Central Bank Policy Rate Guidance and Financial Market Functioning*

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Several central bankers have expressed concern that providing forecasts of future policy rates may impair financial-market functioning. We look for evidence of such impairment by examining the behavior of financial markets in the United States, the euro area, and New Zealand in light of the communication strategies of the central banks. While we find evidence that central bank policy rate forecasts influence market prices in New Zealand, we find no evidence that market participants in the three regions systematically overweight policy rate guidance or that they do not appreciate the uncertainty and conditionality of it. The results suggest that the risk of impairing market functioning is not a strong argument against central banks' provision of policy rate guidance or forecasts.

JEL Codes: E52, E58, G14.

1. Introduction

When evaluating the advantages and disadvantages of providing to the public guidance about or regular forecasts of policy rates, central bankers have expressed concerns that the provision of such guidance or forecasts may impair financial-market functioning because market participants will place an inordinate amount of weight on them.

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In this paper, we assess the seriousness of these concerns by evaluating the behavior of financial markets in the United States, the euro area, and New Zealand in light of the communication strategies of central banks. While we find evidence that central bank policy rate forecasts influence market prices in New Zealand, we find no evidence that market participants in the three regions systematically overweight policy rate guidance or that they do not appreciate the uncertainty and conditionality of it. The results suggest that the risk of impairing market functioning is not a strong argument against central banks' provision of policy rate guidance or forecasts.

There has been a profound transformation in central bank communication practices over the past two decades. Previously, central banks often shrouded their deliberations, policy intentions, and even policy actions in secrecy. Nearly all central banks now announce publicly their policy actions: most provide detailed information about their policy meetings in the form of minutes, press briefings, or even transcripts; many make their policy intentions clear by announcing inflation targets or other objectives; and some release their economic projections. The current cutting edge of the movement toward greater transparency is the issue of whether or not central banks should provide regular forecasts of their own policy rates. The Reserve Bank of New Zealand (RBNZ) has provided regular forecasts of the ninety-day bank bill rate since June 1997. Among other central banks, those of Norway (in November 2005), Sweden (in February 2007), Iceland (in March 2007), and the Czech Republic (in February 2008) have also begun publishing policy rate forecasts.[1]

Some central banks have opted to provide guidance for finite periods of time about the likely near-term path for policy rates. From April 1999 to August 2000 and from March 2001 to July 2006, the Bank of Japan (BOJ) indicated that its target of zero for the interbank rate would be maintained until deflationary concerns were dispelled. The Federal Open Market Committee (FOMC) signaled the trajectory for rates from August 2003 to December 2005, first by stating that rates would remain at 1 percent for a "considerable period," and then by indicating that the tightening in policy

[1]While the central banks of New Zealand, Norway, and Sweden publish the expected policy rate path of their monetary policy decision makers, the central banks of Iceland and the Czech Republic publish staff forecasts of the policy rate.

would proceed at a pace that was likely to be "measured."[2] The European Central Bank (ECB) telegraphed each of its policy moves during the tightening episode from December 2005 to August 2007 by using language inserted in the statement released following the previous month's policy meeting. "Strong vigilance" always preceded (and was taken by market participants to imply) a tightening at the next meeting, and "close monitoring" preceded unchanged policy. In contrast to the RBNZ, the FOMC and the ECB have not provided explicit or regular forecasts for interest rates.

Little theoretical work has been done so far on whether the provision of forecasts of their own policy rates by central banks is beneficial. Rudebusch and Williams (2006) argue that in an economy where private agents have imperfect information about the determination of monetary policy, central bank communication of interest rate projections is desirable because the projections can help shape financial-market expectations and improve macroeconomic performance. Much of the literature on the effect of central bank transparency has focused on the effects of central bank transparency about exogenous state variables and economic projections, rather than about the policy rate set by the central bank. Svensson (2004) and Woodford (2005) argue that more transparency is better than less, since greater transparency reduces uncertainty about central bank objectives and enhances accountability. Morris and Shin (2002, 2005) argue that market participants will focus too intently on the public forecasts and pay too little attention to other private sources of information. The inattentiveness of market participants to their own private information reduces the information content of market prices.[3]

Central bankers typically see advantages and disadvantages in providing interest rate forecasts (see Archer 2005; Issing 2005; Kohn 2005, 2008; Bergo 2007; Ingves 2007; King 2007; Rosenberg 2007; and Tucker 2007). They recognize the value of reducing uncertainty

[2]In the past, the FOMC provided balance-of-risk assessments suggesting the likely direction of future monetary policy, the impact of which on financial markets has been studied in Ehrmann and Fratzscher (2007b).

[3]Svensson (2006), however, argues that the conclusions of Morris and Shin (2002) depend on implausible parameter assumptions.

about central bank objectives and tactics. They also note that affecting private-sector expectations about future monetary policy is an important means by which central banks influence economic activity. On the other hand, many point out that it can be difficult for monetary policy committees to reach agreement about a forecast for policy rates. For example, Donald Kohn (2005), the Vice Chairman of the Federal Reserve Board, states that "the possibility that discussions of future policy, even nonspecific, could create presumptions about a string of policy actions makes finding a consensus among policymakers on what to say about future interest rates quite difficult—more so than agreeing on the policy today." Goodhart (2001, 172) states, "One alternative would be to have the MPC decide, and vote, not just on the change in interest rates this month but also on the whole prospective path.... The space of choice becomes so great that it is hard to see how a committee could ever reach a majority for any particular time path." Reaching a consensus is not a concern, however, for a sole monetary policy decision maker, as in the case of the RBNZ.

Central bankers also frequently note that central bank forecasts of policy rates run the risk of impairing market functioning. For example, in a speech at the 2005 American Economic Association meetings, Donald Kohn listed two considerations that have constrained the pace of central bank transparency about their outlook: The first consideration is that informational efficiency could be impaired by the provision of policy rate guidance, with financial markets placing too much weight on central bank forecasts, reducing their own analysis of economic developments, and not appreciating sufficiently the uncertainty surrounding these forecasts and their conditionality. The second consideration is the possibility that deviations from policy projections that were too firmly believed by market participants would unsettle financial markets, a possibility that would make it difficult for policymakers to depart from the projected path. For example, Kohn (2005) stated that "in any case, the risks of herding, of overreaction, of too little scope for private assessments of economic developments to show through, would seem to be high for central bank talk about policy interest rates." Issing (2005, 70) stated, "However, with the use of such code words, the central bank puts itself under pressure to honor a quasi-promise. If, in the meantime, its assessment of the situation has changed,

owing to new developments, the central bank will be faced with the dilemma of triggering market disturbances if they 'disappoint' expectations, even though they may have convincing arguments to justify their reassessment of the circumstances. For this reason, indications about future decisions must always be seen only as conditional commitments. In practice, however, it is likely to prove extremely difficult to communicate this proviso with sufficient clarity. The more straightforward the 'announcement' and the simpler the code, the more difficult it will be to explain its conditionality ex ante." Goodhart (2001, 175) expressed the concern that "any indication that the MPC is formally indicating a future specific change in rates (e.g., as driven by a 'rule'-based formula) would be taken to indicate some degree of commitment."

In this paper we evaluate these two risks to financial-market functioning about which policymakers have expressed concerns, in light of the communication strategies of central banks. We do so by examining the following four questions: Do policy rate forecasts influence market prices? Are market participants inattentive to other developments when central banks provide policy rate forecasts? Do market participants take policy rate forecasts too seriously? And, do deviations from policy rate forecasts unsettle financial markets? We find evidence that policy rate forecasts do influence market prices, but we find no evidence that the forecasts impair market functioning.

2. Does Policy Rate Guidance Influence Market Interest Rates?

If policy rate guidance does not influence market interest rates, then the guidance would seem unlikely to impair market functioning or, for that matter, be particularly useful. Some studies for the United States have found that policy rate guidance influences U.S. market interest rates. Kohn and Sack (2003) find that statements released by the FOMC significantly affect market interest rates, partly since these statements convey information about the near-term policy inclinations of the FOMC. Gürkaynak, Sack, and Swanson (2005) find that a factor with a structural interpretation as the "future path of policy" significantly influences U.S. market interest rates,

with the impact being larger for longer-term U.S. Treasury yields than for shorter-term market interest rates.

While the evidence from the United States is suggestive, the FOMC does not provide an explicit policy rate forecast, unlike the Reserve Bank of New Zealand, which has the longest history of providing forecasts of future policy rates. Therefore, to investigate whether policy guidance influences market rates, we focus on the evidence from New Zealand. The RBNZ has provided forecasts of the ninety-day bank bill rate since June 1997 at various horizons. We use the interest rate projections published by the Reserve Bank of New Zealand in their quarterly Monetary Policy Statements (MPSs), which were published starting in June 1997.[4] The MPSs are published at 9 a.m. New Zealand time on scheduled dates, four times a year. In March 1999, the RBNZ switched from a quantity-based system of implementing monetary policy, which had been accompanied by "open-mouth operations," to a system based on the overnight cash rate (OCR) (see Brookes and Hampton 2000, and Guthrie and Wright 2000). The MPSs are published at the same time as the OCR announcements. In addition, there are four OCR announcements a year not accompanied by an MPS and policy rate forecast, but just by a one-page press release. We match the published interest rate forecasts up to eight quarters ahead with the market interest rates implied by the New Zealand ninety-day bank bill futures contracts, in order to study the relationship of the forecasts with expected future market interest rates.

In order to evaluate the effect of the new central bank interest rate forecast on market interest rates, we would like to evaluate the reaction of the futures rate on the day of publication of the forecast, $(f_n(t) - f_n(t-1))$, to the surprise in the forecast,

$$f_n(t) - f_n(t-1) = c + b(f_n^{CB}(t) - E_{t-1}f_n^{CB}(t)) + \varepsilon_t, \qquad (1)$$

where $f_n^{CB}(t)$ is the central bank's interest rate forecast n quarters ahead made at time t, $f_n(t)$ is the futures rate on the day of publication of the forecast expiring n quarters ahead, $f_n(t-1)$ is the futures

[4]The RBNZ's policy rate forecast is determined endogenously along with inflation and output using their Forecasting and Policy System model (see McCaw and Ranchhod 2002, and Ranchhod 2003).

rate on the day before publication of the forecast, and $E_{t-1}f_n^{CB}(t)$ is the market's expectation of the central bank's forecast on the day prior to its publication.[5]

In the absence of a perfect measure for the market expectation of the central bank's forecast in equation (1), $E_{t-1}f_n^{CB}(t)$, we include two proxy measures for it in the regression. The first proxy is the futures rate on the day prior to publication of the forecast, $E_{t-1}^{(1)}f_n^{CB}(t) = f_n(t-1)$. The second proxy we use is the previous central bank forecast made a quarter ago, $E_{t-1}^{(2)}f_n^{CB}(t) = f_{n+1}^{CB}(t-1q)$. Here, $f_{n+1}^{CB}(t-1q)$ is the forecast $n+1$ quarters ahead made in the previous quarter.[6] The first proxy measure is the most timely one. It should incorporate all the information available to market participants up to the day prior to publication of the central bank's forecasts. However, this measure may contain term premia and therefore may not reflect market participants' expectations accurately. In addition, market participants' true expectations about future interest rates may differ from those of the central bank. We therefore also include the second proxy measure, the central bank's previous forecast, which does not suffer from these two drawbacks and which market participants are likely to factor into their expectations. However, it is a less timely measure and does not include the latest information.

Using these proxies for market expectations of the central bank's forecast, the regression equation for changes in market interest

[5]We consider daily changes in market interest rates in equation (1), rather than intraday changes. Some researchers use intraday data (see, e.g., Andersen et al. 2003). But others use daily data, including Ehrmann and Fratzscher (2004, 2007a). Ehrmann and Fratzscher (2004) argue that intraday data may capture overshooting effects of the market that quickly disappear. Moreover, not all market participants necessarily react to news within a few hours. Based on these arguments, and based on our experience with conducting event studies for the United States and Canada (see Gravelle and Moessner 2002), we use daily data in this study. Drew and Karagedikli (2008) consider the reactions of market interest rates in New Zealand to economic news at both the daily and intraday frequency. They find that daily data give similar results to intraday data for the estimated coefficients, with the coefficients still quite significant for short-term interest rates (which we consider in our paper).

[6]It refers to $n+1$ quarters ahead in order to match the n-quarter-ahead forecast made a quarter later.

rates to surprises in forecasts on the forecast publication dates becomes

$$f_n(t) - f_n(t-1) = c + b(f_n^{CB}(t) - dE_{t-1}^{(1)} f_n^{CB}(t) - (1-d)E_{t-1}^{(2)} f_n^{CB}(t)) + \varepsilon_t, \quad (2)$$

which we estimate using nonlinear least squares. Table 1 reports the results for these regressions, separately for each horizon n.[7] We can see from table 1 that the surprises in the RBNZ forecasts have a significant influence on financial-market interest rates at horizons of two to six quarters ahead, with coefficients between 0.17 and 0.22. These results are consistent with those reported in Archer (2005), who finds that the New Zealand yield-curve slope is weakly influenced by surprises in the published interest rate slope. On the one hand, these coefficients may appear small, with market interest rates not moving one-for-one with surprises in central bank forecasts. This may suggest that market participants ignore central bank forecasts to a large degree, which may be perceived as damaging the central bank's credibility. On the other hand, we only have imperfect proxy measures available for the market's expectations of the RBNZ forecasts in the regressions, so that their correspondence is not perfect, and coefficients below 1 would be expected due to this measurement problem. Moreover, no doubt at least to some extent the central bank forecast is surprising to market participants because the central bank has changed its views about the likely future path for interest rates for reasons that market participants do not find compelling, and so a coefficient below 1 should be expected.[8]

[7] Another alternative is to regress the central bank forecast on the two proxies for the market's expectation and use the residual from the regression as a measure of the surprise component of the forecast. Using this alternative approach yields very similar results for the coefficients on the surprises reported in table 1. We prefer the specification reported in table 1, however, since it does not use a derived measure for the surprise in the regression.

[8] As discussed above, the futures rates will also not equal expected future interest rates because of term premia. However, term premia might be expected to be fairly small at the horizons we consider.

Table 1. Reaction of Daily Changes in Interest Rate Futures to Surprises in RBNZ Interest Rate Forecasts on the Days of Publication of the Forecasts

Quarters Ahead	**1**	**2**	**3**	**4**	**5**	**6**
Constant, c	0.01	−0.005	0.001	−0.01	−0.01	−0.02
	(0.4)	(−0.2)	(0.0)	(−0.8)	(−0.6)	(−0.7)
Surprise in Forecast, b	0.13	0.20**	0.20**	0.22**	0.20**	0.17**
	(1.9)	(3.6)	(4.6)	(5.9)	(5.5)	(4.1)
First Proxy for Expected Forecast, d	0.00	0.51**	0.43**	0.52**	0.44**	0.45**
	(0.0)	(2.8)	(2.9)	(4.7)	(3.8)	(2.8)
No. of Observations	39	39	39	33	30	29
R^2	0.20	0.29	0.38	0.54	0.53	0.40
LM Test for Serial Correlation of Residuals[1]	1.30 [0.29][2]	1.56 [0.21][2]	1.05 [0.40][2]	0.19 [0.94][2]	0.53 [0.72][2]	0.90 [0.48][2]

Notes: t-values are in parentheses; * and ** denote significance at the 5 percent and 1 percent level, respectively.
[1]Breusch-Godfrey LM test with four lags, F-statistic.
[2]p-values are in square brackets.
The first proxy for the expected forecast, with weight d, is the New Zealand ninety-day bank bill futures rate on the day prior to publication of the forecast, the same number of quarters ahead as the forecast; the second proxy for the expected forecast, with weight $1 - d$, is the previous central bank forecast made a quarter ago. The sample is from June 27, 1997, to March 8, 2007, at quarterly intervals on the dates of publication of the interest rate forecasts in the RBNZ's Monetary Policy Statements. The New Zealand ninety-day bank bill futures contracts are traded on the Sydney futures exchange.

3. Are Market Participants Inattentive to Other Developments When Central Banks Provide Policy Rate Guidance?

A common concern raised by central bankers is that market participants may pay too much attention to policy rate forecasts and pay too little attention to other sources of macroeconomic information. As a consequence, if policy rate forecasts are provided, market prices would become less informative. To investigate this possibility, we examine the response of interest rate futures and option-implied volatilities to macroeconomic data releases and central bank policy announcements. We find no evidence that policy guidance leads market participants to reduce their reaction to other sources of news.

3.1 Response of Interest Rate Futures to Economic Data Releases

One might expect that during the period when the FOMC was providing clear signals about future monetary policy (August 2003 to December 2005), the sensitivity of asset prices to macroeconomic releases might fall, insofar as the FOMC was signaling that future policy adjustments would be gradual. However, we find that the responsiveness of one-year-ahead Eurodollar futures rates to a set of major macroeconomic releases was significantly higher during the guidance period (see table 2). Table 2 reports results for the regressions of daily changes in one-year-ahead Eurodollar futures rates (in basis points), $y(t) - y(t-1)$, on the surprise components of eleven economic releases,

$$y(t) - y(t-1) = c + c_g\ dum_g(t) + \sum_{e=1}^{11}(b_e\ surprise_e(t) + g\ b_e\ surprise_e(t)\ dum_g(t)) + \varepsilon_t, \qquad (3)$$

where the subscript e denotes changes in nonfarm payrolls, the unemployment rate, hourly earnings, CPI inflation, PPI inflation, industrial production, the trade balance, retail sales, housing starts,

Table 2. Difference in the Effect of Macroeconomic Data Releases on Daily Changes in One-Year-Ahead Eurodollar Futures Rates When the FOMC Was Providing Rate Guidance[a]

Variable	Estimate
Constant	−0.5**
	(−2.9)
Guidance Dummy on Constant (c_g)	0.5
	(1.6)
Nonfarm Payrolls	5.0**
	(7.8)
Unemployment	−1.9**
	(−4.4)
Hourly Earnings	1.0*
	(2.5)
CPI	0.5
	(1.4)
PPI	−0.3
	(−0.7)
Industrial Production	0.3
	(1.0)
Trade Balance	0.5
	(1.4)
Retail Sales	1.8**
	(3.8)
Housing Starts	−0.3
	(−0.8)
ISM	1.1**
	(2.9)
GDP	−0.1
	(−0.2)
Common Proportional Change in Response during Guidance Period (g)	2.1**
	(4.4)
No. of Observations	2,247
R^2	0.10

Notes: * and ** denote significance at the 5 percent and 1 percent level, respectively. t-values are in parentheses. [a]Daily changes in basis points; the sample period is from June 1998 to August 2007. The guidance period is defined in the note to table 3. The macroeconomic data surprises are calculated relative to the median of the most recent Bloomberg survey and are normalized by their standard deviation.

the ISM manufacturing index, and GDP.[9] The surprises are calculated relative to Bloomberg median survey expectations and are normalized by their standard deviation. The guidance dummy, $dum_g(t)$, is equal to 1 during periods when the FOMC provided guidance and 0 at all other times. The coefficient b_e is the estimated response, in basis points, of one-year-ahead Eurodollar futures rates to a one-standard-deviation surprise in the economic statistic outside the guidance period, and $(1 + g)b_e$ is the response during the guidance period. A significantly negative estimate of g would indicate reduced responsiveness during the guidance period, while a significantly positive estimate would indicate increased responsiveness.

We can see from table 2 that the coefficients on five of the economic releases are statistically significant and of the expected sign. The coefficient g is estimated to be 2.1 and is highly significant, indicating that the response of interest rate futures was significantly stronger during the guidance period. These results suggest that financial-market participants continued to pay close attention to macroeconomic information during the period when the FOMC was providing guidance on future policy rates. Our finding that the reaction to macroeconomic surprises does not decrease significantly during the guidance period is consistent with a result of Ehrmann and Fratzscher (2007b), who find only weak evidence for a reduction in market reactions to macroeconomic surprises with the introduction of balance-of-risk assessments by the FOMC in 1999.[10]

3.2 Response of Interest Rate Futures to Policy Announcements

If market participants shift their focus toward policy announcements when policy rate guidance is provided, the responsiveness of the outlook for future interest rates to monetary policy releases should increase *relative* to the response to other sources of information. To

[9]The releases are essentially the same as those considered by Gravelle and Moessner (2002).

[10]By contrast, there is some evidence that greater transparency in the form of publication of an inflation target can lead to a better anchoring of private agents' long-term inflation expectations and reduce the sensitivity of long-term inflation expectations derived from government bond yields to economic news (see Gürkaynak, Levin, and Swanson 2006, and Libich 2006).

examine that hypothesis, we consider the ratio of the absolute values of daily changes in one-year-ahead interest rate futures on monetary policy announcement days to the averages of those changes over recent periods (up to N days previously),

$$r_i^a(t) = 100|y_t - y_{t-1}|^i / \sum_{n=1}^{N}(|y_{t-n} - y_{t-n-1}|^i/N), i = 1 \text{ or } 2, \quad (4)$$

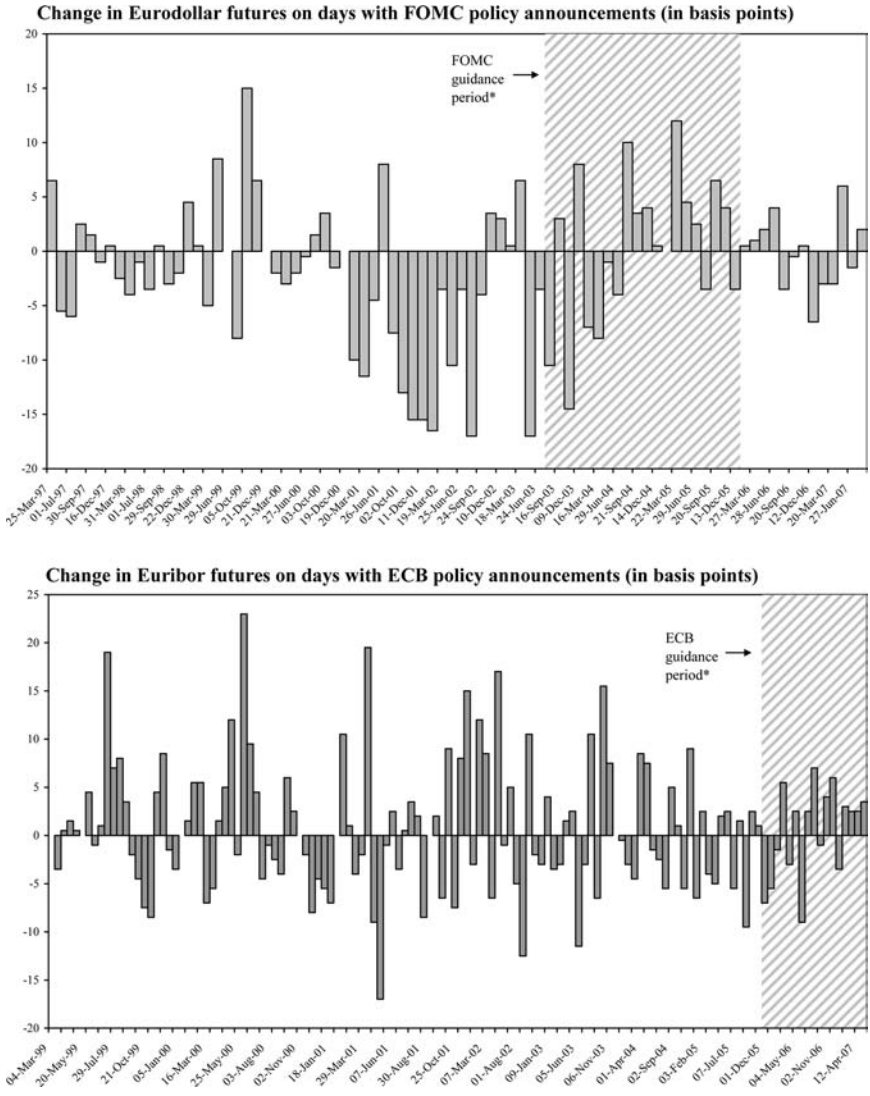
on the view that movements on contiguous non-policy-announcement days will reflect the responsiveness of rates to other sources of information. We then compare the ratio over all the monetary policy days in our sample with those policy days when the central banks were providing guidance about the future path of interest rates. We look at both the FOMC and the ECB. In general, we find no evidence that there is a significant increase in this ratio during the periods with guidance.

The one-year horizon is short enough that the interest rate futures are determined primarily by expectations about monetary policy but long enough not to be nailed down by any implicit commitment to specific monetary policy choices inherent in the central banks' statements about the outlook for policy rates. During these episodes, the central bank communications were designed to telegraph near-term policy choices, and there were virtually no surprises in the precise choice of policy rates at each meeting. Judging by the changes in one-year-ahead interest rate futures, however, during the guidance periods, revisions to the outlook for the path of policy beyond the very near term were just about as volatile as during other periods (see figure 1).

For the FOMC, we use the absolute value of daily changes in one-year-ahead Eurodollar futures as our measure of the revision to the interest rate outlook. The change on the day of FOMC meetings is divided by the average change over the preceding four weeks (the FOMC meets about every six weeks). The sample begins in 1994, when the FOMC first began releasing press statements when it changed policy. The results for the following regressions are shown in table 3,

$$r^a(t) = c + b\ dum_g(t) + \varepsilon_t, \quad (5)$$

Figure 1. Changes in Eurodollar and Euribor Futures on Days with Policy Announcements



where again the guidance dummy, $dum_g(t)$, is equal to 1 during periods when the FOMC provided guidance and 0 at all other times. The absolute changes on all FOMC days average 33 percent higher than other days over the preceding month.

Table 3. Ratio of Absolute Value of Changes in Interest Rate Futures on Policy Announcement Days to Other Days during Periods When Central Banks Provide Policy Guidance

	Federal Reserve	ECB
Constant, c	132.7**	157.95**
	(11.6)	(10.6)
Guidance Dummy, b	8.4	−6.8
	(0.3)	(0.2)
No. of Observations	109	64
R^2	0.00	0.03

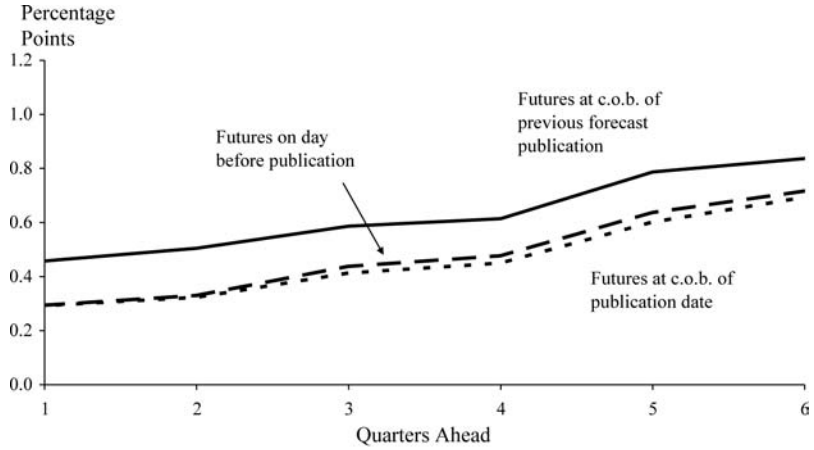
Notes: * and ** denote significance at the 5 percent and 1 percent level, respectively. t-values are in parentheses. The FOMC provided guidance about the likely trajectory for policy from August 12, 2003, to December 13, 2005, when it first indicated that interest rates would be held at 1 percent for a "considerable period" and then stated that policy tightening would proceed at a pace likely to be "measured." The sample consists of the 109 FOMC meetings from February 1994 to August 2007. The ECB telegraphed its policy moves one month in advance from December 2005 to August 2007. The sample consists of the sixty-four monetary policy announcements from January 2002 to August 2007.

The changes are an additional 8 percentage points higher on meeting days when the FOMC was using the "considerable period" and "measured pace" language, but the difference is not statistically significant.

For the ECB, we use the daily changes in one-year Euribor futures, and the sample begins in January 2002. We only use a three-week moving average as the denominator so that the period does not include a previous meeting day (the Governing Council of the ECB has met once a month to decide on the policy rate since 2002).[11] We test to see if the relative variance on meeting days rose during the period when the ECB's President Trichet alternated between

[11] We start in 2002 since prior to 2002, the ECB's Governing Council met twice monthly at scheduled meetings to decide on monetary policy, although policy rates were generally not changed at the meeting in the middle of the month. In September 2001, the Governing Council met three times for monetary policy decisions.

Figure 2. Mean Absolute Difference between Futures[a] and RBNZ Forecasts[b]



[a] Futures on New Zealand ninety-day bank bills.
[b] Forecasts by Reserve Bank of New Zealand of ninety-day bank bill rates.

"strong vigilance" and "close monitoring" to signal if the next move would be a 25-basis-point increase or no change, respectively.

The results provide even less evidence that markets became overly attentive to the ECB's policy announcements or press conferences. For the sample as a whole, the absolute value of the interest rate changes is 58 percent higher on policy announcement days than on other days during the preceding three weeks. The boost on meeting days is 7 percentage points *less* during the signaling period, but the decrease is not statistically significant.

In New Zealand, market participants' and the RBNZ's forecasts of the ninety-day bill rate have moved together closely over time. This result is illustrated in figure 2, separately for each horizon n quarters ahead, for the forecasts published between June 1997 and March 2007. Figure 2 shows the mean absolute difference between the published forecast and the futures rate on the day of publication of the forecast, the futures rate on the day prior to publication, and the futures rate the day the previous forecast was published. While the futures rate moves closer to the forecast on the day the forecast is published, that narrowing of the gap is small compared with the narrowing that occurs over the quarter up to the day prior to the

forecast. The narrowing of the difference between the futures rates and the forecasts occurring over the quarter up to the day prior to the release of the forecast cannot, of course, reflect a response to the as-yet-unknown RBNZ forecast. This suggests that both forecasts and futures are to some extent reacting to the same news about the economic outlook arriving between forecast publication dates, to the OCR announcement and accompanying press release occurring in between the publication of the MPSs, or that additional changes in the RBNZ's policy outlook are revealed to the market in speeches, testimonies, or by other means. That is, futures rates adjust to new information arriving between the publication of forecasts, and market participants do not just react to published forecasts. The RBNZ forecasts may also be influenced by movements in interest rate futures.

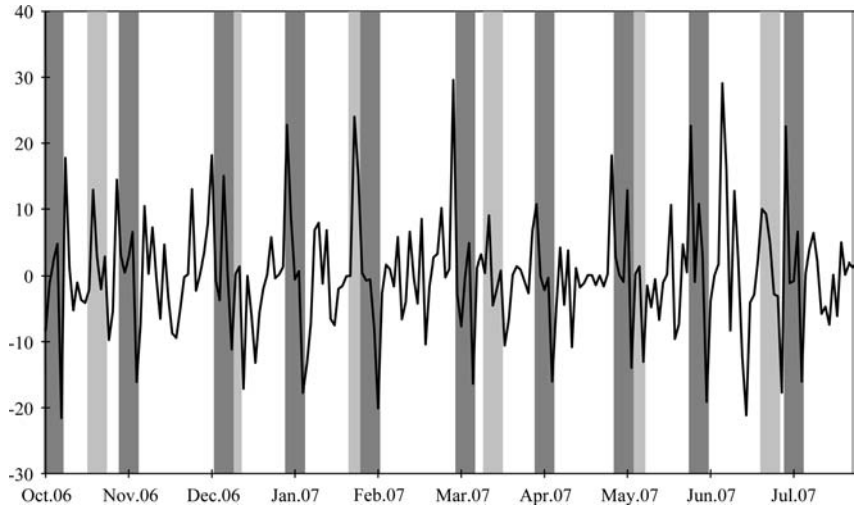
3.3 Response of Option-Implied Interest Rate Volatility

We can also evaluate the relative impact on market interest rates of central bank policy announcements by examining the behavior of the option-implied volatility of interest rates. The implied volatilities we use are taken daily from over-the-counter options on five-year Treasury securities with one week to maturity.[12] We examine the implied volatility in five-year yields rather than at shorter maturities because we do not have data available on shorter-maturity securities for options with a constant, short period to expiry. While movements in five-year-ahead *futures* or *forward* rates may have little to do with monetary policy, the five-year Treasury yield is a yield to maturity and not a forward rate, and so is significantly influenced by interest rates expected for the next few years, which are determined importantly by monetary policy expectations. For example, the correlation between the daily changes in five-year and two-year Treasury yields was 0.92 over the period 1990 to mid-2007.

These data are different from the implied volatility data most commonly used. Usually, daily time series on implied volatility are taken from a single option or interpolated from two options with constant maturity dates. Once a quarter, the reference options switch to

[12]Goldman Sachs has generously provided us with these data.

Figure 3. Option-Implied Volatility of Five-Year U.S. Treasury Note Yields, Effect of Employment Reports and FOMC Announcements



Note: Daily. The implied volatilities are from options with one week to maturity. The shaded regions are the one-week periods prior to FOMC announcements (light grey) and U.S. employment reports (dark grey).

ones maturing one quarter later. The maturity dates are often several quarters into the future. The data we use here measure implied volatility using a different option each day. The option chosen always expires in one week. The short and constant maturity of the options allows us to measure the increase in implied volatility when specific events enter the relevant window and the decline when the events leave the window.[13] As can be seen in figure 3, when specific risk events—in this case, employment reports or FOMC meetings—are scheduled to occur within the week remaining till the option expires, the volatility in five-year yields over the week implied by the option price is noticeably higher.

Since these data are only available to us for the United States, we can only test for the impact of U.S. economic news and FOMC announcements, not for similar events in other countries. We look

[13]We benefited from discussions with Brian Sack concerning this procedure.

at the effects of FOMC announcements and of macroeconomic releases from March 1994 to the present, and test for any difference in the effects during the period when the FOMC was providing policy outlook guidance. Because of risk premia, implied volatilities are only imperfect proxies for market participants' true uncertainty. However, daily variations in such risk premia are likely to be small, so that they would not be expected to significantly affect regression results involving daily changes in implied volatilities.

Specifically, we regress the daily log-difference in the implied volatility, $100^*(log(iv(t)) - log(iv(t-1)))$, on one or more sets of two dummies. The first dummy, the event dummy $dum_e(t)$, is equal to 1 on the day one week before the event of interest (when the event can first begin to influence the payoff of the underlying options) and equal to -1 on the day of the event (when the potential influence ends).[14] The second dummy is the event dummy interacted with a variable that equals 1 during the period when the FOMC was providing guidance ($dum_g(t)$). When analyzing the effect of FOMC meetings, the regression is of the form

$$100^*(log(iv(t)) - log(iv(t-1))) = c + b\ dum_e(t) + d\ dum_e(t)\ dum_g(t) + \varepsilon_t, \quad (6)$$

where the subscript e denotes FOMC meetings. When analyzing the effect of data releases, we use an approach similar to the one we report above for measuring the effect of data releases on interest rate futures. The daily percentage change in volatility is regressed on the dummies for each of the data releases described above as well as those dummies interacted with the "guidance period" dummies. A coefficient is estimated for each data release and a single additional coefficient measures the proportional change in the effect of all the data releases during the guidance period. The data releases considered are the same set as considered above—namely, the employment

[14] We are restricting the increases and decreases in implied volatility to be equal, a restriction accepted by the data.

report (which includes changes in nonfarm payrolls, the unemployment rate, and hourly earnings released at the same time), CPI inflation, PPI inflation, industrial production, the trade balance, housing starts, retail sales, the ISM manufacturing index, and GDP. In this case, the equation takes the form

$$100^{*}(log(iv(t)) - log(iv(t-1))) = c + \sum_{e=1}^{9}(b_e\ dum_e(t) + g\ b_e\ dum_e(t)\ dum_g(t)) + \varepsilon_t, \tag{7}$$

where the subscript e denotes the data releases. The release increases implied volatility by b_e percent outside of the guidance period and $(1 + g)b_e$ percent during the guidance period. The results are reported in table 4.

The implied volatility of the five-year U.S. Treasury yield behaves in a manner consistent with the results for the ex post volatility of interest rate futures discussed above. Implied volatilities are higher by about 5 percent when an FOMC meeting occurs during the week before the option expires, and the increase is highly statistically significant. The increase was 0.3 percentage point greater during the "considerable period/measured pace" interval, but the difference is not statistically significant.

The presence of an economic statistical release during the week before the option expires also generally boosts implied volatilities. Seven of the nine releases considered increased implied volatilities by a statistically significant amount. Employment reports were, in fact, viewed as more consequential risk events for five-year yields than FOMC meetings, increasing implied volatilities by 18 percent (see table 4 and figure 3). The impact of economic data releases on implied volatilities did not fall during the guidance period; it rose by a highly statistically significant 70 percent.

In sum, the behavior of implied volatilities provides no evidence that the FOMC's guidance led market participants to be inattentive to other sources of information. FOMC announcements were expected to have about the same impact on five-year yields as during other times, and macroeconomic releases were expected to have, if anything, a larger impact.

Table 4. Percent Increase in the Option-Implied Volatility Caused by FOMC Meetings and Macroeconomic Releases during Periods When the FOMC Provided Policy Guidance

Variable	Estimate
Constant	0.0
	(0.1)
FOMC Meeting Dummy	5.4**
	(6.5)
FOMC Meeting Dummy*Guidance Period Dummy	0.3
	(0.1)
No. of Observations	3,221
R^2	0.02
Constant	−0.0
	(−0.2)
Employment Report	17.8**
	(32.0)
CPI	3.5**
	(7.5)
PPI	2.2**
	(4.8)
Industrial Production	−0.2
	(−0.3)
Trade Balance	−0.3
	(−0.6)
Retail Sales	1.9**
	(4.2)
Housing Starts	1.4**
	(3.0)
ISM	1.9**
	(4.4)
GDP	2.5**
	(3.3)
Common Proportional Change in Coefficients during Guidance Period (g)	0.7**
	(7.8)
No. of Observations	3,221
R^2	0.3

Notes: * and ** denote significance at the 5 percent and 1 percent level, respectively. t-values are in parentheses. The sample is from March 31, 1994, to July 27, 2007. The guidance period is defined in the note to table 3. The implied volatilities are taken from options with one week to expiration on five-year Treasury notes. The regressions estimate the increase and decrease (restricted to be equal) in the implied volatility when FOMC meetings, or the indicated economic releases, enter and leave the one-week window.

4. Do Market Participants Take Central Bank Policy Rate Guidance Too Seriously?

A slightly different concern commonly raised by central bankers is that market participants will not understand that central banks' statements about future policy rates are not commitments, that the statements are conditional on developments or are forecasts subject to uncertainty and error. Put another way, when provided with forecasts or policy guidance, do market participants become excessively confident in their outlook for interest rates?

When evaluating this concern, it seems important to distinguish between providing forecasts on a regular basis, such as is done by the Reserve Bank of New Zealand, and including forward-looking language in policy announcements for a temporary period. When a forecast is released regularly, the central bank is not making a tactical decision to release or not release the forecast, and so the *existence* of the forecast does not necessarily imply anything about the central banks' intentions (which is not to say that the content of the forecast does not convey information about the central banks' intentions).[15] However, if a central bank only sometimes provides guidance about future policy, the central bank is making a tactical decision to manage market participants' expectations. As a result, when a central bank only sometimes provides guidance, the *existence* of the guidance may imply some degree of commitment and therefore a lower level of uncertainty about near-term policy rates.

For example, the minutes of the August 2003 FOMC meeting indicate that the FOMC foresaw keeping policy accommodative for a "considerable period" because it was concerned about the risk of deflation and anticipated keeping interest rates lower than normal in the future when the economy strengthened.[16] Similarly, when the FOMC adopted the "measured" language in May 2004, it indicated that the tightening would likely be more gradual than normal

[15]However, Rosenberg (deputy governor of the Sveriges Riksbank) mentioned in a speech that one of the motivations for a central bank to publish forecasts of its policy rate was to steer expectations (see Rosenberg 2007).

[16]Minutes of the Federal Open Market Committee, August 12, 2003.

because inflation was so low.[17] We do not have minutes for the ECB's meetings and so cannot determine the thinking behind its strategy to signal its tightening moves one meeting in advance. Nor did President Trichet explain the reasons for providing guidance in his press conferences over the period. It seems likely, however, that the FOMC and the ECB both chose to provide fairly explicit guidance when they were beginning a tightening episode in order to prevent long rates from rising sharply, imparting too large a degree of financial restraint.

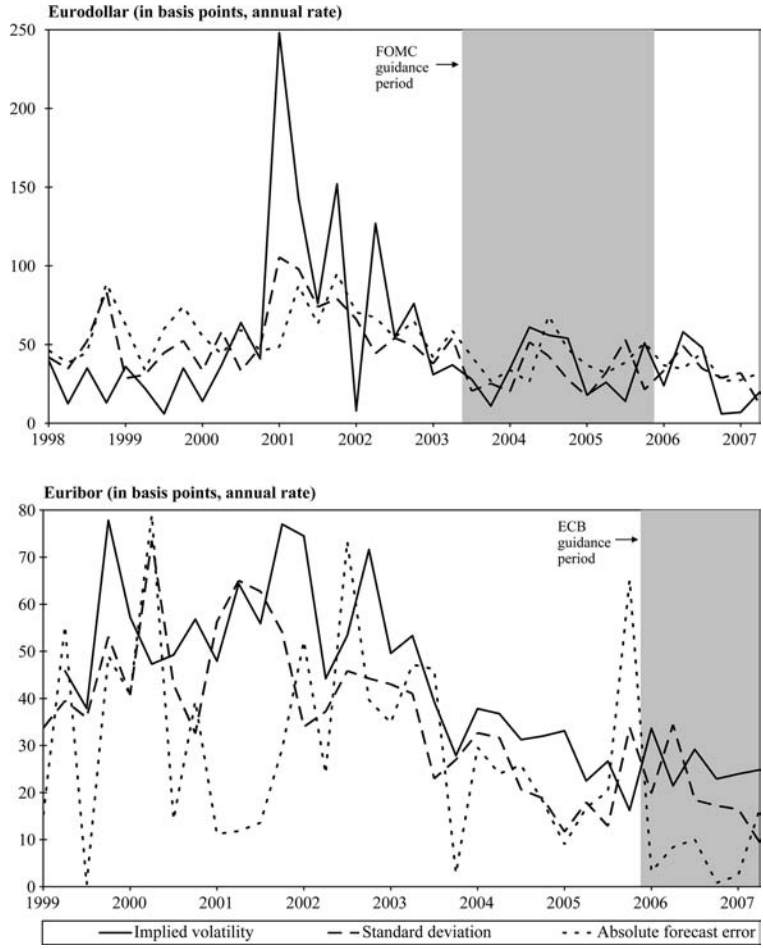
In sum, the issue is not whether market participants take central bank statements about future policy as involving some degree of commitment, but whether they take the statements *too* seriously. To evaluate this possibility, we compare investors' assessments of the uncertainty in the policy outlook as measured by implied volatilities with realized volatilities or forecast errors. If realized volatilities or forecast errors are larger relative to implied volatilities during periods when central banks provide guidance, then the guidance is possibly being taken too seriously.

We look at option-implied volatilities from futures contracts on money-market interest rates with three months to expiration for the United States and the euro area. Implied volatilities are derived from option prices under the assumption that the reference price evolves according to geometric Brownian motion. Under this assumption, it is reasonable to compare implied volatilities with the standard deviation of the daily changes in interest rates. Brownian motion is not, however, a particularly good assumption for interest rate futures prices, since interest rate changes are serially correlated and are subject to jumps, so we also compare the implied volatilities with the realized errors. Neither procedure suggests that market participants are unduly confident about monetary policy when forward-looking guidance is provided by the central bank.

Figure 4 presents the implied volatilities, standard deviations of interest rate changes, and absolute values of the forecast errors for the United States and the euro area. For the United States, the option-implied volatility is for Eurodollar futures with three months to expiration, and the realized standard deviation is for the

[17] Minutes of the Federal Open Market Committee, May 4, 2004.

Figure 4. Implied Volatilities, Standard Deviations of Interest Rate Changes, and Absolute Values of Forecast Errors for Eurodollar and Euribor Futures



daily first difference in the underlying Eurodollar futures rate.[18] The errors are calculated as the difference between the futures rate with three months to expiration (at the same time as the measurement of

[18]The implied volatility is the normalized "basis point" volatility, not the "interest rate" volatility, and so measures the uncertainty in absolute terms around the expected rate, not as a percentage of that rate.

implied volatility) and the spot rate at settlement. We are assuming that term premia will have a negligible, or at least a constant, effect on the realized error over the three-month horizon. For the euro area, the implied volatilities are from Euribor futures, the standard deviation from Euribor futures rates, and the forecast errors are calculated using the Euribor futures and spot Euribor rate. The dummy is defined for the "vigilance/monitoring" interval.

As can be seen, the implied volatilities, especially in the United States, fell to particularly low levels during the period when the central banks were providing interest rate guidance. However, the investor confidence appeared to be warranted, as the realized standard deviations and forecast errors were also quite low. Indeed, Swanson (2004) finds a downward trend in implied volatility that he attributes to investors' ability to forecast interest rates and to increased FOMC transparency.

The impressions from figure 4 are confirmed by regression results reported in table 5. We regress the ratio of the realized standard deviation, $s(t)$, to the implied volatility, $iv(t)$, or the ratio of the absolute value of the realized forecast errors, $fe(t)$, to the implied volatility on a constant and a dummy for the "considerable period/measured pace" interval for the United States and the "vigilance/monitoring" interval for the euro area,

$$r_i^b(t) = c_i + b_i \; dum_g(t) + \varepsilon_t, \;\; i = 1 \text{ or } 2, \tag{8}$$

where $r_1^b(t) = s(t)/iv(t)$ and $r_2^b(t) = fe(t)/iv(t)$.[19] In both the United States and the euro area, the standard deviations were a touch *lower* relative to the implied volatilities during the interval when guidance was provided, but in neither case were the differences statistically significant. The forecast errors were a bit higher in the United States and a bit lower in Europe relative to the implied volatilities during the relevant periods, but again, neither result is statistically significant.

Market participants have been very confident in their outlooks for near-term money-market interest rates when central banks have provided guidance. Judging by the muted changes in interest rates

[19] More details on the exact definitions of these variables are given in the notes to table 5.

Table 5. Ratio of Realized Money-Market Rate Volatility to Implied Volatility during Periods When Central Banks Provide Policy Guidance

	Standard Deviation of Daily Changes in Futures Rate ($i = 1$)	**Absolute Value of Forecast Error ($i = 2$)**
Eurodollar, FOMC Guidance		
Constant, c_i	0.9**	0.8**
	(15.1)	(6.3)
Guidance Dummy, b_i	−0.1	0.1
	(0.4)	(0.3)
No. of Observations	50	50
R^2	0.00	0.00
Euribor, ECB Guidance		
Constant, c_i	0.8**	0.8**
	(12.1)	(5.8)
Guidance Dummy, b_i	−0.1	−0.6
	(0.5)	(1.6)
No. of Observations	33	33
R^2	0.00	0.08

Notes: * and ** denote significance at the 5 percent and 1 percent level, respectively. t-values are in parentheses. The guidance periods are defined in the note to table 3. The implied volatility is measured three months before the maturity of Eurodollar futures contracts. The standard deviations are for the daily first differences of the futures rates for the three months before maturity. The forecast error is the expected Eurodollar rate implied by futures prices three months prior to maturity minus the spot rate at maturity. All variables are in basis points and are at an annual rate. The quarterly observations run from 1995:Q1 to 2007:Q2. The Euribor measures of uncertainty are defined in the same way as the Eurodollar measures and extend from 1999:Q2 to 2007:Q2.

and the accuracy of interest rate forecasts embedded in futures rates, however, that confidence was justified and did not reflect a tendency for investors to take the guidance too seriously. Of course, it remains possible that the stability and predictability of realized rates during the guidance periods are the consequence of the monetary

policymakers assiduously avoiding surprises after their guidance was misconstrued, but we find this possibility implausible in part, as discussed in the next section, because there is no evidence that monetary policy surprises have had notably bad effects on financial markets.

We also see no evidence of an overreaction in financial markets to surprises in the Reserve Bank of New Zealand's interest rate forecasts. As shown in table 1, surprises in central bank forecasts lead to some reaction of market interest rates, but with a coefficient much less than 1 at all horizons. Moreover, as mentioned above, Archer (2005) finds that the market yield-curve slope in New Zealand is only weakly influenced by surprises in the published interest rate slope, which also suggests no overreaction by financial markets to surprises in the central bank's interest rate forecasts.

Forecasts in which the policy rate projection is endogenous, as in the case of the RBNZ, are likely to be more credible than those made under the assumption of an exogenous interest rate path. Hence the conclusions regarding the effects of publishing policy rate forecasts may differ in the two cases. Moreover, in countries without an explicit inflation target, the publication of policy rate forecasts may have greater informational content than in countries with an explicit inflation target, since it may contain some signal about the level of an implicit target. Geraats (2005) shows that publishing economic forecasts may send a signal about the inflationary intentions of a central bank. Considering the case of New Zealand, which has an explicit inflation target, may therefore understate the importance of publishing policy rate forecasts for countries such as the United States and the euro area without an explicit inflation target.

5. Do Deviations from Earlier Policy Guidance Unsettle Markets?

The final concern raised by central bankers that we consider is that, insofar as market participants take policy rate guidance too seriously, deviations from the foreshadowed policy paths will unsettle markets. The concern is not only that the stability of financial markets and institutions will be lessened, but also that policymakers'

awareness of the potential consequences of deviations will constrain their future decisions.[20]

Undoubtedly, central bankers are concerned about the consequences for financial stability of surprising markets. For instance, when the FOMC began tightening policy in 1994 after a long pause, Chairman Alan Greenspan argued that, even though he believed that there was a case on macroeconomic grounds for a 50-basis-point tightening, the first tightening should be only 25 basis points because the surprise would rattle financial markets.[21] If central bankers believed that their statements about the future would be taken too seriously, then those statements would increase the expected magnitude of monetary policy surprises and so could reasonably be seen as posing a risk of constraining future policy choices.

As shown above, however, we find no empirical evidence that policy guidance is, in fact, taken too seriously. In this section, we test if monetary policy surprises are more likely to lessen financial stability during periods when central banks are providing guidance. Unsurprisingly, we find no compelling evidence of such increased sensitivity.

We assess financial stability using option-implied volatilities, $iv(t)$, of ten-year Treasury yields and of the S&P 500 stock index. We measure monetary policy surprises, $mps(t)$, using two variables. The first—the target surprise, $ts(t)$—is the absolute value of the difference on days of FOMC monetary policy announcements between the FOMC's target federal funds rate and the target expected on the eve of the announcement, judging by federal funds futures rates. The second measure—the path surprise, $ps(t)$—is the absolute value of the change in the one-year-ahead Eurodollar futures rate on announcement days.[22] We interact each surprise measure with a dummy,

[20]See Kohn (2005).

[21]FOMC transcript, February 3, 1994, p. 55. In the event, there were a number of abrupt jumps in longer-term interest rates, and associated market volatility, during the tightening episode that began in 1994 as the market and the FOMC reacted to economic data that came in stronger than expected. It would seem reasonable to suppose that the 1994 experience contributed to the decision by the FOMC to use the "measured pace" language during the tightening episode that began in 2004.

[22]We are following the "target" and "path" surprise terminology of Gürkaynack, Sack, and Swanson (2005), but we do not calculate the path surprise

$dum_g(t)$, equal to 1 for the "considerable period/measured pace" interval,

$$100^*(log(iv(t)) - log(iv(t-1))) = c + a\ ts(t) + b\ ps(t) + d\ dum_g(t)\ ts(t) + f\ dum_g(t)\ ps(t) + \varepsilon_t. \quad (9)$$

The significance of the coefficient on the interaction term measures the effect of the guidance on market sensitivity to monetary policy surprises.

The results are reported in table 6. The monetary policy surprise measures do not have a significant effect on these measures of financial stability. In no case was the effect of the policy surprises significantly different during the "considerable period/measured pace" FOMC announcements. By these measures, monetary policy surprises generally do not unsettle markets, and they did not unsettle markets by more when the FOMC was providing forward guidance.[23]

As noted earlier, however, target surprises were very low during the guidance period because the guidance (and other communications) left little doubt about the policy outcome for each meeting. In this sense, we are not strictly testing the effect of departing from a past policy rate forecast. Still, the *path* surprises were substantial during the period (see figure 1). Revisions to the expected path in response to the new statements are an indication that the FOMC was seen as likely to follow a path somewhat at odds with the path market participants previously expected.

The results for New Zealand presented in table 1 above suggest that surprises in central bank interest rate forecasts influence

as a residual from a regression of the change in the futures rate on the target surprise.

[23] We also evaluated the effect of monetary surprises on two measures of financial stress developed at the Federal Reserve Board—a broad index of financial stress and the odds that multiple financial institutions will default over the subsequent year (see Nelson and Perli 2005). The results are the same as those reported above using implied volatilities. The effects of the policy surprises are not significantly different during the "considerable period/measured pace" FOMC announcements for either measure. We also find no significant effect when, instead of the absolute value of the surprises, we use the level of the surprises or the squared surprises.

Table 6. Effect on Measures of Financial Stability of Monetary Policy Surprises When the FOMC Provided Policy Guidance

	Percentage Change on Day of FOMC Meeting	
	Implied Volatility of Ten-Year Treasury Note	**Implied Volatility of S&P 500 Index**
Constant, c	−2.1**	−2.9**
	(3.8)	(3.0)
Target Surprise	−1.0	11.2
	(0.2)	(1.1)
Path Surprise	9.3	0.3
	(1.4)	(0.0)
Target Surprise*	−34.8	−29.4
Guidance Dummy	(0.5)	(0.3)
Path Surprise*	−4.9	12.1
Guidance Dummy	(0.4)	(0.6)
No. of Observations	97	97
R^2	0.03	0.02

Notes: * and ** denote significance at the 5 percent and 1 percent level, respectively. t-values are in parentheses. The "target surprise" is the absolute value of the difference between the target for the federal funds rate announced by the FOMC and the target expected on the eve of the announcement as implied by federal funds futures rates. The "path surprise" is the absolute value of the change in the one-year-ahead Eurodollar futures rate on the day of the announcement. The guidance period is defined in the note to table 3. The sample consists of the ninety-seven days with FOMC announcements from August 22, 1995, to May 9, 2007.

changes in market interest rates, with coefficients below 1, suggesting that there is no disorderly overreaction to unexpected changes in projected interest rates and no unsettling effect on financial markets.

6. Conclusions

Central bank communication has changed dramatically over the past decade, with some central banks providing guidance about, or explicit forecasts of, likely future policy rates. One frequently made

argument against the provision of such guidance or forecasts is that it runs the risk of impairing market functioning. In this paper, we evaluated the behavior of financial markets in the United States, the euro area, and New Zealand in light of the communication strategies of central banks. We found evidence for New Zealand that central bank forecasts of policy rates influence market prices, but we found no evidence that forecasts or guidance impair market functioning in the United States, the euro area, or New Zealand. In particular, market participants do not appear inattentive to other developments when central banks provide policy rate guidance; they do not appear to take central bank policy rate guidance too seriously; and deviations from earlier policy guidance do not appear to unsettle markets. Consequently, this evidence suggests that concerns about impairing market functioning are not a strong argument against central banks' provision of policy rate guidance or forecasts.

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