "easy." Although Taylor provides some qualification in footnote 12, he is explicit in his interpretation of these episodes of "easy" and "tight" policy as representing policy mistakes.

Now if, as we have learned from the central bankers present at this conference, the Taylor rule can be and is used as a benchmark for assessing the current stance of actual monetary policies, then certainly it can also be used as part of a framework to interpret monetary history. But certainly the caveats that apply to its use as a benchmark for current policy also apply, and perhaps with even greater force, to its use as a framework for interpreting monetary history. Unobservable but essential inputs to the Taylor rule such as the equilibrium real interest rate and the NAIRU fluctuate over time. Data get revised, and with these revisions the amplitudes—and sometimes the signs—of business cycle indicators appear much different with hindsight than they did to contemporaries. Taylor's paper exhibits the appreciation and awareness of these issues that I would expect of him, and subsequent authors that pursue this approach would do well to emulate him.

As applied to U.S. monetary policy since 1960, I believe Taylor's interpretations are largely correct. In fact, my paper with Jordi Galí and Mark Gertler (1998a) makes very similar points using an estimated version of what we call a "forward-looking" Taylor rule. A forward-looking Taylor rule estimated over the post-1979 period—with $h = 1.96$ and $g = 0.07$—captures all the major swings in the funds rate. When we backcast the post-1979 rule on the pre-1979 data, we also infer—as does Taylor—that policy was "too easy" between 1965 and 1979. Indeed, our parameter estimates for the 1960–79 period ($h = 0.80$ and $g = 0.52$) confirm Taylor's interpretation that the source of the 1965–79 policy mistake was that the Fed, when faced with an increase in inflation, raised the funds rate, *but by less than the rise in inflation so that a rise in inflation was countered by a fall in the real interest rate.* This finding is perfectly consistent with, indeed it can be viewed as the explanation for, Mishkin's (1981) famous empirical result that during the 1970s the ex ante real interest rate varied inversely with inflation.

Why is it that before 1979, the Fed appears to have followed a policy that, with hindsight, was clearly inferior to the policy it has followed since? According to Clarida et al.:

> Another way to look at the issue is to ask why it is that the Fed maintained persistently low short term real rates in the face of high or rising inflation. One possibility, emphasized by DeLong (1997), is that the Fed thought the natural rate of unemployment at this time was much lower [and potential output higher] than it really was. . . . Another . . . possibility is that, at the time, neither the Fed nor the economics profession understood the dynamics of inflation very well. Indeed, it was not until the mid-to-late 1970s that . . . textbooks began emphasizing the absence of a long run trade-off between inflation and output. The idea that expectations may matter in generating inflation and that credibility is important in policy-making were simply not well established during that era. What all this suggests is that in understanding historical economic behavior, it is important to take into account the state of policy-maker's knowledge of the economy and how it may have evolved over time. Analyzing policy-making from this perspective, we think, would be a highly useful undertaking. (1998a, 24)

To this, I might add that I believe policymakers and the profession only began, in the late 1960s, to appreciate the distinction between movements in nominal and real interest rates.

As Taylor suggests in his paper, a systematic policy of raising the funds rate by less than inflation "would ultimately imply an unstable inflation rate." In Clarida et al. (1998a), we embed a forward-looking Taylor rule with $h < 1$ in a version of the sticky price models found in King and Wolman (1996), Woodford (1996), and McCallum and Nelson (chap. 1 of this volume). We find that for $h < 1$, there can be bursts of inflation and output fluctuations that result from self-fulfilling changes in expectations. These sunspot fluctuations may arise because under this rule individuals correctly anticipate that the Fed will accommodate a rise in expected inflation by letting real interest rates decline. These sunspot fluctuations do not arise when $h > 1$.

As Taylor mentions in his paper, in Clarida et al. (1998b), we introduce another way to use the Taylor rule baseline to interpret recent monetary history. Specifically, we interpret the collapse in September 1992 of the European Monetary System (EMS) by calculating for France, Italy, and Britain during the several years leading up to and several years following the collapse a stress indicator defined as

$$\text{stress}_{j,t} = r_{j,t} - r_{j,t}^{\text{fltr}}.$$

When $\text{stress}_{j,t}$ is positive, short-term interest rates in country j are higher than they would be if they were set according to a Taylor rule based on inflation and output in country j. Does this mean that monetary policy in country j is "too tight"? In this instance no, because with the dismantling of capital controls in the 1990s, these countries' decisions to fix their exchange rates meant they

gave up autonomy over their national monetary policies. The EMS evolved into a system in which Germany set the level of interest rates for all member countries; any remaining fluctuations in country-specific interest differentials with Germany reflected the changing sentiments of speculators regarding the commitment of that country to the fixed exchange rate. How then do we interpret a positive reading of stress? It is a measure, in basis points, of the cost to country *j* of belonging to a fixed exchange rate system when monetary policy is not being set based on the macroeconomic conditions in country *j*.

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Discussion Summary

Laurence Ball asked Taylor for his conjecture on how much of the economy's better performance under Alan Greenspan than under Arthur Burns was attributable to optimal policy and how much to better luck in the sense of not experiencing the Vietnam War and two oil shocks. This could be addressed formally by decomposing output variance into the variance of shocks and variance caused by deviations from the optimal rule. *Taylor* replied that his view on this issue was influenced by De Long (1997), who indicates that the policy mistake, under this definition, began well before the oil shocks. A more responsive policy rule could have led to a bigger decline in output during the first oil shock, but it is quite likely that inflation would not have risen so much. Thus the economy would have gotten away with a much smaller disinflation in the early 1980s.

Ball then questioned the result that policy was too tight in 1983, whereas there was a rapid recovery going on during that time. *Taylor* responded that the policy mistake had already occurred at the beginning of 1982. While the gen-

eral raising of interest rates by Volcker during 1979–81 was about right, the funds rate should have been lowered by a greater amount when the economy really sank. *Glenn Rudebusch* expressed doubts as to whether another measure of output gap rather than the one used in the paper would have shown such a deep recession for 1982. *Taylor* replied that the gap obtained with the Hodrick-Prescott filter looked similar to the one in Judd and Trehan (1995). *Martin Feldstein* mentioned that part of the reason for overtight interest rates at that point was that Volcker felt keeping up with the disinflation for much longer was politically unsustainable; hence, the disinflation had to occur in a shorter than optimal length of time. *Edward Gramlich* mentioned that Volcker shifted from the money to the funds standard during that period. This happened at least in part because there was a shift in money demand due to, for example, interest payments on demand deposits. *Donald Kohn* added that money growth was accelerating toward the end of 1982 and inflation expectations were persistently high, much higher than ex post realized inflation. *Frederic Mishkin* added that after a history of bad policy, Volcker wanted to be tough in order to gain credibility. *Ben McCallum* mentioned that the Federal Reserve was below its M1 target in 1981. *William Poole* stressed that the economy sank much more quickly than anybody anticipated in 1982. There was an enormous inventory runoff, and the unemployment rate shot up in literally two months.

Bob Hall noted that during the national bank era, prior to the creation of the Federal Reserve, the control of the price level was through the commodity definition of the dollar. Federal involvement in the portfolio sense of controlling the quantity of money was only indirect, through the national bank notes. Hall expressed concern about the fact that the paper repeats what he sees as the mistake of Friedman and Schwartz in trying to understand the commodity standard as if it were a portfolio-based monetary standard. *Taylor* replied that the gold standard kept the price level stable during that period through the pressure of purchasing power parity, similar to the early time in Bretton Woods.

Michael Woodford remarked that the coefficient on inflation for the nineteenth-century period was even lower than in the 1970s. The Gibson paradox suggests that under the gold standard, interest rates seem to be related to the price level rather than the inflation rate. Even if interest rates rise with the price level but are not associated with the inflation rate, the real rate does not need to fall since the inflation rate and even the price level were mean reverting during that period.

Robert King wondered about the determination of the trend in inflation with an interest rate rule. Under the monetarist, Friedman and Schwartz interpretation the trend in money growth determines the trend in inflation. *Taylor* suggested thinking about the policy rule as an inverted money demand equation. An inflation coefficient greater than one will generate a stable inflation rate. If inflation rises, real interest rates rise in the same way as with a money-based rule. Therefore, this is not inconsistent with the money-based view on the determination of the inflation rate.

King then noted that an output gap measured by the Hodrick-Prescott filter implied that the Federal Reserve had to react to output in the future. *Taylor* agreed but reminded him that already with revised data, as mentioned by Donald Kohn before, policy rules look very different than with actual data.

Martin Feldstein remarked that Taylor rightly stresses, and the diagrams in the paper nicely show, that the response coefficient on inflation has to be greater than one, so that when inflation increases, real rates rise. In the 1960s and 1970s, for the reasons given by De Long (1997), the focus was too much on nominal rates. Even though nominal rates were tightened, real rates were going down. However, what really matters are the real net rates as shown in the following equation:

$$R_{\text{N}} = (1 - \theta)i - \pi.$$

If the nominal rate, i, is raised one to one with inflation, π, the real net rate, R_{N}, falls by the marginal tax rate coefficient θ. If the real net rate should rise when inflation goes up, the derivative of i with respect to π has to be at least equal to $1/(1 - \theta)$. The coefficient θ is equal to 1/3, which means that in the policy rule, the coefficient on inflation should be greater than one. Of course, there are a lot of markets in which taxes do not matter or for some players the marginal tax rate is higher than that, so this makes not too much of a point about a value of exactly 1/3 for θ, but it makes a point that the coefficient on inflation should be greater than one and that 1.5 might not be a bad number at all.

Poole recalled that in the early 1970s, Friedman's natural rate hypothesis did not sweep the profession instantaneously. Year after year, prominent members of the profession came to the academic consultants' meetings reporting that this was a nice theoretical idea, but that in practice there was a long-run trade-off between unemployment and inflation. The real rate of interest was not yet a variable in the Federal Reserve's macromodel, built in the mid-1960s, until its revision in 1968. The influence of fiscal policy on aggregate demand was vastly overestimated. The potential impact of tight money on housing and fiscal policy—all sorts of excuses were made to delay actions. It was not until 1975, the end of the Burns era, that the Federal Reserve finally decided that the long-run Phillips curve was indeed vertical. *Ben McCallum* noted that Taylor (1996) supports the point just made. A small piece of documentation is a long speech about inflation written by Arthur Burns and published by the Federal Reserve Bank of Richmond during the late 1970s. In that 20-page document, monetary policy is not mentioned in any shape or form.

McCallum liked Taylor's approach of running a policy rule through history and encouraged further research in this direction.

John Lipsky pointed out that market participants have paid increasing attention to the Taylor rule formulation as an indicator of the appropriateness of Fed policy. Its predictive power has been extremely impressive over the past few

years. Lipsky conjectured that the deregulation of financial markets and pervasive securitization is enhancing the linkage between the real economy, policy, and financial markets. Thus the impact of monetary policy has been boosted, underscoring the importance of research on potential policy rules like the Taylor rule.

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