Do Interventions Smooth Interest Rates?

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Introduction

It is commonly acknowledged that the Federal Reserve adjusts sluggishly its policy instrument, the federal funds rate. Although the smoothing characteristic of short-term interest rates is well documented, it is difficult to provide a valid rationalisation for its behaviour. The explanations are numerous and heavily disputed.

One branch of studies, in particular Goodfriend (1991) and Roberds (1992), highlight periodic concerns between financial stability and domestic policy objectives. Sharp unanticipated increases in interest rates can generate capital losses for financial institutions that are exposed to interest rate risk. Smoothed interest rate adjustments thus reduce the possibility of disrupting financial markets. The manner in which the Federal Reserve chose to raise rates gradually in 1994 after the economy had previously experienced financial stress is an example of how the Fed must cope in balancing its policy objectives (Clarida *et al.*, 1999).

Another branch of the recent literature on interest rate smoothing considers the influence of longer-run cycles. An often cited explanation is parameter uncertainty. Sack (1997), Wieland (1997) and others extend Brainard's

(1969) work and show that this kind of uncertainty introduces lags in the policy response, because the Federal Reserve is unsure of the impact that the rate adjustment will have on the economy.

Woodford (1999) offers an alternative explanation of interest rate smoothing over the cycle. He claims that lagged dependence permits the central bank to manipulate long-term rates and hence aggregate demand with more modest movements in the short-term rate than would be otherwise required. The view is that every policy action reveals how policy will be conducted in the future. The central bank is seen to make policy consistent with the implicit path made known through previous policy choices. Policymakers thus have to walk a tightrope between the need to respond to new information and their implicit prior commitment to a particular path for interest rates.

This paper, along the lines of the first group of studies, seeks to emphasise the view that conflicts in the Fed's objective may protract interest rate decisions. The Federal Reserve may feel obliged at times to respond to developments in currency markets that are incompatible with its long-term domestic policy objectives. On these occasions the Federal Reserve uses interventions as an instrument to address its immediate exchange rate concerns. Changes in the target funds rate are temporarily postponed so that the exchange rate is not further undermined. These tensions between exchange rate and domestic policy prolong the duration of the target funds rate.

The objective of this paper is to consider empirically the influence of interventions on the duration of the target funds rate. The intervention literature has focused primarily on the effectiveness of interventions on the exchange rate and has not considered whether the decision to intervene influences the dynamics of other monetary instruments such as short-term interest rates. To capture the effect of duration dependence stemming from interventions, the Autoregressive Conditional Duration (ACD) specification developed by Engle and Russell (1998) is used to model the duration of the target funds rate. This modelling strategy has several attractive features. First, the ACD framework is able to determine the degree of duration dependence of the target funds rate.[1] Second, the model's setup allows hypothesis testing of economic variables that could influence the time deformation. The role of

[1]There is considerable dispute in the literature concerning the level of persistence in the funds rate. Barro (1989) and Mankiw and Miron (1986) state that because of the Fed's practice of smoothing interest rates changes in the short rates are unpredictable while Balduzzi *et al*. (1998), Goodfriend (1991) and Hamilton (1996) claim that limited prediction up to two months ahead is possible.

interventions will be given particular attention.

The paper is organised as follows. Section 1 outlines the conceptual issues as to how interventions correspond with delayed changes in the target funds rate. Section 2 presents the time deformation model for the target funds rate and discusses the testing strategy involving interventions. Section 3 describes the data and offers some preliminary evidence. Section 4 presents the empirical results for the time deformation of the funds rate. Section 5 offers concluding remarks.

1. Interventions: A Procrastinating Device

To understand how interventions can periodically lead to a prolonged duration in the target funds rate, three characterisations of the Fed's policy are assumed. First, the federal funds rate is the Fed's policy instrument. Second, adjustments in the target funds rate are not in response to new information but are undertaken to achieve a balanced mix between domestic and external objectives. Domestic objectives include unemployment, inflation, and credit market conditions, whereas external objectives are primarily manifested in the exchange rate. Third, the Fed does not signal future changes in monetary policy through interventions as is assumed under the signalling hypothesis. While the first two assumptions are less controversial (see Goodfriend, 1991), the last one requires further clarification.

Interventions are assumed to operate either through the portfolio or the noise hypothesis. The former hypothesis states that domestic and foreign bonds are imperfect substitutes so that sterilised interventions by changing the relative supply of two assets may affect the expected returns and the exchange rate. The latter hypothesis, developed by Hung (1997), claims that that some form of noise trading prevails in the market and that the exchange rate is determined by the flow market equilibrium. The noise channel assumes that the Fed can manipulate the exchange rate by entering in relatively thin markets. The sterilised intervention is able to disrupt temporally the flow equilibrium, though the effect may be prolonged if the intervention causes chartists to perceive the prevailing trend as broken and that a reversal in trend is eminent. Unlike the signalling channel, which states that 'publicly announced' interventions are consistent with subsequent changes in the policy instrument, the portfolio or the noise channel make no prediction as to the direction of future changes in the target funds rate.

The prolonged duration in the target funds rate arises from periodic conflicts between the Federal Reserve's domestic and external objectives.[2] At certain stages within the business cycle, the Fed may need to tighten monetary policy in order to achieve its domestic objectives. However such a policy action may not always be consistent with its external policy objectives and thus may result in counterproductive movements in the exchange rate. The Fed recognises that a 'leaning against the wind' policy of simultaneously intervening in the foreign exchange market and adjusting the target funds rate could provide the market confusing signals. The Fed therefore prefers to address immediately its exchange rate concerns and delays temporarily adjustments in the target funds rate.[3]

Indirect empirical evidence on the tensions between the Fed's response to exchange rate developments and changes in monetary policy is offered by several studies testing the signalling hypothesis. Kaminsky and Lewis (1996), Lewis (1995), and Klein and Rosengren (1991) find that Fed interventions

[2]Lewis (1995) documents episodes of conflict between the objectives of fighting inflation and keep the dollar from strengthening.

[3]The possibility that changes in the target funds rate reduce the need to intervene is not necessarily excluded. In a similar setup as in Fischer and Zurlinden (1998), I find however only weak evidence that changes in the target funds rate lengthen the intervention duration.

do signal future changes in monetary policy. The direction in the policy change however is inconsistent with what the signalling channel would predict. Namely, they find that interventions intended to support the dollar are followed by an increase in money growth or a lowering of the discount rate. Along similar lines in a more recent study, Fatum and Hutchison (1999) find that interventions significantly increase the conditional variance of federal funds futures rates, suggesting an increase in the degree of uncertainty over the future course of monetary policy.

2. ACD Models and the Duration of the Target Rate

The ACD model by Engle and Russell (1998) is used to estimate the probability of a change in the target funds rate.[4] The model specifies the conditional expectation of duration as a function of past duration. The variable of interest is the duration of the target funds rate, which is defined as $x_i = t_i - t_{i-1}$, where t_i is the time when a change in the target funds rate occurs with $(t_0 < t_1 <, ..., < t_n, ...)$.[5] Hereafter, I refer to x_i as the duration

[4]See Engle and Russell (1998) and Russell (1996) for a detailed discussion of ACD models.

[5]Note, x_i only defines the timing of a change in the target and not its direction.

of the target funds rate.

Let ψ_i be the expectation of the i^{th} duration of the target rate, where

$$E(x_i|x_{i-1},...,x_1) \quad = \quad \psi_i(x_i|x_{i-1},...,x_1) \equiv \psi_i. \tag{1}$$

The ACD models are parameterisations of (1) and assume that x_i/ψ_i is independent and identically distributed for all i. Following Engle and Russell, the ACD model is specified as

$$\begin{aligned} \psi_i \quad &= \quad \omega + \sum_{j=1}^{m} \alpha_j x_{i-j} + \sum_{j=1}^{q} \beta_j \psi_{i-j}, \qquad (2) \\ \alpha_j, \beta_j \quad &\geq \quad 0, \omega > 0, \forall i, i = 1,...,N, j = 1,...,m, q, \end{aligned}$$

where m and q refer to the lag order. The duration of the target funds rate are autoregressive or 'self-exciting' when $\sum_{j=1}^{m} \alpha_j + \sum_{j=1}^{q} \beta_j > 0$. The conditional distribution is assumed to be Weibull and the log likelihood function is

$$L = -\sum_{i=1}^{N(T)} (ln\gamma/x_i) - (\Gamma(1+1/\gamma)x_i\psi_i^{-1}) + (\Gamma(1+1/\gamma)x_i\psi_i^{-1})^{\gamma}. \tag{3}$$

where $\Gamma(\cdot)$ is the gamma function and γ is the Weibull parameter.

The Weibull ACD (WACD) has the attractive feature that it can generate either an increasing or a decreasing hazard in t. When $\gamma = 1$, the Weibull collapses to the exponential distribution and the hazard is no longer time dependent. Thus, it is possible to examine the distibutional assumptions by testing whether $\gamma = 1$.

The dynamic specification of the conditional duration (2) can be generalized to include non-linear functions and additional variables, z_t, such that ψ_i is defined as:

$$\psi_i = \psi(x_{i-1}, x_{i-2}, ..., x_{i-m}, \psi_{i-1}, \psi_{i-2}, ..., \psi_{i-q}, z_i, ..., z_{i-1}, ..., z_{i-k}, \theta).$$

This extension of the model allows hypothesis testing of the economic determinants (z_i) of the duration of the target funds rate. In particular, I am interested in whether lagged interventions prolong the duration of changes in the target funds rate.

3. A Description of the Target Funds Rate

The empirical sample begins March 15, 1984 and ends June 30, 1999. There is some dispute concerning the transition date when the Federal Reserve switched from a reserves targeting approach back to an interest rate targeting approach.[6] My strategy begins with the earliest starting date and tests for possible differences in the duration process. The source of the target series is the FRBNY for the period from March 15, 1984 to January 31, 1996.

[6]Rudebusch (1995) begins his sample for the post reserves period in March 15, 1984. Several studies on the federal funds rate target (i.e. Balduzzi *et al.*, 1997 and Bonser-Neal *et al.*, 1998) begin their sample after 1984.

Thereafter, I rely on the Board of Governors official press releases.[7]

The empirical analysis considers daily, weekly (the first business day of the week) and monthly (the last business day of the month) observations. The duration data for both sample periods excludes holidays and weekends. A primary motive for considering alternative frequencies is to show that the weak persistence in the duration of the target funds rate does not arise only in daily data as recently claimed by Balduzzi *et al.* (1998), but also in monthly observations.

Figure 1 plots the duration of the target rate (vertical axis) against the dates of the changes in the target rate (horizontal axis). Duration is measured in days, weeks and months. The profile of the three series is similar. Until the end of the 1980s the duration between changes in the federal funds rate target is short and few outliers of long duration occur. Thereafter the pattern of the duration changes markedly. The number of changes in the target funds rate diminishes, resulting in longer duration spells.

One means for determining whether changes in the target funds rate are intertemporally correlated is to examine the waiting times between events.

[7] See Thornton (1996) and Pakko (1995) for a discussion on the change in the Federal Reserve's practice of immediate disclosure.

Table 1 presents F-tests on the lags of x_i. The results show that the duration of the target rate remains highly autocorrelated even after 15 changes in the target rate. This result is true regardless of the observation's frequency.

Preliminary evidence of the behaviour between interventions prior to the change in the target funds rate and its duration is given in Table 2. The results show the average duration of the target funds rate with and without prior interventions. The average duration measured in days is more than three times longer if at least one intervention occurred prior to a change in the target funds rate. In the next section, this relation is examined more thoroughly using econometric methods based on duration dependence.

4. Empirical Results

The empirical strategy is to first specify a baseline model for the target funds rate. The baseline model is purely a function of past duration in the target funds rate. The higher the persistence of past duration, the greater the forecasting power of the model. The second stage of the strategy tests whether interventions explain the time deformation of the duration in the target funds rate. Attention is also given to whether interventions influence the persistence of the target funds rate.

The Baseline Model

The estimates for the baseline WACD (1,1) are given in Table 3. The autoregressive, α, and the moving-average components, β, are positive in each of the specifications. The unconditional mean is constant (i.e. $\alpha + \beta < 1$). The level of persistence is highest for the weekly data (i.e. 0.59). The dynamics suggests that the target funds rate have some (but limited) forecasting power even at the monthly frequency.

The use of the WACD model allows one to directly test the time dependence of the hazard. The null hypothesis of a constant hazard (conditional exponential distribution $\gamma = 1$) is rejected for all the models. The result $\gamma > 1$ implies that the hazard is increasing in time. In other words, a long observed duration of no change in the target funds rate implies that it is more likely that one will occur in time.

Since 1989 several changes in the discount rate fell on the same day as the changes in the target funds rate. The ACD specification includes a dummy variable, labelled $disc_{i-1}$, which is +1 when a discount rate change occurred at the same time as a change in the target funds rate, otherwise it is zero. The positive coefficients for the dummy variable suggest that parallel discount and funds rate changes prolong the duration of the target funds rate. A test for the significance for changes in the discount rate that did not fall on the date of the previous change in the target funds rate was found to be insignificant.

Alternative specifications to the WACD(1, 1) are considered in Table 4. The WACD(2, 2) model is estimated for the duration of the target funds rate. The more general specification for the WACD model does not represent an improvement. In several cases only the first-order autoregressive and moving-average components are significant. The ACD(1, 1) specification is thus preferred as a baseline model for it offers a more parsimonious representation.

Testing for Interventions

Different intervention measures are introduced into the duration model. The results of these estimates are presented in Tables 5 to 8. The significance of lagged interventions is found to be robust to various specifications and always enters with a positive sign. In other words, the empirical evidence finds that interventions lengthen the duration of the target funds rate without influencing the dynamics of the ACD model.

In Table 5 the lagged intervention variable is $inter_{t-1}$. This variable registers the number of interventions since the previous change in the target funds rate. The coefficient of $inter_{t-1}$ is positive and is significant for the daily and the weekly specifications. The degree of persistence of the WACD(1, 1) model with $inter_{t-1}$ ranges between 0.4 and 0.5, thus the introduction of $inter$ does not drastically alter the duration's dynamics.

Next I consider whether it is interventions just before the change in the target funds rate that are driving the results. The variable $interx_{t-1}$ is the number of interventions $x = (1, 5, 10, 20, 40)$ days before a change in the target funds rate. Table 6 presents the results with $interx_{t-1}$ for the daily frequency. The results show that the significance of interventions is not sensitive to how close in time the last intervention was to the change in the target funds rate. All the measures of $interx$ are significant apart from when $x = 40$.

The next intervention measure is $DumInterx_{t-1}$, which is a dummy variable with value one if an intervention took place x days before a change in the target funds rate, otherwise it is zero. The dummy variable is a check against the likelihood that more interventions arise during long duration spells in the target funds rate. The results with $DumInterx_{t-1}$ for the daily model are given in Table 7. The significant and positive signed dummy suggests that the frequency of interventions between changes in the target funds rate is not driving the intervention result. Rather, it is whether an intervention took place.

The last test considers the sensitivity of different sample periods. Two break points are considered February 21, 1987 and April 1, 1990. The first represents the beginning of the Louvre Accords and the second is taken to be the collapse of G-3 countries attempt at exchange rate management. Table 8 presents the results for the daily model with $DumInter1$. Although the dynamics of the WACD(1, 1) changes slightly over the different sample periods, the intervention measure remains robust.

5. Concluding Remarks

The paper considers the hypothesis that exchange rate tensions proxied by official interventions correspond with delayed adjustments in the target funds rate. The argument is that the Fed is confronted with conflicting objectives. The Fed needs to respond to short-run developments in the currency market, yet a policy change in its instrument settings is not undertaken because such a move is inconsistent with its long-term domestic policy objectives. Under such circumstances the Fed uses interventions to address its immediate exchange rate concerns. Changes in the target funds rates are temporarily delayed in order to avoid confusing signals in the currency market.

The smoothing hypothesis with interventions is tested using the ACD model. Such a framework is suitable for the duration of the target funds rate is found to be weakly persistent; a result consistent with the empirical findings in Balduzzi *et al*. (1997) and Goodfriend (1991). These studies highlight the forecastability of the federal funds rate in the short-run. The ACD model of duration dependence favours of a specification where the probability of a change in the target funds rate is higher the longer time has elapsed since the previous rate change. The introduction of interventions into the ACD model yields the paper's main finding that previous interventions lengthen the duration of the target funds rate. This result is found to be robust for several intervention measures.

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Figure 1:

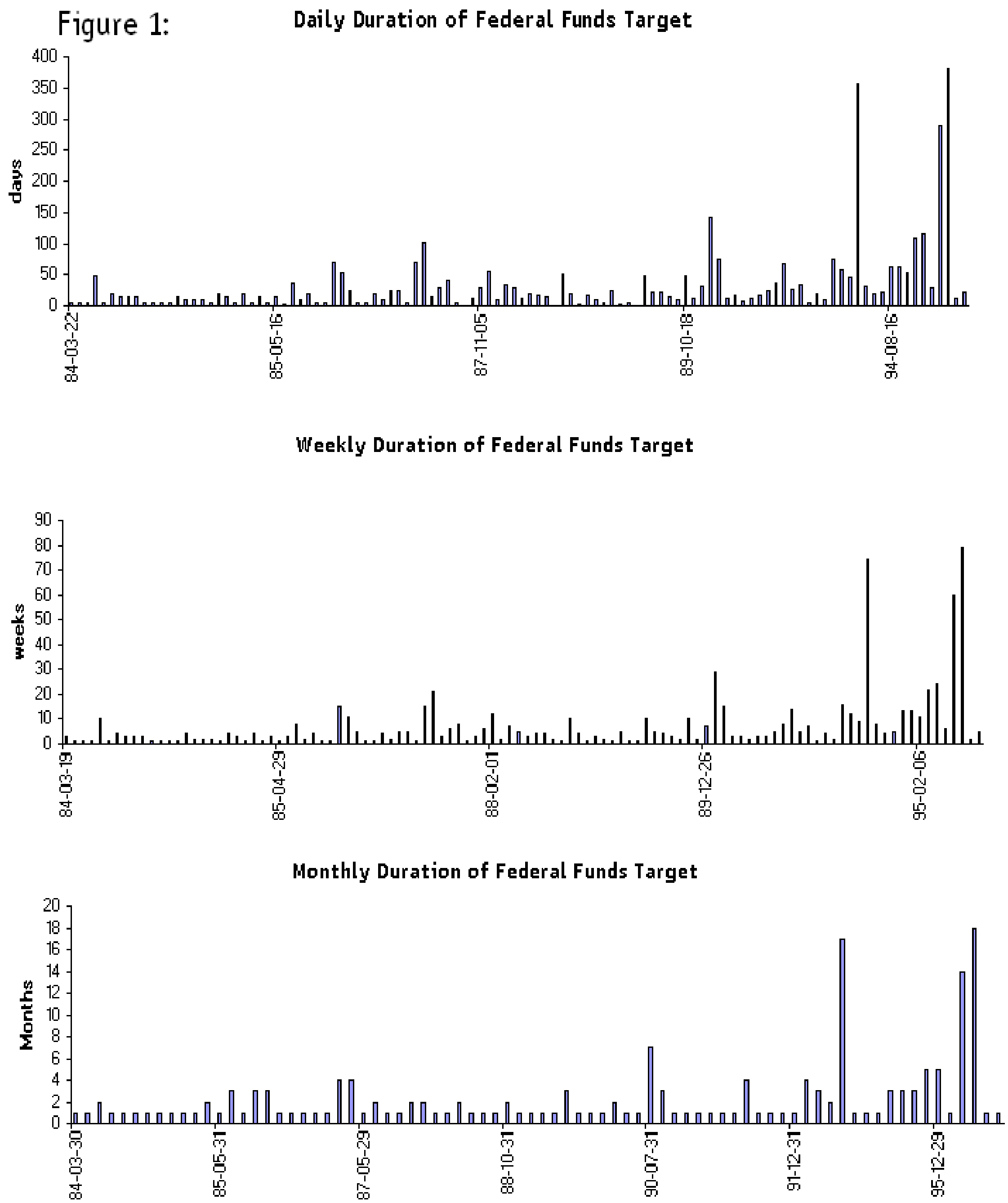
Daily Duration of Federal Funds Target
days
400
350
300
250
200
150
100
50
0
84-03-22
85-05-16
87-11-05
89-10-18
94-08-16
Weekly Duration of Federal Funds Target
weeks
90
80
70
60
50
40
30
20
10
0
84-03-19
85-04-29
88-02-01
89-12-26
95-02-06
Monthly Duration of Federal Funds Target
Months
20
18
16
14
12
10
8
6
4
2
0
84-03-30
85-05-31
87-05-29
88-10-31
90-07-31
91-12-31
95-12-29

Table 1: F-Tests for Autocorrelation

sample 15/3/84 to 31/12/98

Frequency	Daily	Weekly	Monthly
$\mu(1)$	11.97	12.12	4.53
	(0.00)	(0.00)	(0.00)
$\mu(5)$	4.86	4.13	1.59
	(0.00)	(0.00)	(0.00)
$\mu(10)$	5.27	4.87	2.52
	(0.00)	(0.00)	(0.00)
$\mu(15)$	5.92	5.39	2.81
	(0.00)	(0.00)	(0.00)

Notes: P-values are given in parentheses

Table 2: Average Duration of the Federal Funds Rate Target with and without Prior Intervention

Average duration of ff target with 6 or more prior interventions	44.6 days
Average duration of ff target with prior interventions	31.7 days
Average duration of ff target without prior intervention	6.8 days
Average number of interventions during a duration spell for the federal funds rate	6.7 interventions

Table 3: Parameter Estimates for the (Baseline) WACD(1,1) Model

$$\psi_i = \omega + \alpha_j x_{i-1} + \beta\psi_{i-1} + \lambda disc_{i-1}$$

	daily	*weekly*	*monthly*
ω	1.4807*	0.6621*	0.6242*
	(0.3900)	(0.1623)	(0.1072)
α	0.0141*	0.0281*	0.0238
	(0.0054)	(0.0107)	(0.0178)
β	0.5353*	0.5613*	0.4246*
	(0.1193)	(0.1073)	(0.0945)
λ	2.1691*	0.9291*	0.5000*
	(0.9538)	(0.3858)	(0.1401)
γ	2.0850*	2.1680*	2.4815*
	(0.1577)	(0.1779)	(0.3183)
L	-242.51	-147.88	-59.26
DOF	105	102	72

Notes: The frequency of the duration is daily, weekly, an monthly. Standard errors are given in the parentheses and * denotes significance at the 5% critical level. The sample is from 15/3/84 to 31/12//98.

Table 4: Parameter Estimates for the (Baseline) WACD(2,2) Model

$$\psi_i = \omega + \alpha_1 x_{i-1} + \alpha_2 x_{i-2} + \beta_1 \psi_{i-1} + \beta_2 \psi_{i-2} + \lambda disc_{i-1}$$

	daily	*weekly*	*monthly*
ω	1.3678*	0.6129*	0.7205*
	(0.2543)	(0.1052)	(0.1385)
α_1	0.0183*	0.0390*	0.0157
	(0.0074)	(0.0151)	(0.0192)
α_2	-0.0118	-0.0282	-0.0282
	(0.0090)	(0.0194)	(0.0268)
β_1	0.4082*	0.4202*	0.0221
	(0.2091)	(0.2004)	(0.1466)
β_2	0.1921	0.2052	0.3616*
	(0.1762)	(0.1698)	(0.1039)
λ	2.4441*	1.0755*	0.7718*
	(0.9898)	(0.4305)	(0.1785)
γ	2.1078*	2.2048*	2.6215*
	(0.1597)	(0.1804)	(0.3261)
L	-241.11	-145.92	-55.72
DOF	103	100	70

Notes: See Table 3.

Table 5: Parameter Estimates for the WACD(1,1) Model with Interventions

$$\psi_i = \omega + \alpha x_{i-1} + \beta\psi_{i-1} + \lambda disc_{i-1} + \eta inter_{i-1}$$

	daily	*weekly*	*monthly*
ω	1.5586*	0.3071*	0.6089*
	(0.2512)	(0.1775)	(0.1219)
α	0.0174*	0.0529*	0.0295
	(0.0054)	(0.0187)	(0.0190)
β	0.3922*	0.4277*	0.3941*
	(0.0932)	(0.1201)	(0.0947)
λ	3.1258*	21703*	0.5633*
	(0.9967)	(0.6029)	(0.1415)
η	0.1207*	0.0424*	0.0076
	(0.0502)	(0.0146)	(0.0052)
γ	2.2682*	2.2179*	2.5012*
	(0.1609)	(0.1884)	(0.3157)
L	-232.44	-145.75	-58.29
DOF	104	102	72

Notes: See Table 3.

Table 6: Parameter Estimates for the WACD(1,1) Model

with (lagged) Interventions

$$\psi_i = \omega + \alpha x_{i-1} + \beta\psi_{i-1} + \lambda disc_{i-1} + \eta interx_{i-1}$$

	x = 1	*x = 5*	*x = 10*	*x = 20*	*x = 40*
ω	1.5586*	1.5853*	1.5802*	1.5392*	1.4401*
	(0.2512)	(0.2487)	(0.2561)	(0.2804)	(0.2821)
α	0.0174*	0.0171*	0.0173*	0.0154*	0.0103*
	(0.0054)	(0.0051)	(0.0053)	(0.0050)	(0.0039)
β	0.3922*	0.3955*	0.3997*	0.4443*	0.5271*
	(0.0932)	(0.0935)	(0.0954)	(0.0968)	(0.0921)
λ	3.1258*	3.0301*	3.0304*	2.6984*	2.4950*
	(0.9967)	(0.9728)	(1.0030)	(1.0110)	(0.9704)
η	0.1207*	0.1488*	0.1646*	0.2619*	0.4340
	(0.0502)	(0.0675)	(0.0771)	(0.1298)	(0.3925)
γ	2.2682*	2.2829*	2.2760*	2.2636*	2.2145*
	(0.1609)	(0.1591)	(0.1599)	(0.1626)	(0.1729)
L	-232.44	-231.54	-231.57	-232.42	-235.49
DOF	105	105	105	105	105

Notes: The data frequency is daily. $interx_{i-i}$ is the number of interventions x days before a change in the federal funds target. Standard errors are given in parentheses and * denotes significance at the 5% level.

Table 7: Parameter Estimates for the WACD(1,1) Model with (lagged) Interventions

$$\psi_i = \omega + \alpha x_{i-1} + \beta\psi_{i-1} + \lambda disc_{i-1} + \eta DumInterx_{i-1}$$

	x = 1	*x = 5*	*x = 10*	*x = 20*	*x = 40*
ω	1.4840*	1.6899*	1.6958*	1.6444*	1.4229*
	(0.3621)	(0.2487)	(0.2648)	(0.3327)	(0.2750)
α	0.0182*	0.0182*	0.0182*	0.0173*	0.0103*
	(0.0067)	(0.0055)	(0.0054)	(0.0059)	(0.0042)
β	0.3751*	0.3594*	0.3539*	0.4101*	0.5320*
	(0.1042)	(0.0973)	(0.0938)	(0.1078)	(0.0908)
λ	3.0077*	2.7575*	2.8053*	2.4836*	2.1586*
	(0.9967)	(0.9733)	(0.9548)	(1.0673)	(0.9714)
η	1.2007*	1.4413*	1.5808*	1.7890*	2.3585*
	(0.4057)	(0.4659)	(0.5004)	(0.6049)	(1.0502)
γ	2.1921*	2.1953*	2.2089*	2.1853*	2.1832*
	(0.1747)	(0.1673)	(0.1689)	(0.1601)	(0.1745)
L	-236.64	-235.69	-234.89	-236.43	-236.84
DOF	105	105	105	105	105

Notes: The data frequency is daily. $DumInterx_{i-i}$ is a dummy variable one if an intervention took place x days before a change in the federal funds target. Standard errors are given in parentheses and * denotes significance at the 5% level.

Table 8: Parameter Estimates for the (Baseline) WACD(1,1) Model with Interventions for Different Sample Periods

$$\psi_i = \omega + \alpha x_{i-1} + \beta\psi_{i-1} + \lambda disc_{i-1} + \eta DumInter1_{i-1}$$

	Full Sample	*2/1/87 to 12/31/99*	*2/1/84 to 4/1/90*
ω	1.4840*	-0.0132	3.2098*
	(0.3621)	(0.4378)	(0.6341)
α	0.0182*	0.0072	0.0295*
	(0.0068)	(0.0050)	(0.0095)
β	0.3751*	0.6531*	0.2022
	(0.1042)	(0.0882)	(0.1682)
λ	3.0076*	3.1167*	2.4797*
	(0.9973)	(0.8559)	(1.0821)
η	1.2007*	2.0025*	2.1168*
	(0.3626)	(0.4175)	(0.3765)
γ	2.1921*	2.1786*	2.6318*
	(0.1747)	(0.2410)	(0.2585)
L	-236.65	-152.83	-147.44
DOF	104	61	74

Notes: Frequency is daily. DumInter1 is a dummy variable +1 if an intervention took place one day before a change in the federal funds target, otherwise zero.