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INTEREST RATES AND THE CONDUCT OF MONETARY POLICY

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Abstract

The paper describes actual Federal Reserve interest-rate targeting procedures and addresses a number of issues in light of these stylized facts. It reviews the connection between rate smoothing and price level trend-stationarity. It critiques interest-rate targeting as inflation tax smoothing. It argues that stabilization policy implemented by interest-rate targeting may inadvertently induce martingale-like behavior in nominal rates and inflation. The paper explains why central bankers prefere continuity of the short rate and indirect rate targeting. Lastly, it surveys empirical evidence of the Fed's influence over short-term interest rates. (JEL: 311)

INTRODUCTION

The inflation instability of the 1960s, 70s and 80s afforded a chance to observe the extent to which nominal interest rates moved with money growth, inflation, and expected inflation as Irving Fisher (1930) predicted. Data through 1971 provided evidence that short-term nominal rates moved in large part with changes in expected inflation, e.g., Fama (1975) and Nelson and Schwert (1977). Data from the period thereafter, however, indicated a more

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important role for real rate variability, e.g., Hamilton (1985). As the inflation rate rose and became more volatile, the Fed announced its famous October 1979 move toward reserve targeting.

The experience with reserve targeting from October 1979 to the fall of 1982 renewed interest in the instrument problem. Poole (1970) had analyzed the choice of reserves vs. interest-rate targeting in a point-in-time model with a fixed price level. Sargent and Wallace (1975) addressed the problem in a fully dynamic context with a variable price level and variable inflation expectations. They argued that in a flexible price model with rational expectations, interest-rate targeting made the price level indeterminate. But McCallum (1981) showed that interest-rate targeting was consistent with a fully determinate equilibrium as long as the interest-rate instrument was employed as part of a rule that targeted the money stock. McCallum's paper reconciled actual Federal Reserve interest-rate policy with rational expectations monetary economics. Although his was not an optimizing model, he showed how a monetary rule could be made to manipulate inflation expectations in order to smooth the interest rate. The idea was later exploited by Goodfriend (1987) to show how interest-rate smoothing by an optimizing central bank could explain non-trend-stationary price level behavior. Barro (1989) augmented Goodfriend's model to investigate the consequences of random walk interest-rate targeting. At about the same time, Mankiw (1987) interpreted highly persistent interest-rate targeting as optimal inflation tax smoothing. Thus, Federal Reserve interest-rate targeting came to be seen as potentially explaining the actual highly persistent behavior of nominal interest rates and inflation.

At a more institutional level, the shift in Fed operating procedures from tight Federal funds rate targeting in the 1970s, to the 1979-82 nonborrowed reserve procedures, to borrowed reserve targeting thereafter rekindled interest in the technical details of policy implementation. Brunner and Meltzer, Poole, and others noticed that because reserve requirements were lagged during the early 80s, weekly nonborrowed reserve targeting was closely related to borrowed reserve targeting. They pointed out that the latter was essentially the noisy Federal funds rate targeting procedure that the Fed had used in the 1950s, 60s, and early 70s. We will see below that the Fed also switched from explicit interest-rate targeting to borrowed reserve targeting in the 1920s. From this perspective, the recent switch from direct to indirect targeting looks less anomalous.

Except for the period from 1934 to the end of the 1940s when short-term interest rates were near zero or pegged, the Fed has always employed either a direct or an indirect Federal funds rate policy instrument. This paper contains a description of the key features of the Fed's interest-rate targeting procedure based on data assembled in Cook and Hahn (1989) and on the views of financial market participants and Fed officials. These are the stylized facts that motivated recent theoretical developments. They are the empirical regularities that must be explained in order to understand the practical implementation of monetary policy. Moreover, awareness of these regularities is essential to interpret empirical evidence on the Fed's influence over market rates.

The plan of the paper is as follows. Key features of the Federal Reserve's interest-rate targeting procedures are described in Section I. Theoretical issues are discussed in Section II, beginning with a brief review of the point-in-time instrument choice problem. A discussion of the mechanics of rate smoothing in a dynamic-rational-expectations model follows, emphasizing consequences for the money stock and price level generating processes. Section III discusses interest-rate targeting as inflation tax smoothing.

Section IV suggests how the high degree of persistence the Fed imparts to the Federal funds rate might naturally arise as a by-product of macroeconomic stabilization policy. It also suggests an explanation for the Fed's tendency to use indirect, i.e., borrowed, reserve rather than direct Federal funds rate targeting. The discussions, in turn, motivate central banker preferences for a continuity of the short rate.

Finally, Section V surveys empirical evidence that the Fed exerts a dominant influence on the process generating short-term interest rates. It begins with Miron's (1986) and Mankiw et al.'s (1987) evidence that the Fed eliminated the interest rate seasonal and converted the three-month rate approximately to a martingale. Next, it reviews Cook and Hahn's (1989) finding of a highly significant effect of Federal funds rate target changes on money market rates at longer maturities. It also reviews the implications of interest-rate targeting pointed out by Mankiw and Miron (1986) for tests of the expectations theory of the term structure. It also interprets, in terms of funds-rate targeting, Fama's (1984) and Hardouvelis's (1988) findings of predictive information in the Treasury yield curve.

I. ASPECTS OF FEDERAL RESERVE INTEREST-RATE TARGETING

The standard view among Fed officials and financial market participants is that the Fed has a dominant influence on the evolution of short-term market interest rates. We may characterize the important aspects of the Fed's policy procedure pertaining to interest rates as follows:

(1) Throughout its history, the Fed's policy instrument has been the Federal funds rate or its equivalent. At times, it has targeted the Federal funds rate directly in a narrow target band, but more often it has targeted

the overnight rate indirectly using the discount rate and borrowed reserve targets.

(2) The Federal funds target has not been adjusted immediately in response to new information. Rather, the target has been adjusted at irregular intervals only after sufficient information has been accumulated to trigger a target change. Target changes are essentially unpredictable at forecast horizons longer than a month or two.

(3) Target changes occur in relatively small steps of 25 to 50 basis points, though on occasions they have been considerably bigger.

(4) Though they have often been separated in time by weeks or months, some target changes have been followed in relatively rapid succession (one or two weeks apart) by further changes in the same direction.

(5) The Fed is undertsood to dislike "whipsawing the market," i.e., following a target change too closely with a change in the opposite direction. A target change establishes the presumption that, absent significant new information, the target will not be soon reversed.

(6) According to market participants, money market interest rates of longer maturities are determined (up to a term premium) by the average expected level of the Federal funds rate over the relevant time horizon (abstracting from default risk).

(7) The Fed adjusts its funds rate target over time in an effort to achieve a favored mix of goals for unemployment, inflation, credit market conditions, and the exchange rate.

Comment: On occasion the Fed and the markets may react to new information simultaneously. In such cases it should not be said that a Federal funds rate target change causes a change in market rates since the Fed is merely reacting to events in much the same way as the private sector does. More generally, to the extent that we believe the Fed reacts purposefully to economic events, we should not say that funds rate target changes are ever the fundamental cause of market rate changes, since both are driven by more fundamental shocks. Of course, such shocks may originate either in the private sector or in the Fed, the latter as policy mistakes or shifts in political pressure on the Fed.

Nonetheless, the above points do assert that Federal funds-rate targeting has substantially altered the timing and magnitude of the way fundamental shocks impact on market interest rates. Furthermore, because the Federal funds-rate target reacts discontinuously to new information, to forecast target changes the public must assess the Fed's view of incoming data as well as any shifting political influence on the Fed. Such factors specific to Fed interest-rate targeting (those that give rise to Fed watching as opposed to economy watching) must be added to any list of fundamental determinants of the process generating market interest rates.

II. INTEREST-RATE SMOOTHING AND MONETARY THEORY

The Federal funds-rate targeting procedure described in Section I, by which the Federal Reserve purposefully influences the evolution of interest rates, is broadly known as interest-rate smoothing. Since the procedure described above may be said to smooth interest rates in a number of ways, however, there is often confusion about what smoothing means. For general discussions of monetary policy, this may not be a problem. But for theoretical discussions of interest-rate smoothing, it is essential to be clear about what aspect of smoothing is being modeled and what is not.

Various aspects of the Federal funds-rate targeting procedure have been addressed in the theoretical literature. Poole (1970) studied the conditions under which the Fed should target bank reserves or the Federal funds rate at a point in time. He was concerned with point 1 above. McCallum (1981) addressed the feasibility of avoiding fluctuations in the interest rate, i.e., of maintaining a continuity of the short rate over time. Roughly speaking, continuity of the short rate captures the behavior in points 1 and 3 above. Goodfriend (1987) studied the consequences of interest-rate smoothing in the sense of minimizing surprise changes in rates. This aspect of smoothing is really captured in point 3. It is also captured in points 1 and 2, to the extent that they eliminate temporary surprise rate movements. Barro (1989) focused on choosing the Federal funds-rate target to maintain an expected constancy in interest rates. He studied the random walk nature of Federal funds-rate targeting implicit in the idea that target changes are unforecastable. Thus, Barro studied aspects of smoothing captured in points 1 and 2, though he ignored the fact that target changes are triggered discontinuously in response to the flow of new information. Interest-rate smoothing can also mean removing deterministic seasonals as studied empirically by Miron (1986) and modeled theoretically in Barro (1989). The most extreme form of rate smoothing, a peg, has also been studied theoretically, e.g., McCallum (1986).

The remainder of this section reviews the instrument choice problem and the mechanics and consequences of minimizing rate surprises in the context of optimal dynamic stabilization policy. Random walk interest-rate targeting is discussed in Section III. Continuity in the short rate is discussed in Section IV, where we focus in more detail on some institutional aspects of Fed behavior. Seasonality and pegging were mentioned for completeness but will be ignored here.

II.1 Instrument Choice

Poole (1970) provided the classic statement and solution of the instrument problem. The problem arises because policy must be implemented by predetermining a variable on a period-by-period basis. He recognized that the choice of instrument would not matter in a world of certainty. If the monetary authority knew the model of the economy and could observe aggregate variables contemporaneously, any feasible outcome could be achieved by setting either the Federal funds rate or aggregate bank reserves. To model the uncertainty actually confronting policymakers, Poole imagined the IS and LM relationships in the assumed model economy to be disturbed by contemporaneously unobservable shocks. Likewise, he assumed implicitly that because of a data processing lag, contemporaneous aggregate output was unobservable as well. Hence, the policy instrument had to be chosen before the IS and LM relationships could definitely be located.

Poole saw that if output deviates from a target level mainly because of IS shocks, then output is best stabilized by holding bank reserves constant. And if the deviation in output is mainly due to LM disturbances, then the interest rate should be the policy instrument. But Poole also recognized that under a reserve instrument, the monetary authority could observe contemporaneous interest-rate movements which contained information about unobservable IS and LM shocks He worked out a combination policy by which bank reserves could respond to contemporaneous interest-rate information to better stabilize aggregate output.

Poole's analysis is interesting for our purposes because it shows why a monetary authority might wish to directly alter the interest-rate generating process in pursuit of deeper stabilization policy goals. Yet Poole's is only a point-in-time analysis, carried out assuming a fixed price level and zero expected inflation.

II.2 Rate Smoothing and the Price Level Generating Process

Goodfriend's (1987) model may be approached as an extension of Poole's analysis to a flexible price-rational expectations model. Goodfriend assumed that the central bank chooses its money supply rule to minimize fluctuations in aggregate output arising from one-period-ahead price level forecast errors. He assumed also that the central bank wishes to minimize expected inflation variability to minimize any distortions that might arise due to costly and incomplete indexation of contracts. He also assumed disturbances to the IS and LM relationships, as well as to aggregate output and prices, to be observable with a one-period lag.

The new feature in Goodfriend's model is a money supply rule that allows the central bank to choose the contemporaneous money stock response to an interest-rate innovation *and* the extent to which the contemporaneous money stock response is offset in the next period. If the offset is exact, then the money stock will be trend stationary; otherwise, it will not be. There is no real-side persistence in the model, so the price level generating process is trend-stationary if and only if the money stock is.

Goodfriend found that if the central bank is concerned only with macroeconomic stabilization of output and inflation, it will choose a trend-stationary process for money and prices. A combination policy a la Poole is optimal with an exact offset.

The reason is as follows. The central bank adjusts the current money stock M_t so that its best guess of the current price level P_t, conditional on observing the interest rate r_t, equals the price level expected as of last period. To achieve constant conditional expected inflation (assumed zero for simplicity), it would like to make the conditional expected future price level equal last period's expectation of the current price level. This is done by breaking any link between M_t and $\underset{t}{E}M_{t+1}$ and setting the latter at a constant such that $\underset{t}{E}P_{t+1} = \underset{t-1}{E}P_t$. Breaking the link between M_t and $\underset{t}{E}M_{t+1}$ means complete offset and trend-stationary money and prices.

In the second part of his paper, Goodfriend showed that coupling a concern for rate smoothing with its other stabilization objectives induces a central bank to make the price level non-trend-stationary. To see why, consider first a trend-stationary money supply rule. To smooth the interest rate beyond that associated with macroeconomic stabilization policy, the central bank adds more money when the rate rises and drains more when it falls. Whereas the contemporaneous conditional covariance between the interest rate and the price level was made zero before, rate smoothing makes it positive. With trend-stationarity, therefore, rate smoothing raises one-period-ahead price level forecast error variance and yields greater output instability.

In Goodfriend's model, however, a central bank wishing to avoid such output instability could make M_t respond to r_t as before and instead make $\underset{t}{E}M_{t+1}$ respond negatively to r_t. Thus, the interest rate could be smoothed by generating negative expected money growth when r_t rose and positive expected money growth when r_t fell. The central bank would thereby transform temporary shocks to the interest rate into permanent shocks to the money stock and the price level. The latter would no longer be trend-stationary but would drift through time randomly.

Goodfriend thus explained how an optimizing central bank could produce a determinate though non-trend-stationary price level. The idea was later used by Barro to model non-trend-stationary inflation.

Goodfriend's analysis is consistent with the monetarist view that interest-rate smoothing creates macroeconomic instability, e.g., Poole (1978, pp. 106–10). Rate smoothing with trend-stationarity makes money too procyclical, causing greater output instability. The new idea is that rate smoothing need not cause output instability if the money supply process is made non-trend-stationary.

A recent empirical study of United Kingdom monetary policy by Bordo, Choudhri, and Schwartz (1990) finds that if the Bank of England had followed a trend-stationary money supply rule since the mid 1970s, it would have reduced the variance of the stochastic trend in prices by more than one half. They suggest that interest-rate smoothing may well have induced the Bank of England to allow money stock "base drift" to reduce the predictability of the trend price level.

There may exist other mechanisms that generate non-trend-stationary money and prices. Van Hoose (1989) has argued that the Fed's monetary targeting itself does so. He uses a version of Goodfriend's model in which either an interest rate or a total reserves instrument is set period-by-period at levels that are expected to make the quantity of money demanded equal to the desired target. The key point is that the instrument does not respond to new information received within the period to which it pertains. So whichever instrument is used, a combination policy is ruled out. Using an interest-rate instrument is an extreme form of smoothing and so clearly implies non-trend stationarity for exactly the reasons argued by Goodfriend. Since the Fed has never used a total reserves instrument, that could not be an alternative explanation for actual price level non-trend-stationarity.

Goodfriend's model is only about the consequences of rate smoothing. It merely suggests that central banks smooth interest rates to cushion the banking system against interest-rate shocks. Cukierman (1989) works out the idea in detail. His explanation is based on the fact that the interest rate on loan contracts is determined prior to the determination of the cost of funds to banks. Unanticipated credit or money demand shocks after banks have entered into loan commitments create a negative correlation between competitive deposit rates and bank profits. Rate smoothing protects the banking system against such negative cash flows and the risk of widespread insolvencies.

It would appear feasible for loan rates to float daily with the Federal funds rate, or for banks to hedge their loan commitments by holding time deposits of similar maturity. Is the fact that they generally do not choose to do so itself a consequence of central bank rate smoothing? One would want to analyze the social value of rate-smoothing more fully in a model in which banks choose the optimal level of capital together with the extent to which they hedge interest-rate risk.

Of course, during a potential liquidity crisis the central bank ought to follow Bagehot's (1873) advice and defend a short-term rate ceiling to prevent interest-rate spikes from creating widespread insolvencies. Targeting the Federal funds rate automatically protects the banking system against risk of insolvency in the event of a liquidity crisis. Nevertheless it would be sufficient to announce and defend a ceiling suitably above the current normal range of market rates. It is difficult to understand the Fed's inclination to target the Federal funds rate period-by-period in terms of lender-of-last-resort concerns.

III. INTEREST-RATE TARGETING AS INFLATION TAX SMOOTHING

Highly persistent interest-rate targeting cannot be explained as financial market stabilization policy. After all, our current saving and loan problems began with the unexpected persistently high interest rates of the 1970s and early 80s. The attractiveness of Mankiw's (1987) view of rate targeting as optimal inflation tax smoothing is that it predicts highly persistent nominal interest rates, inflation, and money growth such as we have observed in recent decades.

The theory as expressed by Mankiw is basically an extension of Barro's (1979) optimal tax-smoothing model. The government raises revenue from two sources. The first is a tax on output, such as an income tax or a sales tax. The second is seigniorage, the printing of new money. The government must satisfy a present value budget constraint by adjusting tax rates on goods and money as it receives new information on its revenue requirements over time. The goal of the government is to minimize the expected present value of dead-weight losses due to the use of distortionary taxes.

Expected dead-weight losses are minimized by maintaining expected constancy in both the goods tax rate and the nominal interest rate. The real interest rate is assumed constant, so the nominal rate moves with expected inflation, which is also a martingale. The theory implies that the contemporaneous marginal dead-weight costs of raising revenue through direct taxation or seigniorage should be equal, so the level of direct taxation should move together with inflation and nominal interest rates. The theory of optimal seigniorage gets support from evidence, documented by Mankiw, that nominal rates and inflation in the postwar United States positively covary with government receipts as a percent of GNP.

Mankiw does not discuss how a central bank could actually implement optimal inflation tax smoothing. For this one must go to Barro (1989). Barro supplements Goodfriend's model in two ways. He makes the interest-rate target an exogenous random walk, and he adds permanent shocks and deterministic seasonals to money demand and the ex ante real interest rate.

So modified, Barro tests the model's implications on U.S. data from 1890 to 1985. Roughly speaking, Barro checks the random walk interest-rate feature of the model, and the restriction that both money growth and inflation should each follow an ARIMA (0,1,2) process. He rejects the model on pre-Fed data, finds mixed results for the interwar period, but cannot reject the model for the post-World War II period.

Barro's work appears to provide support for the tax-smoothing theory of monetary policy. However, a closer look reveals that he uses the tax-smoothing theory merely to motivate including the random walk interest-rate target in the model. Though he offers no alternative theory, he admits that interest-rate targeting could have nothing to do with fiscal concerns. Thus, Barro's work is also potentially supportive of other explanations for random walk interest-rate targeting, such as one sketched in Section IV below.

Poterba and Rotemberg (1990) extend Mankiw's empirical analysis to Japan, France, Germany, and the U.K., but find a significant positive association between inflation and tax rates only in Japanese data. Grilli (1988) reports, with mixed results, unit root tests and cointegration tests of the theory on a sample of ten industrialized countries.

At the theoretical level, Kimbrough (1986) and Lucas (1986) have suggested that modeling money as an intermediate good can overturn the traditional conclusion that the inflation tax should be used in a second-best world. If the tax rate on final output is set optimally, taxing money is inefficient. Barro points out, however, that a positive tax rate on money allows the government to tax output in the underground economy, and that if the main existing taxes are on some factor inputs, especially labor, then it may be desirable to tax other inputs such as monetary services. Woodford (1990) surveys these issues in detail. In Mankiw's words, the precise circumstances under which the use of the inflation tax is second-best optimal remain an unsettled issue.

Mankiw's model of optimal seigniorage makes expected money growth and inflation react to new information on government revenue requirements. However, an optimal inflation tax rule should also allow the contemporaneous money stock and price level to react to such news. The revenue obtained by surprise inflation amounts to an ex post capital levy. As with other surprise capital levies, surprise inflation raises revenue with little dead-weight loss. Although systematic inflation surprises cannot arise in rational expectations equilibrium, the rule would optimally allow for inflation surprises contingent on innovations to expected government revenue requirements. Judd (1989) makes some related points in a more general analysis of the role for surprise contingent capital levies in a dynamic-stochastic economy.

On this basis, one can question whether Barro's (1988) model of rate targeting should be interpreted as optimal inflation tax policy at all. Recall that he followed Goodfriend in assuming that the central bank minimized one-period-ahead price level forecast errors. While such might be well motivated by a concern for stabilization policy, it is contrary to optimal inflation tax policy.

IV. CONTINUITY OF THE SHORT RATE

This section asks why central bankers themselves might have a preference for maintaining continuity of the short rate. The preference is reflected in the Fed's use of a Federal funds rate policy instrument rather than a bank reserve instrument. It is also evident in the reluctance to change the target frequently and in the reluctance to change targets in steps bigger than 25 or 50 basis points. The tendency is, however, not a hard and fast rule so that target changes may occur more frequently and step sizes may be bigger in periods of greater underlying volatility, e.g., the period from October 1979 to October 1982.

The purpose of this section is two-fold. It is to offer an alternative explanation for the high degree of persistence the Fed imparts to interest rates, and to understand its preference for indirect rather than direct Federal funds rate targeting. In so doing, we will develop an understanding of central banker preferences for continuity of the short rate.

IV.1 Stabilization and the Persistence of Interest Rates

While it may be possible to rationalize temporary rate smoothing as optimal financial stabilization policy, it does not seem reasonable to rationalize highly persistent rates this way. The tax-rate-smoothing theory is appealing because it predicts highly persistent rates. But there is little evidence that the Fed considers fiscal implications when it routinely adjusts its Federal funds rate target. So we seek to understand how the routine pursuit of macroeconomic stabilization policy might induce the Fed to impart martingale-like behavior to short-term interest rates.

An argument to this effect might run as follows. The Fed adjusts its Federal funds rate target over time in an effort to stabilize unemployment and inflation as best it can. Output and prices do not respond directly to weekly Federal funds rate movements but only to rates of at least three- or six-months' maturity. Hence, the Fed targets the Federal funds rate with the aim of stabilizing and manipulating longer-term money market rates. Let us say it chooses a current week's Federal funds rate target for its effect on the three-month rate for the following thirteen weeks. As point 6 in Section I asserts, the market determines the three-month rate (abstracting from a time-varying term premium and default risk) as the average expected level of the Federal funds rate over the next three months. To see why, note that a bank may fund a three-month loan with a three-month certificate of deposit, or it could plan to borrow Federal funds overnight for the next three months. Accordingly, cost minimization and competition among banks keep the CD rate in line with the average expected future Federal funds rate. Bank loan rates are linked to expected future funds rates by a similar argument. Arbitrage among holders of money market securities links Treasury bill and commercial paper rates to CD rates of similar maturity.

Since longer-term rates are determined as an average of expected future Federal funds rates, the Fed could target the three-month rate with a variety of expected future Federal funds rate paths. Clearly the simplest path is to maintain an expected constancy in the Federal funds rate for the next three months. Since simplicity is highly valued in communicating policy intentions, it is easy to understand why the Fed might manage its Federal funds rate target to maintain an expected constancy of the Federal funds rate over any three-month period. But we can say more. Adjusting the target to maintain an expected constancy in the Federal funds rate for three months rules out any expected change in the three-month rate in any week of the upcoming three-month period. This, in turn, implies an expected constancy forever. So even though the Fed may care only about controlling the current three-month rate, doing so by maintaining a three-month expected constancy of the Federal funds rate tends to impart a more permanent expected constancy to interest rates.

Thus, we can appreciate how the pursuit of stabilization policy itself may tend to impart a high degree of persistence to short-term interest rates. We have not said anything yet about the ex ante real interest rate. Suppose real rate shocks, whether or not they are influenced by monetary policy, are transitory. Then the interaction between the Fed's martingale-like nominal interest-rate generating process and the ex ante real rate process implies a highly persistent component in the inflation-generating process. This view would explain inflation persistence not as optimal tax smoothing but as the outcome of an expected continuity that the central bank builds into the short rate in the pursuit of stabilization policy.

Continuity plays another role here as well. The Federal funds rate target is not changed in response to new information received daily or even weekly. By point 2 of Section I, target changes occur discontinuously only after an accumulation of new information is deemed sufficient to trigger a change. As such, in practice it may be possible to predict somewhat the likelihood of a target change before it occurs. Thus, the expected future funds rate may vary around the prevailing Federal funds rate target causing the Fed to lose leverage over, say, the three-month rate. To some extent, the infrequency of target changes itself minimizes somewhat the loss of control. One may also understand point 3 of Section I in this regard. By restricting target changes to relatively small steps of 25 or 50 basis points, the Fed reduces the extent to which the expected future funds rate will vary around the current target. Of course, there is a tradeoff here. For the restriction to be credible, the Fed must actually delay or spread out target changes that it might otherwise like to make immediately.

IV.2 Direct vs. Indirect Federal Funds Rate Targeting

Point 1 of Section I described the Federal Reserve as having employed either direct or indirect Federal funds rate targeting throughout its history. This section contrasts direct and indirect targeting and reviews briefly their history. It also discusses the costs and benefits of each from the point of view of a central bank.

The Fed targets the Federal funds rate directly by using open market operations to defend a relatively narrow band within which the funds rate is allowed to move. For example, from 1975 to October 1979 the range was commonly 25 basis points (see Cook and Hahn (1989, app. A)). In practice, a target change means moving the band up or down. One can imagine the funds rate bouncing around within the band, triggering "defensive" open market operations whenever it hits the upper or lower intervention points. A target change becomes apparent to the market whenever the rate moves beyond a previously defended point. Under direct funds rate targeting, the market understands target changes clearly and immediately by merely observing Federal funds rate movements.

Indirect funds rate targeting is more complicated. Here the Fed estimates the banking system's demand for reserves and provides the bulk of those reserves through open market purchases. But it forces the banking system to borrow a small fraction from the discount window. Given the non-price-rationing at the discount window, the quantity of discount borrowing that banks are willing to do depends positively on the spread between the Federal funds rate and the discount rate. So for a given discount rate, targeting borrowed reserves allows the Fed to target the Federal funds rate indirectly. In contrast to direct funds rate targeting, however, borrowed reserve targeting is inherently noisy because borrowing cannot be targeted exactly and because the demand schedule for borrowed reserves itself is unstable. In other words, a given borrowed reserve discount rate combination will tend to tie the funds rate only loosely to a target. Moreover, since there is no narrow band within which the rate is clearly kept, it is not as obvious to the market what the target is. In addition, it generally takes the market longer to perceive changes in the target.

During the early years of the Federal Reserve System, there was no non-pricing-rationing at the discount window and the discount rate was the Fed's policy instrument. In 1919 and 1920 discount window borrowing even exceeded member bank reserve balances at the Fed. Consequently, the overnight loan rate, e.g., then the call loan rate, was directly linked to the discount rate. Later in the 1920s, Fed open market security purchases largely replaced borrowed with nonborrowed reserves, and the Fed gradually came to treat borrowing as a privilege and not a right. Having effectively introduced non-price-rationing at the window, the Fed then began to target the Federal funds rate indirectly with a borrowed reserve target.

In the 1930s, interest rates declined to a fraction of the levels they had averaged in the 20s. The discount rate was reduced but not allowed to fall below market rates, so discount window borrowing was negligible from 1934 on. Essentially, short rates were near zero during this period and the Fed did not bother to target them either directly or indirectly. During the 40s, monetary policy was constrained by the wartime and postwar interest-rate peg.

When monetary policy regained its independence after the 1951 Accord, the Fed returned to the indirect Federal funds rate targeting procedure it had used in the late 20s and early 30s. At the time the procedures were known as "free reserve" or "net borrowed reserve" targeting (see Brunner and Meltzer (1964)). The Fed continued to target the Federal funds rate indirectly until the early 1970s, when it shifted gradually to directly targeting the Federal funds rate within a narrow band.

The period of nonborrowed reserve targeting between October 1979 and the fall of 1982 was one in which the Fed was willing to allow a more volatile funds rate. But while strictly targeting nonborrowed reserves could have allowed the funds rate to be determined automatically by market forces, in practice the funds rate was usually indirectly controlled by a borrowed reserve target. Cook (1989) has documented that roughly two-thirds of the movement in the funds rate during this period was due to deliberate discretionary actions of the Fed, e.g., changing the discount rate or the borrowed reserve target.

Since 1982 the Fed appears to have completely reverted to indirect targeting procedures akin to those of the 20s, 50s, and 60s. Recently, there is some evidence of a gradual return to direct targeting within a narrow band, though that has not yet been formalized in the Directive.

Why has the Fed employed both direct and indirect procedures for targeting the Federal funds rate? Direct targeting would appear to have an advantage for the purpose of controlling, say, the three-month rate. It communicates the current target exactly to the market and allows the market to pick up a target change immediately.

We can appreciate what the Fed perceives to be the benefit of indirect targeting in the following two statements. The first statement is one by Governor Strong from 1927:

> ... It seems to me that the foundation for rate changes can be more safely and better laid by preliminary operations in the open market than would be possible otherwise, and the effect is less dramatic and less alarming to the country if it is done in that way than if we just make advances and reductions in our discount rate ... . [Strong 1927, p. 333]

The second statement is one by Chairman Greenspan from 1989. He is talking about whether the Fed should be mandated to publicly state its current Federal funds rate target and announce immediately a target change. But as discussed below, this issue is closely related to the perceived benefit of indirect targeting. Chairman Greenspan says:

> The immediate disclosure of any changes in our operating targets would make this information available more quickly to all who were interested, but it would have costs. Simply put, this provision would take a valuable policy instrument away from us. It would reduce our flexibility to implement decisions quietly at times to achieve a desired effect while minimizing possible financial market disruptions. Currently, we can choose to make changes either quite publicly or more subtly, as conditions warrant. With an obligation to announce all changes as they occurred, this distinction would evaporate; all moves would be accompanied by announcement effects akin to those currently associated with discount rate changes... [Greenspan 1989, pp. 14–15]

Remarkably, although the statements were made sixty years apart, they make essentially the same point. Any direct interest-rate targeting procedure, especially one in which the current target is publicly announced, would likely give a target change the status of a major news event. The Fed believes it best that routine target changes not make the news. Indirect, i.e., borrowed reserve, targeting gives the Fed that option. It allows the Fed to control the current funds rate without defending a narrow target band, so the market at large cannot easily see the target. Fed watchers follow the funds rate target and thus transmit Fed intentions to the market. Target changes can be brought about quietly for two reasons. Open-market operations can be used to gradually change the borrowed reserve target, and the uncertainty surrounding target changes is resolved gradually. By stretching out a target change, i.e., by maintaining a continuity of the short rate, the Fed can keep its target change out of the headlines. Essentially, it does so by assuring that a change in the general perception of its target is not sufficiently newsworthy on any one day. Of course, by using the discount rate to change the funds rate target, the Fed can always grab the headlines if it wants to.

We can thus appreciate the perceived benefit of indirect funds rate targeting. The option to quietly change its target, however, is not without cost. It opens the door to having its target misinterpreted, e.g., Wessel and Herman (1989). The Fed faces a tradeoff. It must accept a risk of being misinterpreted if it wants the option to quietly change its target. We may understand the Fed's choice of direct vs. indirect targeting as driven by shifts in its perception of the cost of being misinterpreted relative to the benefit of avoiding the headlines.

V. EMPIRICAL EVIDENCE AND IMPLICATIONS

This paper has explored the view that the Fed dominates the evolution of short-term interest rates. This section surveys empirical evidence from the founding of the Fed and from the 1970s that demonstrates the Fed's power over rates. The evidence supports the expectations theory of the term structure as embodied in point 6 of Section I. Federal funds rate targeting itself has implications for conventional tests of the expectations theory of the term structure that are discussed briefly.

V.1 The Founding of the Fed

The Federal Reserve radically altered the character of short-term rate movements when it began operations in 1914. Consider one measure of the short-term rate, the monthly average New York call loan rate as reported in Macaulay (1938). Prior to the creation of the Fed, this rate rose suddenly and sharply from time to time. For example, in October 1867, after remaining between 4 and 7 percent for the previous three years, the call loan rate rose suddenly from 5.6 to 10.8 percent. Although this change seems large by postwar U.S. standards, similar episodes occurred 26 times between the Civil War and the creation of the Fed. Moreover, sudden changes of over 10 percentage points occurred with surprising frequency, on eight occasions during the same 49-year period. Accompanying these sudden upward jumps in call loan rates were similar though much less severe movements in 60- to 90-day commercial paper rates. These episodes were distinctly temporary, ranging from one to four months, with many lasting for no more than one month. Such extreme temporary spikes are absent from interest-rate behavior since the creation of the Fed.

Another distinctive feature of the period before the Fed was the large seasonal in short-term rates. According to Miron (1986), the average seasonal variation of the call loan rate from 1890 to 1908 ranged from a peak of +4.6 percent in January to a trough of -1.39 percent in June. Rates were at their annual mean in the spring, below it in summer, and above it in the fall and winter. By the 1920s the prominent interest-rate seasonal had virtually disappeared.

Mankiw et al. (1987) documented a substantial change in the stochastic process generating the three-month time loan rate. Between 1890 and 1910, they found the rate to be quickly mean-reverting and highly seasonal. By contrast, between 1920 and 1933 they found it to be close to a random walk. Mankiw et al. also examined the relation between three- and six-month rates before and after the founding of the Fed. The two rates moved together more closely in the later period, as predicted by the expectations theory of the term structure, given the greater persistence of the three-month rate.

The evidence strongly suggests that the Fed altered the process generating short rates. Yet Mankiw et al. do not explain how the Fed was able to smooth rates. The problem is that the U.S. was on a gold standard during the period, and the Fed was committed to maintin a fixed dollar price of gold. How then was the Fed able to pursue a second objective, namely, interest-rate targeting? The answer, worked out in Goodfriend (1988), is that a central bank has two degrees of policy freedom under a gold standard. It can choose policy rules for both money and gold. Goodfriend explained how the Fed stockpiled excess gold reserves, and allowed its stockpile to vary in support of the fixed dollar price of gold while using monetary policy to target the interest rate.

V.2 Federal Funds Rate Targeting in the 1970s

The standard test of the Fed's influence on interest rates is to regress rates on current and past money growth. The regressions yield little support for the view that the Fed can influence rates (see Reichenstein (1987)). However, one may question the findings by noting, as Mishkin (1982) did, that such tests may be misspecified if the Fed smooths rates. Indeed, interest-rate targeting requires the Fed to accommodate changes in money demand to support the current target. So there need be no close relationship between observed changes in money growth and interest rates.

Cook and Hahn (1989) test for evidence of the Fed's influence on rates by examining the reaction of interest rates to Fed target changes. They estimate the reaction of rates to target changes in the period from September 1974 to September 1979. This period is unique in that the Fed controlled the Federal funds rate so closely that market participants could identify most target changes on the day they were first implemented, and the changes were reported in the financial press the following day.

Cook and Hahn found that changes in the Federal funds rate target were followed by large movements in the same direction in short rates, moderate movements in intermediate-term rates, and small but significant movements in long-term rates. The 3-, 6-, and 12-month bill rates all moved by about 50 basis points in response to a 1-percentage-point change in the funds rate target. The 3-year bond rate moved by 29 basis points. The 10-year bond rate move was 13 basis points. The 20-year bond rate moved 10 basis points. All regression coefficients were significant at the 1% level.

The similar response of 3-, 6- and 12-month bill rates to target changes is striking confirmation of the idea that the Fed maintains an expected constancy in the Federal funds rate for periods as long as a year. But the declining responses of 3- to 20-year bond rates are consistent with slow mean reversion in rates. In this regard, Cook and Hahn's findings are broadly consistent with those of Fama and Bliss (1987).

A particularly interesting aspect of Cook and Hahn's results is that bill rates move by only about 50 percent of a target change. This suggests that on average the market has already built into rates about half of each target change by the day it occurs. Roughly speaking, about half of each target change appears to be expected by the time it happens. This supports the conjecture in Section IV.1 that, given the Fed's targeting procedures, target changes ought to be forecastable to some extent. The similarity of the response of 3- to 12-month bills, however, implies that any forecastability must be limited to a horizon of only a month or so. We find just this sort of evidence in Fama (1984) and Hardouvelis (1988). Fama, for example, presents evidence that the one-month forward rate has power to predict the spot rate one month ahead.

The interpretation of Cook and Hahn's regression results rests on the assumption that movements in the funds rate target caused movements in other rates and not the reverse. They defend their assumption as follows:

> The Desk changed the funds rate target in this period either under explicit instructions from the FOMC or under the Desk's interpretation of the latest FOMC directive. As we document in a working paper (1989), in all but five of the former cases the actual change in the target lagged the FOMC instructions by one or more days, and in about half of the latter cases the market's perception of a change in the target lagged the Desk's decision to change the target by at least one day. In these cases the reverse causation argument makes no sense because changes in the target initially decided on prior to the day they were reported to have occurred by the Journal could not possibly have been made on the basis of the movement in market rates that day. [Cook and Hahn, 1989, p. 342]

Cook and Hahn go on to say that 20 out of the 76 target changes in their sample did occur on the same day as the Wall Street Journal reported them. They argue that even these were unlikely to be contaminated. But they reestimate their basic regression leaving out the suspect observations, without significantly different results.

V.3 Implications for Tests of the Expectations Theory of the Term Structure

The views of market participants together with Cook and Hahn's findings constitute strong evidence that expectations of the future level of the funds rate influence current market rates. Yet a recent group of papers that have studied the slope of the money market yield curve have found little, if any, support for the expectations theory of the term structure (see references in Cook and Hahn (1989)). The standard test of the expectations theory in these papers is to regress the change in the 3-month rate from period t to period $t+1$ on the difference between the 6-month and 3-month spot rates in period t. Mankiw and Miron (1986) pointed out that in the presence of a time-varying term premium, the coefficient in such a regression tends to be biased downward. The greater the proportion of the variance of the yield curve slope due to the expected term premium and the less due to the expected change in the 3-month rate, the greater will be the downward bias.

Cook and Hahn showed that the slope of the yield curve from three to twelve months is not responsive to new information (funds rate target changes) that influence interest-rate expectations. So the variance of the yield curve slope over this range is likely to be dominated by movements in the term premium. Thus, as Mankiw and Miron argued, the conventional test of the expectations theory performs poorly in the presence of interest-rate targeting as practiced by the Federal Reserve.

VI. CONCLUSION

This paper has described key features of the Federal Reserve's interest-rate targeting procedures and addressed a number of issues in light of these stylized facts. It has pointed out various ways in which the procedures may be said to smooth rates and identified each with one or more theoretical models of rate smoothing.

The theoretical models all had in common the idea that interest rates are smoothed by manipulating expected money growth and inflation. This suggested, in turn, that rate smoothing may be an important determinant of the inflation-generating process. At a minimum, rate smoothing can imply more persistant inflation and tends to induce non-trend-stationarity in the price level. Moreover, policy that maintains an expected constancy in rates tends to induce non-trend-stationarity in the inflation rate.

There was some question about what motivates the Fed to maintain near expected constancy in rates. One possibility, critiqued in the paper, is that such rate smoothing is optimal inflation tax smoothing. An alternative argument advanced in the paper is that stabilization policy, implemented by interest-rate targeting, inadvertantly induces martingale-like behavior in nominal rates and inflation. Thus, we saw Fed rate targeting as potentially explaining the highly persistent inflation process in the U.S. The rate targeting perspective is radical for two reasons. It reverses the usual view of the relationship between inflation and interest rates, and it suggests that explaining the process generating inflation involves understanding central bank interest-rate targeting.

As described in the paper, instead of targeting the funds rate within a narrow band, the Fed has more often chosen to target it loosely using borrowed reserve objectives. The resulting noise in the funds rate obscures the underlying target, makes the funds rate appear free of Fed influence, and weakens the relationship between the funds rate and longer-term money market rates. This point bears repeating because it tends to complicate empirical investigation of the stylized facts of rate targeting presented here. Empirical work could proceed, though, by recognizing that longer-term rates would be closely related to the market's estimate of the underlying borrowed reserve target, which indicates the Fed's intentions for the current and expected future funds rates.

We saw that indirect funds rate targeting is valued by the Fed because it gives the central bank the option of quietly changing its target. Because it works by obfuscation, however, it raises the risk of the target being misinterpreted. This suggested that the Fed's tendency to shift back and forth from direct to indirect targeting is driven by perceived shifts in the cost of being misinterpreted vs. making the headlines. It is hard to imagine environments with stable preferences that allow such relative costs to vary over time. Progress on this question would make an important contribution to our understanding of central banking.

The last section of the paper surveyed empirical evidence from the founding of the Fed and the 1970s demonstrating the Fed's power over market interest rates. It nicely supported a number of the stylized facts presented at the beginning. Even the greatest skeptic of the Fed's power to systematically influence market interest rates should find the evidence surveyed here troubling. Of course, all this says nothing about the Fed's power over ex ante real interest rates. But we need to take first things first.

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