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**Working Paper**

## Monetary policy surprises and the expectations hypothesis at the short of the yield curve

Working Paper, No. 0802

**Provided in Cooperation with:**

Koç University - TÜSİAD Economic Research Forum, Istanbul

Suggested Citation: Demiralp, Selva (2008) : Monetary policy surprises and the expectations hypothesis at the short of the yield curve, Working Paper, No. 0802, TÜSİAD-Koç University Economic Research Forum, Istanbul

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TÜSİAD-KOÇ UNIVERSITY ECONOMIC RESEARCH FORUM  
WORKING PAPER SERIES

MONETARY POLICY SURPRISES AND THE EXPECTATIONS  
HYPOTHESIS AT THE SHORT END OF THE YIELD CURVE

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Working Paper 0802  
February 2008

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TÜSİAD-KOÇ UNIVERSITY ECONOMIC RESEARCH FORUM  
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## **Monetary Policy Surprises and the Expectations Hypothesis at the Short End of the Yield Curve**

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### **Abstract**

We test the expectations hypothesis by analyzing changes in three month T-Bill rates (TB3) after FOMC meetings. By estimating the revisions in expectations of future overnight rates, we find a one-to-one relationship between changes in TB3 and path revisions.

**JEL Code:** E43

**Keywords:** Expectations Hypothesis, Policy Path Revisions

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I would like to thank Refet Gürkaynak for his feedback, Sarah Shoff for her help with the data, and Marcus Cuda for his computational assistance.

## **I. Introduction**

According to the rational expectations hypothesis (REH), current long-term interest rate equals the average of the current and expected short-term rates. For example, the yield on the three-month T-Bill (*TB3*) is determined as the average of the current one-month rate and the expected one-month rates over the next two months. Hence, changes in *TB3* should be proportional to changes in the expectations of monthly rates over the course of the next two months. Kuttner (2001) underlines this point and notes that Treasury rates change in anticipation of changes in the federal funds rate target. Consequently, on the day of a target change, changes in Treasury rates should only reflect unanticipated changes in the target. To test this argument, he regresses changes in Treasury rates onto expected and unexpected target changes. He finds that the coefficient estimate for unanticipated changes is significantly greater than that for anticipated changes, however it is significantly less than one. Kuttner notes that these findings are consistent with the REH. Changes in Treasury rates on the day of a target change reflect changes in the average expected overnight rates over the duration of the contract. Hence, the impact of a one-day surprise is expected to be less than one-for-one. Furthermore, many one-day policy surprises have to do with the timing of actions rather than with their ultimate size (see Demiralp and Jorda, 2004). The advancement or postponement of anticipated rate changes have smaller effects than actions that affect expectations of future rates.

Kuttner's explanation of his findings is that changes in overnight interest rate affect term rates only to the extent that they lead to revisions in expectations of future overnight rates. Kuttner does not test this argument but only offers it as an explanation for his findings. In this paper, we offer a formal investigation of this argument by estimating the revisions in expectations of future overnight rates over the

course of a three-month Treasury Bill rate. Our findings are highly consistent with the expectations theory and along the lines discussed by Kuttner. Specifically, changes in *TB3* closely follow revisions in expected overnight rates over the next 90 days. After 1996, this relationship is not significantly different from one.

## II. Measuring Revisions in the Policy Path

In order to test the REH, we need to measure revisions in the policy path not only for the current month, but also over the duration of a financial contract. The contract that we consider is the *TB3*. Kuttner's methodology allows us to estimate revisions in the policy path for the current month, following a target change. In order to estimate revisions in the policy path three months into the future, we need to assess how the target change on day  $t$  affects policy expectations for the following two months. We assume that the market expects a policy change only on regularly scheduled FOMC meetings and dismiss inter-meeting changes.<sup>2</sup> This assumption is reasonable for the post-1994 period that we consider, since there are only 5 target changes (out of 50) that took place on non-FOMC days. We also assume that the market expects the average overnight rate for a given month to be equal to the funds rate target. This assumption is also strongly supported by the data as daily deviations from the target are only temporary (see Carpenter and Demiralp, 2006).

Consider the FOMC calendar illustrated in Figure 1. FOMC meetings are typically scheduled four to six weeks apart. If there is an FOMC meeting in month one, two possibilities exist for the next month: there may be no FOMC meeting (2a), or there may be an FOMC meeting (2b). If there is no FOMC meeting in month two, then, there has to be an FOMC meeting in the following month (3a). Alternatively, if

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<sup>2</sup> As it will be explained shortly, the identification procedure depends on the formation of expectations around the FOMC calendar. Therefore, we also exclude those observations where there was an intermeeting move prior to an FOMC meeting in the same month because these intermeeting changes would disrupt the procedure that extracts market surprises based on regular meetings.

there was an FOMC meeting in month two, then, there may not (3b) or may be (3c) a meeting in the following month.

Our methodology consists of estimating the market surprise regarding the FOMC decision at each node. In particular, we are interested in how the target change in the current month affects policy expectations in the second and third months. The market surprise for the current month is calculated following Kuttner (2001), using the federal funds futures contracts for the spot month (*FF1*) and one-month forward (*FF2*). The surprises for months two and three are calculated using fed funds futures contracts for two-month (*FF3*) and three month (*FF4*) forward as described next.

#### 2.a. *No FOMC Meeting in Month 2*

If there is no FOMC meeting in the second month, then, the policy surprise in that month is the same as the market surprise from the first month (*Surprise m1*), assuming that the term premium is unchanged between the first and the second months. Sack (2004) notes that constant term premium at the short end of the yield curve is supported empirically.

#### 2.b. *FOMC meeting on day k of Month 2*

If there is an FOMC meeting on day  $k$  of the next month, then one-month futures contract as of day  $t-1$  (in the current month) is equal to:

$$FF2_{t-1} = \frac{kE_{t-1}(T_1) + (m_2 - k)E_{t-1}(T_2)}{m_2}$$

where  $T_1$  is the funds rate target as of day  $t$  in month one,  $T_2$  is the funds rate target as of day  $k$  in month two,  $E$  is the expectations operator, and  $m_2$  is the number of days in month two.

Taking the difference between the price of the one-month contract between days  $t$  and  $t-1$ :

$$FF2_t - FF2_{t-1} = \frac{k}{m_2}[T_1 - E_{t-1}(T_1)] + \frac{m_2 - k}{m_2}[E_t(T_2) - E_{t-1}(T_2)] \quad (1)$$

Solving for the second term on the right hand side:

$$\underbrace{E_t(T_2) - E_{t-1}(T_2)}_{\text{Surprise } m2} = \frac{m_2}{m_2 - k}(FF2_t - FF2_{t-1}) - \frac{k}{m_2 - k} \underbrace{[T_1 - E_{t-1}(T_1)]}_{\text{Surprise } m1} \quad (2)$$

The term on the left hand side in equation (2) gives the market surprise for the second month (*Surprise m2*) which is related to the surprise from the first month. The intuition is rather simple: total change in one-month forward rate on day  $t$  consists of two parts: revisions in expectations for overnight rates that are expected to prevail until day  $k$  of next month (which is the market surprise for the current target change), and revisions in expectations for overnight rates that are expected to prevail after day  $k$  next month (*Surprise m2*). Hence, we can identify the remainder of the market surprise for the next month by subtracting current month's surprise from the total revision.

Equation (2) is used to obtain the market surprise for most days of the month except for:

- i. If a target change occurs in the last three days of the *next* month, the difference in the two-month forward rate is used to derive the policy surprise since it reflects the expected average funds rate for the following month:

$$(FF3)_t - (FF3)_{t-1} = \Phi \underbrace{[T_2 - E_{t-1}(T_2)]}_{\text{Surprise } m2}, \text{ where } \Phi = 1 \quad (3)$$

- ii. If the target change takes place on the first day of the *current* month, we use the two-month forward rate from the *previous* month to assess market's expectations on day 1.

$$(FF2)_t - (FF3)_{t-1}^{\text{Previous Month}} = \Phi \underbrace{[T_2 - E_{t-1}(T_2)]}_{\text{Surprise } m2}, \text{ where } \Phi = 1 \quad (4)$$

### 3.a. FOMC meeting on day $j$

Market surprise is calculated analogous to 2.b., but this time utilizing the two-month forward contract (as opposed to one-month). In the special cases where target change takes place on the last days or on the first day of the following month, adjustments analogous to 2.b. are made, this time using *FF4*.

### 3.b. No FOMC meeting

If there is no FOMC meeting in the third month, then, the policy surprise in that month is the same as the surprise from the second month (as derived under 2.b.).

### 3.c. FOMC meeting on day $p$

Market surprise in this case is calculated analogous to 3.a. The only difference is that the total revision in *FF3* consists of the surprises from the first and the third months in 3.a. whereas it consists of the surprises from the second and the third months in 3.c.

Using this methodology, we compute revisions in the policy path three months into the future (not shown). Path revisions in the second and the third months are



usually in the same direction as the surprise in the current month and they are of similar magnitudes. The uniformity of futures rates' responses to surprise target changes in the current month is also highlighted by Kuttner (2001). Our results support this argument.

### III. Empirical Analysis

In this section, we compute path revisions in the next 90 days after a target change to analyze whether changes in the three month T-Bill are proportional to these revisions consistent with the REH. If the REH holds, then there should be a one-to-one relationship between changes in the T-Bill rate and changes in path revisions over the duration of the contract.

Table 1 reports the results from the regression where changes in *TB3* are regressed onto changes in path revisions for the post-1994 sample of FOMC days with target changes. The equation is estimated for different starting points for each year after 1994. Column 2 reports the coefficient estimates associated with the revisions variable. Column 3 reports the p-value from the hypothesis that tests whether this estimate is significantly different from one. Post-1996 samples (rows 3-7) provide strong support for the REH where the coefficient estimate for the revisions variable is not significantly different from one.<sup>3</sup> Furthermore, high  $R^2$  values (column 4) reflect the strong explanatory power of the revisions variable, reinforcing our identification methodology.

Columns 5-7 report the results for the specification where two-day changes in *TB3* are regressed onto path revisions to incorporate any lagged response of T-Bill rates. Once again, the REH is strongly supported, although  $R^2$  statistics are

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<sup>3</sup> Notice that our identification relies on the market's expectations of a target change on regularly scheduled FOMC meetings. While the assumption of target changes on FOMC days became an established pattern of policy making after February 1994, it may have taken the market time to adjust to the new practice. Indeed, a decreasing likelihood of inter-meeting changes may account for the observed increase in the parameter estimates as well as the p-values over time.

somewhat lower as expected, given that the variation in the dependent variable is now susceptible to non-policy related changes over a longer time period. When the analysis is repeated for the days of FOMC meetings only (Table 2) we still find significant evidence of the REH although the power of the test is not as strong.

### **Conclusion**

In this paper, we present a methodology that allows us to test the REH from a new perspective using revisions in policy expectations. Previous tests of the REH focused on the implication that if the expectations hypothesis holds, then the spread between current long and short rates should predict future changes in the short rate (see e.g. Rudebusch, 1995, and the references therein). Our findings are consistent with Rudebusch (1995).

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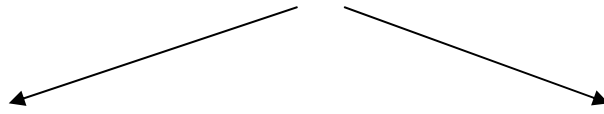
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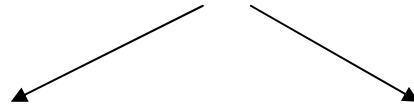
**Figure 1: FOMC Calendar**

1. FOMC in Month 1



2.a. No FOMC in Month 2

2.b. FOMC in Month 2



3.a. FOMC in Month 3

3.b. No FOMC in Month 3

3.c. FOMC in Month 3

**Table 1: The Response of T-Bill to Path Revisions on FOMC Days with Target Changes**

		<i>Dependent variable</i>					
		$TB3_t - TB3_{t-1}$			$TB3_{t+1} - TB3_{t-1}$		
Sample Period	1. Sample Size	2. Coeff.	3. p-value	4. $R^2$	5. Coeff.	6. p-value	7. $R^2$
1. 2/4/94-11/20/06	44	0.71	0.06	0.35	0.77	0.25	0.27
2. 1/1/95-11/20/06	39	0.79	0.11	0.52	0.81	0.31	0.34
3. 1/1/96-11/20/06	36	0.99	0.93	0.82	0.97	0.89	0.46
4. 1/1/97-11/20/06	35	0.98	0.85	0.82	0.97	0.88	0.45
5. 1/1/98-11/20/06	34	0.98	0.78	0.82	0.97	0.89	0.45
6. 1/1/99-11/20/06	32	0.95	0.56	0.81	1.08	0.70	0.51
7. 1/1/00-11/20/06	29	0.97	0.74	0.84	1.10	0.65	0.51

**Table 2: The Response of T-Bill to Path Revisions on FOMC Days**

		<i>Dependent variable</i>					
		$TB3_t - TB3_{t-1}$			$TB3_{t+1} - TB3_{t-1}$		
Sample Period	1. Sample Size	2. Coeff.	3. p-value	4. $R^2$	5. Coeff.	6. p-value	7. $R^2$
1. 2/4/94-11/20/06	102	0.58	0.00	0.23	0.82	0.21	0.26
2. 1/1/95-11/20/06	94	0.63	0.00	0.30	0.82	0.20	0.28
3. 1/1/96-11/20/06	86	0.76	0.02	0.41	0.94	0.69	0.33
4. 1/1/97-11/20/06	78	0.75	0.02	0.39	0.90	0.53	0.30
5. 1/1/98-11/20/06	70	0.86	0.15	0.56	0.87	0.43	0.31
6. 1/1/99-11/20/06	62	0.84	0.07	0.63	0.95	0.76	0.37
7. 1/1/00-11/20/06	54	0.86	0.10	0.68	0.97	0.85	0.37

p-values correspond to the null hypothesis  $H_0 : \beta = 1$

Sample Period: 2/4/1994-11/20/2006