



The Relationship between  
the Federal Funds Rate and  
the Fed's Federal Funds Rate Target:  
Is it Open Market or  
Open Mouth Operations?

Daniel L. Thornton

(Federal Reserve Bank of St. Louis)

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Deutsche Bundesbank, Wilhelm-Epstein-Strasse 14, 60431 Frankfurt am Main,  
P.O.B. 10 06 02, 60006 Frankfurt am Main, Federal Republic of Germany

Telephone (0 69) 95 66-1

Telex within Germany 4 1 227, telex from abroad 4 14 431, fax (0 69) 5 60 10 71

Internet: <http://www.bundesbank.de>

Please address all orders in writing to: Deutsche Bundesbank,  
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## **Abstract**

It is widely believed that the Fed controls the funds rate by altering the degree of pressure in the reserve market through open market operations when it changes its target for the federal funds rate. Recently, however, several economists have suggested that open market operations may not be necessary for controlling the funds rate. Rather, they suggest that the Fed controls the funds rate through open mouth operations. The Fed merely indicates its desire to change the funds rate and the market does the rest. This paper investigates the extent to which the close relationship between the federal funds rate and the federal funds rate target is due to open market or open mouth operations. Finding little evidence to support either the open-market or open-mouth hypothesis, the possibility that the Fed adjusts its funds rate target directly in response to changes in the market interest rate is briefly considered.

**Keywords:** Federal funds rate target, monetary policy, open market operations, open mouth operations

JEL Classification: **E40, E52**

## **Zusammenfassung**

Es herrscht die weitverbreitete Ansicht, dass die Fed den Zielzinssatz für Tagesgeld (Funds Rate) steuert, indem sie bei einer Änderung ihres Ziels für den Federal Funds Satz den Druck am Geld-Markt über Offenmarktgeschäfte erhöht oder vermindert. Mehrere Ökonomen äußerten allerdings in letzter Zeit die Ansicht, dass Offenmarktgeschäfte zur Steuerung der Funds Rate nicht erforderlich seien und die Fed vielmehr ihren Leitzins über eine Politik des „Offenen Mundes“ steuern sollte. Dabei würde von der Fed lediglich angedeutet, dass sie eine Änderung des Leitzinses wünsche, und der Rest werde vom Markt selbst erledigt. Diese Arbeit untersucht, inwieweit die enge Wechselbeziehung zwischen der Federal Funds Rate und ihrem Zielwert auf Offenmarkt- bzw. „Offenmund“-Operationen zurückzuführen ist. Nachdem sich allerdings nur wenig Belege finden, mit denen sich die Offenmarkt- oder die „Offenmund“-Hypothese untermauern ließe, wird kurz auf die Möglichkeit einer Anpassung des Zielwertes als Reaktion der Fed auf Veränderungen der Marktzinssätze eingegangen.

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# The Relationship Between the Federal Funds Rate and the Fed's Federal Funds Rate Target: Is It Open Market or Open Mouth Operations? \*

## 1 Introduction

During much of its history, the Federal Reserve has implemented monetary policy by targeting the federal funds rate [Goodfriend (1991)]. Consistent with this view of the Fed's operating procedure, recently available data on the Fed's funds rate target [Rudebusch (1995)] shows that the relationship between these rates is very close for the period 1974-79 and since the early 1980s. The conventional view is that the close relationship between the funds rate and the funds rate target is due to open market operations.<sup>1</sup> The Fed raises the funds rate by reducing the supply of reserves through an open market sale when it raises the target and reduces the funds rate by purchasing securities when the target is lowered.

Recently, however, it has been suggested that open market operations are not essential for controlling the funds rate. For example, McCallum (1995) observed that the Reserve Bank of New Zealand (RBNZ) appears to move the interbank rate without conducting open market operations. Following up on McCallum's observation, Guthrie and Wright (2000) develop a model where private agents motivated by self-interest drive the interbank rate to the level desired by the monetary authority. The monetary authority needs only to communicate its desire for the overnight rate. Of course, the market must believe that the central bank can and will operate to enforce its desire, and Guthrie and Wright report several instances where the RBNZ signaled its willingness to enforce the rate. In general, however, they find no systematic relationship between changes in the interbank rate and open market operations conducted by the RBNZ. They speculate that *open mouth operations* might "explain the small liquidity effects found in practice, despite the apparent

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\* D.L. Thornton, Federal Reserve Bank of St. Louis, e-mail: [thornton@stls.frb.org](mailto:thornton@stls.frb.org). The views expressed here are the author's and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System, the Federal Reserve Bank of St. Louis or the Bundesbank. I would like to thank Clemens Kool, Lucio Sarno and members of the Economics Departments of the University of Missouri-Columbia, North Carolina State University and the University of North Carolina for helpful comments and Jonathan Ahlbrecht, Kathy Cosgrove and Stephen Majesky for their valuable research assistance.

<sup>1</sup> See Thornton (2000) for a complete model of the process under alternative operating procedures.

ease with which overnight rates, as well as other rates, move substantial amounts when changes are desired by the monetary authority.”<sup>2</sup>

Recently, Meulendyke (1998) and Hanes (1998) suggest that open market operations have not been an essential element of funds rate control in the 1990s. Meulendyke (1998, pp. 141-42 ) states that:

*“...achieving the degree of reserve pressures specified in the directive has been interpreted since the late 1980s to mean creating conditions consistent with the FOMC’s desired Federal funds rate. That rate has generally been apparent to the banks; since 1994 it has been announced formally and in prior years it was clearly indicated through an open market operation. The rate has tended to move to the new, preferred level as soon as banks knew the intended rate, with little or no change in the amount of borrowing allowed for when constructing the path for nonborrowed reserves.”*

This paper investigates whether the observed close relationship between the funds rate and the funds rate target during the 1974-79 period and since the early 1980s is due to open market or open mouth operations using a methodology similar to that used by Cook and Hahn (1989a).<sup>3</sup> Specifically, the response of interest rates to changes in the Fed’s funds rate target is investigated. Unlike Cook and Hahn, who only investigated the response of Treasury rates, I investigate the response of both the 3-month T-bill rate and the federal funds rate. If the Fed controls the funds rate through open market operations, the funds rate should change when the Fed changes the funds rate target. Moreover, this should happen even if the market is not aware that the target has changed. Consequently, target changes are partitioned into those that the market knew occurred and those that the market was unaware that had taken place. If the Fed controls the funds rate through open market operations, the funds rate should respond immediately when the market is unaware that the target has changed, while the response of the T-bill rate should be attenuated. Of course, neither rate will respond to target changes if the market anticipates the Fed’s action. In order for this to occur, the market would have to anticipate both the timing and the magnitude of target changes. Consequently, most target changes should have an unanticipated component.

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<sup>2</sup> Guthrie and Wright (2000), p. 28.

<sup>3</sup> If the Fed controls the funds rate through open market operations there should be a strong, systematic negative relationship between interest rates and monetary aggregates that are directly affected by open market operations. Research [e.g., Christiano, Eichenbaum and Evans (1996ab), Pagan and Robertson (1995) and Thornton (1988b, 2000)] has had difficulty establishing such a relationship, however.

If the Fed controls the funds rate through open mouth operations, both rates should respond immediately to target changes, but only if the market is aware that the target changed. Moreover, open mouth operations cannot account for the close relationship between the funds rate if the market is unaware that the Fed was targeting the federal funds rate.

It is important to emphasize that the question being addressed is *has* the Fed changed the funds rate through open market operations, not *can* the Fed change the funds rate through open market operations. Given the size of the market for reserves relative to the Fed's capacity to alter reserve availability, there is little doubt that the Fed can affect the federal funds rate through open market operations. The fact that the Fed has the capacity to affect the federal funds rate does not, *ipso facto*, establish that it has done so.

Finding little evidence that the observed close relationship between the federal funds rate and the federal funds rate target is due to either open market or open mouth operations, I briefly consider the possibility that the close relationship exists because the Fed adjusts its funds rate target to changes in market interest rates. While some may find the idea that the Fed responds to changing financial market conditions novel, it has classical roots [Humphrey (1983ab)] and is consistent with several monetary policy models [e.g., Friedman (1968) and Woodford (1999)], where the monetary authority adjusts its target to exogenous changes in the *natural* rate. Moreover, it is central to Goodfriend (1987, 1991) and Barro (1989) analyses of how the Fed smoothes interest rates.<sup>4</sup>

## **2 The Relationship between the Funds Rate and the Fund Rate Target**

Historically, the federal funds rate has stayed very close to the Fed's funds rate target. This is illustrated in Figures 1 – 3, which show daily observations of the funds rate and the funds rate target for three periods: September 13, 1974 to October 5, 1979, March 1, 1984 to September 29, 1989 and October 2, 1989 to December 31, 1997. The federal funds rate is the “effective” federal funds rate published by the Federal Reserve Bank of New York. Prior to January 3, 1985 the Fed's funds rate target is from Rudebusch (1995). From January 3, 1985 to December 31, 1997 the funds rate target is from the Federal Reserve

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<sup>4</sup> In both Goodfriend (1987) and Barro (1989) the nominal interest rate is determined by an exogenously determined real rate and the expected rate of inflation.

Bank of New York.<sup>5</sup> Settlement Wednesdays and the first two and last two days of the year have been excluded because large and transient moves in the funds rate, that sometimes occur on these days, can distort statistical measures of the relationship between these rates.

During the 1974-79 period, when the Fed was explicitly targeting the funds rate, the funds rate stayed very close to the funds rate target. The average absolute spread was just 9 basis points and the standard deviation was just 13 basis points. On 72 percent of the days the funds rate deviated from the funds rate target by fewer than 10 basis points.

There is also a close relationship between the funds rate and the funds rate target during the 1984-89 period, shown in Figure 2. While the relationship is not as tight as during the 1974-79 period, the absolute average difference between the funds rate and the funds rate target was just 17 basis points, with a standard deviation of 26 basis points. Moreover, on nearly half of the days the funds rate deviated from the funds rate target by fewer than 10 basis points.

The relationship between the funds rate and the funds rate target for the 1989-97 period is presented in Figure 3. In late 1989 the Fed began the practice of adjusting its funds rate target only in multiples of 25 basis points. Prior to that target changes were made in various amounts, with changes as small as 6.25 basis points. Moreover, rate adjustments became less frequent. The Fed made 32 adjustments to the funds rate target during the period from 1989-1997, an average of about one change every 13 weeks. In contrast, the Fed changed its funds rate target 98 times during the 1974-79 period, an average of about once every 2.5 weeks, and 76 changes during the 1984-89 period, an average of about one change about every 4 weeks. Despite the fact that the funds rate target was changed relatively infrequently and by large amounts, the funds rate stayed nearly as close to the funds rate target during this period as during the 1974-79 period. The mean absolute spread was 11 basis points and the standard deviation was 19 basis points. Moreover, on 67 percent of the days the funds rate deviated from the funds rate target by fewer than 10 basis points.

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<sup>5</sup> Prior to August of 1989, the New York Fed's funds rate target was occasionally presented as a range of about a quarter percentage point. On these occasions, the target was taken to be the midpoint of the reported range. In addition, for a period after the stock market crash in 1987, specifically from October 19, 1987 to November 4, 1987, no funds rate target was reported. For these days the target level is taken to be the level on October 16, 1987.

### 3 The Market's Reaction to Target Changes

Noting that the relatively “little support for the view that the Fed can influence interest rates, except perhaps through the positive impact on inflation expectations...conflicts with the standard view among participants in the financial markets that the Fed has a strong influence on interest rate movements,” Cook and Hahn (1989a, p. 331) proposed testing the standard view by investigating the market's reaction to federal funds rate target changes. They found that during the period from September 13, 1974 to October 5, 1979 rates on Treasury securities from three months to 20 years responded significantly to funds rate target changes reported in the *Wall Street Journal* (hereafter, *WSJ*). Cook and Hahn concluded that their findings support “the standard view among financial market participants that the Federal Reserve has a strong influence on market interest rates through its control of the funds rate.”<sup>6</sup>

Because Cook and Hahn (1989a) only investigated the reaction of Treasury rates to funds rate target changes, they did not directly test whether the Fed influences the funds rate. If the Fed influences the funds rate, the funds rate should respond immediately and significantly to funds rate target changes. Moreover, if the Fed controls the funds rate by altering the degree of pressure in the reserve market, the funds rate should respond even when the market is unaware that the target has changed. If the Fed controls the funds rate through open mouth operations, however, the funds rate should respond only when the market is aware that the target is changed.

Moreover, Cook and Hahn's (1989a) results are difficult to interpret because the Fed did not always change the funds rate target when market analysts thought that it had changed. Rudebusch (1995) has constructed a series of actual target changes that includes Cook and Hahn's sample period. Rudebusch reports that the funds rate target was changed 98 times during this period, 22 more target changes than the 76 reported in the *WSJ*.<sup>7</sup> Rudebusch notes that his target changes are similar to those reported by Cook and Hahn (1989b). Cook and Hahn (1989b) undertook a similar analysis, but only for days close to the dates when the *WSJ* reported a target change. Moreover, Rudebusch's series matches the funds

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<sup>6</sup> Cook and Hahn (1989a), p. 346.

<sup>7</sup> This number is similar to the 21 “gaps” in the *WSJ*'s target level reported by Cook and Hahn (1989b). A gap occurred when the difference between the last reported target level and the currently reported level is more than the currently reported target change. When the number of gaps is added to the 76 *WSJ*-reported changes, the total number of changes is only one short of the 98 target changes reported by Rudebusch.

rate target series supplied by the Federal Reserve Bank of New York for the period 1985-92.<sup>8</sup>

In addition, Cook and Hahn (1989a) ignored the central element of the *WSJ* stories from which they derived their federal funds rate target changes; namely, the reason market analysts gave for concluding that the Fed had changed its funds rate target. Market analysts relied on four types of signals in concluding that the target had changed. These are:

Type 1: The Fed injected or drained reserves when the funds rate was at the funds rate target.

Type 2: The Fed injected [drained] reserves when the funds rate was trading below [above] the previously targeted rate.

Type 3: The funds rate moved above or below the previous target before the Fed took action to restrain the funds rate from moving further.

Type 4: The funds rate moved above or below the target without the Fed taking action.

The first type is the textbook example of open market operations. The funds rate is trading at the target level and the Fed pushes the rate higher [lower] by draining [injecting] reserves. The second type is similar, except that the funds rate had already moved before the Fed took an action consistent with pushing the funds rate further in the same direction. In the third and fourth types, the Fed is passive. In the third type, the Fed acts to restrain further movement in the funds rate: in the fourth, the Fed does nothing, which causes market analysts to infer that the Fed's target has changed.<sup>9</sup>

Of the 76 *WSJ* target changes, there were three instances when market analysts concluded that the Fed had changed its funds rate target without stating how they reached this conclusion. These changes are called type 5 target changes. Of 73 *WSJ* target changes that could be classified, there were 35 occasions when the Fed was passive: 22 were classified as type 3 changes and 13 were classified as type 4 changes. There were 19 occasions when analysts' thought that the Fed was taking exogenous actions to move the funds rate from

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<sup>8</sup> Rudebusch (1995) constructed his series from the *Report of Open Market Operations and Money Market Conditions*, which was prepared weekly by the Federal Reserve Bank of New York. Rudebusch notes that "For a few target changes, the exact date that the Desk began to enforce the new target could have been a day or two sooner or later than the one that I have designated."

<sup>9</sup> Photocopies of these stories are available upon request.

the target level to another [type 1 changes] and 19 occasions when the market believed that the Fed was trying to move the funds rate further [type 2 changes].

The reason market analysts concluded that the Fed had changed the funds rate target is important for investigating whether the Fed controls the funds rate through open market operations. For the 19 type 1 changes, the conclusion that the market's reaction is due to open market operations would be justified. For the 19 type 2 changes, however, this conclusion would be more tenuous because the federal funds rate had already moved in the direction of the target change before the Fed undertook open market operations to move it further.

For the 35 type 3 and type 4 changes, the Fed did not move the funds rate through open market operations. Market analysts concluded that the Fed had changed the funds rate target, not because the Fed engaged in open market operations to move the funds rate but because the funds rate had moved and either the Fed took actions to limit further movement or did nothing.

Some might argue that the funds rate moved before the Fed engaged in open market operations because the market anticipated the Fed's actions. If this is the case, however, the T-bill rate should respond significantly only to type 1 and 2 target changes.

The dates and magnitudes of federal funds rate target changes reported by the *WSJ* and Rudebusch (1995) are presented in Table 1. The type of the change [1 – 5] for *WSJ* target changes is given in parentheses. There are 38 instances when the actual target change reported by Rudebusch (1995) occurred on the day that the *WSJ* reported the change had occurred.<sup>10</sup> Hence, the market was correct about the timing of Fed actions about 40 percent of the time. Even when the market got the timing right, Table 1 shows that the market often missed the magnitude of the target change. These data appear to provide little support for Cook and Hahn's (1989a, p. 332) claim that "market participants could identify most changes in the funds rate target on the day they were first implemented by the Fed..."

That the market frequently missed the timing or magnitude of target changes in the 1970s is not surprising. Unlike today, the Fed was intentionally secretive then. Indeed, in its landmark Freedom of Information Act case, *Merrill vs. FOMC* the Fed argued that

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<sup>10</sup> This number is similar to that of Cook and Hahn (1989b), who reported that the market got the timing of the change right about half of the time. Specifically, 37 of the 76 target changes reported by the *WSJ* were reported to have occurred "on the same day they were decided on by the Desk." For the remainder of the cases, the actual target change preceded the date it was announced by the *WSJ* by one or more days.

monetary policy was most effective when the market was surprised.<sup>11</sup> Motivated in part by a desire to be secretive, the Fed entered the market frequently during this period, often buying and selling government securities on the same day.<sup>12</sup>

I attempted to link the 38 times when the market missed the timing of target changes with actual target changes, assuming that the market never anticipated a Fed action and never missed the actual change by more than a week. I was able to link 33 of these changes with actual target changes.<sup>13</sup> Of these, there were 14 occasions when the *WSJ* missed the timing by a day, 9 by two days and 10 by three or more days. There are four occasions when the market perceived a target change that never occurred. I call these *phantom* target changes.<sup>14</sup>

## 4 The Model Specification and Results

The data are daily observations on changes in the effective federal funds rate,  $\Delta ff$ , and changes in the 3-month Treasury bill rate,  $\Delta tb3$ . There are two series on changes in the federal funds rate target, *WSJ* announced changes,  $\Delta fftar^{WSJ}$ , and actual target changes,  $\Delta fftar^A$ , identified by Rudebusch. *WSJ* target changes are partitioned into those that coincided with actual target changes,  $\Delta fftar_A^{WSJ}$ , and those that did not,  $\Delta fftar_{NA}^{WSJ}$ . The latter changes are further partitioned into those that could be linked to actual changes,  $\Delta fftar_L^{WSJ}$  and the four phantom changes,  $\Delta fftar_P^{WSJ}$ . Actual target changes are also partitioned into those that coincided with *WSJ* announcements,  $\Delta fftar_{WSJ}^A$ , and those that

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<sup>11</sup> In 1975 the FOMC denied a Freedom of Information Act request by David R. Merrill, a student at Georgetown University Law Center, for access to the Record of Policy Actions at its January and February 1975 meetings. This action led to the famous Merrill vs. FOMC, which ultimately was resolved by the U.S. Supreme Court [e.g., Goodfriend (1986)].

<sup>12</sup> Indeed, Milton Friedman chided the Fed for excessive churning of its portfolio. See Friedman (1981, 1982ab) and Levin and Meulendyke (1982).

<sup>13</sup> Cook and Hahn (1989b) argue that the *WSJ* announcements followed the actual target changes. The funds rate target was changed so frequently during this period, however, that it is often difficult to determine whether the market led or followed the Fed.

<sup>14</sup> These sum to 37 because the very first change reported by Cook and Hahn was on September 13, 1974 and there was no change reported by Rudebusch for this date. Since there was no target change prior to this, this change could not be classified. This result differs somewhat from that reported by Cook and Hahn (1989b). They report only four instances when an actual change preceded a *WSJ* reported change by four or more days.

did not  $\Delta \text{fftar}_{\text{WSJ}}^A$ . Descriptive statistics for these target changes and various partitions of each are presented in Table 2.<sup>15</sup>

Treasury rates are determined simultaneously with the federal funds rate. Indeed, these rates are cointegrated. To control for the dynamic interaction between these rates so that specific rate changes are not inappropriately attributed to funds rate target changes, the vector error correction model,

$$(1) \quad \Delta x_t = \Psi(L)\Delta x_{t-1} + EC_{t-1}\delta + \Delta \text{fftar}_t\beta + \varepsilon_t,$$

is estimated, where  $\Delta x_t' = (\Delta \text{ff}_t, \Delta \text{tb}3_t)$ . The error correction term is denoted  $EC$ ,  $\delta$  denotes a 2 by 1 vector of coefficients that measure the speed with which the federal funds and T-bill rates return to their long-run equilibrium relationship,  $\beta$  denotes a 2 by 1 vector of coefficients that measure the response of the T-bill and federal funds rates to changes in the funds rate target and  $\Psi(L)$  is the usual matrix polynomial in the lag operator  $L$ .<sup>16</sup>

Because the market has some knowledge of the Fed's reaction function, changes in the funds rate target may be anticipated, at least to some degree. The degree to which the market is able to forecast target changes appears to be limited, however [e.g., Robertson and Thornton (1997) and Hamilton and Jorda (1997)]. The idea that there is an unanticipated component associated with all target changes is also supported by the fact

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<sup>15</sup> The similarity of descriptive statistics over various partitions of actual and *WSJ*-announced target changes suggests that the differences shown later are not due to fundamental differences in the target changes over the various partitions.

<sup>16</sup> In the case of the federal funds rate, the lack of a statistically significant response is due to the conditioning variables. For example, when Equation 1 is estimated using the 38 target changes, the estimate of  $\beta$  is 0.35 and the adj.  $R^2$  is 0.3719. When the 60 target changes are used, the estimate of  $\beta$  drops to 0.19 and the  $R^2$  drops to 0.0565. When the funds rate is conditioned on its and the T-bill rates' past behavior, however, the coefficient on the 38 target changes drops dramatically and the significance level rises. Moreover, a detailed analysis of changes in the funds rate and changes in the funds rate target for the 60 target changes that were not simultaneously announced in the *WSJ* reveals that this coefficient is greatly affected by two relatively large changes in the funds rate that are associated with 0.125 percentage point changes in the funds rate target. These occurred on April 21, 1976 (32 basis points) and July 19, 1978 (64 basis points), both settlement Wednesdays. When these observations are omitted, or a dummy variable for settlement Wednesdays is included as a separate regressor, the coefficient drops dramatically and becomes statistically insignificant.

that the market frequently missed both the timing and magnitude of target changes during this period.<sup>17</sup>

The model was estimated using *WSJ* target changes and actual target changes, with various partitions of each. Cook and Hahn (1989a) omitted the target change that occurred on November 1, 1978; however, the results are insensitive to whether this observation is included or excluded, so it is included here for completeness.<sup>18</sup> In addition, the model is estimated using all of the daily observations over the period and not just days when the target was changed.

### ***Market Perceptions and Reality***

The model was estimated assuming a constant in the cointegrating vector and the standard errors were estimated using White's (1980) heteroskedasticity consistent covariance estimator. In all cases, the usual likelihood ratio test indicated a single cointegrating vector. Estimates of the model using *WSJ* target changes are presented in Table 3. To conserve space, only estimates of the constant term,  $\delta$  and  $\beta$  are presented. The estimate of  $\beta$  for the T-bill rate, 0.5324, is similar to Cook and Hahn's (1989a) estimate, 0.554.<sup>19</sup> Hence, the response of the T-bill rate to *WSJ* reported target changes does not appear to be affected by the conditioning variables in the model.<sup>20</sup>

The response of the T-bill rate is smaller when *WSJ* changes do not coincide with actual target changes, but the difference is not statistically significant. Though not statistically significant, the response to the 4 *phantom* changes is similar to that of the 38 announcements that coincided with Fed actions. These results suggest that the response of the T-bill rate to changes in the funds rate target is merely an announcement effect. When

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<sup>17</sup> Forecasting target changes should have become easier recently. Since February of 1994, the Fed has followed the practice of changing the funds rate target at regularly scheduled meetings of the FOMC. The one exception to this practice occurred on April 18, 1994. In any event, the results using a two-step estimator, where changes in the funds rate target are regressed on past changes in both the federal funds and T-bill rates, produced nearly identical results.

<sup>18</sup> On this day the Fed and the Treasury announced a program to support the dollar. This caused a very large reaction in foreign exchange markets [e.g., Mudd (1979) and Batten and Thornton (1985)] and a significant fall in longer-term interest rates. Since it had little effect on the T-bill rate, the results presented in Table 5 are relatively unaffected by this observation.

<sup>19</sup> Cook and Hahn estimated the equation only using days when the target was changed. When this is done, the estimates are nearly identical to those reported in Table 1, and the Adj.  $R^2$  and estimated standard error are nearly identical to theirs. Differences are likely attributable to small differences in the T-bill rate used.

<sup>20</sup> This finding was confirmed through additional analyses. The same is not true for the federal funds rate, however. The response of the funds rate to target changes is very different when Equation 1 is used.

the market believes the Fed has changed the funds rate target, it reacts. Indeed, when the market believes that an action has taken place, the response is as large as when the actual target change took place a day or more previously, or not at all.

The federal funds rate does not respond to the 76 target changes identified by the *WSJ*. It does respond significantly to the 38 target changes that coincided with actual changes. The response is small, however, less than half that of the T-bill rate.

Does the response depend on whether the Fed was active or passive? To answer this question, the 76 *WSJ*-identified target changes were partitioned according to the classification system mentioned above. The results are presented in Table 4. For the T-bill rate, the answer to the question is no. The T-bill rate responds significantly whether the Fed appeared to be changing the funds rate exogenously through open market operations or merely acquiescing to market pressures. Indeed, the market responded significantly to the three changes that could not be classified by type. The only thing that appears to matter is whether market analysts thought the Fed had changed its funds rate target. If market analysts announced that the target had been changed the market reacted, regardless of whether the target had actually changed. These results reinforce the conclusion that the response of the T-bill rate to *WSJ*-announced target changes is an announcement effect. The only thing that matters is the market's belief that the target has changed.

The results for the federal funds rate depend on whether the Fed was active or passive. The funds rate responds significantly only when the Fed was passive. When the Fed was active, there was no significant response of the funds rate to target changes. Hence, the significant response of the funds rate to the 38 *WSJ*-announced target changes that coincide with actual target change is due to instances when the Fed was passive.

The statistically significant relationship between the funds rate and type 3 and type 4 *WSJ*-announced target changes appears to be an instance of reverse causation. *WSJ*-announced target changes did not cause large change in the funds rate rather they were the result of these large changes in the funds rate. For type 3 changes, the observed changes in the funds rate were so large that the Fed attempted to offset them. Consistent with market analysts' observations, the coefficient for type 3 changes is larger than for type 4 changes, however, the difference is not statistically significant.

For Type 1 and Type 2 target changes, the reaction of the funds rate to these changes is perverse—the funds rate fell when market analysts believed that the target was raised and vice versa. In neither case, however, was the response statistically significant. These

results provide no support for the view that the Fed has controlled the funds rate through open market operations.

### ***The Market's Response to Actual Target Changes***

Estimates of the response to the 98 actual target changes are presented in Table 5. The response of the T-bill is somewhat smaller than the response to the 76 target changes announced by the *WSJ*. The response of the T-bill rate to the 60 target changes that the *WSJ* did not identify is only about half that of those that the *WSJ* identified. Moreover, the estimated response to these 60 actual target changes is fragile. Indeed, the response is due to three dates when there were uncharacteristically large changes in the T-bill rate: June 6, 1975 (33 basis point change), April 29, 1977 (30 basis point change) and November 21, 1978 (62 basis point change). When any one of these observations is omitted, the coefficient becomes smaller and statistically insignificant.<sup>21</sup>

The fact that the T-bill rate responds significantly only when the market is aware that the target has changed is consistent with the conclusion that the response of the T-bill is an announcement effect. When the market believes that the Fed has changed its funds rate target, the T-bill rate responds. When the Fed changes the funds rate target but the market is unaware of the Fed's action, the T-bill rate does not respond. For the T-bill rate, perceptions are the only thing that matter.

The response of the funds rate to the 98 actual target changes is small but statistically significant. The estimate is also very fragile, however. When actual target changes are partitioned into the 38 target changes that the market correctly identified and the 60 that it did not, neither response is statistically significant at the 5 percent level.

The fact that the funds rate does not respond significantly to actual funds rate target changes is inconsistent with the view that the Fed controlled the funds rate through open market operations. The statistically significant response of the T-bill rate to *WSJ*-announced target changes is simply an announcement effect. Consequently, the fact that the T-bill rate responds significantly to *WSJ*-announced funds rate target changes does not necessarily imply that the Fed influences market interest rates through its control of the

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<sup>21</sup> The fragility of the T-bill response to the 60 target changes is also reflected in estimates of Equation 1, using only days when the funds rate target was changed. Because these changes are orthogonal, Equation 1 can be estimated separately for both sets of target changes. The adj.  $R^2$  for the 38 target changes is 0.4257, while for the 60 target changes it is 0.1020. When these three observations are deleted, the adj.  $R^2$  for the remaining 57 target changes drops to 0.0131. Sensitivity to outliers is not unusual in studies of the market's reaction to specific news, [e.g., Thornton (1989)].

funds rate. While common in financial markets, announcement effects *per se* are not a basis for causal inference.<sup>22</sup>

## 5 Evidence From The Post-Nonborrowed Reserves Targeting Period

A stronger test of the open mouth hypothesis can be obtained by estimating the market's reaction to funds rate target changes in the post-nonborrowed reserves targeting period.<sup>23</sup> In October 1979 the Fed switched from an explicit funds rate targeting procedure to a nonborrowed-reserves operating procedure that was specifically designed to control M1. When the relationship between M1 and nominal GNP broke down in the early 1980s, the Federal Open Market Committee, FOMC, abandoned M1 targeting and, *ipso facto*, the nonborrowed reserves targeting procedure.

Officially, the Fed switched to a borrowed reserves targeting procedure, [e.g., Wallich (1984), Strongin (1995) and Meulendyke (1998)], however, there is evidence that the Fed was targeting the federal funds rate during this period. Thornton (1988a) showed that during the early 1980s the funds rate stayed closer to the funds rate target than borrowing did to the borrowing target, suggesting that the Fed was targeting the funds rate rather than borrowed reserves. Consistent with this evidence, Greenspan (1997) has acknowledged recently that “increasingly since 1982 we have been setting the funds rate directly in response to a wide variety of factors and forecasts.”<sup>24</sup> That the Fed was directly targeting the funds rate in the early 1980s is also borne out by the close relationship between the

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<sup>22</sup> There is an extensive literature on announcement effects and in nearly every case, the precise reason for them remains unclear. Announcement effects have been associated with money surprises [e.g., Hardouvelis (1987), Dwyer and Hafer (1989) Thornton (1989)], discount rate changes [e.g., Thornton (1994, 1998), Roley and Troll (1984), Smirlock and Yawitz (1985), Cook and Hahn (1988), Batten and Thornton (1984, 1985)], the employment report [e.g., Hardouvelis (1988) and Cook and Korn (1991)] and other special announcements [Cook and Hahn (1988)].

<sup>23</sup> During this period, borrowing was particularly sensitive to the spread between the funds rate and the discount rate. Hence, borrowing would offset, at least in part, the effect of open market operations on reserve supply. It is this feature of discount window borrowing that led to the discussion of whether the discount mechanism offsets [e.g., Friedman (1960)] or reinforces [e.g., Samuelson (1960)] the monetary policy objectives of the Fed. Aware of the relationship between borrowing and the funds rate spread, the Fed made an estimate of the level of discount window borrowing. The initial borrowing assumption, as this estimate was called, was as an integral part of the nonborrowed reserves operating procedure, [e.g., Meulendyke (1998) and Thornton (2000)]. Meulendyke (1998), Strongin (1995) and others have suggested that the Fed would implement policy by changing the initial borrowing assumption and, hence, force banks to the discount window. However, Thornton (2000) has shown that changes in the initial borrowing assumption significantly lagged changes in actual borrowing, so this interpretation is incorrect.

<sup>24</sup> Greenspan (1997), p. 3.

federal funds rate and the funds rate target during this period and by the verbatim transcripts of FOMC meetings.<sup>25</sup>

The response of the T-bill rate and the funds rate during this period provides a strong test of the open mouth operations hypothesis. If the Fed was targeting the funds rate but the market was not aware of it, the T-bill rate should not respond significantly to changes in the funds rate target. If the market is unaware that the Fed is targeting the funds rate, however, the close relationship between these rates during this period cannot be due to open mouth operations.<sup>26</sup> Moreover, if the funds rate does not respond to funds rate target changes, the close relationship between the funds rate and the funds rate target cannot be due to open market operations either.

### ***When Did the Market know that the Fed was Targeting the Funds Rate?***

It is now well known that the Fed is targeting the funds rate. The critical question is when did the market become aware that the Fed was targeting the funds rate? Answering this question is difficult because, unlike the switch to nonborrowed reserves targeting in 1979 and to borrowed reserves targeting in 1982, the Fed has never formally acknowledged switching from a borrowed reserves target to a funds rate target. The Federal Reserve Bank of New York did not publish the federal funds rate target in its annual summary of monetary policy until 1991. Even then, the funds rate target was euphemistically referred to as the *associated federal funds rate*, which was defined as “the middle of the federal funds rate trading area that is expected to be consistent with the borrowing assumption.”<sup>27</sup>

One way to estimate when the market became aware that the Fed was targeting the funds rate is to date the T-bill rate’s first reaction to federal funds rate target changes. Assuming that the market could identify at least some of the target changes on the date they were

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<sup>25</sup> For example, at the July 12-13, 1983 FOMC meeting Chairman Volcker sought the Committee’s views on whether the so-called “proviso range” for the federal funds rate range should be 6 to 10 percent or 7 to 11 percent, indicating that he would be happy with either. After a very brief discussion, the Chairman asked for a show of hands. Finding that 5 favored 6 to 10 and 3 opposed it, the Chairman noted that “Some people are not voting again.” At this point an unnamed participant said, “I don’t care. As long as you’re planning on somewhere between 9-1/4 and 9-1/2 percent, I’m for either.” Transcript (1983), p. 78.

<sup>26</sup> The facade of borrowed reserves targeting became increasingly difficult to maintain when large banks began to shun the discount window in the wake of the unprecedented large discount window borrowing by the then-troubled Continental Illinois Bank in May and June of 1984 [Clouse (1992, 1994)]. Adjustment borrowing, which averaged nearly \$1 billion a day from January 1979 to June 1984, declined dramatically. More importantly, borrowing became increasingly insensitive to the spread between the federal funds and discount rates.

<sup>27</sup> The FOMC did not explicitly state its funds rate target in the operational paragraph of its policy directive until August 1997.

made, the T-bill rate should respond to target changes fairly soon after the market became aware that the Fed was targeting the funds rate.

Hence, it is possible to date when the market became aware that the Fed was targeting the funds rate by estimating the equation,

$$(2) \quad \Delta i_t = \Psi(L)\Delta i_{t-1} + EC_{t-1}\delta + \Delta fftar_t(k)\beta_1 + \Delta fftar_t(K-k)\beta_2 + \varepsilon_t,$$

where  $i$  is either the T-bill or federal funds rate. Equation 2 assumes that there is a structural break in the market's response to changes in the funds rate target, where  $k = q, q+1, q+2, \dots, K-q$  is the target change at which the structural break occurs, and  $K$  is the number of target changes during the sample period.

When  $i$  is the T-bill rate, estimates of  $\beta_1$  should be small and insignificantly different from zero until the market becomes aware that the Fed is targeting the funds rate and is aware of funds rate target changes. Defined in this way, the  $k+1$  target change is the first time the market responded significantly to a funds rate target change. When  $i$  is the federal funds rate, estimates of  $\beta_1$  and  $\beta_2$  should be positive and statistically significant if the Fed controls the funds rate through open market operations.

The sample period is March 1, 1984 to December 31, 1997. There were 108 changes in the funds rate target during this period, i.e.,  $K = 108$ . Equation 2 is estimated with  $q = 25$  and  $\sup_{k \in \Omega} LR_K(k)$  is chosen.<sup>28</sup> Separate likelihood ratio statistics are obtained for the federal funds and T-bill rates. The distribution of the test statistic is non-standard because the parameter  $k$  does not exist under the null hypothesis [Andrews (1993)]. Consequently, the critical value for  $\lambda$  under the null hypothesis is determined by a Monte Carlo experiment with 10,000 replications. The 1-percent critical value is 10.51.

For the T-bill rate the  $\sup_{k \in \Omega} LR_K(k)$  occurred on August 9, 1988. For the funds rate the date was December 7, 1990. The significant break in the T-bill rate is associated with the 0.375 percentage point increase in the funds rate on that date. All Treasury rates moved by large amounts on that date, but the T-bill rate does not appear to respond significantly to target changes made for some time thereafter. When the change made on August 9, 1988 is omitted,  $\sup_{k \in \Omega} LR_K(k)$  for the T-bill rate also occurs on December 7, 1990.

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<sup>28</sup> To simplify the estimation, the error correction term,  $EC_t$ , was constructed using the cointegrating vector estimated using data over the entire sample period.

The December 7, 1990 break point is interesting because it coincides with the elimination of the *proviso clause* from the FOMC's operating directive. At the October 1990 meeting, just as Chairman Greenspan was calling for a vote on the operating directive, Governor Angel raised concern about the directive's proviso clause, which stated,

*“The Chairman may call for Committee consultation if it appears to the Manager for Domestic Operations that the reserve conditions during the period before the next meeting are likely to be associated with a federal funds rate persistently outside a range of 6 to 10 percent.”*

Governor Angel suggested that “in light of our abilities on the funds rate, I wonder whether it would be a little more accurate to pull that range in a bit.” The Chairman directed the staff to prepare a recommendation, on what he termed an *anachronism*, for consideration at the November meeting. While staff presented five options, only the option to drop the proviso clause got serious consideration. At its November 13, 1990 meeting, after a brief discussion about the potential political consequences of dropping the proviso clause, the Committee voted to drop it.<sup>29</sup>

Estimates of Equation 2 with both break points are presented in Table 6. The federal funds rate does not respond significantly to target changes before or after either break point. For the federal funds rate, the likelihood ratio test indicated no statistically significant break point; however, the response after December 7, 1990 is nearly seven times larger than that before. The lack of a significant response of the funds rate to changes in the funds rate target is consistent with the findings over the 1974-79 period and suggests that the Fed has not implemented policy through open market operations as the conventional view suggests.

The T-bill rate also does not respond significantly to target changes before either break point, suggesting that the market was unaware that the Fed was targeting the funds rate until after the December 7, 1990 meeting. Of course, it could be that the market was aware that the Fed was targeting the funds rate, but was unable to determine the dates of any target changes until December 1990. In view of the 1974-79 experience, it seems unlikely

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<sup>29</sup> Governor Angel began the discussion by saying “Well, it does seem to me that there might be one alternative that would get us a little more volatility in the fed funds rate. And if we did have more volatility in the fed funds rate, then the 4 percent rate specified could be a clear indication of what we were doing. Now, it may be unlikely that there will be a majority who would wish to do that.” To that, Greenspan responded, “I think that happens to be true. But I’m not sure that solves the problem because you’re talking about substance and we’re talking about public relations.” Transcript (1990), p. 9.

that the market was aware that the Fed was targeting the funds rate but never identified the timing of any target change.<sup>30</sup>

If the market was not aware that the Fed was targeting the funds rate, the close relationship between the funds rate and the funds rate target in Figure 2 cannot be due to open mouth operations. The lack of a statistically significant response of the funds rate to target changes suggests that the relationship is not due to open market operations either. Hence, the evidence for both periods suggests that the Fed has not controlled the funds rate through either open market or open mouth operations.

## **6 If Neither Open Market Nor Open Mouth Operations, What?**

If the Fed has not controlled the funds rate through open market operations or open mouth operations, what accounts for the close relationship between the federal funds rate and the funds rate target? One possible answer is that the Fed does not move the funds rate, *per se*, but rather adjusts the funds rate target with changes in market rates. This idea that a central bank's ability to influence real rates is very limited has classical roots [e.g., Humphrey (1983ab)]. Moreover, in some macroeconomic models [e.g., Woodford (1999)], policymakers adjust their target rate to changes in the "natural rate," which is independent of current monetary policy.

Indeed, the idea that the Fed responds to changes in market rates is also fundamental to the Goodfriend (1987, 1991) and Barro (1989) models of interest rate smoothing. Goodfriend (1991, p. 10), makes this point explicitly, noting that,

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

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<sup>30</sup> Another unlikely explanation is that the market correctly anticipated the timing and magnitude of all of the target changes, so they were already reflected in the T-bill rate when they occurred. This explanation seems particularly unlikely given the Fed's efforts to disguise its intent, the general inability of the federal funds futures market to forecast target changes [e.g., Robertson and Thornton (1997)] and the fact that the T-bill rate began responding significantly to target changes later in the sample.

Goodfriend (1987, 1991) argues that the Fed controls the federal funds rate by injecting reserves to restrain the upward movement in interest rates when rates are rising and by draining reserves to restrain the downward movements when rates are falling. The Goodfriend/Barro hypothesis of interest rate smoothing is broadly consistent with the historical positive relationship between narrow monetary aggregates (like total reserves and the monetary base) and interest rates. Some economists [e.g., Christiano, Eichenbaum and Evans (1996ab)] argue that the positive relationship between narrow monetary aggregates and interest rates stems from a failure to separate the exogenous and endogenous components of narrow monetary aggregates. The Goodfriend/Barro hypothesis, however, argues that the positive relationship is a direct consequence of the Fed's policy of smoothing interest rates.

### ***Additional Evidence—The 1974-79 Experience***

The analysis of the 1974-79 period is broadly consistent with the Goodfriend/Barro hypothesis. Thirty percent of the time when market analysts concluded that the Fed had changed its funds rate target it was because the Fed took action to offset movements in the federal funds rate. Moreover, the Fed changed its funds rate target about every two weeks during this period. Such frequent changes in the interest rate target would seem unjustified by monetary policy considerations, but are consistent with the idea that Fed was adjusting its target to rapidly changing market conditions.

### ***Additional Evidence—Temporal Ordering***

If the Fed is causing changes in market interest rates, changes in the funds rate target should precede changes in market rates. If, on the other hand, the Fed is merely adjusting its target to changes in market rates, changes in market rates should precede changes in the funds rate target. Hence, in principle, one can differentiate between these competing hypotheses by testing the temporal ordering between the funds rate target and the 3-month T-bill rate by performing Granger "causality" tests.

Of course, temporal ordering from the T-bill rate to the funds rate target is consistent with the expectations theory of the term structure. Specifically, changes in the market rate would precede changes in the target if the market anticipated the Fed's action. Generally the expectations theory has received very little empirical support [e.g., Campbell and Shiller (1991) and Shiller, Campbell and Schoenholtz (1983)], and even less support when the short-term rate is the federal funds rate [Hardouvelis (1988), Simon (1990), Roberds,

Runkle and Whiteman (1996) and Thornton (1999)].<sup>31</sup> Also, it is unlikely that the market expected changes in the funds rate target during the 1984-89 period, when the evidence is that the market was unaware that the Fed was targeting the funds rate.

Even if the expectations theory is correct, it is unlikely that the market correctly anticipated all target changes. The market should have been surprised, at least on some occasions. If the market correctly predicted target changes on some occasions and was surprised on others, there should be bi-directional Granger causality between the funds rate target and the T-bill rate. The change in the target would precede changes in the T-bill rate when the market is surprised and the T-bill rate would precede target changes when the market anticipated the Fed's action. Hence, the expectations theory could not explain unidirectional causality going from the T-bill rate to the funds rate.

The results for tests of Granger causality are reported in Table 7 for the three sample periods. Since these rates are cointegrated, the tests are performed using the level of the rates.<sup>32</sup> The results indicate unidirectional temporal ordering from the T-bill rate to the funds rate target for all but the 1974-79 period, where the test indicates bi-directional temporal ordering. The funds rate target was changed very frequently during this period. Consequently, it is not surprising that the test indicates bi-directional temporal ordering. During periods when the funds rate target was adjusted less frequently, however, the test indicates unidirectional temporal ordering from the T-bill rate to the funds rate target.

#### ***Additional Evidence—The 1989 Experience***

It is well known that the Fed has an incentive to adjust its interest rate target with exogenous changes in market rates. Failure to do so would result in an unintended change in policy.<sup>33</sup> For example, if interest rates were to rise exogenously and the Fed wished to maintain its target, it would have to increase the growth rate of money in order to resist the upward movement in rates. All other things the same, the failure to raise the target in the face of rising interest rates would eventually result in higher, not lower, nominal interest

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<sup>31</sup> Moreover, there is evidence [e.g., Robertson and Thornton (1997) and Hamilton and Jorda (1997)] that target changes are difficult to predict, even *ex post*.

<sup>32</sup> The results are qualitatively the same if the tests are performed using first differences.

<sup>33</sup> In the extreme, nominal interest rate targeting leads to price-level indeterminacy [Friedman (1968), Sargent and Wallace (1975) and McCallum (1981)]. Woodford's (1999) model overcomes this problem because the Fed's objective is keep the funds rate target in line with the *natural rate of interest*, which Woodford defines as "the equilibrium real rate of return under flexible prices that corresponds to the nominal interest rate consistent with an equilibrium with constant prices."

rates [Friedman (1968)]. The reverse would be true if an exogenous shock caused the interest rate to fall.

While the funds rate target tends to lag changes in market rates, there is one instance when the change in the funds rate target significantly lagged behind changes in market rates. After rising in 1988 and early 1989, interest rates peaked in March 1989 and began to fall. At the time, inflation was running at an unacceptably high rate—in excess of 4 percent. Indeed, on February 24, 1989 the Board of Governors raised the discount rate by 50 basis points, citing a desire “to implement in a visible way the System’s continuing commitment to the fight against inflation...”<sup>34</sup> The Fed further indicated its desire for a restrictive monetary policy by raising the funds rate target modestly from 9.75 percent to 9.8125 percent on May 4.

Despite increases in the discount rate and the funds rate target, other short-term interest rates declined. The T-bill rate declined by about 85 basis points between its March peak and June 5, the day before the first of three 25 basis point cuts in the funds rate target. A second target reduction occurred on July 7 and a third on July 27. An additional 6.25 basis point cut occurred on August 10. These actions occurred even though the Fed’s outlook for the economy and inflation was essentially unchanged.<sup>35</sup> CPI inflation in 1989 was about 75 basis points higher than in 1988.

What happened to reserves? Total reserves decreased by \$0.89 billion from February to May. Decreases in reserves over a period of three months are very uncommon, owing to the need to increase the monetary base to meet the growing demand for currency. Moreover, this is the largest three-month decline in total reserves in the entire period from January 1959 to March 1995.<sup>36</sup> This is but a single episode; nevertheless, it is consistent with the Fed reducing the funds rate target in response to the market.

Ironically, this episode provides the best evidence that the Fed can control the federal funds rate through open market operations. Despite the significant decline in other short-term interest rates, the federal funds rate remained close to the Fed’s target. Presumably, the Fed kept the funds rate from falling by draining reserves.

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<sup>34</sup> Board of Governors (1989), p. 67.

<sup>35</sup> Greenbook’s fourth-quarter to fourth-quarter forecasts for economic growth and inflation [fixed weighted GDP deflator], respectively were: February 1 meeting, 3.0 and 4.4 percent; March 22 meeting, 2.9 and 4.7 percent; May 10 meeting, 2.8 and 4.7 percent; June 28 meeting, 2.2 and 4.5 percent; and the August 16 meeting, 2.4 and 4.3 percent.

<sup>36</sup> Banks began implementing sweep programs in March 1995 in order to avoid the reserve tax. Since these programs have been implemented, reserve growth has been negative.

## 7 Conclusions

It is widely believed that the Fed controls the federal funds rate by altering the degree of pressure in the reserve market. More recently, however, several analysts [McCallum (1995), Guthrie and Wright (2000) and Meulendyke (1998)] have suggested that open market operations may not be essential to the Fed's ability to control the funds rate. All the Fed need do is make its intentions for the funds rate known. Believing that the Fed has the power to enforce its desires, the market works to keep the funds rate close to the target level.

Noting that historically there is a close relationship between the federal funds rate and the Fed's funds rate target, this paper investigates whether the relationship is due to open market operations or open mouth operations. This is done by testing the market's reaction to actual and perceived changes in the funds rate target. If changes in the funds rate target represent exogenous policy actions that the Fed implements through open market operations, the funds rate should change point-for-point with the funds rate target regardless of whether the market knows that the target has changed. If the Fed controls the funds rate through open mouth operations, the funds rate should change with the target only when the market is aware that the target has changed.

There is no statistically significant relationship between changes in the funds rate and target changes during any period when there is a close relationship between the funds rate and the target. Hence, there is no evidence that the Fed moved the funds rate through open market operations. Moreover, the funds rate did not respond even when the market was aware that the target had changed. Some might argue that the lack of response is because the market anticipated the Fed's actions. There is evidence that the market had difficulty determining when the Fed had acted, let alone anticipating the Fed's actions. During the 1974-79 period, the market frequently missed the timing and magnitude of target changes. Moreover, the expectations explanation is at odds with the response of the T-bill rate to target changes that the market knew (or thought) had occurred. If the funds rate did not respond because the market anticipated the Fed's action, why did the T-bill rate respond?

Beginning in the late 1980s or early 1990s, the market became aware that the Fed was targeting the funds rate. Since February 1994, the Fed has announced target changes immediately. Hence, it is conceivable that the close relationship between the funds rate and the funds rate target in recent years is due to open mouth operations. Open mouth operations cannot account for the close relationship between the funds rate and the target during other periods, however. The documented uncertainty about the timing and magnitude of target changes during the 1974-79 period raises doubts about the role of open

mouth operations during this period. The strongest evidence against the open-mouth-operations hypothesis, however, is the fact that the relationship between the funds rate and the funds rate target was close during the 1984-89 period when the market was unaware that the Fed was targeting the funds rate.

The apparent inability of open market operations or open mouth operations to account for the relationship between the funds rate and the funds rate target over all of the periods led to the consideration of a third possibility; namely, that the Fed reacts to changing market conditions when it changes its funds rate target.<sup>37</sup> Some evidence is presented that is consistent with this explanation for the historically close relationship between the funds rate and the funds rate target.

Some will be understandably skeptical that it accounts for all funds rate target changes. By the same token, the evidence presented here should make one skeptical of claims—implicit or explicit—that all persistent changes in short-term interest rates are the result of the exogenous policy actions of the Fed. What is perhaps more likely is that some changes in the funds rate target are exogenous policy actions, while others are merely adjustments of the rate to maintain the stance of policy. Of course, the Fed need not respond to changes in market interest rates *per se*. The Fed and the market may be responding to the same shocks. There is some evidence [Wheelock and Thornton (2000)]; however, that some target changes were in response to changes in reserve demand. The critical question is when did the Fed move the market and when did the market move the Fed?

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<sup>37</sup> Of course, it could be that the market believes that if the Fed maintains its current policy stance, inflation will accelerate. Believing this, market interest rates would rise, but they would not rise because the Fed had restricted the supply of reserves through open market operations.

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**Table 1: WSJ Announced and Actual Target Changes**

Date	$\Delta \text{fftar}_t^{\text{wsj}}$	$\Delta \text{fftar}_t^a$	Date	$\Delta \text{fftar}_t^{\text{wsj}}$	$\Delta \text{fftar}_t^a$
09/13/74	-0.5000 (2)	0.0000	05/28/76	0.0000	0.0625
09/20/74	0.0000	-0.3750	07/02/76	0.0000	-0.1250
09/23/74	-0.2500* (2)	0.0000	07/09/76	-0.2500 (3)	-0.1250
09/27/74	0.0000	-0.1250	10/01/76	0.0000	-0.0625
10/04/74	-0.2500 (1)	-0.3750	10/08/76	-0.2500 (3)	-0.1875
10/11/74	0.0000	-0.3750	11/19/76	-0.2500 (2)	-0.1250
10/18/74	-0.5000 (4)	-0.5000	11/26/76	0.0000	-0.1250
11/01/74	0.0000	-0.2500	12/10/76	0.0000	-0.0625
11/25/74	0.0000	-0.2500	12/14/76	-0.1250** (2)	0.0000
11/29/74	0.0000	-0.1250	12/17/76	0.0000	-0.0625
12/03/74	-0.2500** (4)	0.0000	01/19/77	0.0000	0.0625
12/09/74	0.0000	-0.2500	04/15/77	0.0000	0.0625
12/13/74	0.0000	-0.1250	04/25/77	0.1250*** (5)	0.0000
12/16/74	-0.2500* (3)	0.0000	04/27/77	0.1250*** (3)	0.0000
12/20/74	0.0000	-0.5000	04/29/77	0.0000	0.2500
12/27/74	0.0000	-0.2500	05/05/77	0.0000	0.2500
01/02/75	-0.2500*** (2)	0.0000	05/10/77	0.1250*** (2)	0.0000
01/03/75	-0.2500 (1)	-0.5000	05/18/77	0.0000	0.1250
01/06/75	-0.2500* (4)	0.0000	05/19/77	0.1250* (4)	0.0000
01/07/75	-0.2500** (3)	0.0000	07/27/77	0.0000	0.1250
01/10/75	0.0000	-0.2500	07/28/77	0.2500 (3)	0.1250
01/14/75	-0.2500** (5)	0.0000	08/01/77	0.0000	0.1250
01/17/75	0.0000	-0.1250	08/09/77	0.1250 (1)	0.1250
01/24/75	0.0000	-0.2500	08/12/77	0.1250 (1)	0.1250
01/31/75	-0.5000 (2)	-0.3750	09/09/77	0.1250 (2)	0.1250
02/07/75	0.0000	-0.2500	09/21/77	0.0000	0.1250
02/13/75	-0.2500*** (1)	0.0000	09/22/77	0.1250* (3)	0.0000
02/14/75	-0.2500*** (2)	0.0000	09/30/77	0.1250 (3)	0.1250
02/21/75	-0.2500 (1)	-0.2500	10/03/77	0.0000	0.0625
03/07/75	0.0000	-0.2500	10/07/77	0.1250 (1)	0.0625
03/21/75	0.0000	-0.2500	10/28/77	0.0000	0.0625
03/26/75	-0.2500*** (2)	0.0000	10/31/77	0.1250* (1)	0.0000
05/02/75	0.0000	-0.2500	11/04/77	0.0000	-0.0625
05/08/75	-0.2500 (1)	-0.1250	01/09/78	0.2500 (2)	0.2500
06/06/75	0.0000	0.1250	04/19/78	0.2500 (1)	0.2500
06/18/75	0.0000	0.2500	04/26/78	0.0000	0.1250
06/20/75	0.5000 (2)	0.2500	04/27/78	0.2500 (3)	0.1250
06/27/75	0.0000	0.2500	05/17/78	0.0000	0.2500
07/16/75	0.1250 <sup>P(17)</sup> (3)	0.0000	05/18/78	0.2500* (1)	0.0000
07/18/75	0.0000	0.1875	06/21/78	0.2500 (3)	0.2500
07/21/75	0.1250* (2)	0.0000	07/19/78	0.0000	0.1250
07/22/75	0.1250** (1)	0.0000	07/20/78	0.1250* (5)	0.0000
09/19/75	0.0000	0.1875	08/16/78	0.1250 (4)	0.1250
09/26/75	0.0000	-0.1250	08/18/78	0.1250 (1)	0.1250
10/03/75	-0.1250 (2)	-0.2500	08/25/78	0.0000	0.1250
10/10/75	0.0000	-0.2500	08/28/78	0.1250* (3)	0.0000
10/21/75	-0.3750*** (2)	0.0000	09/08/78	0.1250 (1)	0.1250
10/24/75	0.0000	-0.1250	09/20/78	0.1250 (1)	0.1250
10/31/75	0.0000	-0.1250	09/22/78	0.0000	0.1250
11/07/75	-0.1250 (4)	-0.2500	09/25/78	0.1250* (3)	0.0000
11/12/75	-0.1250** (2)	0.0000	09/28/78	0.1250 (4)	0.1250
12/26/75	0.0000	-0.1250	10/18/78	0.1250 (2)	0.2500
01/02/76	0.0000	-0.1250	10/20/78	0.1250** (4)	0.0000
01/06/76	-0.1250** (1)	0.0000	10/26/78	0.1250 <sup>P(6)</sup> (4)	0.0000
01/09/76	0.0000	-0.1250	10/31/78	0.3750 (4)	0.6250
01/12/76	0.0000	-0.1250	11/01/78	0.2500* (3)	0.0000
02/27/76	0.2500 (4)	0.0625	11/21/78	0.0000	0.2500
03/10/76	0.0000	-0.0625	11/28/78	0.1250*** (3)	0.0000
03/30/76	-0.1250 <sup>P(14)</sup> (1)	0.0000	12/19/78	0.1250 (1)	0.1875
04/21/76	0.0000	0.1250	01/15/79	0.1250 <sup>P(17)</sup> (4)	0.0000
04/23/76	0.1250** (3)	0.0000	04/27/79	0.1880 (2)	0.1875
04/30/76	0.0000	0.1250	07/20/79	0.3750 (3)	0.2500
05/05/76	0.1250*** (3)	0.0000	07/27/79	0.0000	0.1250
05/11/76	0.0000	0.1250	08/15/79	0.3750 (2)	0.3750
05/12/76	0.1250* (3)	0.0000	08/24/79	0.2500 (3)	0.2500
05/14/76	0.1250 (4)	0.1250	08/31/79	0.0000	0.1250
05/19/76	0.1250 (3)	0.1250	09/04/79	0.1250* (3)	0.0000
05/21/76	0.0000	0.0625	09/19/79	0.1250 (1)	0.1250

<sup>P</sup>(n), Phantom (number of days after the last target Change).

\* 1 day after, \*\* 2 days after, \*\*\* 3 or more days after

**Table 2: Descriptive Statistics**

Statistic	Mean	Std. Dev.	Min.	Max.	No. Obs.
$\Delta fftar^{WSJ}$	0.0206	0.2260	-0.5000	0.5000	76
$\Delta fftar_A^{WSJ}$	0.0497	0.2566	-0.5000	0.5000	38
$\Delta fftar_{NA}^{WSJ}$	-0.0101	0.1872	-0.3725	0.2500	38
$\Delta fftar_L^{WSJ}$	-0.0189	0.1929	-0.3750	0.2500	33
$\Delta fftar_P^{WSJ}$	0.0625	0.1250	-0.1250	0.1250	4
$\Delta fftar^A$	-0.0025	0.2145	-0.5000	0.6250	98
$\Delta fftar_{WSJ}^A$	0.0433	0.2463	-.5000	0.6250	38
$\Delta fftar_{NWSJ}^A$	-0.0323	0.1871	-.5000	0.2500	60

**Table 3: The Market's Reaction to Wall Street Journal Announcements of Federal Funds Rate Target Changes: September 13, 1974-October 5, 1979**

Coefficient (# of changes)		$\Delta tb3_t$			$\Delta ff_t$	
Const.	0.0004 <sup>1/</sup> (0.14)	0.0003 <sup>2/</sup> (0.11)	0.0003 <sup>3/</sup> (0.10)	0.0001 <sup>1/</sup> (0.02)	-0.0001 <sup>2/</sup> (0.01)	-0.0002 <sup>3/</sup> (0.03)
$\Delta$	0.0125 (1.10)	0.0127 (1.12)	0.0127 (1.12)	-0.0722* (3.78)	-0.0719* (3.78)	-0.0719* (3.77)
$\Delta ff_{tar}^{WSJ}$ (76)	0.5324* (7.58)	--	--	0.1351 (0.95)	--	--
$\Delta ff_{tar}_A^{WSJ}$ (38)	--	0.5771* (6.22)	0.5772* (6.22)	--	0.2250* (2.18)	0.2264* (2.19)
$\Delta ff_{tar}_{NA}^{WSJ}$ (38)	--	0.4100* (4.51)	--	--	-0.0491 (0.14)	--
$\Delta ff_{tar}_L^{WSJ}$ (33)	--	--	0.4371* (4.37)	--	--	-0.0932 (0.25)
$\Delta ff_{tar}_P^{WSJ}$ (4)	--	--	0.5156 (1.10)	--	--	-0.7795 (0.84)
Adj, R <sup>2</sup>	0.0988	0.0993	0.0986	0.3411	0.3410	0.3407
s.e.	0.0944	0.0944	0.0945	0.2937	0.2937	0.2938
Wald test	--	1.0228	0.5311	--	0.5978	0.5547

1/ Estimated normalized cointegrating vector is  $ff_t = 1.2774tb3_t + 1.2938$ .

2/ Estimated normalized cointegrating vector is  $ff_t = 1.2775tb3_t + 1.2944$ .

3/ Estimated normalized cointegrating vector is  $ff_t = 1.2760tb3_t + 1.2851$ .

\* Indicates statistical significance at the 5 percent level.

**Table 4: Response to Target Changes Classified by Type**

Coefficient (# of changes)	$\Delta tb3_t$ <sup>1/</sup>	$\Delta ff_t$ <sup>1/</sup>
Const.	0.0006 (0.24)	-0.0013 (0.16)
$\delta$	0.0126 (1.12)	-0.0734* (3.86)
$\Delta ff_{tar}^{WSJ}$ (1) (19)	0.5728* (2.82)	-0.1520 (0.71)
$\Delta ff_{tar}^{WSJ}$ (2) (19)	0.6321* (4.69)	-0.2696 (0.98)
$\Delta ff_{tar}^{WSJ}$ (3) (23)	0.4537* (9.26)	0.7605* (5.16)
$\Delta ff_{tar}^{WSJ}$ (4) (12)	0.3845* (2.69)	0.5587* (2.83)
$\Delta ff_{tar}^{WSJ}$ (5) (3)	0.4722* (2.49)	-0.3578 (0.78)
Adj R <sup>2</sup>	0.0989	0.3438
s.e.	0.0944	0.2931
F-statistic	0.7258	6.2940*

1/ Estimated normalized cointegrating vector is  $ff_t = 1.2750tb3_t + 1.2781$ .

\* Indicates statistical significance at the 5 percent level.

**Table 5: The Market's Reaction to Actual Funds Rate Target Changes:  
September 13, 1974-October 5, 1979**

Coefficient (# of changes)	$\Delta tb3_t$		$\Delta ff_t$	
	Const.	0.0010 <sup>1/</sup> (0.38)	0.0006 <sup>2/</sup> (0.23)	0.0003 <sup>1/</sup> (0.04)
$\Delta$	0.0143 (1.82)	0.0140 (1.27)	-0.0704* (3.67)	-0.0701* (3.68)
$\Delta fftar^A$ (98)	0.4434* (5.28)	--	0.2499* (2.47)	--
$\Delta fftar_{WSJ}^A$ (38)	--	0.5679* (5.04)	--	0.2232 (1.69)
$\Delta fftar_{NWSJ}^A$ (60)	--	0.3102* (2.60)	--	0.2784 (1.79)
Adj. R <sup>2</sup>	0.0776	0.0826	0.3422	0.3417
s.e.	0.0956	0.0953	0.2935	0.2936
Wald test	--	2.5032	--	0.0733

1/ Estimated normalized cointegrating vector is  $ff_t$   $\begin{bmatrix} 1.2737 \\ 1.2701 \end{bmatrix}$   $tb3_t$ .

2/ Estimated normalized cointegrating vector is  $ff_t$   $\begin{bmatrix} 1.2800 \\ 1.3103 \end{bmatrix}$   $tb3_t$ .

\* Indicates statistical significance at the 5 percent level.

**Table 6: The Market's Reaction to Actual Funds Rate Target Changes:  
March 1, 1984 – December 31, 1997**

Coefficient (# of changes)	$\Delta tb3_t$		$\Delta ff_t$	
Const.	-0.0009 (0.87)	-0.0008 (0.85)	-0.0014 (0.25)	-0.0014 (0.24)
$\Delta$	0.0089* (2.31)	0.0086* (2.25)	-0.2126* (4.14)	-0.2122* (4.14)
$\Delta ff_{tar}_{B88}^A$ (60)	0.0244 (0.48)	--	0.1391 (0.67)	--
$\Delta ff_{tar}_{A88}^A$ (48)	0.3032* (6.65)	--	0.3144 (1.45)	--
$\Delta ff_{tar}_{B90}^A$ (82)	--	0.0596 (1.32)	--	0.0743 (0.42)
$\Delta ff_{tar}_{A90}^A$ (26)	--	0.3363* (5.81)	--	0.4752 (1.76)
Adj. R <sup>2</sup>	0.0528	0.0519	0.1964	0.1969
s.e.	0.0587	0.0587	0.3379	0.3378
LR test	47.492*	44.244*	0.570	2.828

1/ Estimated normalized cointegrating vector is  $ff_t = 1.1415tb3_t + 0.3027$ .

\* Indicates statistical significance at the 5 percent level.

**Table 7: Tests of Granger Causality Between *tb3* and *fftar***

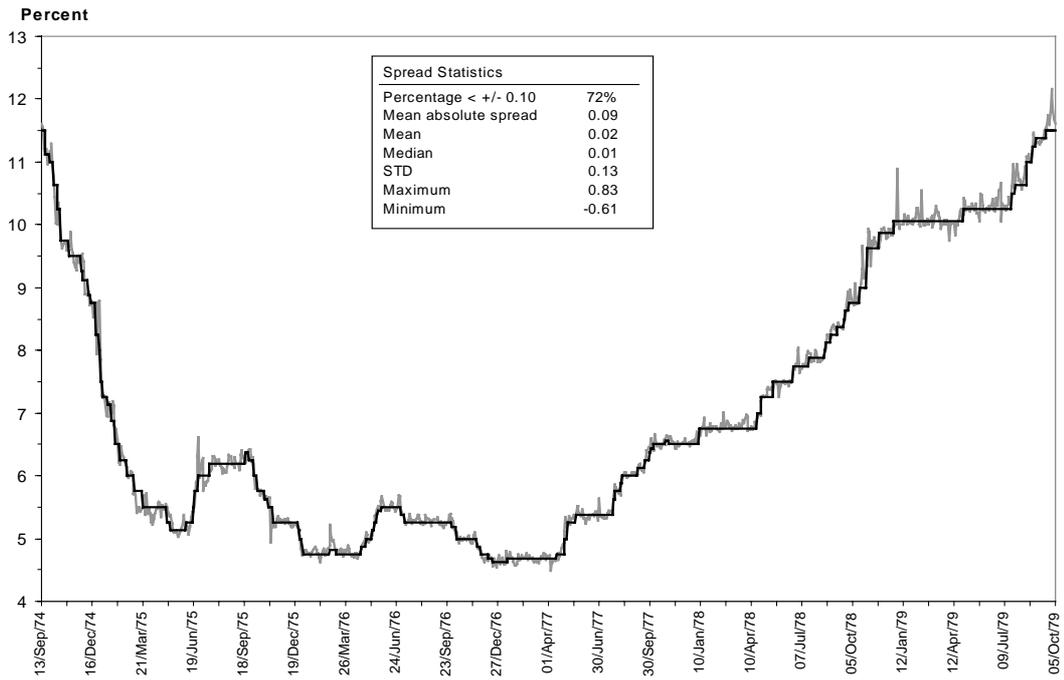
	Sample Period					
	9/13/74-10/5/79		3/1/84-9/29/89		10/2/89-12/31/97	
Lag Length	F1	F2	F1	F2	F1	F2
2	29.46*	2.70	481.55*	2.41	29.79*	1.32
4	14.87*	5.25*	249.24*	1.37	15.54*	1.18
6	5.72*	6.40*	171.97*	1.23	10.83*	0.76
8	5.87*	5.42*	132.53*	0.87	8.36*	0.57
10	4.80*	7.29*	107.23*	0.95	7.02*	1.28

F1=*tb3* does not Granger cause *fftar*.

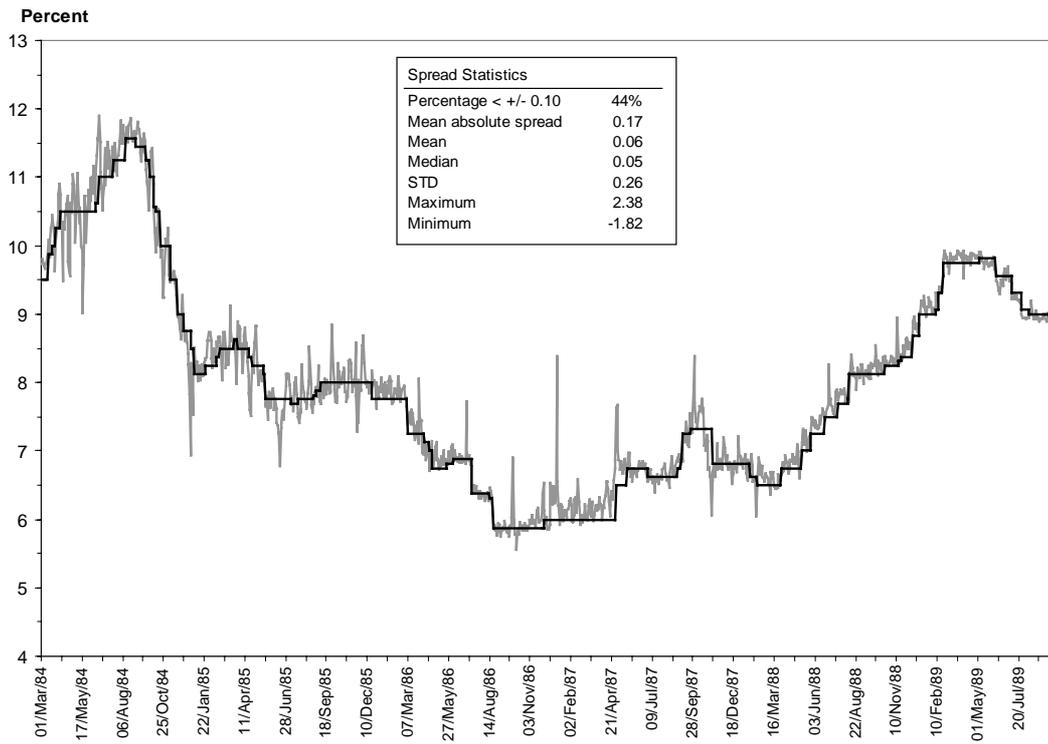
F2=*fftar* does not Granger cause *tb3*.

- Indicates statistical significance at the 5 percent level.

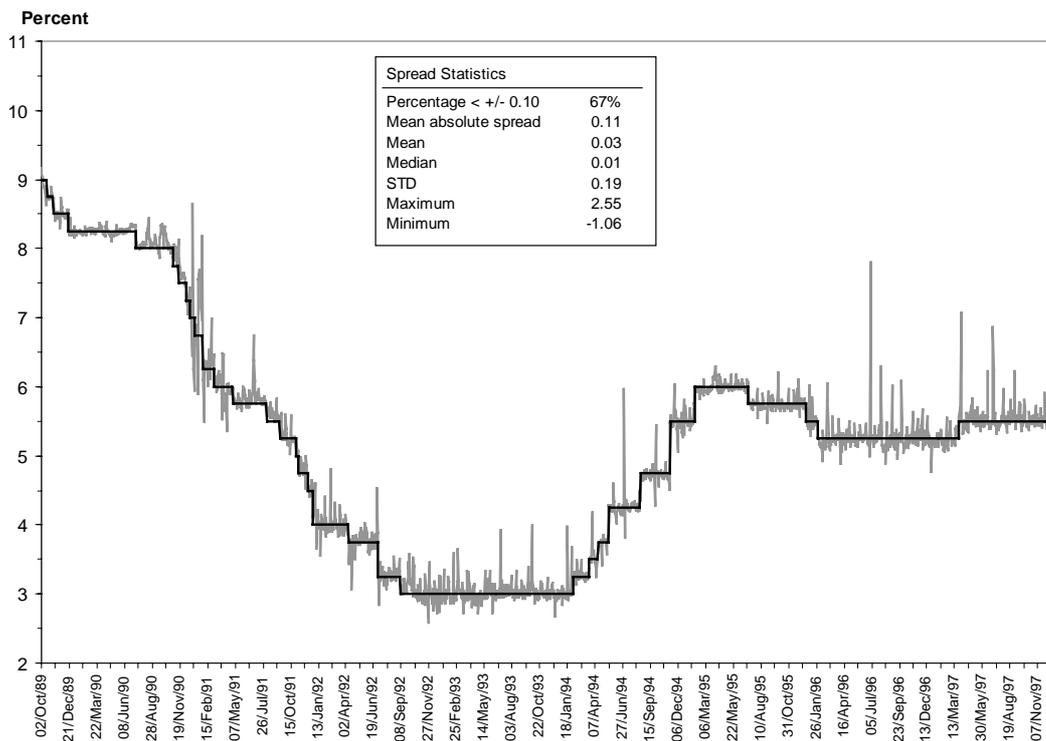
**Figure 1: Federal Funds Rate and Target**  
 (September 13, 1974 - October 5, 1979)



**Figure 2: Federal Funds Rate and Target**  
 (March 1, 1984 - September 29, 1989)



**Figure 3: Federal Funds Rate and Target**  
 (October 2, 1989 - December 31, 1997)



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