

Borrowed Reserves, Fed Funds Rate Targets, And the Term Structure

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5 January 1997

Abstract

When examined for the period 1985-1992 as a whole, the impact of changes in the targeted Fed funds rate on U.S. treasury bill rates has been weaker than during previous periods. The period, however, should be viewed as three separate regimes. First, I show significant differences between the Greenspan and Volcker eras arising from management style. Volcker emitted ambiguous signals to the market, which induced "heterogenous" expectations. Greenspan's market leadership forged more homogeneous expectations allowing treasury rate responses prior to the target change to be attributed to *market* anticipations. Further, I find strong annual seasonality in borrowed reserves targets, corresponding to an agricultural cycle. It suggests the Fed no longer "defends" a target for borrowed reserves and instead allows them to follow the cycle. Subsequently, the Fed funds rate adheres more closely to a target rate and Treasury rates react similarly to an earlier direct Fed funds target regime. Thus, I conclude that as of late 1989, the Fed again directly targets the Fed funds rate.

Target rate changes induce starkly different reactions by treasury rates of various maturities over the three regimes. Applied to the term structure, I find that the average monthly interest rates implied by the expectations theory is consistent with the pattern of actual treasury rate reactions. I compare implied monthly rate reactions after a policy shock between direct Fed funds rate regimes of the latter Greenspan period and the 1975-1979 Fed. I find that after a policy easing, the market expects the monthly rate to remain at a lower level throughout a horizon of at least 20 years. This is consistent with expectations of a Fed that is able and willing to contain inflation: although easing, the public has confidence it will not inflate over the foreseeable future.

Keywords: Interest Rates, Expectations Theory, Term Structure, Monetary Policy, Fed Funds Market, Central Bank

JEL Codes: E43

This paper is based on my Ph.D. dissertation at Princeton University and was continued during my visit to CERGE. I have greatly benefitted from the guidance of Ben Bernanke. Larry Ball, Lester Taylor, and discussant Marvin Goodfriend provided very helpful comments. Thanks to Joe Beaulieu, Spence Hilton, Cara Lown and Clara Vega from the Federal Reserve for data. Suggestions by Tim Cook, John Penrod, Phil Reny, Pushpa Trivedi, and a reserve manager at a major money center bank were helpful, as were comments by seminar participants at CERGE, York University, the EEA Congress in Prague, Nova Universidade de Lisboa, the Norwegian Institute of Management, the Banca d'Italia-IGIER conference on the term structure, and EPRU. Thanks to Alex Michaelides for research assistance. All remaining errors are my responsibility.

I. Introduction

Although the empirical support for the expectations theory is deeply contested (see Shiller (1990) and Campbell (1995) for surveys), this leading theory of the term structure retains great intuitive appeal. It is the simple idea that long and short term interest rates should adjust until an investor interested in a relevant time horizon is indifferent between investing in short term bonds rolled over and a long term bond. Bond traders, notably, believe it the rule responsible for the pattern of different maturity treasury securities observed in market trading (Cook and Hahn, 1989).

Macroeconomists too are very interested in any mechanism relating short- and long-term rates. The short-term interest rate is agreed to be the most important instrument by which monetary policy actions affect the economy. Standard logic also maintains that real investment decisions of private firms are mainly influenced by longer-term rates. The term structure, the difference between long and short-term rates, is then an interesting arena of study as long-term rates do not mechanically follow changes in short term rates. The former, inter-alia, are believed to be strongly influenced by expectations of inflation. It thus seems that the term structure embodies information about the influence of monetary policy on the economy, but the exact mechanism it represents is not yet clearly understood.

Mankiw and Miron (1986) provide a plausible reason for the lack of empirical support for the expectations theory: the central bank fixes a certain level of a very short-term interest rate that is only as predictable as the central bank wants it to be. They provide evidence that the predictive power of contemporaneous longer-term rates on future short-term rates disappears after the Fed was founded. Specifically, Mankiw and Miron argue that a term premium compensating investors for holding bonds outside the investors' "preferred habitats", the maturities they prefer, fluctuates over time which biases downward the estimated effect on the term structure by the short term rate.

Cook and Hahn (1989) examine the effect on the pattern of longer-term rates by a change in the central bank influenced target Fed funds rate. Cook and Hahn (C&H hereafter) find that a change in the Fed target has an approximately equal impact on all daily money market rates but has a diminishing effect on rates of instruments with longer maturities. A Fed tightening then, on average, shifts up the yield curve

parallel for short-term rates, with a smaller increase for each longer maturity rate. Since the short-term rates are affected approximately equally by the Fed's policy move, C&H conclude that market participants expect the Fed funds (overnight) rate, the basic rate on the yield curve and the Fed's primary policy tool, to remain at the same level for approximately a year. In the light of the findings of Mankiw and Miron, it means that the term premium fluctuations predominate over this horizon, hiding evidence from standard tests of the expectations theory.

The present study also examines the reaction of treasury securities' rates to changes in the targeted Fed funds rate, but the setting is 1985-1992 which differs in important ways from the time studied by C&H. One difference concerns the degree of control the Fed desires to have on the Fed funds rate. The late 1970's was a time when the Fed manipulated reserves to hold the Fed funds rate to the targeted Fed funds rate with great accuracy in seeking non-inflationary output growth. 1985-1992 was a much more complicated time, but also more interesting. First, the central bank instituted new operating procedures which include relaxed control over the market Fed funds rate. Market participants, thanks partially to lower transactions costs enabled by financial derivatives¹, may more actively anticipate Fed moves than during the earlier study. They are also likely to have had more confidence in the ability of their central bank to contain inflation. Finally, growing international integration has likely affected the Fed's influence on market rates. One indication noted by Rivera-Batiz, Rivera-Batiz (1993): foreign exchange trading in New York has grown from \$5 billion per day in 1977 to \$50 billion a day in 1986 to \$303 billion a day in 1992. Taken together, these factors make prediction of the Fed's impact on the pattern of market rates based on the results of the C&H study highly uncertain.

I find compelling evidence that substantially different regimes were in effect during this time period. First, the reaction by treasury security rates during 1985 - 1987, a time corresponding to the tenure of Chairman Volcker, but also within a highly unstable international environment, were significantly attenuated compared to those during later periods. Reports of market activity in the Wall Street Journal, WSJ hereafter, suggest this was due to ambiguous signals emitted from the Federal Reserve. Further, I find evidence that

¹ Trading in options on treasury instruments, for example, began in 1982.

late in 1989 Chairman Greenspan dropped borrowed reserves targeting and resumed direct Fed funds targeting. According to official Fed records, the Fed began changing borrowed reserves targets very frequently, and they then exhibited a surprisingly substantial seasonal with annual frequency². This is inconsistent with maintaining some desired level of borrowed reserves as was done earlier in the Greenspan tenure. The reaction in the term structure to the Fed's target rate changes during 1985-1992 thus depends not only on who is the chairman, but also his choice of operating procedures.

The corollary is that one must pay close attention to the sub-periods for reliable analysis. The whole sample results of the the weaker impact of the Fed on Treasury security rates is explained by examining the reactions across the regimes. The weakest response occurs during the time presided by Volcker which I attribute to either signalling, to expectations differences arising from differing activity within the periods or to bias in the estimates due to the Fed using bond rates as indicator variable. The latter Greenspan direct Fed funds targeting regime reactions are comparable in size and fit to the C&H results corresponding to an earlier direct Fed funds targeting regime. With respect to the term structure, I find that the average monthly interest rates implied by the expectations theory is consistent with the pattern of actual treasury rate reactions. For the borrowed reserves target regimes, I find the initially weaker reaction during the Volcker regime is offset by a strong reaction by 5 year rates to bring monthly rates near to the pre-policy shock rate over the 5-7 year horizon. The reversion to the pre-policy shock rate comes within a 7-10 year horizon under the first Greenspan regime. I also compare implied monthly interest rate after a policy shock between direct Fed funds rate regimes of the latter Greenspan regime and the 1975-1979 Fed. I find that after a policy easing, the market expects the monthly rate to remain at a lower level throughout a horizon of at least 20 years. This is consistent with expectations of a Fed that is able and willing to contain inflation: although it is easing, the public puts a lower expected value on inflation over the foreseeable future.

The remainder of the paper is organized as follows. I first replicate the C&H study and find a weaker reaction for the period as a whole. Seeking to assign some cause for this lower influence of the Fed's direct

² Work by Bernanke and Mihov (1995) using econometric techniques to find that the Fed funds rate is an especially good indicator of monetary policy after 1988 supports this decision. Goodfriend (1991) suggests the Fed switches at will between borrowed reserves and direct Fed funds targeting.

influence on market rates, I examine whether procedural differences within the central bank may have been responsible. An indication of a major difference in Fed policy between the studies is a Fed funds rate subject to much greater fluctuations. For 1975-1979, Rudebusch (1994) measures a standard deviation of .28 for the difference between the Fed funds rate and the target as opposed to .43 during 1985-1992). In the more recent period, the Fed states it regulates liquidity in the banking system by monitoring banks' borrowings at its window for discount loans rather than targeting the Fed funds rate directly. Goodfriend (1991) argues that this procedure makes the Fed funds rate more susceptible to fluctuations in the demand for reserves and so adds noise to the Fed's signals to the markets. Another new procedure, contemporaneous reserve accounting, is also frequently blamed for creating volatility in the Fed funds rate. On the other hand, differences observed in the reaction of market rates may be induced by events in the real economy, for example the stock market crash, the financing of great budget deficits, and payments imbalances from chronic trade deficits. In Part III, I investigate the reaction of treasury security rates in three distinct regimes, incorporating controls for the new operating procedures. In Part IV, I examine in greater detail whether market participants react in anticipation to the Fed or the Fed moves partly in response to the action in the Treasury markets. Then in Part V, I summarize the findings for implications to the expectations theory and conclude.

II. Are The New Operating Procedures to Blame?

This study's ultimate goal is to measure the proximate impact of changes in the target Fed funds rate on the rates of different-maturity Treasury securities and thus on the term structure of interest rates. First, I replicate as simply as possible the C&H results as a guide. I measure, on dates the Fed reported changing the target, the impact of these policy moves on treasury security rates of various maturities. Following this I examine in some detail the complications introduced by the Fed's current 'borrowed reserves' regime with 'contemporaneous reserve requirements' accounting.

II.A. Simple Replication of Cook and Hahn

In the earlier study, C&H examine the effect of perceived changes in the target Fed funds rate on treasury instruments' rates. C&H identify the perceived target changes using reports published in the "Credit Markets" column of the Wall Street Journal (WSJ hereafter) and emphasize a close correspondence of this measure to actual Fed target changes. In the 1985-1992 period, the Fed funds rate was very volatile so that market participants were often unable to perceive a change in the Fed's target Fed funds rate. Indeed, many target changes remained unnoticed by the WSJ reporters. This prevented me from following the C&H strategy, so I thus use official target changes as provided by the Federal Reserve Bank.

According to the expectations theory, the interest rates on long- and short-term treasury securities are set by market forces so that a hypothetical investor having a certain investment horizon will be indifferent to purchasing a long-term instrument that corresponds to her horizon and rolling a short-term instrument repeatedly over for the period. Extending this logic to overnight rates, the investor with a horizon of three months would consider rolling over overnight Fed funds for three months if she expected a return equal to that on a three-month security. Accordingly, a change in the Fed's targeted Fed funds rate, given a constant term premium, results in a new configuration of treasury security rates that implies the market's average expectation of the overnight rate for the next three months (and longer-term securities imply even further into the future) and indicates how long the market expects the Fed to support the new Fed funds rate level. Assuming for the moment that the Fed funds rate target is exogenous (an issue I address in part IV), equation (1) is the most direct measurement of the impact of a Fed funds rate target change on treasury market securities' rates. The first column of Table 1 gives results for the current sample period with C&H estimates provided as reference in the last column.

$$(1) \quad \Delta RTB^-_t = \alpha + \beta \cdot \Delta RFF^{TAR}_t + u_t$$

Clearly the coefficients estimated using daily data from 1985-1992 are about one-half the size of those estimated in the C&H study. The accuracy of the estimates has also diminished. Nevertheless, the basic pattern of the coefficients' magnitudes is similar to that of the C&H study: relatively large and accurate coefficients for the short-term rates decreasing in both dimensions as maturity increases. This suggests that

Fed policy changes have had a weaker, but similar effect on the term structure as that found by C&H for 1975-1979.

One problem with this simple specification is that the coefficients are likely to be biased by the effects of the changed operating procedures. For example, changes in the targeted amount of borrowed reserves may also be an important determinant of rates in the Treasury securities markets. In the remainder of part II, I discuss the effects of important new operating procedures on Treasury security rates' reactions to policy shocks. Later in part IV, I examine whether one reason the influence of the Fed may have changed is that of greater anticipations by market participants.

II. B. Borrowed Reserves Targeting

In the standard description of the borrowed reserves operating regime (Goodfriend and Whelpley, 1986), the Fed supplies an insufficient amount of reserves via open market operations for the banking system to meet its requirements. On net, this induces an excess demand for reserves on the Fed funds market, where those banks deficient in reserves borrow from others holding excess reserves, and some banks are then compelled to obtain reserves by borrowing from the Fed's discount window. Banks face a trade-off when they consider discount loans. The Fed strongly discourages banks from repeated borrowing, as described by the famous phrase: "borrowing is a privilege and not a right". On the other hand, banks have a pecuniary advantage in discount borrowing as the Fed funds rate is often higher than the discount rate. See Goldfeld and Kane's (1966) seminal work in modelling this relationship.

The idea behind "targeting" borrowed reserves is that the Fed wants to maintain that level of borrowed reserves associated with a desired rate of economic activity³. And accordingly, the Fed will undertake open market operations to adjust non-borrowed reserves to reattain that desired or target level of borrowed reserves if equilibrium had been upset by one shock or another. One advantage of borrowed

³ One way that borrowed reserves may reflect real activity is if Fed monitors the characteristics of the banks borrowing from the window. For example, Ho and Saunders (1985) model a Fed funds market in which risk-averse small banks always lend while large banks always borrow. If, counter to their usual behavior, small banks suddenly begin to request discount loans, the Fed may reasonably infer a serious negative reserve demand shock. See also empirical evidence by Allen, Peristiani, and Saunders (1989) and the discussion in Stigum (1990).

reserves targeting from the Fed's perspective is to spread out over time the impact of policy changes (Goodfriend, 1991). Yet it also permits the *market* Fed funds rate to drift further from the target than under a direct Fed funds target regime. If the Fed uses a direct target, policy makers can achieve very low dispersion of the market rate around the target rate.

A simple first attempt to trace the effect of borrowed reserves targeting scheme on the impact of Fed funds target changes on treasury security rates is to augment equation (1) with the independent variable recording the official changes in the borrowed reserves targets. This simple alteration of the model increases the coefficients on the target Fed funds rates by about 15%, at least for the short-term securities. The fit of the regressions on short-term securities also improves. I do not report the results in detail for the sake of brevity.

II.C. Contemporaneous Reserves Accounting

Since February, 1984, the Fed requires banks to maintain a level of reserves for their deposit liabilities over a concurrent biweekly period as contrasted to the previous system's calculation over a past weekly period. The requirement is calculated by averaging the bank's daily amounts of "reservable accounts" (mainly time and demand deposits) for a ten-day "computation" period ending on a Monday which is then compared to the bank's average reserve holdings for a mostly-coincident ten-day "maintenance" period ending on the following Wednesday, the settlement date. Obviously, the description "contemporaneous" is something of a misnomer since compliance to the requirement is not enforced until after the end of the computation period. As banks must now estimate both their accounts and reserves with but two days to correct discrepancies, increased trading of Fed funds results, along with greater fluctuations in the market Fed funds rate (the standard deviation of the closing Fed funds rate is 5.16% on settlement days, vs. 1.92% otherwise⁴). Under this system then, banks are more likely to find themselves with unintended reserves or may be forced to scramble for reserves due to unintended shortages. Indeed, recent research, e.g. Balducci,

⁴This noise is also indicated by the high interest rates during this period. The maximum closing quote of the Fed funds rate was 62.5% on December 26, 1990, a time when the market rates were much more modest.

Bertola, and Foresi (1993) and Hamilton (1996), has shown the system to introduce biweekly seasonality in the Fed funds rate.

Does this seasonality imposed on the Fed funds rate also have an impact on how changes in the Fed funds target affects treasury security rates? The signalling function of the Fed funds target rate could surely be weakened if target changes occur on settlement days, when the banks' last-minute adjustments to the new requirements are likely to interfere with the rate's signal to market participants. To measure this influence, I construct a dummy variable taking the value of one if a Fed policy change occurs on either the last Wednesday or the first Thursday of the reserve period⁵. When interacted with the Fed funds target change, the coefficients are highly significant, not only for the impact on Fed funds rates, but also for the treasury securities rates (see the second column of Table 1). I do not interpret the coefficients on the interacted term as any reaction of market rates to Fed policy change, but simply as a control for the settlement dates' noise. I therefore interpret the coefficient on the un-interacted independent variable as the treasury rate response on days other than the settlement dates. The preferred model will include both the variables controlling for contemporaneous reserves accounting and borrowed reserves targeting, to be described in the next part.

II. D. Responses for Entire 1985-1992 Period⁶

⁵ It is important to use the first Thursday since market rates are returning to their normal levels on this date from the either very high or very low rates of the final Wednesday. The attenuation of signals to the market present the Fed an additional policy instrument: for a subdued response to a Fed funds target change, the Fed can institute it on settlement dates. Interestingly, a large proportion of target changes occur on Thursdays.

⁶ I do not include discount rate changes separately in the analyses since they were usually made in concert with Fed funds target changes (the four exceptions occurred very early in the sample). Further, when included in the final model, their coefficients differ insignificantly from zero.

The influence of inflation expectations might bias the response of treasury rates. I have run regressions including the price of gold futures, a derivative aimed to avoid capital losses on nominal instruments, to reduce omitted variable bias (although possibly introducing simultaneity bias). Since they do not influence materially the coefficients on Fed funds target changes, I do not report results.

Controlling for settlement dates' effects and borrowed reserves target changes as motivated above, regressions of changes in various maturity treasury security rates on Fed funds target changes imply a similar, albeit weaker impact on the term structure as found by C&H (see results in second column of Table 1).

$$(2) \quad \Delta RTB^-_t = \alpha + \beta_1 \Delta RFF^{TAR}_t + \beta_2 \Delta BR^{TAR}_t + \beta_3 \Delta (F.Thurs * RFF^{TAR})_t + u_t$$

Table 1 (second column) shows that short-term treasury securities' rates react in a significantly negative way to a change in borrowed reserve targets. The standard model of the Fed funds market, Goodfriend and Whelpley (1986) cannot easily explain negative β_2 coefficients since it predicts the joint determination of the Fed funds rate and the amount of borrowed reserves (given a discount rate). From a different perspective, however, it is sensible that an increase in borrowed reserves will increase the liquidity of the banking sector and thus decrease treasury security rates. Furthermore, given the data at my disposal (see figure 1), it does seem that the Fed determined borrowed reserves targets follow for most of the 1985-1992 period the actual amount of borrowed reserves.

Any event study must fulfill two conditions to measure an accurate reaction by e.g. treasury security rates to Fed funds rate target changes. First, a change in the Fed funds target rate must be accurately signalled to treasury market participants. Obviously, if noise or other interference prevents market participants from perceiving a target change, little of any response should be attributed to an expectations story. In this case, the only response by treasury security rates might be due to banks' treasury security sales motivated by a need to obtain reserves after e.g. a tightening. The second condition for an accurate measure is that the change in impulse, here the Fed funds rate target, must not be widely expected by market participants. Otherwise, market participants' anticipatory transactions are likely to bring the reaction before the impulse. On several occasions during this period, WSJ reported Fed signals of an imminent policy move prior to the official target change date. Discount rate changes, for example, sometimes preceded the corresponding Fed funds rate target change. Obviously in these cases, measuring the response on the target change date will ignore the part of the reaction prior to the official change.

For these reasons, one can question whether the results shown in the first two columns of Table 1 are free from bias due to the changes not being perceived by market participants. To test this, I assign a dummy variable the value one for those changes that were recognized and reported in the WSJ on the day subsequent to the target change. This should be an accurate measure of recognizance by the market: the WSJ reporters certainly had an interest in reporting changes in the targeted funds rate: they often discussed expected policy moves⁷. I further assign another dummy variable to one if it was universally expected by market participants. I followed the same conservative selection criterion as explained in greater detail in section IV below. Table 4 reports results from regressing various maturity treasury market securities on Fed funds target changes when the two conditions are fulfilled. Unfortunately, only 21 observations remain out of 77, yet comparing Table 1's second column with Table 4 shows that the reaction by a treasury security's rates to an average Fed funds target change differs little from an "ideal" target change. The greatest difference is seen in the reaction by 10 and 30 year securities which differ by .03 from the ideal⁸. This should reassure that the response on the same day as the target change does not differ substantially due to measurement error. Further analysis will be done in part IV to measure treasury securities reactions both before and after the target change date.

III. The Three Regimes of 1985-1992

The story as presented so far, however, is deceptive. Based on logic described below, I analyze the time period between 1985 and 1992 as consisting of three distinct sub-periods in which the Fed's policy impulse yielded substantially different reaction by treasury market securities' rates.

III.A. Borrowed Reserves *and* Fed Funds Targeting

⁷ For support, I regressed the change in the Tbill rates on the target change and borrowed reserves target change for those episodes not reported in the WSJ and found near zero coefficients with a below zero adjusted R².

⁸ Surprisingly, "ideal" target changes were evenly distributed over the three regimes, 8 during Volcker, 5 during Greenspan I and 8 during Greenspan II; the latter had the best proportion of target changes that were ideal, at 40%.

The borrowed reserve target scheme remains in use officially and has been taken seriously by several researchers, e.g. Leeper (1995) pg. 9, Roberds, et.al (1996), Strongin (1995). Yet I find convincing evidence that the Fed has in fact abandoned borrowed reserves targeting to return to a direct Fed funds rate targeting regime⁹. For one, the average time between borrowed reserve "target" changes has decreased from 80 business days during Volcker's regime to 14 during the latter period of Greenspan's regime. Figure 1, plotting daily average borrowed reserves targets and the Fed funds target to discount differential over 1985-1992, shows that starting in late 1989, the Fed repeatedly changes borrowed reserves targets without corresponding changes in the differential. These frequent changes in borrowed reserves targets are more plausible if borrowed reserves were being used as indicator to support a Fed funds target rate. Figure 1 shows that the underlying pattern in borrowed reserves especially after 1989 is heavily influenced by a huge seasonal with annual frequency (the figure includes as orientation the fitted value of borrowed reserves resulting from a regression in daily levels of the borrowed reserves target on linear and quadratic trends with monthly dummies). The fitted policy relationship rises in the spring and summer and falls steeply in the fall and winter with exceptions in 1986 and early in 1989, when the Fed likely did maintain a borrowed reserves target¹⁰. The tight coincidence of the two lines argues strongly against a spurious relation. Support is also given by significant seasonal coefficients¹¹ in a regression in differences of borrowed reserve targets on the changes in the Fed funds to discount differential (and one lag) as well as the monthly dummies (Table 2). Further, autocorrelations (Figure 2) show the market Fed funds rate has adhered more closely to the target during the latter Greenspan regime. The market, as represented by the WSJ, certainly noted a difference: reports mentioned fully 18 of the 20 target changes the following day during the latter Greenspan regime, a

⁹ One conjecture for the abandonment of borrowed reserves targeting is that the Fed wanted an instrument that provided stronger signals to the market. Goodfriend (1991) gives as one of the advantages of borrowed reserves targeting that the Fed can avoid "news-making" policy, spreading the market reaction over several days. Perhaps the Fed changed to Fed funds targeting with the option of changing the target on settlement dates if it wants a "non-news-making" reaction (due to the high volatility of the Fed funds rate on these dates).

¹⁰ As can be seen from figure 1, the Fed funds - discount rate differential was historically very high during 1989 when the borrowed reserves target was running against the fitted seasonal.

¹¹ Coefficients were significantly negative for the months of October and November for the whole sample and positive for May during the Greenspan period.

much greater proportion than the 16 of 28 in the Volcker period or the 12 of 29 during the Greenspan borrowed reserves target period. I continue the analysis suggested by these results in part III.D below.

III.B. The Fed and the Governors

Another explanation for the different market rate reactions during the C&H and present studies is suggested by the WSJ "Credit Markets" column which reported distinctive management styles by Greenspan and Volcker. It is surprising that a difference can arise in the impact of monetary policy since the chairmen share a strong dislike for inflation. As reported in the WSJ, market participants were unclear about the direction of policy during Volcker's time. One remark not atypical of others, cited near the end of Volcker's tenure: "There is a malaise in the market ... a sense that no one is in control and that the markets are being pushed and pulled by every development." (WSJ, April 24, 1987). Monetarists accused the Fed of trying to obfuscate its actions. Friedman (1985), for example, thought that the Fed undertook excessive open market operations to hide their net effect and thus avoid responsibility. Finally, Volcker's comments before the Senate Banking Committee were often so obtuse that the press reported lengthy detailed debate on the precise interpretation of his words (WSJ, various issues). One example of the resulting volatility is that, according to Federal Reserve records, the Fed increased its targeted rate by 12 1/2 basis points on January 24th, 1985. Fed "watchers" quoted in the WSJ debated this point for over two weeks, a far cry from 1975-1979, when C&H describe analysts as almost always able to identify target changes on the same day. In stark contrast, Greenspan obviously cares about guiding the market, e.g. on Jan. 23, 1991, WSJ reported the Fed would ease so long as money growth did not accelerate. Since money supply figures are a focal point and published weekly, it gave credit markets a clear indication of the Fed's intentions.

Volcker's tactics may have been an clever adaptation to economic conditions. Volcker's contradictory goals mainly involved the long slide from highest yen/dollar exchange rate (260 yen per dollar) to the level agreed at the Louvre (the February, 1987 policy agreement preceded Greenspan's swearing-in on August 11, 1987). Many WSJ reports during this time made clear the Fed's dilemma between high interest rates to defend the dollar and low rates to avoid a recession.

In a very simple first attempt to ascertain the influence of the chairman on the impact of Fed policy, I construct a dummy variable taking the value of one during Greenspan's time as chairman. I interact this variable with the change in the targeted Fed funds rate to use in a regression including the change in borrowed reserves target as above. Nearly all explanatory power during 1985-1992 arises during Greenspan's chairmanship¹². A more detailed set of results will be presented and discussed below.

III.C. Treasury Market Responses of the Three Regimes

The final "same-day" specification of the model includes variables as motivated in parts III.A and III.B above. Based on this analysis, I divide 1985 - 1992 into three regimes. The Volcker period is a turbulent time when markets were divided in their expectation of the direction of the economy. Greenspan became chairman and continued a borrowed reserves target policy, but markets were reassured either through his leadership style or by the new international cooperation. Finally, Greenspan switched in a later period to direct Fed funds targeting, without commitment to defend some desired level of borrowed reserves. I fix the date of the second regime shift at October 19, 1989, after which borrowed reserves targets began to trace very closely the annual seasonal component (see figure 1). Although not based on statistical methods, this choice is logical and Chow tests are consistent with the regime shifts as shown in Table 3 (see also the third to fifth columns of Table 1).

There are stark differences between the regimes in the reaction of treasury market security rates. The smallest impact during the Volcker regime, a larger impact under the Greenspan I regime and finally, the strongest under the Greenspan II regime. This is not surprising. If markets did not receive strong signals from Volcker's Fed, any treasury rate reaction would be muted¹³. Finally, the reaction in the Greenspan II

¹² I do not evaluate the effectiveness of the Fed chairman. First, as noted above, one cannot separate the chairman from the period in which he governed. Further, I have not yet discussed the dynamic impacts of policy, i.e. Volcker may have moved market rates prior to the target date. Finally, even if the market's reaction over several days is also weaker during Volcker's regime, it is inappropriate to use influence over market rates as a sufficient statistic for the chairman's effectiveness.

¹³ The surprisingly weaker response of the market Fed funds rate under Greenspan I vs. Volcker is explained in part IV below: under Greenspan I, practically the entire response occurs on the two days prior to the official target change.

regime is similar to that reaction measured by C&H, further support that the Fed again pursues a direct Fed funds target. I continue the analysis using the total sample and also provide estimates separately for the Volcker, Greenspan-I and Greenspan-II regimes. For reasons to be described in part IV.D below, I consider the Greenspan II results to be reliable estimates of the impact of a policy change on the term structure. Estimates for Volcker and Greenspan I regimes will be reported in part IV.C below.

IV. Anticipation and Recognition

As discussed above, an anticipated target change may escape measurement since much of the impulse on the market may occur before the "event". After all, bond traders have high pecuniary incentives to anticipate Fed actions. A clever trader who infers an imminent Fed move to ease the Fed funds rate can, for example, purchase treasury bills to sell them later at a higher price once the Fed has implemented the lower rate. Event studies may also ignore reactions in the market if the price does not immediately attain an equilibrium level on the target change date. This recognition effect suggested by Goodfriend (1991) is especially likely during borrowed reserves target regimes since the Fed funds rate is not as clear a signal as during direct Fed funds target regimes¹⁴. Event studies are also sensitive to the issue of exogeneity of the independent variable. Later, I examine whether the changes in observed market rates are due to market participants' anticipations or the Fed reacting to changes in treasury rates. It may also be the case that both the Fed and markets follow a third impulse (e.g. indications of the state of the real economy).

There are also problems using estimations over several days to measure the impact. First, how should the start date of the multiple date target change episode be determined? In theory, it should begin when the market begins to anticipate, obviously an unobservable variable. As discussed in more detail below, I find no systematic significant relationships of treasury rates and the target change prior to four days before

¹⁴ In the study C&H probe two days before and after the event and find that treasury security rates do not change significantly prior to the event, although some short-term rates change after the event. Dale (1993) finds the Bank of England's policy moves induce large rate changes after the target change date.

the target change, so I define the "event" to have a duration of 9 days, 4 days prior to and 4 days after the target change¹⁵.

To isolate changes in market rates that arise due to anticipations of a Fed move, I define a qualitative variable that indicates days on which the WSJ reported market participants had formed a consensus on a projected Fed funds target change. This is important since whether the Fed is exogenous or not is contentious. Some researchers, for example Dale (1990), suggest the central bank may be influenced by market rates prior to a policy change. This is an argument that the Fed is endogenous to make suspect any inferences about the Fed's influence on market rates. Alternatively, Goodfriend (1991) suggests the Fed moves are exogenous since the Fed funds target is adjusted at irregular intervals only after sufficient information has been accumulated. The profit motive induces traders to react quickly to any news suggesting a possibly new market direction. The Fed, on the other hand, can insulate itself from the daily fluctuations to instead maintain a reputation for reliability. It constructs a model of the economy that evolves from a rigorous process to culminate in a decisive policy move. Understanding this, market participants thus gain information about the state of the economy in the timing and amount of a change in the Fed funds target. A study by Cook and Korn (1993) finds a significant reaction in interest rates to the change in employment announced in the monthly U.S. Labor Department report. As they argue, this is consistent with the market trying to mimic the Fed's decision process to move before the Fed does.

A final problem in using estimations over several days is that once the market anticipates that the Fed is to change its targeted Fed funds rate, the changes engendered in the term structure induce other reactions in the economy. This final problem may be considered as serious as time aggregation of weekly or monthly data. Given the market's volatile reaction to news, the average 9 day episode may be interpreted as the time required for the market to converge to a new configuration of rates following the target change.

In the remainder of part IV, I report measurements of changes in treasury security rates several days prior and subsequent to changes in the targeted Fed funds rate. After describing the rationale for using a 9-

¹⁵ In a previous draft, I defined episodes to begin 5 days prior to the target change. The significant relationships between long-term rates 5 days before the target change and the target changes, however, have since been found to be entirely due to reactions on 3 settlement dates in each of the three regimes. This casts considerable doubt on a robust relationship between target changes and market rates in the 5 day horizon.

day episode, I report results that show significant anticipatory and recognition effects. I then examine whether it is plausible that the market anticipates the Fed or if the Fed uses some interest rate as a gauge of the economic conditions.

IV.A. Reaction of Treasury Securities' Rates in the Nine-Day Episode

I first summarize the reaction of treasury securities rates, and thus the term structure, to changes in Fed funds rate targets during the entire 1985-1992 period. These results should be considered preliminary due to the evidence that different regimes were operative. Later, I report efforts to control for the most important remaining influences on rates.

Results of the cumulative regressions using the whole sample of 44 observations (third sub-column of each maturity in Table 5) confirm at least crudely the basic pattern found by C&H: short term rates react most strongly with a diminishing reaction by longer-term rates. In detail, however, there are interesting differences. The strongest reaction is by 3 and 6 month securities while the 1 and 3 year maturities react less (although the 3 year securities react strongly relative to the time studied by Cook and Hahn).

$$(3) \quad \Delta RTB_{-t+i} = \alpha + \beta_1 \Delta RFF^{TAR}_t + \beta_2 BR^{TAR}_{t+i} + u_{t+i} \quad s.t. i = -4, \dots, 0, \dots, 4$$

Interesting patterns are observed prior to the target changes (see Table 5). Significant reactions are measured in long-term rates on days T - 4 and T - 1 (in fact, the long-term bond reactions are stronger *before* the target date). Short-term rates' reactions prior to the target change date are more evenly distributed, e.g. the 6 month T-bill reacts significantly on each day prior to the target change. Further, the 3 year bond rate is apparently reacting similarly to both long- and short-term rates. On the day of the target change, the 3-year rate rises as much as short-term rates, yet longer-term rates do not react at all. On day T - 3 too, the 3-year bond reaction was closer to that of shorter-term rates than to longer-term rates. More insight into these anomalies can be gained by separating the sample into regimes discussed in part III. This will be done in part IV.C below. First, however, I address whether the Fed reacts to market rates to imply that anticipations are not responsible for the significant relationships in treasury security rates prior to the target change.

IV. B. Incorporating the Market's Anticipation of Fed Action

To measure market participants' anticipations of Fed policy, I use a qualitative criterion to select those episodes that were generally anticipated¹⁶. I carefully read the "Credit Markets" column in the WSJ to distinguish whether there existed a clear unanimous belief among analysts of an imminent change in Fed policy¹⁷. I emphasize that according to this algorithm, a day during an episode is anticipated only if there was reported to exist a *consensus* among market participants. Under other circumstances, lucky or skillful analysts anticipate the Fed, but since the beliefs are not widely shared, bond prices and hence interest rates are less likely to be influenced. The variable may be considered a lower bound, however, since there certainly were times when speculation of a Fed target change affected bond prices and yet the view of the market was not unanimous. In practice, classifying the market's Fed anticipations on individual days prior to the target changes is not subject to much ambiguity once it is decided to base the decision on a consensus view of a change in Fed policy. It is indicated by a phrase such as "most analysts believe..." and is confirmed by a thorough search through the article for any dissenting opinions. I follow this procedure for each day before a target change in each of the 44 episodes. The consensus criterion permits in most cases a clear judgement, although again it tends to be conservative. See appendix 1 for details about the decision regarding each episode.

$$(4) \quad \Delta RTB_{-t+i} = \alpha + \beta_1 \cdot \Delta RFF^{TAR}_t + \beta_2 (\Delta RFF^{TAR}_t * Fed.Antic_{t+i}) + u_{t+i} \quad s.t. i = -4, -3, -2, -1$$

I make regressions of equation (4) for each day prior to the target change. Included on the right-hand side is an interaction of the target change and the qualitative variable (given a value of one if the day of the episode is anticipated). A significantly positive β_2 with $\beta_1 = 0$ would support the exogeneity of Fed policy. Table 6 shows that on average, market participants significantly anticipate the Fed's policy move only two

¹⁶ The effects on treasury markets of speculators seeking to exploit expected Fed changes are well-known. One analyst illustrates clearly: "The market clearly is expecting a discount rate cut. If it doesn't happen, you can expect short-term rates to bounce back up. The market is already priced for a discount rate cut." (WSJ, May 17, 1985)

¹⁷ Cook and Hahn (1988) use a similar strategy to classify discount rate announcements as either leading or following the market during 1973-1985.

days before the actual target change. Several significant β_1 coefficients on days T - 3 and T - 4 raise doubts about the Fed's exogeneity. Further insight will be given below.

IV.C. Borrowed Reserves: Volcker or Greenspan?

The questions posed by the whole sample results in Table 6 beg for explanation. I thus examine the sample differentiating the Volcker and Greenspan I borrowed reserves regimes using interaction terms. I seek to find which regime or both is responsible for the day T - 4 reaction that was not, according to table 6, caused by anticipations. I am unable to include with confidence the Greenspan II observations in this analysis since with elimination of episodes brought only two values of the Fed funds target changes (easings of 25 and 50 basis points)¹⁸.

$$(5) \quad \Delta RTB_{-t+i} = \alpha + \beta_1 \cdot \Delta RFF^{TAR}_t + \beta_2 (\Delta RFF^{TAR}_t * GreenI_{t+i}) + u_{t+i} \quad s.t. i = -4, -3, -2, -1$$

The results show (see Table 7) that the day T - 4 reaction by long-term rates occurred only during the Volcker regime¹⁹. In fact, the first rate reactions prior to the target date during Greenspan I occurred on day T - 2, the same day there were significant anticipations as shown in Table 6. This may suggest to some that the Volcker Fed used long-term interest rates as indicator of real activity regularly 4 days prior to the actual target date. It is also consistent, however, with the market moving by anticipations: perhaps the qualitative variable I construct is simply too conservative. More credence for this argument is gained when we recall that Volcker did not encourage (an understatement) the market to form homogeneous expectations about the Fed's likely tactics. Accordingly, analysts anticipated the Fed moves, but there was no consensus in the market and this obscured the WSJ reporters perception.

¹⁸ During Greenspan II, the interaction term and target change are subject to high multicollinearity, (e.g. the correlation of the Fed funds target change and the interaction term was over .90 on day T - 1). Based on this strong relationship, I attribute to anticipations the treasury rates' responses on days before the target change.

¹⁹ Separate regressions on day T - 4 observations during the Greenspan I regime gave target change yielded very poor fit indeed, all adjusted R² were less than zero.

IV.D. Implications for the Expectations Theory

I find that borrowed reserves target changes bring such weak same-day treasury responses that they implausibly represent the entire change in treasury security rates to Fed policy changes. I thus interpret the cumulative nine-day response (table 7) as the impact on the term structure during these regimes. This is consistent with Goodfriend's (1991) characterization of this regime as spreading out a policy move's impact over several days. On the other hand, I use the same-day responses (table 1) to measure the impact on the term structure during the direct Fed funds rate target regime (Greenspan II). I justify this choice on several grounds. First, the market recognized (as reported in WSJ) the response in 18 of the 20 episodes. Second, the Fed funds rate reaction was very strong (Table 1). And finally, the reactions are comparable in magnitude to those found by C&H during the 1975-1979 direct Fed funds target regime (Table 1).

I compare borrowed reserves regimes (Volcker and Greenspan I) and the direct Fed funds rate regimes (Greenspan II to 1975-1979) to gain intuition of the implications of the results to the expectations theory. I thus construct an average monthly implied interest rate suggested by the constant term premium version of the expectations theory. Roughly, the lowest maturity reaction suggests an average monthly rate over its horizon. The next higher maturity reaction encompasses the earlier average, thus implying a monthly average for the horizon between the last month covered by the shorter reaction and the last month of its own horizon. Since the gap between maturities is up to twenty years (in the case of the longest maturity tested), the average gives a more intuitive view than by simply looking at the reaction itself.

An example should clarify this procedure. The Greenspan II reaction of the 3 month and 6 month treasury securities were .46 and .49 respectively. First I assume that the monthly average rate over months $t+0$, $t+1$, and $t+2$ is .46. Using the estimated 6 month reaction and the expectations theory gives us the average monthly rates for months $t+3$, $t+4$, and $t+5$. That is,

$$E.T. \Rightarrow \Delta RTB_t^6 = \frac{1}{6} \sum_{i=0}^5 [\Delta RTB_{t+i}^1] = \frac{3}{6} \overline{\Delta RTB_{0,1,2}^1} + \frac{1}{3} \sum_{i=3}^5 [\Delta RTB_{t+i}^1]$$

$$\Delta RTB_t^6 - .5 \overline{\Delta RTB^1_{0,1,2}} = \frac{1}{3} \sum_{i=3}^5 [\Delta RTB^1_{t+i}] \equiv \overline{\Delta RTB^1_{3,4,5}}$$

(where the overlined variables represent the implied average monthly rate over the horizon given in subscript). The average monthly of longer horizons are then constructed using the reaction of each succeeding longer term treasury securities reaction from table 1 (Greenspan II direct) and table 7 (Volcker and Greenspan I borrowed reserves schemes)²⁰. This is the method used to construct figures 3 and 4.

A comparison of borrowed reserves regimes on graph 4 shows that as a result of 1% tightening²¹, the two regimes differ most noticeably below the 36 month and over the five-year horizons. The public expected nominal interest rates to increase more under Greenspan I for the horizon to three years out. Later, however, it seems that the public expected Volcker's Fed to be more able to return short run rates to the pre-policy level. The average level over the above-10-year horizon during Greenspan I was approximately three times higher than during Volcker.

I compare direct Fed funds target change under Greenspan II to the time studied by C&H. This is interesting because, prior to the great Volcker switch to non-borrowed reserves targeting in 1979, the market had little confidence in the central bank's ability to restrain inflation. I will compare easings in this circumstance since Greenspan II policy moves were only of this type. In this case, however, a conservative central banker such as Greenspan would be understood not to be prone to ease excessively and we can thus hypothesize that the market would expect inflation not to be excited by a central bank under such a chairman. In this case, inflation expectations over the long run would be lower than in the earlier direct Fed funds rate regime. And thus the reaction in long run rates should be greater. According to figure 4, this is exactly what

²⁰ Implied average monthly rate changes shown in figures 3 and 4 include reaction by 5 and 7 year securities not presented in tables 1 and 7 for space reasons. Point estimates for Volcker: .56 and .38; Greenspan I: .70 and .62; Greenspan II: .37 and .31 for the 5 and 7 year maturities, respectively.

²¹ For simplicity, I assume the Fed policy move occurs to a flat term structure.

I find. Starting at the 12 month horizon, short-term rates are expected to be lower under Greenspan II than during the time studied by C&H. Despite the similarity in average monthly rates implied by the short-term reactions, there is a consistent and large gap between the Feds over the longer horizon.

V. Conclusion

First, I find a large amount of seasonality in borrowed reserves targets at an annual frequency, which corresponds to an agricultural cycle, rising in the spring and declining in the autumn. This leads to suspect that the Fed no longer "defends" a target for borrowed reserves, but follows the demand for reserves incorporated in this seasonal cycle. This is a partial basis for concluding that the Fed has actually, if not officially, abandoned borrowed reserves targeting and now uses a direct Fed funds rate to aim for non-inflationary growth. The conclusion is supported by a closer adhesion of the Fed funds rate to the target and larger same-day responses to target changes (similar indeed in size to a previous direct Fed funds target regime). That the Fed again uses direct Fed funds targeting is likely a reason that the Fed funds rate is again an excellent indicator of Fed policy, as found by Bernanke and Mihov (1995).

Paying close attention to the sub-periods shows that the weaker market reaction to the Fed using the whole sample is explained by differences in each regimes. The weakest response occurs during the time presided by Volcker which I attribute to either signalling (Volcker's style was to emit no clear signals to the market so expectations were "heterogenous" while Greenspan's market leadership forged more "homogeneous" expectations), to expectations differences arising from differing activity within the periods or to bias in the estimates due to the Fed using bond rates as indicator variable. The latter Greenspan direct Fed funds targeting regime reactions are comparable in size and fit to the C&H results corresponding to an earlier direct Fed funds targeting regime. With respect to the term structure, I find that the average monthly interest rates implied by the expectations theory is consistent with the pattern of actual treasury rate reactions. For the borrowed reserves target regimes, I find the initially weaker reaction during the Volcker regime is offset by a strong reaction by 5 year rates to bring monthly rates near to the pre-policy shock rate over the 5-7 year horizon. The reversion to the pre-policy shock rate comes within a 7-10 year horizon under the first

Greenspan regime. I also compare implied monthly interest rate after a policy shock between direct Fed funds rate regimes of the latter Greenspan regime and the 1975-1979 Fed. I find that after a policy easing, the market expects the monthly rate to remain at a lower level throughout a horizon of at least 20 years. This is consistent with expectations of a Fed that is able and willing to contain inflation: although it is easing, the public puts a lower expected value on inflation over the foreseeable future.

Appendix 1: Anticipations of Fed Target Changes in Specific Episodes

This appendix gives examples of language in the "Credit Markets" column of the WSJ to illustrate the logic for categorizing whether each date within the 44 episodes (1985 - 1992) was subject to a unanimous expectation of a target change. Dates reported in the WSJ are those appearing in print the day following the day given in the second column. Since I use the WSJ to uncover whether the market was anticipating the Fed or the Fed was responding to the long-term interest rates, I omit days subsequent to the target change; i.e. the target change date is the final date listed in the 2nd column of the table.

| Epi- sode | Date | Fed Move | Ant Fed | <u>Wall Street Journal</u> "Credit Markets" description of episode |
|--------------|---------------------------|-------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Jan.17 - 24, 1985 | Tight | 0 | Government reports indicated lower inflation. On Jan. 18: "Fed will stick to easy money policy for the next few weeks". On Jan. 23 (the day before the target change) "investors are beginning to believe inflation will stay at low levels". |
| 2 | July 5 - 11, 1985 | Ease | 0 | On July 10, day before target change, "Concern about dollar may prevent Fed from easing" But there was pressure to ease (Kemp telegram to Fed requesting discount rate cut). |
| 3 | July 19 - 25, 1985 | Tight | 0 | On July 23, reporter noted "market is wandering aimlessly". |
| 4 | Dec. 12 - 18, 1985 | Ease | 0 | This is a difficult one to call. On Dec. 13, "pressures are mounting for the Fed to ease ... many analysts say...". On Dec. 16 (Monday), Kaufman was reported to predict lower rates; the market acted on his comments, with rates going lower. Opinions were noted to differ, however. On Dec. 17, "many say the Fed appears to have adopted an easier credit policy..." But later in the same article, "many analysts argue that the [FOMC] probably voted to maintain the easier credit conditions of recent weeks". I assign the value of 1 to anticipated Fed move only on Dec. 17. |
| 5 | Mar. 3 - 7, 1986 | Ease | 1 | The market did not widely expect the Fed to move until March 6. On March 4, for example, "pressure on Fed intense to cut rate if Germany and Japan cut." was followed by "... but others disagree". The Mar. 6 headline was "Bond prices rise on wide expectations of cut in discount rate". |
| 6 | May 16 - 22, 1986 | Tight | 0 | The concern apparent in the WSJ was on likely inflation from oil price increases. On May 19, was reported "oil price increase cuts optimism about inflation and strengthens argument that Fed won't ease". However, oil prices eased and "dollar played an increasingly influential role". |
| 7 | May 30 - Jun. 5, 1986 | Tight | 0 | On June 3, Treasury secretary Baker announced that there was "room for further decline in rates", but this did not result in a widely expected Fed move. |
| 8 | Jul. 7 - 11, 1986 | Ease | 1 | On July 8, "speculation that Fed will lower discount rate has swept through market for weeks leading many investment managers to contend that bond prices already reflect such a move". The discount rate change was announced a day before it became effective. |
| 9 | Nov. 28 - Dec. 4, 1986 | Tight | 0 | The Fed's tightening move was clearly unanticipated since the headline on Dec. 3 was "Bond Prices rise as belief grows Fed will ease in coming months" |

| Episode | Date | Fed Move | Ant Fed | <u>Wall Street Journal</u> "Credit Markets" description of episode |
|---------|-----------------------|----------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 10 | Apr. 24 -30, 1987 | Tight | 1 | Expectations of a policy move grew from Apr. 24 when "some analysts say the Fed will react soon ..." to Apr. 27 (the next Monday): "... a growing number of analysts. They say the Fed has tightened its credit hold slightly ..." On the next day, "Speculation that the Fed has tightened has been widespread for weeks now." I assigned Fed expectation to 1 starting on the 28th. |
| 11 | May 15 - 21, 1987 | Tight | 0 | Inflation was feared throughout this episode. For example, May 19: "...concern about inflation was responsible for the big sell-off in financial futures...". No great concern about a Fed move. |
| 12 | Jun. 26 - Jul 2, 1987 | Ease | 0 | WSJ characterized this episode as "lackluster" with little activity by market participants. |
| 13 | Sep. 18 - 24, 1987 | Tight | 0 | On Sept 21, Greenspan stated that there was little evidence of inflation. Little about expectations of a Fed move was reported during this episode. |
| 14 | Jan. 22 - 28, 1988 | Ease | 0 | A clear example of unanticipated Fed policy: headline for Jan. 26, the day before the Fed eased: "Bond [prices] decline as durable goods report indicates Fed easing is unlikely soon". |
| 15 | Feb. 5 - 11, 1988 | Ease | 1 | Anticipation of Fed move illustrated by headline for date of Feb. 9: "Short Term rates fall as speculation grows that the Fed is easing slightly". Also "... the market smells Fed ease." |
| 16 | Mar. 14 - 30, 1988 | Tight | 0 | Fed move unanticipated: on Mar. 28 "most agree that a credit-tightening move isn't likely any time soon". |
| 17 | May 3 - 9, 1988 | Tight | 1 | On May 6, "Almost every analyst believes that rates are going up". |
| 18 | May 19 -25, 1988 | Tight | 0 | Inflation, central during this episode (May 19: "commodity prices dominated the credit markets", although May 23 lower prices were noted), led to "growing speculation that the Fed may tighten", but had not become unanimous by the time of the Fed policy move. |
| 19 | June 16 - 22, 1988 | Tight | 1 | June 16 headline: "Bonds sag as inflation fear flares up...". This culminated in the headline of June 20 "...allowing new rise in Fed Funds rate to curb inflation". |
| 20 | July 13 - 19, 1988 | Tight | 0 | Greenspan quoted as saying Fed would "err on the side of restrictiveness", but no clear indication of anticipation of the Fed's policy move. |
| 21 | Oct. 14 - 20, 1988 | Tight | 0 | WSJ did not note any widespread anticipation of policy move by Fed. |
| 22 | Dec. 9 - 15, 1988 | Tight | 1 | For Dec. 9, the headline indicated that the market already believed that the Fed was tightening: "Fed seems to have tightened policy slightly..." (this is 4 days before the actual policy change). |
| 23 | Apr. 28 - May 4, 1989 | Tight | 0 | Inflation was problem leading up to the Fed change, but abated with lower oil prices and more favorable government reports. On May 3 it was reported that the "beige book" released by Fed indicated that "inflationary pressures may be easing" and this increased the likelihood of Fed keeping the target steady. |

| Episode | Date | Fed Move | Ant Fed | <u>Wall Street Journal</u> "Credit Markets" description of episode |
|---------|------------------------|----------|---------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24 | May 31 - June 6, 1989 | Ease | 1 | Opinions on whether the Fed would ease or not were divided until the release of the employment report on June 2 which resulted in the headline "Fed likely to reduce rates soon" |
| 25 | June 30 - July 7, 1989 | Ease | 1 | On June 30, "bond prices surged again as speculation grew that the Fed will cut short term interest rates soon." On July 6, an analyst was quoted "We had 3 questions last week: whether the Fed would ease, when and by how much. We've got 2 out of 3. How much ... will sort itself out by Monday or Tuesday." (this appeared in the WSJ the day the Fed eased). |
| 26 | July 21 - 27, 1989 | Ease | 1 | On July 21: "many economists are warning their customers not to expect the Fed to ease any further until August... - if then". But on July 25 "speculation that the Fed is allowing interest rates to move lower gained momentum yesterday when the Fed failed to enter the market during its normal pre-noon intervention period." [it had not drained reserves, as predicted]. The next day's headline was "Bond Prices Mark Time as Further signs emerge the Fed is easing". |
| 27 | Aug. 4 - 10, 1989 | Ease | 0 | Anticipations in this episode were set by an unexpectedly strong employment report and "speculation that the Fed had paused in its march toward lower interest rates". This appeared for Aug. 4. News in the remainder of the episode centered on the treasury's bond sales. |
| 28 | Oct. 12 - 18, 1989 | Ease | 1 | Anticipations were aroused early this episode. On Oct. 12, the headline: "Treasury Bonds rise modestly on speculation that Fed is letting rates ease slightly". Problems in the junk bond and stock markets influenced trading in the bond markets. |
| 29 | Oct. 31 - Nov. 6, 1989 | Ease | 0 | Oct. 31: A sharper than expected fall in sales of single-family homes aroused the anticipation of the market to the hope that the Fed would cut rates. This was not universal, however, and the market was described as waiting for the results of the difficult-to-predict employment report. |
| 30 | Dec. 14 - 20, 1989 | Ease | 0 | Junk bonds were in trouble, but the Fed did not act to ease credit conditions at the convenience of the traders. Dec. 18: "Many are sniping at the Fed for failing to cut rates". And: "Although there are widespread expectations that the Fed will eventually ease credit conditions further, uncertainty about the timing of the move is keeping many investors out of the market." |
| 31 | July 9 - 13, 1990 | Ease | 0 | There was little anticipation by market participants during this episode until July 12 (the day before the target change) when Greenspan "surprised the bond market ... to ease credit conditions". |
| 32 | Oct. 23 - 29, 1990 | Ease | 0 | There was some anticipation of a Fed move on Oct. 25, not widespread. Then on Oct. 26, a budget agreement in congress put pressure on the Fed to cut since they had indicated they would if this were to happen. |
| 33 | Nov. 7 - 14, 1990 | Ease | 1 | On Nov. 13, speculation about the Fed "supported short-term Treasury securities". "Many investors expect the Fed to ease as early as today". |
| 34 | Jan. 3 - 9, 1991 | Ease | 0 | On Jan. 7 & 8, mid-east war fears raised oil prices to stoke inflation fears. On Jan 8, the market recognized a Fed easing (a day before the target change) |
| 35 | Jan. 28 - Feb 1, 1991 | Ease | 0 | A low-volume episode when market participants were waiting for results from the employment report and news from the war in Kuwait. |

| Episode | Date | Fed Move | Ant Fed | <u>Wall Street Journal</u> "Credit Markets" description of episode |
|---------|------------------------|----------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 36 | Mar. 4 -8, 1991 | Ease | 0 | Market participants were unsure whether the end to the war in Kuwait would bring an end to the recession. |
| 37 | Apr. 24 - 30, 1991 | Ease | 1 | On Apr. 24, institutional investors were reported buying in anticipation of Fed action. Pres. Bush pressured for lower rates, reported for Apr. 25. On Apr. 26 "The Fed will probably cut both the discount rate and Fed funds rate this spring, many analysts say". |
| 38 | Jul. 31 - Aug. 6, 1991 | Ease | 0 | On Aug. 2, "economy now looks increasingly wobbly, that inflation pressures will subside and that the Fed probably cut interest rates later this month or early September". A bond rally on Aug. 6 was attributed to the "surprise" target change by the Fed shows that the majority of market participants were unwilling to commit themselves. |
| 39 | Sept 9 - 13, 1991 | Ease | 1 | On Sept. 11, traders were nervous about the inflation implications from an expected labor department report. The Sept. 12 headline, "...amid signs Fed will act soon to push interest rates lower.", was based on remarks by a Fed official. |
| 40 | Dec. 2 - 6, 1991 | Ease | 0 | An unexpected episode. On Dec. 4 (day before the target change) it was reported that participants expected that "pressure on the Fed to cut rates is likely to surge if tomorrow's employment report indicates economic decay..." |
| 41 | Dec. 16 - 20, 1991 | Ease | 1 | On Dec. 16, prior to planned new bonds sales, "It's widely expected in the markets that the FOMC will authorize another ...cut in the Fed funds rate." |
| 42 | Apr. 3 - 9, 1992 | Ease | 1 | On Apr 6, there was a "...small possibility the Fed may ease...". Then on Apr. 7, the headline "Bond prices move higher as expectations grow that Fed will cut rates soon to spur economy". There followed a discussion about whether the Fed had already eased (it hadn't). However, the next day, it was noted "Economists don't believe ..a sign that the Fed is easing". |
| 43 | June 26 - July 2, 1992 | Ease | 1 | A heavily anticipated episode. Many economic indicators signalled a slowing economy which analysts believed would compel the Fed to ease credit conditions. On June 29, headline "Bill rates at auction decline to 20 year lows as sentiment grows that Fed will ease credit". and June 30 headline "...speculation continues over likelihood of Fed rate cut". |
| 44 | Aug. 31 - Sept 4, 1992 | Ease | 0 | This was an episode which had very light activity reported since bond market participants were waiting for results from the employment report. |

The dummy variable, anticipation of Fed target change, is assigned the value of 1 if the Wall Street Journal indicated the market was unanimously expecting the Fed to move. Although each individual day has its own value for the variable in the data, the third column in the above table summarizes each episode. So, for example, when only one day of the episode was affected by inflation, the column is marked 0, but for that day the dummy variable is assigned the value of 1.

References:

- Allen, Linda, Stavros Peristiani, and Anthony Saunders (1989) "Bank Size, Collateral, and Net Purchase Behavior in the Federal Funds Market: Empirical Evidence" Journal of Business 501-515
- Balduzzi, Pierluigi, Giuseppe Bertola and Silverio Foresi (1993) "A Model of Target Changes and the Term Structure of Interest Rates" NBER Working Paper 4347
- Bernanke, Ben (1990) "The Predictive Power of Interest Rates and Interest Rate Spreads" New England Economic Review
- Bernanke, Ben and Ilian Mihov (1995) "Measuring Monetary Policy" NBER Working Paper
- Campbell, John Y. (1995) "Some Lessons from the Yield Curve" Journal of Economic Perspectives
- Cook, Timothy and Thomas Hahn (1989) "The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s" Journal of Monetary Economics
- Cook, Timothy and Thomas Hahn (1988) "The Information Content of Discount Rate Announcements and Their Effect on Market Interest Rates" Journal of Money, Credit, and Banking
- Cook, Timothy and Steven Korn (1991) "The Reaction of Interest Rates to the Employment Report: the Role of Policy Anticipation" Federal Reserve Bank of Richmond Economic Review
- Dale, Spencer (1990) "The Effect of Changes in Official UK Rates on Market Interest Rates Since 1987" Bank of England Working Paper
- Friedman, Milton (1985) "The Case for Overhauling the Fed" in Wilcox, ed. Current Readings on Money, Banking and Financial Markets 243-251
- Goldfeld, Stephen and Edward Kane (1966) "The Determinants of Member Bank Borrowing: An Econometric Study" Journal of Finance 499-514
- Goodfriend, Marvin (1984) "The Promises and Pitfalls of Contemporaneous Reserve Requirements for the Implementation of Monetary Policy" Federal Reserve Bank of Richmond Economic Review
- Goodfriend, Marvin (1991) "Interest Rates and the Conduct of Monetary Policy" Carnegie-Rochester Series on Public Policy 34 7-30
- Goodfriend, Marvin and William Whelpley (1986) "Federal Funds: Instrument of Federal Reserve Policy" Federal Reserve Bank of Richmond Economic Review
- Hamilton, James D. (1995) "The Daily Market for Fed Funds" Journal of Political Economy
- Ho, Thomas and Anthony Saunders (1985) "A Micro Model of the Federal Funds Market" Journal of Finance 977-987
- Leeper, Eric M. (1995) "Reducing Our Ignorance about Monetary Policy Effects" Federal Reserve Bank of Atlanta Economic Review
- Mankiw, Gregory and Jeffrey Miron (1986) "The Changing Behavior of the Term Structure of Interest Rates" Quarterly Journal of Economics
- Nilsen, Jeffrey H. (1994) unpublished Ph.D. dissertation, Princeton University

Peristiani, Stavros (1991) "The Model Structure of Discount Window Borrowing" Journal of Money, Credit, and Banking 13-34

Rivera-Batiz, F. and L. Rivera-Batiz (1994) International Finance and Open Economy Macroeconomics

Roberds, William, David Runkle, and Charles Whiteman (1996) "A Daily View of Yield Spreads and Short-term Interest Rate Movements" Journal of Money, Credit, and Banking 34-53

Rudebusch, Glenn D. (1995) "Federal Reserve Interest Rate Targeting and the Term Structure" Journal of Monetary Economics

Shiller, Robert J.(1990) "The Term Structure of Interest Rates" Handbook of Monetary Economics

Stigum (1990) The Money Market Irwin

Strongin, Steven (1995) "The Identification of Monetary Policy Disturbances; Explaining the Liquidity Puzzle" Journal of Monetary Economics

Wall Street Journal (1985-1992) "Credit Markets" various dates

Table 1
Same-Day Reaction of Treasury Security Rates
To Fed Funds Target Change

| Dep. | Ind. | Simple (141 obs) | All (141 obs) | Volcker (37 obs) | Green I (34 obs) | Green II (70 obs) | Cook & Hahn |
|---------------|--------------------|---------------------|---------------------|---------------------|---------------------|----------------------|-----------------|
| \bar{R}^2 | DW: | .03 2.11 | .21 1.88 | .31 1.90 | -.06 1.82 | .32 1.81 | |
| ΔRFF | ΔRFF^{TAR} | .40 (1.76) | .72* (3.31) | .72* (3.99) | 0.32 (1.52) | 1.39* (2.71) | |
| | ΔBR^{TAR} | | .0004 (.80) | .0011 (.66) | .0005 (.81) | .0006 (.69) | |
| | F.Thur.IA | | -2.02* (-3.63) | -2.52** (-2.35) | -.86 (-1.73) | -3.80* (-3.11) | |
| \bar{R}^2 | DW: | .25 1.80 | .32 1.98 | .14 2.24 | .28 2.15 | .59 2.09 | .47 1.89 |
| $\Delta 3mo$ | ΔRFF^{TAR} | .23* (4.15) | .29* (4.91) | .13 (1.45) | .30* (3.40) | .46* (7.74) | .55* (8.10) |
| | ΔBR^{TAR} | | -.0003** (-2.42) | -.0007 (-1.66) | -.0002 (-1.45) | -.0002 (-1.61) | |
| | F.Thur.IA | | -.23** (-1.91) | -.33** (-2.31) | -.11 (-.76) | -.18 (-.77) | |
| \bar{R}^2 | DW: | .27 1.92 | .35 2.06 | .06 2.04 | .27 2.51 | .63 2.12 | .59 1.82 |
| $\Delta 6mo$ | ΔRFF^{TAR} | .24* (4.57) | .31* (5.42) | .13 (1.55) | .32* (3.51) | .49* (9.12) | .54* (10.25) |
| | ΔBR^{TAR} | | -.0002** (-2.21) | -.0004 (-1.01) | -.0002 (-1.66) | -.0002 (-1.31) | |
| | F.Thur.IA | | -.29* (-2.87) | -.30** (-2.10) | -.25 (-1.87) | -.23 (-1.82) | |
| \bar{R}^2 | DW: | .24 2.04 | .30 2.11 | .11 2.22 | .22 1.96 | .55 2.21 | .56 1.94 |
| $\Delta 12mo$ | ΔRFF^{TAR} | .23* (4.58) | .27* (5.20) | .15 (1.69) | .13** (2.50) | .48* (7.81) | .50* (9.61) |
| | ΔBR^{TAR} | | -.0001 (-1.59) | -.0003 (-.75) | -.0001 (-1.19) | -.0001 (-.76) | |
| | F.Thur.IA | | -.22** (-2.16) | -.41* (-2.98) | .11 (1.13) | -.33* (-2.79) | |
| \bar{R}^2 | DW: | .15 2.17 | .17 2.20 | .06 2.07 | .23 1.87 | .32 2.35 | .46 1.59 |
| $\Delta 3yr$ | ΔRFF^{TAR} | .19* (4.21) | .23* (5.01) | .19** (1.93) | .13* (2.96) | .40* (5.80) | .29* (7.87) |
| | ΔBR^{TAR} | | -.0001 (-1.37) | -.0001 (-.24) | -.0002** (-2.78) | .0001 (.75) | |
| | F.Thur.IA | | -.19 (-1.69) | -.46** (-2.25) | .17 (1.49) | -.51* (-3.19) | |
| \bar{R}^2 | DW: | .04 2.03 | .05 2.04 | .00 2.01 | .08 1.57 | .20 2.22 | .32 1.94 |
| $\Delta 10yr$ | ΔRFF^{TAR} | .09** (2.11) | .13** (2.67) | .09 (.82) | .09** (2.15) | .26* (4.35) | .13* (5.85) |
| | ΔBR^{TAR} | | -.0001 (-1.24) | -.0001 (-.15) | -.0001** (-2.18) | .0001 (.85) | |
| | F.Thur.IA | | -.14 (-1.46) | -.40** (-2.19) | .13 (1.30) | -.46* (-3.30) | |
| \bar{R}^2 | DW: | .02 2.02 | .02 2.04 | -.03 2.05 | .06 1.66 | .16 2.09 | .29 2.04 |
| $\Delta 30yr$ | ΔRFF^{TAR} | .06 (1.58) | .09** (2.07) | .03 (.35) | .09** (1.95) | .21* (4.15) | .10* (5.46) |
| | ΔBR^{TAR} | | -.0001 (-1.31) | .0000 (-.01) | -.0001** (-2.03) | .0000 (.25) | |
| | F.Thur.IA | | -.10 (-1.17) | -.30** (-1.92) | .11 (1.13) | -.40* (-3.10) | |

Constants were included in the estimations, but were economically small and significant only in two cases (the 30 bond rate during Greenspan I and the Fed funds rate for the entire sample). I also allowed for changes in First Thursday intercepts which were only significant for the long-term bonds in the Greenspan II regime. The t-statistics in parentheses are calculated using errors corrected for heteroskedacity according to White or Huber.

Table 2
Incentive for Borrowed Reserve and Seasonals

| Dep: ΔBR^{TAR} | Sample 1983 | Volcker 648 | Green I 534 | Green II 801 |
|-------------------------------|--------------------|------------------|-------------------|-------------------|
| \bar{R}^2 DW | 0.16 2.18 | 0.08 2.13 | 0.28 2.07 | 0.22 2.06 |
| $\Delta(RFF^{TAR}-dis)_t$ | 114.11* (4.98) | 51.27 (1.86) | 255.24* (5.13) | 116.32* (6.48) |
| $\Delta(RFF^{TAR}-dis)_{t-1}$ | 2.24 (1.31) | 17.69 (1.60) | 0.75 (0.93) | 9.63 (0.57) |
| mo2 | 0.33 (0.30) | -0.16 (-0.13) | -0.36 (-0.20) | 1.16 (1.55) |
| mo3 | -0.19 (-0.13) | 0.91 (0.98) | -4.40 (-0.97) | 1.15 (1.30) |
| mo4 | 1.29 (1.47) | 2.36 (1.56) | -0.73 (-0.73) | 1.87 (1.75) |
| mo5 | 2.58 (1.77) | -0.36 (-0.17) | 2.89 (1.04) | 4.11** (2.08) |
| mo6 | 1.24 (1.28) | -0.03 (-0.11) | -1.92 (-1.41) | 4.58** (2.42) |
| mo7 | 1.59 (1.37) | 0.12 (0.20) | 3.64 (0.87) | 2.22 (1.64) |
| mo8 | 0.61 (0.56) | 1.75 (1.32) | -1.45 (-0.59) | 1.04 (1.10) |
| mo9 | 0.28 (0.31) | 2.33 (1.32) | -0.24 (-0.15) | -1.52 (-1.33) |
| mo10 | -3.01** (-2.80) | 0.66 (1.94) | -1.73 (-0.85) | -5.73* (-2.98) |
| mo11 | -4.68** (-2.75) | -0.71 (-0.51) | -7.77 (-1.22) | -5.07* (-3.13) |
| mo12 | -1.84 (-1.67) | -1.55 (-0.78) | -3.25 (-1.26) | -1.95 (-1.68) |

All regressions included constants which were insignificantly different from 0 and also linear and quadratic trend terms which were significant only at the time of Volcker. *, ** denote significance at 1% and 5% levels respectively.

Table 3
Chow Tests of Treasury Security Response to Fed Funds Target Changes
During Volcker, Greenspan I and Greenspan II Regimes

| | | ΔRFF | $\Delta 3$ mo | $\Delta 6$ mo | $\Delta 12$ mo | $\Delta 3$ yr | $\Delta 10$ yr | $\Delta 30$ yr |
|------------------------------------------------|--------------------|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| | \bar{R}^2 | .24 | .42 | .42 | .39 | .21 | .10 | .07 |
| Volcker (BR ^{TAR}) | ΔRFF^{TAR} | .72** (2.42) | .13** (2.14) | .13** (2.14) | .15** (2.39) | .19** (2.61) | .09 (1.30) | .03 (0.52) |
| | ΔBR^{TAR} | .001 (0.83) | -.0007** (-2.34) | -.0004 (-1.35) | -.0003 (-0.90) | -.0001 (-0.32) | -.0001 (-0.21) | -0 (-0.01) |
| | F.Thur.IA | -2.52* (-3.92) | -.33* (-2.55) | -.30** (-2.21) | -.41* (-3.10) | -.46* (-2.91) | -.40* (-2.71) | -.30** (-2.22) |
| Green I (BR ^{TAR}) | ΔRFF^{TAR} | -.40 (-0.78) | .17 (1.65) | .19 (1.74) | -.01 (-0.13) | -.06 (-0.47) | -.00 (-0.00) | .05 (0.49) |
| | ΔBR^{TAR} | -.0007 (-0.43) | .0005 (1.56) | .0002 (0.72) | .0002 (0.55) | -.0001 (-0.21) | -.0001 (-0.22) | -.0001 (-0.39) |
| | F.Thur.IA | 1.66 (1.82) | .22 (1.22) | .05 (0.25) | .52** (2.78) | .63* (2.81) | .53** (2.54) | .41** (2.14) |
| Green II (Direct RFF ^{TAR}) | ΔRFF^{TAR} | .67 (1.55) | .33* (3.75) | .36* (3.90) | .34* (3.73) | .21** (1.92) | .17 (1.74) | .18** (1.94) |
| | ΔBR^{TAR} | -.0005 (-0.33) | .0004 (1.24) | .0002 (0.58) | .0001 (0.36) | .0003 (0.61) | .0002 (0.51) | 0 (0.11) |
| | F.Thur.IA | -1.28 (-1.21) | .16 (0.73) | .07 (0.30) | .08 (0.36) | -.05 (-0.20) | -.06 (-0.23) | -.10 (-0.47) |
| | Chow:pr >F | .16 | 0 | .01 | 0 | .07 | .06 | .09 |

The model also included constants, and allowed for changing intercepts in each regression. They were in all cases insignificantly different from 0. *, ** represent significance at the .01 and .05 levels, respectively.

Table 4
Responses of Treasury Security Rates to "Ideal" Target Changes

| 21 obs | ΔRFF | $\Delta RTB3$ | $\Delta RTB6$ | $\Delta RTB12$ | $\Delta RTB3y$ | $\Delta RTB10y$ | $\Delta RTB30y$ |
|--------------------|--------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| \bar{R}^2 | 0.48 | 0.60 | 0.67 | 0.53 | 0.44 | 0.29 | 0.31 |
| DW: | 1.91 | 1.79 | 1.27 | 1.40 | 1.85 | 1.86 | 1.92 |
| ΔRFF^{TAR} | 1.286 ** (2.28) | 0.277* (7.34) | 0.278* (7.09) | 0.228* (5.68) | 0.208* (4.36) | 0.099** (2.05) | 0.116* (2.74) |
| ΔBR^{TAR} | 0.0018 (0.94) | -0.0019* (-6.93) | -0.0016* (-6.26) | -0.0012* (-5.06) | -0.0011* (-4.57) | -0.0013* (-5.05) | -0.0011* (-4.85) |
| F.thurs | 0.324** (2.19) | 0.088** (2.47) | 0.098* (3.78) | 0.105* (3.42) | 0.076* (2.73) | 0.062** (2.58) | 0.049** (2.30) |
| F.thurs.IA | -3.589* (-5.06) | 0.1862 (0.92) | 0.204 (1.36) | 0.157 (0.95) | 0.339** (2.42) | 0.403* (3.20) | 0.343* (3.05) |
| cons | -0.07 (-1.08) | -0.07* (-4.90) | -0.07* (-5.49) | -0.07* (-5.53) | -0.06* (-4.07) | -0.04** (-2.59) | -0.03* (-2.73) |

All regressions are reported with standard errors corrected for heteroskedasticity according to Huber/White. t-statistics are reported below coefficient estimates in parentheses. *, ** represent significance at the .01 and .05 levels, respectively.

Table 5
Changes in T-bill Rates Pre- and Post- Target Change

| 44 obs | Fed funds | | 3 mo T-bill | | 6 mo T-bill | | 12 mo T-bill | | 3yr T-bond | | 10yr T-bond | | 30yr T-bond | |
|-------------|-----------------|-----|-----------------|------|-----------------|------|-----------------|-----|-----------------|-----------------|-------------|-----------------|-------------|-----------------|
| | β | Cum | β | Cum. | β | Cum. | β | Cum | β | Cum | β | Cum | β | Cum |
| Episode Day | | | | | | | | | | | | | | |
| T - 4 | -.10 (-1.16) | .06 | .11 (1.46) | .05 | .12** (1.94) | .05 | .10** (2.96) | .05 | .15** (2.46) | .10** (1.99) | .07 | .11** (2.12) | .08 | .11** (2.12) |
| T - 3 | .36* (3.36) | .20 | .09** (2.11) | .01 | .10** (2.34) | .04 | .09** (2.03) | .01 | .10 (1.79) | .04 (0.71) | .00 | .03 (0.56) | .00 | .16** |
| T - 2 | .03 (.21) | .15 | .10** (2.37) | .06 | .11** (2.77) | .04 | .04 (0.82) | .00 | -.00 (-.06) | -.01 (-0.19) | .00 | -.03 (-0.54) | .00 | .12** |
| T - 1 | -.12 (-4.8) | .00 | .07 (1.07) | .00 | .11** (2.71) | .12 | .07** (2.27) | .05 | .10* (3.12) | .09* (3.19) | .14 | .07* (2.82) | .18 | .15** |
| T | 1.07* (3.01) | .33 | .22** (2.60) | .21 | .24* (2.93) | .26 | .24* (3.15) | .27 | .18* (3.12) | .06 (.97) | .01 | .01 (0.25) | .00 | .08 |
| T + 1 | .15 (1.78) | .00 | .04 (1.57) | .00 | .03 (1.38) | .00 | .06 (1.56) | .03 | .09** (2.42) | .13** (2.61) | .07 | .09** (2.36) | .06 | .26* |
| T + 2 | .04 (0.19) | .06 | .09* (3.17) | .21 | .07** (2.55) | .07 | .06 (1.53) | .04 | .09** (1.95) | .06 (1.34) | .00 | .05 (1.05) | .00 | .31* |
| T + 3 | .01 (.11) | .19 | .11 (1.72) | .03 | .05 (0.98) | .00 | .00 (0.11) | .02 | -.01 (-.13) | -.03 (-.57) | .00 | -.03 (-.59) | .00 | .12 |
| T + 4 | .16 (1.12) | .01 | -.03 (-.51) | .03 | -.01 (-.19) | .23 | -.02 (-.82) | .09 | -.01 (-.39) | -.03 (-.76) | .00 | -.03 (-.87) | .00 | .29** |

Regressions included the cumulative change in borrowing targets and also first Thursday dummy variables for each day. The cumulative columns are obtained from separate regressions including the cumulative borrowing targets and thus may differ slightly from the sums of the individual regression on preceding days. *, ** represent .01 and .05 levels respectively.

Table 6
Measuring Anticipations of a Fed Policy "Shock"

| | | Treasury Security Rates | | | | | | |
|----------|--------------------|-------------------------|-----------------|-----------------|-----------------|-----------------|----------------|-----------------|
| Variable | RFF | 3 mo. | 6mo. | 12mo. | 3 yr. | 10 yr | 30 yr | |
| T - 4 | \bar{R}^z | .00 | .00 | .05 | .05 | .07 | .05 | .10 |
| | ΔRFF^{TAR} | -.04 (-.24) | .08 (1.41) | .11** (1.97) | .09 (1.51) | .15** (2.11) | .11 (1.88) | .12** (2.42) |
| | Fed. Antic. | -.15 (-.42) | -.10 (-.78) | -.03 (-.20) | .09 (.68) | .00 (.02) | .01 (.08) | -.00 (-.03) |
| T - 3 | \bar{R}^z | .13 | .05 | .11 | .06 | .04 | .00 | .00 |
| | ΔRFF^{TAR} | .40* (2.91) | .08 (1.78) | .12** (2.68) | .09** (2.07) | .10 (1.76) | .08 (1.25) | .03 (.69) |
| | Fed. Antic. | -.30 (-1.31) | -.01 (-.07) | -.10 (-1.28) | -.03 (-.44) | -.01 (-.15) | -.00 (-.05) | -.02 (-.28) |
| T - 2 | \bar{R}^z | .03 | .19 | .14 | .00 | .00 | .00 | .00 |
| | ΔRFF^{TAR} | .31 (1.78) | .02 (.41) | .03 (.51) | .02 (.42) | -.02 (-.34) | -.03 (-.43) | -.03 (-.54) |
| | Fed. Antic. | -.37 (-1.53) | .16** (2.26) | .14 (1.86) | .03 (.43) | .06 (.59) | .04 (.47) | .01 (.08) |
| T - 1 | \bar{R}^z | .06 | .12 | .12 | .16 | .23 | .19 | .18 |
| | ΔRFF^{TAR} | -.44 (-1.65) | -.04 (-.66) | .01 (.12) | -.04 (-.69) | .06 (.97) | .04 (.76) | .04 (.89) |
| | Fed. Antic. | .69** (2.16) | .16** (2.17) | .12 (1.62) | .16** (2.47) | .10 (1.48) | .10 (1.44) | .08 (1.29) |

t-statistics are given in parentheses below the coefficient estimates. *, ** indicate significance at the 1% and 5% levels, respectively.

Table 7
Borrowed Reserves Targets And Fed Chairmen
Cumulative Impact over 9 day Episodes

| | 28 obs | RFF | 3 mo. | 6 mo. | 12 mo. | 3 yr | 10 yr | 30 yr |
|-------|-----------------------------|------------------|-------------------|-------------------|-----------------|-----------------|-----------------|-----------------|
| T - 4 | Rb2/DW | -0.01 2.45 | .25 1.74 | .06 1.56 | -.02 1.84 | .03 1.83 | .01 1.80 | .14 1.63 |
| | Δ RFF ^{TAR} | -.07 (-.69) | .28* (2.93) | .24* (3.05) | .17** (2.65) | .24** (2.67) | .19** (2.34) | .23* (4.30) |
| | Green IA | -.10 (-.26) | -.46* (-3.97) | -.23** (-2.08) | -.09 (-.86) | -.15 (-1.19) | -.09 (-.85) | -.17 (-1.88) |
| T - 3 | Rb2 DW: | -.06 2.09 | .23 2.35 | .15 1.88 | .02 1.98 | .08 1.85 | -.01 1.65 | .05 1.54 |
| | Δ RFF ^{TAR} | .30** (2.11) | .34* (3.05) | .35** (2.31) | .21 (1.69) | .30 (1.61) | .11 (.76) | .18 (1.91) |
| | Green IA | -.24 (-.65) | -.43** (-2.87) | -.28 (-1.53) | -.05 (-.30) | -.03 (-.13) | .11 (.55) | -.02 (-.15) |
| T - 2 | Rb2 DW: | .04 1.79 | .26 2.09 | .40 1.98 | .19 1.87 | .16 1.70 | .00 1.90 | -.05 1.76 |
| | Δ RFF ^{TAR} | .39** (2.21) | .34* (3.46) | .38* (3.14) | .15 (1.59) | .21 (1.75) | .03 (.25) | .11 (1.02) |
| | Green IA | .13 (.37) | -.05 (-.29) | .09 (.53) | .26 (1.56) | .22 (1.22) | .26 (1.51) | .04 (.29) |
| T - 1 | Rb2 DW: | .09 1.67 | .34 2.03 | .48 1.73 | .29 1.72 | .28 1.56 | .09 1.58 | .07 1.49 |
| | Δ RFF ^{TAR} | .61** (2.22) | .37* (3.24) | .45* (3.01) | .22 (1.75) | .36** (2.14) | .16 (1.12) | .20 (1.75) |
| | Green IA | .18 (.41) | .12 (.62) | .21 (1.03) | .35 (1.76) | .26 (1.14) | .27 (1.42) | .09 (.60) |
| T | Rb2 DW: | .14 1.99 | .46 2.10 | .40 2.13 | .34 1.92 | .27 1.80 | .03 1.66 | .04 1.66 |
| | Δ RFF ^{TAR} | 1.36* (2.91) | .54* (3.49) | .46** (2.17) | .32** (1.97) | .36 (1.45) | -.03 (-.15) | -.08 (-.47) |
| | Green IA | -.35 (-.63) | .08 (.39) | .23 (.95) | .36 (1.66) | .31 (1.11) | .38 (1.55) | .31 (1.60) |
| T + 1 | Rb2 DW: | .28 2.18 | .38 2.25 | .33 2.02 | .28 1.82 | .33 1.83 | .16 1.77 | .16 1.77 |
| | Δ RFF ^{TAR} | 1.02** (2.59) | .52* (3.25) | .50** (2.02) | .38** (2.15) | .52** (1.94) | .21 (.90) | .12 (.62) |
| | Green IA | .15 (.27) | .05 (.24) | .24 (.87) | .26 (1.00) | .22 (.69) | .23 (.88) | .21 (1.01) |
| T + 2 | Rb2 DW: | .30 2.04 | .45 2.09 | .33 2.03 | .31 1.81 | .35 1.62 | .18 1.75 | .13 1.96 |
| | Δ RFF ^{TAR} | .91* (5.31) | .63* (3.45) | .60** (2.54) | .46** (2.76) | .66** (2.75) | .41 (1.82) | .26 (1.24) |
| | Green IA | .25 (.64) | .03 (.15) | .19 (.69) | .25 (.94) | .15 (.47) | .04 (.16) | .09 (.39) |
| T + 3 | Rb2 DW: | .17 2.07 | .50 2.43 | .28 2.36 | .32 2.01 | .35 1.83 | .17 2.00 | .09 2.19 |
| | Δ RFF ^{TAR} | .44 (1.74) | .65* (4.05) | .62** (2.45) | .47** (2.68) | .63** (2.84) | .35 (1.40) | .20 (.82) |
| | Green IA | .41 (1.03) | .11 (.50) | .23 (.76) | .36 (1.25) | .31 (1.00) | .20 (.72) | .24 (.86) |
| T + 4 | Rb2 DW: | .29 2.19 | .58 2.45 | .21 2.67 | .34 2.11 | .36 2.00 | .11 2.11 | .03 2.28 |
| | Δ RFF ^{TAR} | .72* (5.25) | .62* (3.94) | .48** (2.16) | .44** (2.63) | .63* (3.13) | .34 (1.57) | .17 (.72) |
| | Green IA | .65 (1.74) | .13 (.63) | .18 (.69) | .35 (1.34) | .23 (.84) | .11 (.46) | .16 (.58) |

These regressions included cumulative borrowing targets, constants and allowed for different borrowing target constants under both regimes. *, ** represent 1% and 5% levels of significance respectively.

(Bor Tar / 100)
+ (RFF Tar - Discr Rate)

o Fitted values

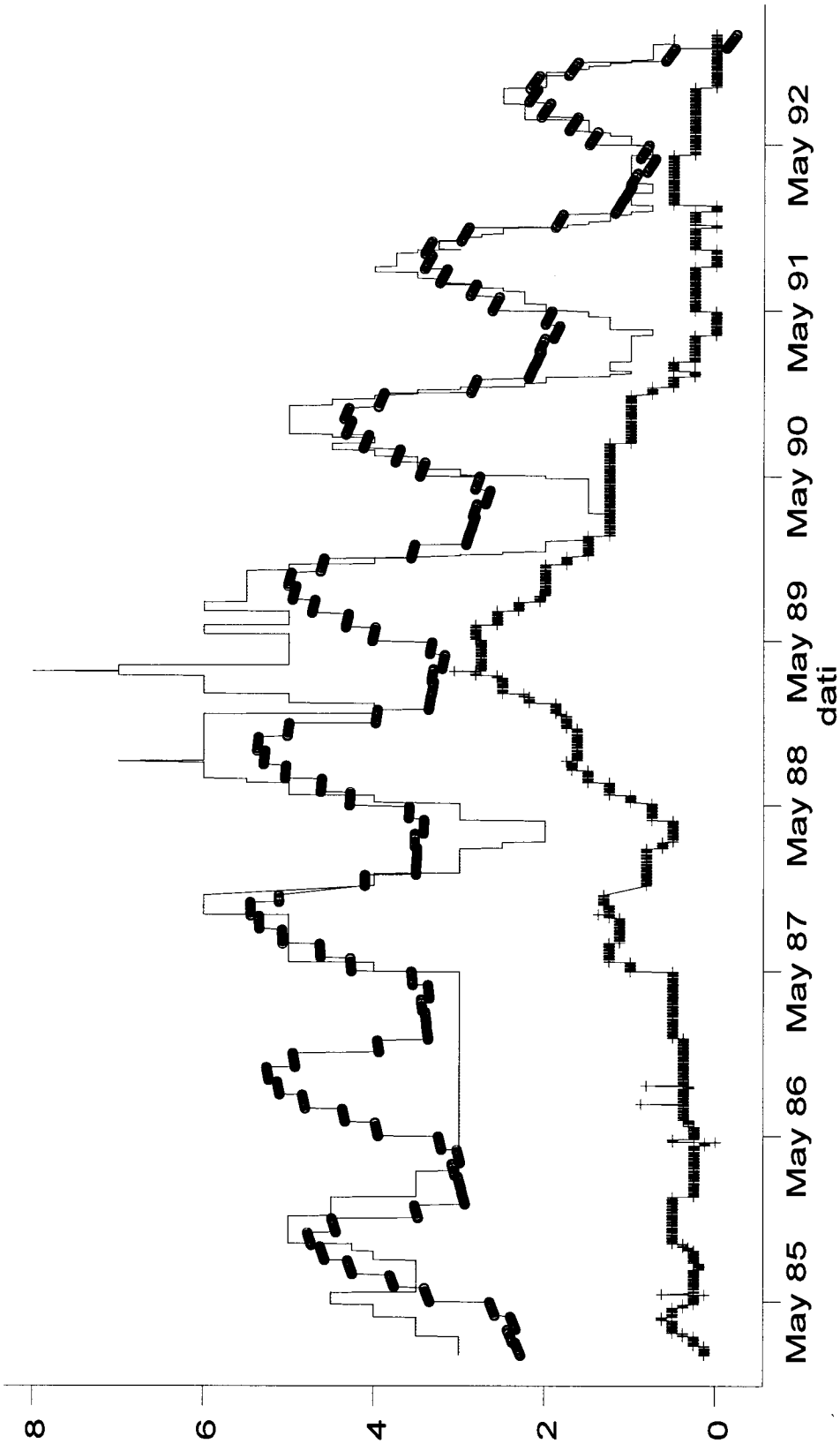
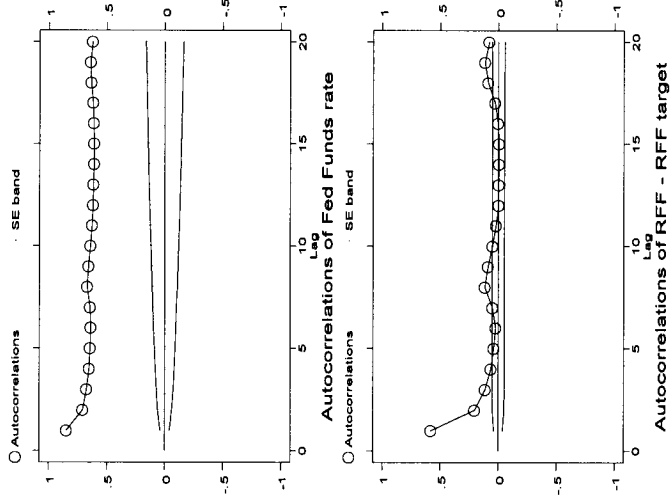
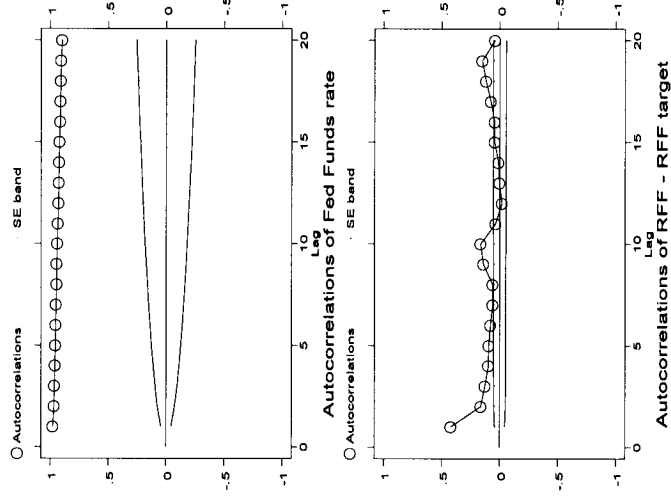


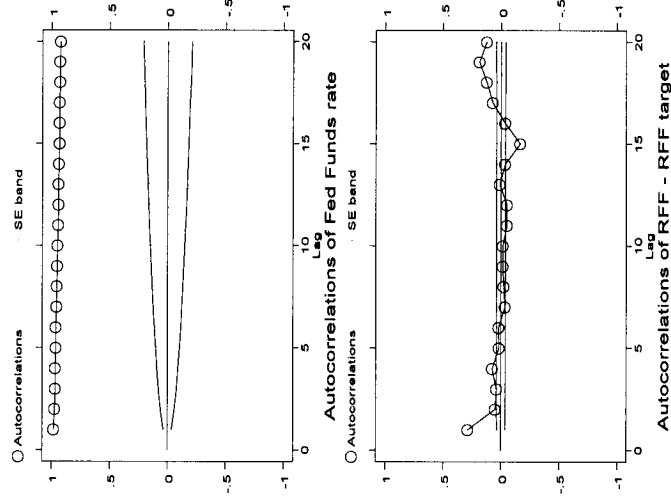
Figure 1



Volcker



Green I
Figure 2



Green II

**Borrowed Reserves Regimes
Implied Average Monthly Rate
After Policy Tightening**

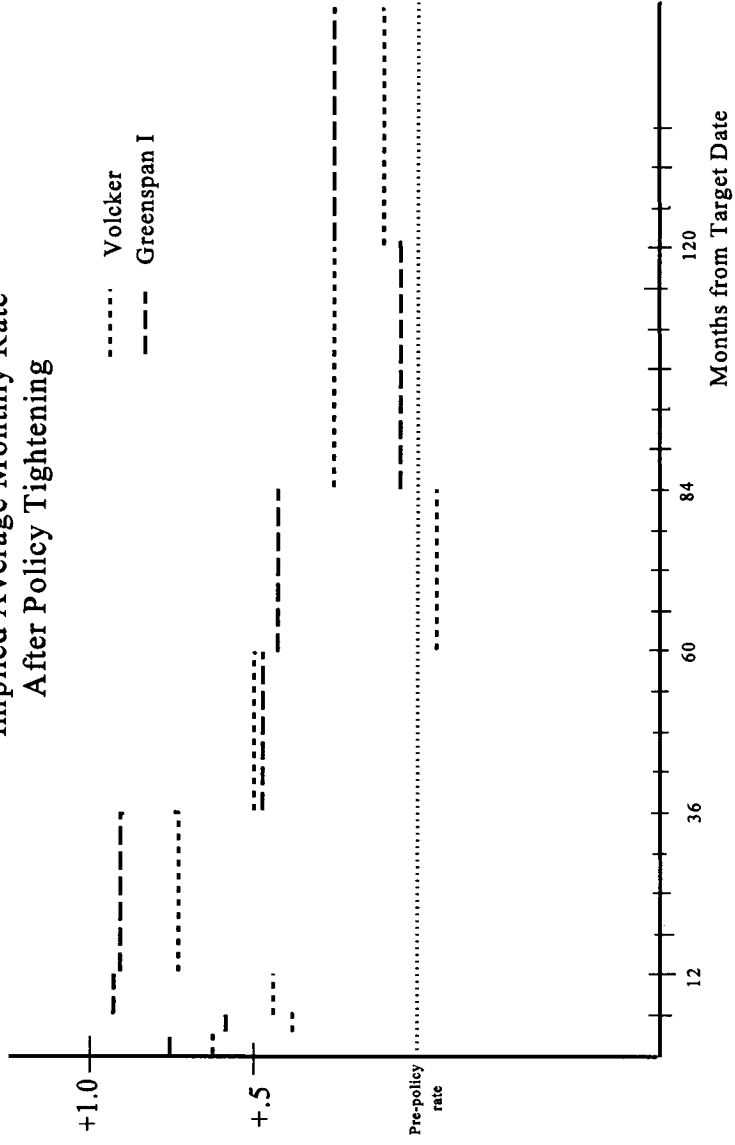


Figure 3

Direct Fed Funds Rate Regimes
 Implied Average Monthly Rate
 After Policy Easing

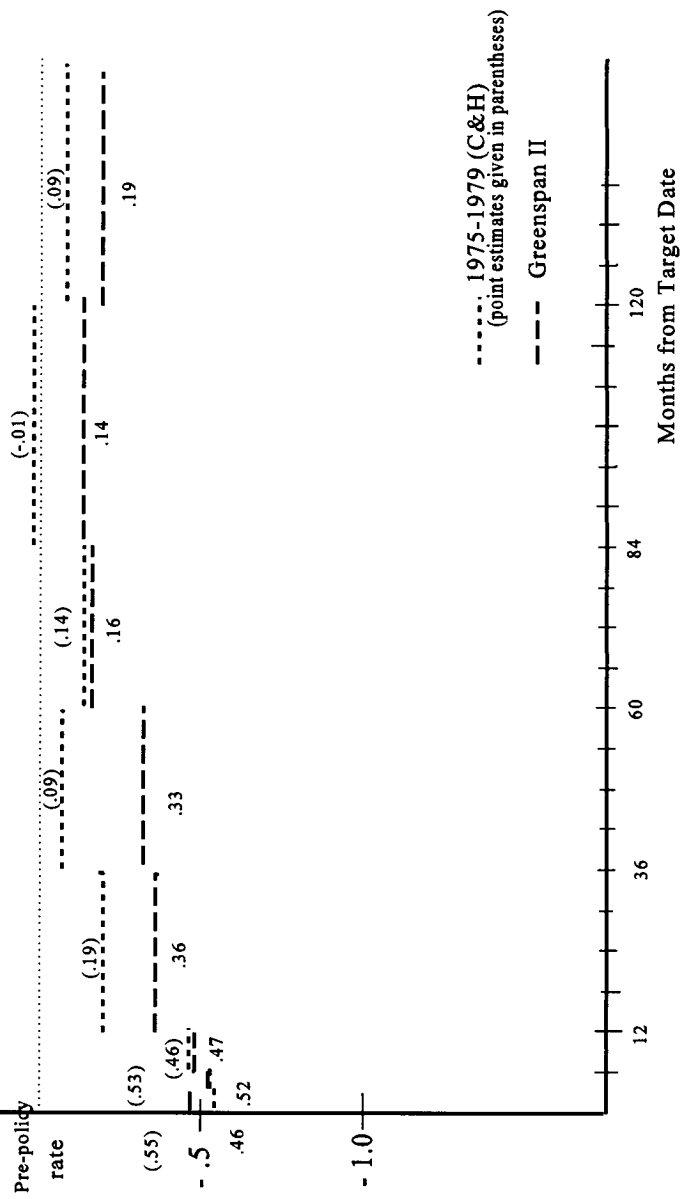


Figure 4