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Special Commentary

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Fed Funds Surprises & Treasury Yields: Part 2

Executive Summary

There is significant uncertainty in 2015 about what will happen to the yield curve when the Fed begins its tightening cycle. In this study, we consider the sensitivity of Treasury yields to surprises in the fed funds target rate.[1] Specifically, we use a decomposition of Treasury yields into two parts–the risk-neutral yield and the term premium–and then study the sensitivity of each to surprises in the federal funds rate. We find that the risk-neutral rate is most significantly affected and the effect is of the same sign as the surprise. Our analysis finds that the term premium is also significantly affected by fed funds surprises, but fed funds surprises have a negative impact on the term premium. These offsetting responses led to a statistically significant effect only on Treasury yields with maturities below six years.

Our analysis supports our forecast for a flattening yield curve as the Fed begins to tighten. As the sensitivity of longer-term rates to fed funds surprises is insignificant, we would not expect a repeat of the "Taper Tantrum" scenario. One way for the "Taper Tantrum" to play out would be if additional Fed guidance, or a positive surprise in the funds rate, were to cause markets to revise expectations for future short-term interest rates. This could lead to a rapid adjustment in yields, and we will study this further in the future. We do not, however, expect this outcome to materialize, as the Fed has indicated its intention on being patient in raising rates. In the remainder of this paper, we explain our intuition, the methodology and give a greater detailed analysis of the results as well as implications this study has for interest rates in the coming years.

These offsetting responses led to a statistically significant effect only on Treasury yields with maturities below six years.

Decomposing Treasury Yields

To understand the impact of changes in the federal funds rate on other interest rates, we find it helpful to decompose Treasury yields into two underlying components, the risk-neutral yield and the term premium. The risk-neutral rate is the interest rate equal to the expected return from continuously rolling over short-maturity Treasury Bills. Hence, the risk-neutral rate is the expected average short term interest rate over the life of a longer-term bond.

The term premium, on the other hand, is the residual. We assume that Treasuries carry no default risk, as is common in both theory and practice. This residual is, therefore, the compensation investors receive for the risk associated with short-term rates behaving differently in the future than expected.[2] For example, an investor buying a longer-term bond would be concerned about the risk that short-term rates end up being higher than the expected path currently discounted into the risk neutral rate, which would negatively affect the price of the bond held by the investor.

Because the term premium and risk-neutral rates are not directly observable, they must be estimated and there are numerous ways of achieving this. Kim and Orphanides (2007) divide the methods of estimating the term premium into regression-based approaches and estimates derived

[1] Silvia, J. E., Iqbal, A, & Moehring, A. V. (2015). "Fed Funds Surprises & Financial Markets: Part 1." *Wells Fargo Economics Group.*
[2] Kim, D. H., & Wright, J. H. (2005). "An Arbitrage-Free Three-Factor Term Structure Model and the Recent Behavior of Long-Term Yields and Distant-Horizon Forward Rates." *Finance and Economics Discussion Series, Federal Reserve Board.*
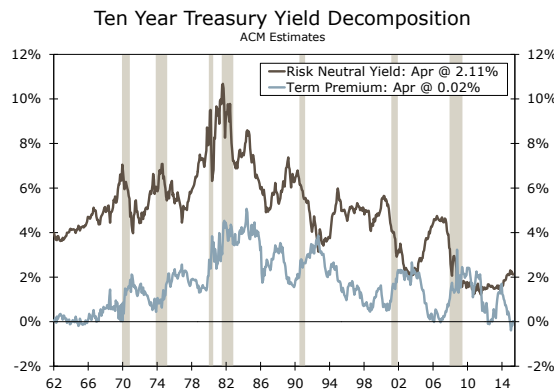
from more complicated models of the term structure.[3] These models get technical quickly, and a detailed explanation of the differing approaches is beyond the purview of this study.
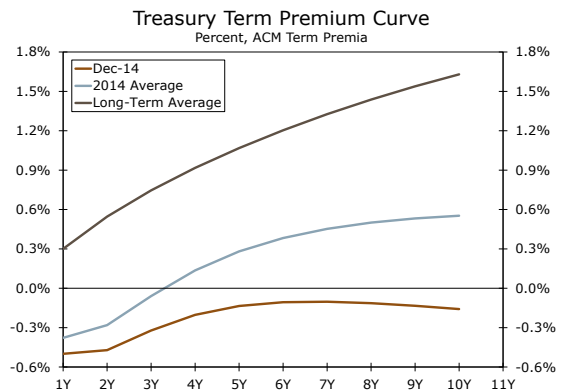
It may seem intuitive that the term premium should be positive. Why would anyone accept a return lower than that expected from rolling over short-term, risk-free bonds? However, this is not necessarily the case. Consider an investor, such as a pension fund or life insurance company, which has liabilities in the future, meaning its concern is falling interest rates and the associated reinvestment risk. Falling rates would make it more difficult for the firm to meet its liabilities when it reinvests at lower interest rates, so the firm would prefer to extend its duration and lock in the current rate for an extended period of time. This firm may be willing to accept a yield lower than the risk-neutral rate in order to remove the reinvestment risk it would face from a lower-than-expected trajectory of short-term rates.[4] Although term premia can be negative, the figures below show they are generally positive. Figure 1 reveals the long-term decline experienced in both term premia and risk-neutral rates. There are many reasons for this decline, including lower and more stable inflation, demographics, the emergence of global capital markets and numerous other structural factors.

We surmise that a shock to the fed funds rate would alter expectations for the future path of short-term interest rates, thus affecting the risk-neutral yield.

Figure 1

Ten Year Treasury Yield Decomposition
ACM Estimates

Figure 2

Treasury Term Premium Curve
Percent, ACM Term Premia

Source: Federal Reserve Bank of New York and Wells Fargo Securities, LLC

Should Fed Funds Rate Shocks Affect Yield Components?

As stated above, the term premium is the compensation investors receive for the risk that the future path of short-term interest rates may be different from what is expected. We surmise that a shock to the fed funds rate would alter expectations for the future path of short-term interest rates, thus affecting the risk-neutral yield. [5]

Thus, we cannot predict simply from inspection, how Treasury term premia behave following a fed funds shock.

The effect of a fed funds rate surprise on the term premium, however, is more ambiguous. On one hand, a shock to the fed funds rate may reduce uncertainty surrounding the path of future policy and thus interest rates, likely reducing the term premium. On the other hand, a shock could increase uncertainty about future policy, as investors discount further unanticipated moves by the Fed. In other words, a fed funds surprise may increase the term premium as investors are less confident about their expectations for the evolution of the short-term rate. During the 1994 tightening cycle, there were several fairly large positive fed funds surprises. Some of these were accompanied by increases in the term premium and others were accompanied by declines. Thus, we cannot predict simply from inspection, how term premia on Treasury securities behave following a fed funds shock. Further analysis is required.

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[3] **Kim, D. H., & Orphanides, A. (2007). "The Bond Market Term Premium: What Is It? and How Can We Measure It?"** *Bank of International Settlements Quarterly Review.*

[4] **Swanson, E. (2007). "What We Do and Don't Know about the Term Premium."** *FRBSF Economic Letter.*

[5] **We formally define a fed funds surprise in Part 1 of this series, referenced above. We define a fed funds shock (used interchangeably) as the unexpected component of a fed funds rate announcement, measured as the difference between the actual fed funds target rate and the expected fed funds rate.**
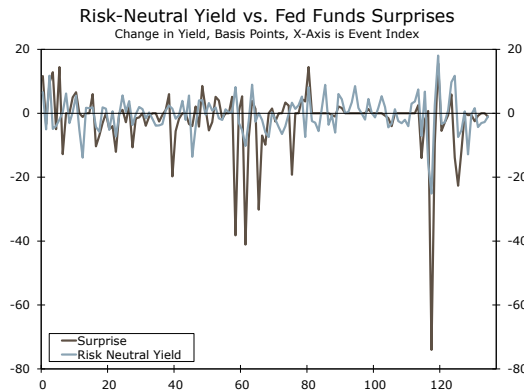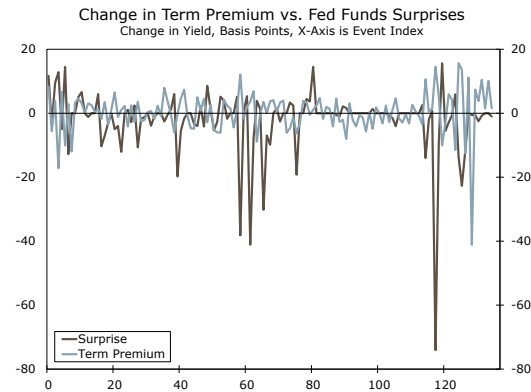
Figure 3

Risk-Neutral Yield vs. Fed Funds Surprises
Change in Yield, Basis Points, X-Axis is Event Index

Figure 4

Change in Term Premium vs. Fed Funds Surprises
Change in Yield, Basis Points, X-Axis is Event Index

Source: Federal Reserve Bank of New York, Bloomberg LP and Wells Fargo Securities, LLC

For tractability, we used the dataset provided by Adrian, Crump and Moench (ACM) of the Federal Reserve Bank of New York.[6] They provide data on yields, term premia and risk-neutral yields for maturities ranging from one year to 10 years.[7] Figure 3 shows a clear positive correlation in changes in the risk-neutral yield and fed funds rate surprises. The term premium and the surprise are negatively correlated (Figure 4). In the tables below, we have summary statistics for the variables and a correlation matrix. There were 127 fed funds rate surprises from 1994 through 2008.[8] In addition, it is clear that the distribution of surprises is negatively skewed. This could affect our results, affecting the significance of the estimates, and must be considered when interpreting our findings.

Table 1: Summary Statistics

Summary Statistics - 10 Year Treasury				
	Surprise	Yield	Term Premium	RN Yield
Count	127	127	127	127
Nonzero Surprises	84	84	84	84
Mean (Bps)	(2.2)	(0.1)	0.3	(0.3)
Std. Dev. (Bps)	10.3	6.6	5.2	5.6

Source: Wells Fargo Securities, LLC

Judging from the correlation matrix presented in Table 2, we can expect there to be a modest relationship between fed funds surprises and the different yield components, although these appear to be offsetting. For example, in column 2 we see a correlation coefficient of 0.01 between fed funds shocks and the yield on the 10-year Treasury security. This means that the two variables are unrelated, and the impact of a fed funds rate surprise on the different components of the yield has caused them to offset each other when aggregated to the entire yield.

Table 2: Correlations

Correlation Matrix - 10 Year Treasury				
	Surprise	Yield	Term Premium	RN Yield
Surprise	1.00			
Yield	0.01	1.00		
Term Premium	(0.44)	0.58	1.00	
RN Yield	0.42	0.65	(0.25)	1.00

Source: Wells Fargo Securities, LLC

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[6] **Adrian, T., Crump, R. K., & Moench, E. (2013). "Pricing the Term Structure with Linear Regressions."** *Federal Reserve Bank of New York Staff Reports.*
[7] **The data on yields are actually fitted yields from their model of the term structure. These yields fit actual yields very well, and we checked our analysis on actual Treasury yields and the results were not materially different.**
[8] **Recall we truncated our dataset in December 2008. See Silvia, et. al. (2015). "Fed Funds Surprises & Financial Markets" for more details.**

Which Part of Yields Are Affected by Fed Funds Surprises?

Now we address whether surprises in the federal funds rate affect the different components of interest rates and, if so, we explore the sensitivities of these components and what implications that may have for the future. Our analysis was structured as an event study around unexpected changes in the fed funds rate. We take the simple difference of the yield, the term premium and the risk-neutral yield from the day prior to the surprise to employ as the dependent variables in our analysis. We opted to use the simple difference instead of another measure, such as the percent change, because our intuition suggested a given fed funds rate surprise should have an effect on the different yield components of the same magnitude, regardless of the level of interest rates.

Sensitivity Varies by Maturity

For a Treasury with a maturity of one year, a 100 basis point (bps) surprise in the fed funds target rate corresponds, on average, with a 34 bps increase in the yield.

We estimate several simple regressions, where the fed funds surprise was the independent variable and the dependent variable was the change in the interest rate, the term premium and the risk-neutral rate.[9] The results of these regressions are presented in Table 3 in the appendix. We find that Treasury yields are significantly affected for maturities up to five years, with sensitivities to fed funds surprises declining as the maturity gets longer. For short-term rates, the coefficient is of meaningful magnitude and the surprises in fed funds rates explain a reasonable amount of the changes in yields around these dates. For a Treasury security with a maturity of one year, a 100 basis point (bps) surprise in the fed funds target rate corresponds, on average, with a 34 bps increase in the yield. This sensitivity decreases as the maturity increases, but remains statistically significant out to five years. If we control for asymmetric responses, a 100 bps positive fed funds surprise corresponds with a roughly 70 bps increase in one-year Treasury yields, while a 100 bps negative fed funds surprise corresponds with a roughly 28 bps decrease in yields. This asymmetric response suggests Treasury securities are more sensitive to increases in the fed funds rate than decreases.

Table 3: Full Sample Results

Maturity (Years)	Yield		Term Premium		Risk-Neutral Yield	
	Intercept	Sensitivity	Intercept	Sensitivity	Intercept	Sensitivity
1	0.1	34.1***	0.2	(8.6)***	(0.1)	42.8***
2	0.4	25.0***	0.2	(13.4)***	0.1	38.4***
3	0.4	19.1***	0.2	(16.0)***	0.2	35.1***
4	0.4	14.7***	0.1	(17.7)***	0.2	32.4***
5	0.3	11.1**	0.1	(19.1)***	0.3	30.1***
6	0.3	8.0**	0.0	(20.2)***	0.3	28.2***
7	0.3	5.3	0.0	(21.2)***	0.3	26.6***
8	0.2	3.1	(0.0)	(22.0)***	0.2	25.1***
9	0.2	1.1	(0.1)	(22.7)***	0.2	23.8***
10	0.2	-0.7	(0.1)	(23.3)***	0.2	22.6***

Fed funds surprises are in percent and independent variables are in basis points.
*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Wells Fargo Securities, LLC

Delving into the components of yields and what explains the relationship between fed funds and Treasury yields, we find that the risk-neutral yields are the most sensitive to changes in the fed funds rate. The sensitivity of the risk-neutral rate is significant across all of the maturities studied, although the magnitude of the coefficient decreases as maturities increase. For a one-year Treasury note, a 100 bps surprise in the fed funds rate corresponds, on average, with a 43 bps increase in the risk-neutral rate. This sensitivity is only 23 bps for a 10-year Treasury security, which is still meaningful. In addition, fed funds surprises explain more of the variation in the risk-neutral rate than the term premium or yields. This makes sense intuitively, as a rather direct link can be seen between a shock to fed funds rate and the expected future path of short-term interest rates, which is the determinant of the risk-neutral rate.

The results for the term premium are a bit more difficult to interpret. The coefficient on the fed funds surprise is negative across all maturities and statistically significant. The term premium

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[9] **We also ran analysis including an interaction term for positive surprises to test for asymmetric responses to fed funds surprises. In general, short-term Treasury yields and risk-neutral yields are more sensitive to positive surprises, while the term premium is more sensitive to negative surprises. In addition, only nonzero surprises were included.**

seems to serve as a buffer, muting (or sometimes completely counteracting) the effect a change in the risk-neutral rate has on the overall yield. One possible explanation for this could be that as investors' expectations regarding the fed funds rate are revised following a fed funds surprise, there is more or less perceived risk to fixed income investors. For example, when the Federal Open Market Committee (FOMC) cut rates beginning in 2007, the term premium rose as the funds rate approached the zero lower bound. The further rates fell, the more the distribution of possible fed funds rate innovations was skewed upward. This represented additional risk to fixed income investors and may have resulted in an increase in the term premium.

We are careful, however, not to draw too many conclusions from this data regarding the term premium, as the results are by no means conclusive. First, the term premium is a tricky concept, and even estimating the different yield components is debated and there are many methods of doing so. Second, we have a limited amount of data and the surprise data we have is skewed to the downside, leading us to be cautious about our results. Finally, the fixed income market has changed over time. Changes in demographics, the regulatory environment, unconventional monetary policies and the economy all can influence the term premium and affect the relationship it has with the fed funds rate.

Differences Before and During the Crisis

We partitioned our dataset into two periods: the period before the financial crisis and the period containing the crisis. Since our dataset was truncated at 2009, there is no post-financial crisis period. Results for the pre-crisis and crisis periods are presented in Tables 4 and 5 in the appendix. The results between the two periods are similar, although the magnitudes of the coefficients for the sample including the crisis are generally larger and more significant than the pre-crisis sample. This may suggest that the relationship between yields, and yield components, and surprises in the fed funds rate was more pronounced during the crisis relative to the pre-crisis period.

It is worth noting, however, that the crisis sample only included an easing cycle and the abrupt rate cuts made by the FOMC likely had stronger signaling effects regarding future policy. It is unclear whether trends experienced before the crisis will be resumed or if the increased sensitivity to fed funds surprises experienced during the crisis will be the new norm. Nonetheless, the results are qualitatively similar.

Surprises and the Maturity Spectrum

We now discuss the results as we move across the maturity spectrum and try to understand why yields are more affected at shorter maturities. As illustrated in Figure 5, this impact clearly deteriorates as the maturity is extended. To first discuss the risk-neutral yield, the decreasing sensitivity is consistent with our intuition. The risk-neutral rate of a longer maturity bond is constructed from expected short-term interest rates reaching out far into the future. Expectations further out into the future of the short-term rate likely display more persistence than shorter-term expectations. There are more important drivers of future short-term rates when we look out years into the future than the current fed funds rate, such as expected growth and inflation. Admittedly, these may be affected by the current fed funds rate, although expectations regarding growth and inflation years into the future are likely to be very weakly affected by a small change to the fed funds target rate today. Thus, because longer-term expectations regarding the short-term rate are not as strongly affected, the impact of a shock to the current fed funds rate on the risk-neutral rate would be diluted as the maturity is extended.

Looking now at the term premium, we can see why the sensitivities of yields fall and are not statistically significant in longer-maturity Treasury securities. A positive shock to the fed funds rate is associated with a fall in the term premium, on average, and the magnitude of the shock increases with maturity. Thus, because risk-neutral yields are less sensitive and term premia are more sensitive at longer maturities, the offsetting effects lead to a small and insignificant sensitivity of yields to surprises in the fed funds rate at maturities longer than five years.

For all maturities, the fed funds rate surprise explains the most variation in the risk-neutral rate, followed by the term premium and then the yield. This was in line with our a priori expectations.

For all maturities, the fed funds rate surprise explains the most variation in the risk-neutral rate, followed by the term premium and then the yield.

Figure 5

Coefficients By Maturity
Independent Variable FFR Surprise
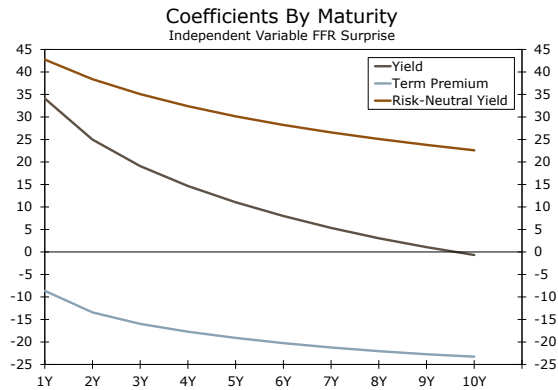
Source: Wells Fargo Securities, LLC

What Should We Expect During This Cycle?

In 2015, as we approach liftoff from zero interest rate policy, we can apply our analysis to the uncertainty surrounding the timing of the first rate hike. We, along with many other forecasters, believe the FOMC will begin tightening later this year. When the Fed does raise the fed funds rate, there will likely be a surprise component to the increase.[10] Our analysis suggests short-term interest rates will rise, as the increased risk-neutral rate dominates the lower term premium. The impact on longer-term rates is more ambiguous, however. The risk-neutral rate will likely rise, but the term premium may offset this effect. Notice in Figure 1 that the term premium on the 10-year Treasury note is at a historically very low level. This does not mean that it cannot fall further, but suggests it is unlikely that, if it does in fact decrease, this decrease would be large. We suspect that the rising risk-neutral rate will outweigh any offset provided by the term premium, although this would still lead to only moderately higher long-term rates.

On the other hand, if come September 2015, the Fed waits to raise the policy rate, there will likely be a negative surprise because futures prices would likely include a material probability of a rate hike at the September meeting. This should lead to a decrease in short-term rates and the same ambiguous result on the longer-end of the curve, leading to a modest steepening of the yield curve. Note our analysis does not account for the fact that waiting to raise rates could lead market participants to revise expectations for future short-term rates, possibly including a more rapid catch-up tightening cycle, which could lead to the opposite reaction for the yield curve than our analysis would suggest.

Conclusion: Flatter Yield Curve Ahead When Fed Moves

The results presented above support the conclusion for a flatter yield curve in the coming tightening cycle as we have been forecasting.

Our analysis of the sensitivity of yields and yield components to surprises in the fed funds target rate suggests that the risk-neutral rate is the most sensitive followed by the term premium. These sensitivities can be offsetting, leading to an insignificant effect on overall yields at longer maturities. The results presented above support the conclusion for a flatter yield curve in the coming tightening cycle as we have been forecasting, because short-term rates are more sensitive to surprises in the fed funds rate, and there will likely be several positive surprises as the Fed begins to normalize monetary policy. This paper suggests that we should not see a repeat of the "Taper Tantrum" when the FOMC first raises rates as some have predicted, because that would require a very large surprise in the fed funds rate. One way in which the "Taper Tantrum" scenario could play out is if rate hikes are accompanied with significant revisions to market expectations regarding the future path of the funds rate as a result of additional information in the announcement. This is what we suspect happened during the "Taper Tantrum," and we will explore this more in the future. We do not expect this outcome, as the Fed has indicated many times that it intends to be patient in normalizing monetary policy.

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[10] Recall that futures represent a probability-weighted average, so they will likely be priced including the possibility of the Fed not raising rates.

Appendix: Sub-Sample Results

Table 4: Pre-Crisis Results

Maturity (Years)	Yield		Term Premium		Risk-Neutral Yield	
	Intercept	Sensitivity	Intercept	Sensitivity	Intercept	Sensitivity
1	(0.2)	23.8 ***	0.1	(4.4)**	(0.3)	28.2 ***
2	(0.1)	13.5 **	0.1	(9.6)***	(0.2)	23.1 ***
3	(0.1)	6.7	0.0	(13.0)***	(0.2)	19.8 ***
4	(0.2)	2.4	(0.0)	(15.0)***	(0.2)	17.5 ***
5	(0.2)	(0.4)	(0.1)	(16.2)***	(0.1)	15.8 ***
6	(0.3)	(2.3)	(0.1)	(16.8)***	(0.1)	14.4 ***
7	(0.3)	(3.7)	(0.2)	(17.0)***	(0.1)	13.4 ***
8	(0.3)	(4.7)	(0.2)	(17.1)***	(0.1)	12.4 ***
9	(0.3)	(5.5)	(0.2)	(17.1)***	(0.1)	11.7 ***
10	(0.3)	(6.1)	(0.2)	(17.0)***	(0.1)	11.0 ***

Fed funds surprises are in percent and independent variables are in basis points.
*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Wells Fargo Securities, LLC

Table 5: During-Crisis Results

Maturity (Years)	Yield		Term Premium		Risk-Neutral Yield	
	Intercept	Sensitivity	Intercept	Sensitivity	Intercept	Sensitivity
1	2.7	49.0 ***	0.7 **	(12.2)***	2.0	61.2 ***
2	4.5 **	43.4 ***	1.4 ***	(15.5)***	3.1	58.9 ***
3	5.2 **	39.5 ***	1.8 **	(16.6)***	3.5	56.1 ***
4	5.4 **	35.3 ***	1.8 **	(17.8)***	3.6	53.1 ***
5	5.3 **	30.8 **	1.8	(19.5)***	3.5	50.3 ***
6	5.1 **	26.3 **	1.7	(21.3)***	3.5	47.6 ***
7	4.9 **	22.0 **	1.5	(23.2)***	3.4	45.2 ***
8	4.6 **	18.0	1.4	(25.0)***	3.3	43.0 ***
9	4.4 **	14.4	1.2	(26.5)***	3.2	40.9 ***
10	4.1 **	11.2	1.1	(27.9)***	3.0	39.1 ***

Fed funds surprises are in percent and independent variables are in basis points.
*** Significant at 1 percent level
** Significant at 5 percent level
* Significant at 10 percent level

Source: Wells Fargo Securities, LLC

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