Variance Risk Premium Term Structure and Monetary Policy

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Abstract

In this paper, we find that the changes in the variance risk premium (VRP) which reflects the market price of variance risk positively respond to the interest rate shocks and the strength of response declines with maturity. The shape of the response is mainly driven by the reactions of implied variance and bad VRP. Additionally, timing surprise, expansionary policy and negative surprise matter for the effects. Overall, investors are sensitive to the downside variance risk and require a higher variance risk premium as compensation for the increased risk.

Keywords: VRP, Term structure, FOMC announcement, Model-free implied variance

JEL Classification Codes: G13, E52,

Contents

1 Introduction

A large literature studies the response of the equity index market to monetary policy news. Thorbecke (1997), Bernanke and Kuttner (2005) and Kaminska and Roberts-Sklar (2018) show that monetary policy significantly affects equity prices. Lucca and Moench (2015) use intraday data and document that a large portion of annual realized stock returns happens in 24-hour before Federal Open Market Committee (FOMC) announcements. While the literature has documented several interesting findings about the impact of federal fund rate announcements on the equity risk premium, we know surprising very little about how interest rate news affects the market price of variance risk. Chuliá et al. (2010) study the influence of interest rate news on S&P 100 stock volatility. Bekaert et al. (2013) and Fernandez-Perez et al. (2017) analyze the effect of monetary policy on VIX, which represents implied volatility of S&P 500 index. Intuitively, we are interested in the impact of monetary policy news on the pricing of variance risk which is proxied by the difference between realized and implied variance. After the global financial crisis, the demand of hedge shifts in future variance grows dramatically. Knowing how monetary policy drives the variance risk premium (VRP) with different maturities can help traders to bet on variance and policy makers to identify the market trend in short- and long-run. Does interest rate news affect the VRP? If so, what is the sign of the announcement response? How does the strength of the announcement response evolve with the maturity? Does VRP react asymmetrically on different monetary policy stance? What is the channel through which the announcement effect arises? These are some of the questions that we set out to answer.

Using a large dataset of S&P 500 index options and spot data, we compute the term structure of the VRP. Equipped with this term structure, we start to study the impact of interest rate news on VRP. We document several findings. First, the dynamics of the VRP observed on announcement days are significantly different from those observed on other

days. This result suggests that FOMC days are special for the pricing of the VRP.

Second, interest rate announcement surprises have a significantly positive impact on the VRP. Economically, the positive announcement effect suggests that investors dislike positive interest rate shocks and require a higher VRP. Interestingly, the announcement effect is the strongest at the short-end of the term structure and decreases with the maturity of the VRP.

Third, we decompose the term structure of the VRP into the term structures of the (i) implied and (ii) realized variance, respectively. Our analysis reveals that both term structures react positively to interest rate surprises. This finding reveals that positive interest rate shocks herald risky times and negative interest rate shocks decrease the market volatility. Comparing the announcement responses of the two term structures, we find that the short-maturity implied variance generally reacts more strongly than the realized variance of equivalent maturity. Analyzing longer maturities, we find very little to distinguish between the two variance series. This set of results help understand the declining pattern of announcement responses along the term structure of the VRP.

Fourth, we dissect the VRP into good and bad VRP. Intuitively, the good VRP captures the compensation for the variance of positive returns. Conversely, the bad VRP reflects the compensation for the variance of the negative returns. By comparing the response of these two components, we are able to shed light on the determinants of the announcement effect. We establish that most of the announcement effects arise from the response of the bad VRP. The results of the 7-day VRP perfectly illustrate this result. A unit shock to the interest rate announcement surprise moves the change of 7-day VRP by 1.45% (t-stat=2.04). The response of the bad VRP (1.29%, t-stat=2.26) completely dwarfs that of the good VRP (0.15%, t-stat=0.92). This implies that investors' risk attitude toward downside risk is more sensitive to the interest rate shocks.

We conduct several additional tests. To begin with, we explore whether the reactions to the announcement surprise is state dependent. We find that contractionary policy has

no significant impact on the term structure of the VRP while expansionary policy significantly decrease the market price of variance risk. Moreover, under expansionary policy, the announcement surprises have a significant and positive impact on the VRP with short maturities. It means that the more target rate decreases, the smaller the VRP is. It implies that expansionary policy is effective and the idea that easing policy kindles the instability of the market is bold. Then, we investigate whether positive and negative announcement surprises have a differential impact on the term structure of the VRP. We find that positive announcement surprises have an insignificant impact on the VRP. In contrast, negative announcement surprises significantly move the market price of variance risk. Furthermore, we analyze the impact of timing and level surprise on VRP. We find that timing surprise has a significantly positive effect on the market price of the variance risk with short maturity. Additionally, our results are generally robust to different measure of implied variance and VRP. Moreover, we use the averages of professional forecasts to measure the interest shocks and analyze the reactions of VRP to them. Again, our main findings are robust to the alternative measurement of shocks.

The remainder of this paper proceeds as follows: Section 2 describes some related studies. Section 3 introduces our data and methodology. Section 4 reports our results and findings. Section 5 presents some additional analyses. Finally, Section 6 concludes.

2 Related Literature

Our work is related to a broader literature on the impact of federal fund rate news on the equity risk premium. Bernanke and Kuttner (2005), Savor and Wilson (2013), Lucca and Moench (2015), and Law et al. (2019) study the response of the stock market to interest rate news. Bernanke and Kuttner (2005) investigate the effect of the federal fund rate on the stock price and find that only the unexpected change of rate statistically significantly affects the stock price. Savor and Wilson (2013) focus on FOMC interest rate, CPI, PPI and

employment data. Their results support that most of the average excess returns accrue on announcement days. Lucca and Moench (2015) focus on FOMC news and find that excess return of the S&P 500 stock index on pre-FOMC day increases and becomes significant. They also present that the mean of excess returns on FOMC days are much larger than other days. Law et al. (2019) study the response of the S&P 500 index to interest rate news and find that the reactions of the stock market to macroeconomic announcements depend on economic conditions. In a more recent study, Avino et al. (2021) use synthetic dividend strip data to analyze the term-structure of the equity risk premium. They document that the announcement effect is strongest at the short-end of the term structure of the dividend risk premium and declines with the maturity of the dividend asset. Inspired by them, our focus is the impact of the unexpected changes of federal fund rate on VRP and then explore whether the impact is state dependent. Different from these studies, we focus on the market price of variance risk rather than the equity risk premium.

Our research is connected to studies on the term structure of the VRP. Bormetti et al. (2016) employ multi-component GARCH model to generate the realistic shape of VRP from very short to long maturities. They document a valley-shaped VRP which decreases sharply with very short maturity and then increases slowly with long maturity. Egloff et al. (2010) also confirm the upward sloping term structure of the VRP for the S&P 500 index. They identify two stochastic variance risk factors to explain the dynamics of the term structure of the VRP. Exploiting the information embedded in the term structure of variance swaps, they show that variance swap contracts can significantly improve the performance of investment. Konstantinidi and Skiadopoulos (2016) investigate how to predict the VRP with different maturities and to explore the driven factors of the term structure of it. They find that trading activity variables can provide the best forecasting performance among all alternative predictive models for VRP. Aït-Sahalia et al. (2020) propose an elaborated model to capture the dynamics of the equity and the variance risk premia and they find that VRP with different maturities have different reactions to various

economic indicators. We complement these studies by studying the impact of interest rate news on the term structure of VRP. To the best of our knowledge, we are the first to undertake this analysis.

Our research also relates to the literature on the impact of interest rate news on the implied and/or realized variance. Chuliá et al. (2010) support that the surprise of federal fund rate is highly significant for stock returns while the expected interest rate changes are insignificant. They document the impact of FOMC announcement surprises on the volatility of individual stock returns and find different reactions of them to positive and negative surprises. Gospodinov and Jamali (2012) study the effect of federal fund rate news on the changes of the realized and implied volatility of the S&P 500 index and confirm that only the surprise change has a significant impact. Similar to us, they document a significant positive relation between interest rate announcement surprises and changes in the realized and implied volatility. Bekaert et al. (2013) use a structural vector-autoregressive method to analyze the relation between monetary policy and the VIX, as well as its components, risk aversion and uncertainty. They confirm that easing monetary policy decreases the two components. Fernandez-Perez et al. (2017) focus on the reactions of VIX and VIX futures to positive and negative interest rate shocks in intraday level. Moreover, they find that there exsits a significantly negatively relation between the levels of changes of VIX and VIX futures and the changes of realized volatility. Our work improves on these studies along several dimensions. To begin with, our focus is on the VRP rather than its components, i.e. implied and/or realized variance. Furthermore, we analyze the term structure dimension. By doing so, we can shed light on which maturity responds the most to interest rate shocks and how the short- and long-run impact of the shocks on the VRP.

We also contribute to the growing literature on good and bad variance and the associated risk premia. Barndorff-Nielsen et al. (2008) formally show how to decompose the realized variance into good and bad semi-variance by high frequency data. Segal et al. (2015) present that the market price of risk is different for good and bad volatility. They show that good

volatility is associated with a booming economy while bad volatility predicts low economic growth. Feunou et al. (2018) and Kilic and Shaliastovich (2019) define the good and bad VRP and analyze their relationship with the equity risk premium. Consistently, they find that bad VRP are the main components of VRPs and the good and bad components play an asymmetric role in the price of risk. It means that the VRP is mainly a compensation for downside semivariance risk. Held et al. (2020) also employ the good and bad VRP to investigate the term structures of them in nine international stock market indices. They document that the downside VRP is lasting and stable across horizons while the upside VRP is not statistically significant. We leverage their methodology to study how the good and bad components of the variables react to FOMC surprises.

3 Data and Methodology

This section begins with the data used for our main analysis in the paper and then presents our main research methodology.

3.1 Data

Options Data We obtain the data related to the S&P 500 equity index option market between March 5, 2008 and March 11, 2019 from IvyDB OptionMetrics. We supplement this dataset with the Zero Coupon Yield Curve, which is taken as the proxy of interest rate term structure.

The option dataset contains the trading date, the expiration date of each option, the daily best bid and offer prices, the open interest, the option dividends, and the Black and Scholes (1973) implied volatility. We keep all the available options with all the maturities on each specific day. Our data cleaning steps follow Oikonomou et al. (2019). Specifically, we remove observations with zero bid or ask prices. Additionally, we discard observations with missing Black-Scholes implied volatility. We also expunge observations that violate

standard no-arbitrage conditions. We discard all the data for the period that precedes March 5, 2008. Prior to that date, OptionMetrics reports the option prices recorded at 16:15 Chicago Time (CT), whereas the latest index spot price is recorded at 16:00 CT. Clearly, this difference in observation times introduces an error in any analysis that requires synchronous observations of both the option and spot index prices. Since March 5, 2008, OptionMetrics records the spot and option prices at 16:00 CT, making the data well-suited for our analysis.

Spot Data We obtain the time-series of the daily underlying index price as well as the corresponding dividends from the Center for Research in Security Prices. In order to compute the realized variance and semi-variance series, we use regularly-sampled data observed at the 5-minute frequency. This data comes from the Oxford-Man Institute Realized Library of the University of Oxford.[1]

Federal Fund Rate Announcements We collect all the data related to the scheduled FOMC interest rate announcements from Bloomberg. There are usually eight meetings per year, each of which is associated with an announcement of the target federal fund rate. The dataset includes the announcement date, the announced interest rate, as well as the expectations of professional forecasters. Given our data requirements for the computation of the VRP, our sample includes 85 monetary policy announcements. Every FOMC meeting is an event in our study. The prices of 30-day federal fund futures contracts are all from Bloomberg.

Following Kuttner (2001), we compute the interest rate announcement surprise as:[2]

$$\Delta i_t^u = \frac{D}{D-d}(f_t - f_{t-1}) \tag{1}$$

where Δi_t^u denotes the time-t surprise of the federal fund rate. D is the number of calendar days in the announcement month. d is the number of days already elapsed during that

month. f_t is the federal fund rate on day t implied from the 30-day federal fund futures price.[3] As is standard in the literature, e.g. Avino et al. (2021)) and (Law et al., 2019), we standardize the interest rate announcement surprise using the full sample standard deviation.[4]

3.2 Methodology

Variance Risk Premium Bollerslev et al. (2009) define the VRP as the difference between the expectation of variance under the risk-neutral measure and that under the physical measure. Carr and Wu (2009) propose to use the model-free implied variance to estimate the risk-neutral expectation of the variance. Furthermore, the authors use the ex-post realized variance to proxy for the physical expectation of the realized variance, thus leading to the following result:[5]

$$VRP_{t,t+\tau} = IV_{t,t+\tau} - RV_{t,t+\tau} \tag{2}$$

where $IV_{t,t+\tau}$ and $RV_{t,t+\tau}$ are the model-free implied variance and realized variance at time t over horizons of τ days, respectively.

Andersen et al. (2007) and Lee and Mykland (2008) show that the S&P 500 index jumps around macroeconomic announcements. Following Oikonomou et al. (2019), we use the Bakshi et al. (2003) estimator, which is argued to be robust to jumps, to compute the model-free implied variance:[6]

$$IV_{t,t+\tau} = \frac{360}{\tau}\left[\int_0^{S_t} \frac{2(1+\ln\frac{S_t}{K})}{K^2} P_t(\tau,K)dK + \int_{S_t}^{\infty} \frac{2(1-\ln\frac{K}{S_t})}{K^2} C_t(\tau,K)dK\right] \tag{3}$$

$\frac{360}{\tau}$ serves to annualize the implied variance estimate. $P_t(\tau,K)$ and $C_t(\tau,K)$ indicate the time-t out-of-the-money (OTM) put and call option prices with maturity τ and strike price K, respectively.

Our implementation broadly follows that of Chang et al. (2012). To fix ideas, we de-

fine the moneyness as the ratio of the strike price (K) over the spot price (S). For each maturity date observed on a given day, we require at least two OTM call and put options. Consequently, we discard days when these requirements are not met. Next, we employ the cubic spline to interpolate the implied volatility across the moneyness levels available in the market. For the moneyness levels greater or lower than the available moneyness levels in the market, we use the implied volatility corresponding to available maximum or minimum moneyness levels, respectively. By implementing the above interpolation-extrapolation method, we obtain a fine grid of 1,000 implied volatilities between a moneyness level of 1% and 300%. Next, we use the Black and Scholes (1973) formula to map the implied volatilities into the corresponding OTM option prices. Finally, we use the trapezoidal rule to numerically estimate the integrals. We repeat these steps for each maturity observed on that day, thus obtaining the term structure of implied variance. From this term structure, we linearly interpolate the implied variance of constant maturity of interest. In our empirical estimation, we separately estimate the (annualized) implied variance of maturity 7, 30, 60, 90, 180, 270, and 360 days.

The risk-free rate used in our application of the Black and Scholes (1973) formula is processed as follows. We employ cubic spline interpolation method to get the risk-free rate with different maturity on each trading day and then match them with options with corresponding expiration days on that trading day. As for the rate that need to be extrapolated, we choose the nearest cubic spline curve parameters and extend the line to get the risk free rate with the corresponding expiration day.

Realized Variance Following Bollerslev et al. (2009) and Bekaert and Hoerova (2014), we use 5-minute data to compute the realized variance:

$$RV_{t,t+\tau} = \frac{252}{N_t^\tau} \sum_{j=0}^{N_t^\tau} \sum_{i=1}^{H} r_{t+j,i}^2 \tag{4}$$

where $RV_{t,t+\tau}$ denotes the time-t annualized realized variance over the next τ days. N_t^τ is the number of trading days between t and $t+\tau$. H indicates the number of intraday observations on a given day. $r_{t+j,i}$ is the intraday return observed at time i of day $t+j$.

4 Main Results

This section presents our main empirical results. We compare the distributions of the VRP with different maturities on announcement and non-announcement days. Then, we analyze the impact of federal fund rate announcement surprises on the VRP. Next, we decompose the VRP into good and bad VRP and study their responses to interest rate announcement shocks.

Before turning to our main empirical results, it is instructive to look at the summary statistics of our primary variables. In doing so, we check whether our computation of the key variable yields results that are comparable to those of the literature. Table 1 shows that the VRP, implied variance and realized variance estimates. For VRP estimates, we observe a positive average estimate across the whole maturity spectrum. We notice that the VRP with maturity of 7 days is higher than that with maturity of 30 days. Not surprisingly, the VRP with maturity of 7 days is with the highest standard deviation and kurtosis, indicating that it is much more volatile than others. In addition, AR(1) coefficient of the VRP with 7-day maturity is the lowest, suggesting a low persistence. Generally, the term structure of the VRP is upward sloping. This finding is consistent with that of Egloff et al. (2010) and Li and Zinna (2018). Our estimates of the average VRP are generally consistent with those of the literature, e.g. Oikonomou et al. (2019). The coefficient of autoregression reveals a high persistence in the time-series of the daily VRP. This is not surprising given the large overlap between two consecutive daily observations. In light of this finding, we model the change in the VRP (ΔVRP) which is stationary rather than the level of the VRP. As for the term structure of implied and realized variance, we notice that the shape of VRP is

mainly driven by implied variance and the realized variance with a long time horizon is more stable.

4.1 Distribution on Announcement vs. Non-Announcement Days

The previous discussion focuses on the unconditional distribution of the variables of interest. Although interesting, that analysis does not distinguish between announcement and non-announcement days. We now present the summary statistics for each of those types of dates, separately. In doing so, we are able to shed light on whether FOMC announcement days are special in that the distribution observed on those days is different from that on non-announcement days.

We now focus on the distributions of the ΔVRP observed on announcement and non-announcement days. Table 2 reveals several interesting results. First, we observe an interesting contrast across these two days. While the ΔVRP is very negative on announcement days, it is generally positive on non-announcement days. The difference between the two mean estimates is generally statistically significant. Turning to the standard deviation of ΔVRP, we do not see a marked difference in the estimates of most maturities. We also implement Kolmogorov-Smirnov testing procedure to test if the distributions of the ΔVRP observed on announcement and non-announcement days are equal. We conclude that there is a statistically significant difference for several maturities. Collectively, these results suggest that the FOMC announcement days have a significant impact on the distribution of the ΔVRP.

4.2 The Impact of FOMC Surprises on

We now explore the impact of announcement surprises on ΔVRP using the following regression:

$$y_t = \alpha + \beta \times \Delta i_t^u + \epsilon_t \tag{5}$$

where y_t is ΔVRP. α is the intercept. β measures the impact of the FOMC announcement surprise on the variable of interest y. Δi_t^u is the FOMC announcement surprise at time t. ϵ_t is the residual at time t. Throughout this paper, we use the White (1980)-corrected standard errors.

Findings We now analyze the impact of the announcement surprise on ΔVRP. Several results are worth discussing in Table 3. To begin with, the explanatory power of the model rises from 7.45 % at the 7-day horizon to 16.70% at the 60-day horizon. Clearly, this result suggests that FOMC announcement surprises can help explain ΔVRP, especially for ΔVRP with short- and mid- maturity. Furthermore, the slope estimate is positive and significant for the short-term maturities. Economically, the positive slope estimates indicate that an unexpected shock in the federal fund rate is associated with a positive ΔVRP. The magnitude of the slope estimates is revealing, too. We can see a declining pattern of announcement response across the maturity spectrum. This evidence points to a declining term-structure of announcement responses: the short-term ΔVRP is more responsive to FOMC news than its long-term counterpart.

In order to better understand the pattern of announcement responses, we decompose ΔVRP into two components, namely ΔIV and ΔRV:

$$\Delta VRP_{t,t+\tau} = \Delta IV_{t,t+\tau} - \Delta RV_{t,t+\tau} \tag{6}$$

We then regress each of these two components on a constant and the announcement surprise. It means that we also employ the Equation (5) and y_t is ΔIV or ΔRV. Table 3 documents that the explanatory power for ΔRV is much larger than that of ΔIV. It means that the fluctuation of stock market on announcement days is largely affected by interest rate shocks. Not surprisingly, both ΔIV and ΔRV respond positively to interest rate news. This result echoes that of Gospodinov and Jamali (2012), who document a similar pattern

for the monthly maturity. The positive slope estimates of ΔIV and ΔRV both decrease across the maturity spectrum, indicating the declining responses to FOMC news. It is also worth noting that, for short maturities, ΔIV reacts more to FOMC news than ΔRV. Economically, this finding suggests that increases in interest rates make the stock market more volatile. Over long horizons, there is very little to distinguish between the two sets of estimates. Collectively, these results help explain the downward-sloping term structure of announcement responses of ΔVRP. Based on the slope estimates, we infer that the interest rate news mostly affects ΔIV. In other words, ΔIV is the main channel of the ΔVRP response to the changes of interest rates.

Digging Deeper: Good vs. Bad Variance Risk Premia Following Kilic and Shaliastovich (2019), we decompose the model-free implied variance into good and bad model-free implied variance:

$$
\begin{aligned}
IV_{t,t+\tau} &= IV^{g}_{t,t+\tau} + IV^{b}_{t,t+\tau} && (7)\\
IV^{g}_{t,t+\tau} &= \frac{360}{\tau}\left[\int_{S_t}^{\infty} \frac{2(1-\ln\frac{K}{S_t})}{K^2} C_t(\tau,K)dK\right] && (8)\\
IV^{b}_{t,t+\tau} &= \frac{360}{\tau}\left[\int_{0}^{S_t} \frac{2(1+\ln\frac{S_t}{K})}{K^2} P_t(\tau,K)dK\right] && (9)
\end{aligned}
$$

where $IV^{g}_{t,t+\tau}$ and $IV^{b}_{t,t+\tau}$ denote the good and bad implied variance for the period starting at t and ending at $t+\tau$. Intuitively, the good (bad) model-free implied variance is defined as the implied variance of positive (negative) payoff components.

Barndorff-Nielsen et al. (2008) also define the concept of realized semi-variances. Briefly, the good and bad realized variance capture the variation of the positive and negative

returns, respectively:

$$RV_{t,t+\tau} = RV^{g}_{t,t+\tau} + RV^{g}_{t,t+\tau} \tag{10}$$

$$RV^{g}_{t,t+\tau} = \frac{252}{N^{\tau}_{t}} \sum_{j=0}^{N^{\tau}_{t}} \sum_{i=1}^{H} r^{2}_{t+j,i} \mathbb{1}(r_{t+j,i} > 0) \tag{11}$$

$$RV^{b}_{t,t+\tau} = \frac{252}{N^{\tau}_{t}} \sum_{j=0}^{N^{\tau}_{t}} \sum_{i=1}^{H} r^{2}_{t+j,i} \mathbb{1}(r_{t+j,i} \leq 0) \tag{12}$$

where $RV^{g}_{t,t+\tau}$ and $RV^{b}_{t,t+\tau}$ are the annualized good and bad realized variance at time t over a horizon of τ days, respectively.

We can then calculate the good and bad variance risk premia:

$$VRP^{g}_{t,t+\tau} = IV^{g}_{t,t+\tau} - RV^{g}_{t,t+\tau} \tag{13}$$

$$VRP^{b}_{t,t+\tau} = IV^{b}_{t,t+\tau} - RV^{b}_{t,t+\tau} \tag{14}$$

where $VRP^{g}_{t,t+\tau}$ is the good VRP for the period t to $t+\tau$ and $VRP^{b}_{t,t+\tau}$ denotes the bad VRP for the period starting at t and ending at $t+\tau$.

We study the response of the change of good and bad VRP to monetary policy shocks. Table 4 presents the results. We can see that the change of good VRP does not significantly respond to monetary policy news. In contrast, the change of bad VRP displays a positive and strong response to interest rate announcement surprises. The strength of the announcement response declines with the horizon. This finding mirrors that of Table 3. Examining the magnitude of the announcement response, we can see that the slope estimates associated with the change of bad VRP are very similar to those of the total VRP. The results of the 7-day horizon perfectly illustrate this pattern. The total change of VRP displays a slope estimate of 1.45%. This estimate is very similar to that of the change of bad VRP 1.29%. We thus conclude that most of the announcement responses of the VRP documented in Table 3 stems from the bad VRP. Intuitively, investors are keen on positive

stock returns and want to hedge against bad components. We infer that investors are more sensitive to the variance of negative returns since investors are risk-averse.

We move to analyze the impact of announcement surprise on the good and bad component of implied variance and realized variance. We observe several findings. First, the good and bad implied variance both react more strongly than good and bad realized variance, respectively. This finding helps us understand the result in Table 3 that implied variance reacts more strongly than realized variance. Second, the bad implied variance reacts more than the good implied variance while the good realized variance reacts more than the bad realized variance.

5 What About...

5.1 Contractionary vs. Expansionary Policy?

When the FOMC follows a contractionary monetary policy, the federal fund target rate will increase and the overheating economic condition is reduced. When the FOMC stimulates the economy and implements an expansionary policy, the federal fund target rate will decrease. In this analysis, we explore whether the reactions of VRP to FOMC announcement news depend on the policy stance. After the global financial crisis of 2008, the debate on whether easing monetary policy could led to financial instability is reignited. It benefits our understanding of the reactions of the financial market to different monetary policy stance that analyzing the relationship between monetary policy stance and the VRP, IV and RV. We define the contractionary stance when the target rate increases and the expansionary stance when the target rate decreases. We perform the following regression:

$$y_t = \alpha_0 + (\alpha_1 + \beta_1 \times \Delta i_t^u) D_t^+ + (\alpha_2 + \beta_2 \times \Delta i_t^u) D_t^- + \epsilon_t \tag{15}$$

D_t^+ is the dummy variable that takes value 1 for contractionary policy on day t and dummy variable D_t^- is equal to 1 for expansionary policy on day t. α_0, α_1, and α_2 denote the intercept on days when there is no change in target rate, increase of target rate and decrease of target rate, respectively. The coefficients β_1 and β_2 estimate the response to increase of target rate and decrease of target rate, respectively.

Table 5 presents the regression results and several findings can be noticed for the response of ΔVRP. First, based on the estimates α_0, we note that announcement days decline the ΔVRP even when the target rates not change. The impacts of no changes of target rate days generally declines across the maturity spectrum. Second, the parameters α_2 show that only the presence of expansionary policy has a significant effect. The impact is negative and the strength of it declines over horizons. Third, the strength of the response on the increase of target rate, which is proxied by β_1, is not significant. Meanwhile, for the decrease of target rate, its magnitude has a significantly positive impact on ΔVRP with short maturities. It infers that the more the target rate decreases, the smaller the VRP will be. Moreover, the strength of the expansionary policy response, proxied by the magnitude of β_2, decreases with maturity in the short end. Overall, it shows that the reaction to the interest rate shock is state dependent and expansionary policy has a stronger impact on the market price of variance. It suggests that expansionary policy decreases the compensation for variance risk and market participants increase the capacity of bearing variance risk.

Turning to the reactions of ΔIV and ΔRV to interest rate news, we get several results. First, by the magnitude of all the parameter estimates, ΔIV reacts more than ΔRV for both contractionary policy and expansionary policy. It suggests that the reactions of ΔIV dominate and it is consistent with the finding in Table 2. Moreover, the shape of ΔVRP responses is mainly driven by reactions of ΔIV. Second, based on the alpha and beta estimates for dummy variables, both ΔIV and ΔRV respond more strongly to the presence and magnitude of expansionary policy than those of contractionary policy. Not surprisingly, the magnitude of impact of decrease in target rate declines over the maturity.

Consistent with Bekaert et al. (2013), expansionary policy diminishes the uncertainty in stock market.

Pursuing the analysis of the impact of announcement surprise on good and bad components, Table 6 presents the following findings. First, in general, both good and bad components of ΔVRP, ΔIV and ΔRV react more to expansionary policy than contractionary policy. It implies that good news, the decrease of target rate, generally has a larger impact on the market. Second, consistent with the findings in Table 4, bad components of ΔVRP and ΔIV respond more strongly than good component, irrespective to expansionary policy or contractionary policy. We can infer that the concern about downside risk is more sensitive. However, expansionary policy has a stronger impact on the good component of ΔRV than the bad component. Third, both expansionary policy and contractionary policy have a larger impact on ΔIV than ΔRV no matter for its good or bad component.

5.2 Positive vs. Negative Surprises?

Up to this point, we have analyzed the impact of announcement surprises on the variables of our interest. However, this analysis does not distinguish between positive and negative announcement surprises. The target rate changes in low frequency while the sign of surprise changes more. Naturally, one may wonder whether positive and negative announcement surprises have the same impact on the variables of interest. This analysis is particularly important given the low interest rate regime that prevails over a significant part of our sample period.

Thus, we also follow the regression (15), where D_t^+ is the dummy variable that takes value 1 for positive surprises of federal fund rate on day t and dummy variable D_t^- is equal to 1 for negative surprises of federal fund rate on day t. α_0, α_1, and α_2 denote the intercept on days when the announcement surprise is zero, positive, and negative, respectively. The coefficients β_1 and β_2 estimate the response to positive and negative surprise, respectively.

Table 7 presents the regression results and several points are worth highlighting. First, the strength of the announcement response, which we proxy by the magnitude of the parameter estimates, decreases with maturity. This is true irrespective of whether we look at positive or negative announcement surprises. Second, the positive announcement surprise has a negative, though insignificant, effect on ΔVRP while the negative surprise has a positive and often significant effect, especially for short maturities. This result is particularly striking for maturities up to 90 days. Together, these results suggest that most of our main findings (see Table 3) may be driven by the periods of negative interest shocks. They are intuitive, too. When the central bank negatively surprises the market, investors view it as a good news and become more confident with the market and therefore require a less compensation for variance risk. Table 8 reports reactions of good and bad components of VRPs to positive and negative interest rate shocks. Consistently, we notice that most of the reactions of VRP to announcement is from bad components. Not surprisingly, both the good and bad components react more strongly to negative interest shocks, suggesting that investors are more sensitive to the negative surprise.

5.3 Timing vs. Level surprise

Bernanke and Kuttner (2005) propose that the federal fund rate surprise can be explained by the surprise of policy action timing which generally does not change the long-term fund rate and the surprise of fund rate expectation which changes the expected path of the rate in a durable time horizon. Gürkaynak et al. (2007) decompose the federal fund rate surprise of Kuttner (2001) into two parts: timing surprise and the level surprise. The level surprise is defined as the change in interest rate which still works after the next FOMC meeting. Following Gürkaynak et al. (2007), we compute the level surprise, $\Delta i_t^{u,l}$ as follows:

$$\Delta i_t^{u,l} = \frac{D_1}{D_1 - d_1}[(f_t^1 - f_{t-1}^1) - \frac{d_1}{D_1}\Delta i_t^u] \tag{16}$$

where d_1 is the number of days of the next FOMC meeting and D_1 is the number of days in the month on which the next FOMC meeting is held, f_t^1 is the federal fund rate from 3-month futures contract for the month containing the occurrence of the next FOMC meeting and Δi_t^u is defined as Equation (1). The timing surprise, $\Delta i_t^{u,t}$, is defined as the change of the interest rate only before the next FOMC meeting. Gürkaynak et al. (2007) estimate that $\Delta i_t^u = \Delta i_t^{u,l} + \Delta i_t^{u,t}$. Following them, we can get the $\Delta i_t^{u,t}$. Instead of Δi_t^u, we use $\Delta i_t^{u,l}$ and $\Delta i_t^{u,t}$ to augment the regression in Equation (5) and repeat our main analysis.

Table 9 presents the regression results. To ΔVRP, we find that the change in VRP responds strongly to the timing surprise compared to the level surprise for maturities up to 60 days. Timing surprise has a significantly positive effect on the VRP with the short-end and it means that the larger the timing surprise is, the larger the ΔVRP is and the larger the VRP is. Gürkaynak (2005) find that the impact of timing surprise on Treasury yields decreases with the increasing of horizon and the significant effect of timing surprise lasts till the 2-year Treasury yields. Kurov (2010) present that timing surprise significantly affects stock prices in bull and bear market and it has a stronger effect than level surprise in bear market. Since the definition of timing surprise is based on the change of the interest rate before the next FOMC meeting, it is not surprising that timing surprise matters for the VRP with short maturities. We also infer that the market price of variance risk reacts more on the change of transitory interest rate shocks. Additionally, both the effects of timing and level surprise on the variance risk premium decrease with the maturity. Table 10 shows the reactions of good and bad components to timing and level surprise. The findings are consistent with our main findings.

5.4 An Alternative Measure of Implied Variance?

In our main specification, we use the jump-robust method of Bakshi et al. (2003) to estimate the implied variance. The nonparametric approach in Britten-Jones and Neuberger (2000) is also a popular way to calculate implied variance (Carr and Wu,2009). Du and

Kapadia (2012) state that Britten-Jones and Neuberger (2000) method is not robust to the underlying asset with jumps. However, the S&P 500 index jumps around macroeconomic announcements, which is presented by Andersen et al. (2007) and Lee and Mykland (2008). In order to check whether the jumps of S&P 500 index affects our results, we follow Britten-Jones and Neuberger (2000) to estimate the implied variance as:

$$IV_{t,t+\tau}^{BN} = \frac{360}{\tau} \times 2 \times \left[\int_0^{S_t} \frac{P_t(\tau, K)}{K^2} dK + \int_{S_t}^{\infty} \frac{C_t(\tau, K)}{K^2} dK \right] \tag{17}$$

where all the variables are defined as before and the implied variance estimate is also annualized. We repeat our main analysis and present the results of robust test in the online supplementary appendix Table A1-A4. We find that these results are consistent with our benchmark.

5.5 An Alternative Definition of Variance Risk Premium?

The definition of VRP in our previous study is the difference between the implied variance over $[t, t+\tau]$ and the ex post realized variance over $[t, t+\tau]$. However, the VRP cannot be directly observed at time t. Following Bollerslev et al. (2009), we assume that $\mathbb{E}_t^P(V_{t,t+\tau}) = RV_{t-\tau,t}$ which means that the realized variance has a unit autocorrelation. In this subsection, the definition of variance risk premium is as:

$$VRP_{t,t+\tau}^{ea} = IV_{t,t+\tau} - RV_{t-\tau,t} \tag{18}$$

where $RV_{t-\tau,t}$ is the realized variance over the $[t-\tau, t]$ time interval. Thus the realized variance is available at time t. We repeat the main analysis by $VRP_{t,t+\tau}^{ea}$ rather than $VRP_{t,t+\tau}$ and report the results in the online supplementary appendix Table A5-A8. Generally, our main findings are robust to the alternative definition of VRP.

5.6 The Reactions from Professional Forecasts?

Balduzzi et al. (2001) employ the professional forecasts of macroeconomic announcements to gauge the shocks of macroeconomic news. The professional forecast is an alternative measure of market expectations of interest rate. Following Balduzzi et al. (2001), we compute the interest rate shocks of day t as the difference between the actual figure and the expectation of professional forecasts and then standardize the surprise:

$$\Delta i_t^{u,f} = \frac{A_t - F_t}{\sigma} \tag{19}$$

where $\Delta i_t^{u,f}$ represents the standardized surprise of interest rate shock made on day t, A_t is the actual announcement of target federal fund rate released at time t, F_t denotes the expected announcement made before actual release day t and in this subsection it is proxied by the mean of all survey forecasts of federal fund rate from professional forecasters surveyed by Bloomberg. σ is the standard deviation of the interest rate shock series based on the sample of 85 FOMC meetings. We repeat the main analysis with the measurement of interest rate shocks $\Delta i_t^{u,f}$ and present the results in the online supplementary appendix Table A9-A12. Overall, our main results are consistent with the alternative measurement of interest shocks.

6 Conclusion

In this paper, we study the impact of monetary policy news on the pricing of variance risk. Interestingly, we document a positive relationship between the change in the VRP and interest rate news. The magnitude of the announcement effect is strong at the short-end of the curve and gradually declines. Furthermore, we find that the shape of reactions of VRP to FOMC announcements is mainly driven by the reactions of implied variance rather than realized variance.

We explore the channels through which the announcement effect arises. We report that timing surprise matters for the VRP with short maturities. Considering monetary stance, we document that only expansionary policy has a significant impact on the VRP, suggesting that the decrease of target rate affects more strongly. Our analysis reveals that most of the announcement effect can be traced back to the negative surprises of the federal fund rate as well as the bad VRP. Collectively, this set of findings suggest that investors are sensitive to downside variance risk and view positive interest rate announcement surprises as signs of bad economic times. Thus, they require a higher variance risk premium as compensation for the increased risk.

Notes

[1]The data is available at the following address: `https://realized.oxford-man.ox.ac.uk/data/download`.

[2]An alternative approach consists in taking the difference between the announced interest rate figure and the mean estimate of professional forecasters. Similar to the extant literature, e.g. Bernanke and Kuttner (2005) and Avino et al. (2021), we prefer to implement the methodology of Kuttner (2001) to estimate the interest rate shock. In so doing, we ensure that our results are more comparable with those of the literature. As a further analysis, we consider the surprise after the current FOMC meeting which implies the near-term path of monetary policy. Following Gürkaynak et al. (2007) we decompose the surprise into timing and level component, we discuss these results in Section 5.3. Another popular measure of announcement surprise is the methodology of Balduzzi et al. (2001), which is based on professional forecasters. We employ this method and discuss these findings in Section 5.6.

[3]Following Kurov (2010), if the announcement occurs during the last 7 days of the month, the change of the federal rate is unscaled and we use the difference between next month's futures rate and the current month rate. If the change happens in the first day of the month, the change of rate is proxied by $f_t - f_D^{-1}$, where f_D^{-1} is the future rate of the last day in the previous month.

[4]Note that the standardization does not affect the statistical significance of our results.

[5]Bollerslev et al. (2009) assume that the realized variance has a unit autocorrelation and use $RV_{t-\tau,t}$ to present the expectation of variance under the physical measure. We repeat our analysis by this measurement of variance risk premium and discuss the results in Section 5.5.

[6]The estimator of Britten-Jones and Neuberger (2000) is also a widely-used estimator of implied variance, we replace implied variance with this estimator as a further analysis. We discuss these results in Section 5.4.

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Table 1: Summary Statistics

This table reports summary statistics of implied variance, realized variance and variance risk premium. The definition and calculation of all the variables are presented in Section 3. Columns under Maturity, Number, Mean(%), Std. dev.(%), Skewness, Kurtosis report the variables with calendar days of maturity (for realized variance, it means the days of average values), number of observations, sample average in percentage, standard deviation in percentage, skewness, kurtosis respectively. AR(1) reports the values of coefficient for the first autocorrelation. Our sample period is from March 5, 2008 to March 11, 2019.

	Maturity	Number	Mean(%)	Std dev(%)	skewness	kurtosis	AR(1)
Panel A: Variance Risk Premium							
	7	2470	3.13	8.59	12.08	243.00	0.53
	30	2470	2.32	4.99	1.60	31.20	0.91
Variance	60	2470	2.60	5.13	0.06	23.11	0.97
Risk	90	2470	2.89	5.13	-0.27	18.22	0.98
Premium	180	2470	3.52	4.86	-0.06	10.39	0.99
	270	2470	4.09	4.70	0.29	7.76	0.99
	360	2470	4.64	4.46	0.68	6.79	0.99
Panel B: Implied Variance							
	7	2470	5.78	11.90	9.55	150.90	0.76
	30	2470	5.00	7.39	5.16	39.13	0.96
Implied	60	2470	5.24	6.36	4.22	25.35	0.98
	90	2470	5.51	5.89	3.87	21.71	0.99
Variance	180	2470	6.06	5.04	3.22	16.55	0.99
	270	2470	6.54	4.65	2.68	12.18	0.99
	360	2470	6.93	4.46	2.33	9.86	0.99
Panel C: Realized Variance							
	7	2470	2.65	5.30	5.95	50.95	0.97
	30	2470	2.68	5.20	5.78	44.25	1.00
Realized	60	2470	2.64	4.76	5.30	37.05	1.00
	90	2470	2.63	4.42	4.74	29.41	1.00
Variance	180	2470	2.54	3.69	3.89	19.42	1.00
	270	2470	2.45	3.19	3.49	15.65	1.00
	360	2470	2.29	2.67	3.37	14.87	1.00

Table 2: Different Dynamics on FOMC days versus on Non-FOMC days
This table provides the mean, standard deviation and distribution of the annualized IV, RV and VRP with different maturities on All days, FOMC days and Other (non-FOMC) days. p_T presents the p-values of t-test for the null hypothesis of mean equality, p_F presents the p-values of F-test for the null hypothesis of standard deviation equality, p_K presents the p-values of Kolmogorov Smirnov test for the null hypothesis of distribution equality. Values in bold indicate that the p-value of the test is statistically significant at 5% level.

	Mean				Standard Deviation				Dist.
Variable	All	FOMC	Other	p_T	All	FOMC	Other	p_F	p_K
				ΔVRP					
ΔVRP_7	0.05	-53.10	1.95	0.33	8.33	4.95	8.43	**0.00**	**0.03**
ΔVRP_{30}	0.04	-59.60	2.16	**0.01**	2.17	2.02	2.18	0.36	**0.05**
ΔVRP_{60}	-0.03	-39.10	1.36	**0.00**	1.27	1.21	1.27	0.57	**0.04**
ΔVRP_{90}	-0.06	-28.30	0.94	**0.00**	1.06	0.89	1.06	**0.04**	0.15
ΔVRP_{180}	-0.05	-21.30	0.71	**0.01**	0.78	0.68	0.78	0.09	0.05
ΔVRP_{270}	0.36	-17.60	1.00	**0.01**	0.66	0.59	0.66	0.20	0.06
ΔVRP_{360}	0.33	-13.00	0.81	**0.02**	0.64	0.53	0.64	**0.03**	0.18
				ΔIV					
ΔIV_7	-0.18	-72.20	2.39	0.27	8.25	5.94	8.32	**0.00**	0.15
ΔIV_{30}	-0.16	-61.70	2.04	**0.01**	2.13	2.26	2.12	0.37	0.06
ΔIV_{60}	-0.16	-40.70	1.29	**0.00**	1.22	1.33	1.21	0.21	**0.04**
ΔIV_{90}	-0.15	-31.60	0.97	**0.00**	1.02	0.97	1.02	0.55	0.06
ΔIV_{180}	-0.13	-22.60	0.67	**0.01**	0.76	0.71	0.76	0.40	**0.04**
ΔIV_{270}	-0.14	-18.20	0.51	**0.01**	0.64	0.60	0.65	0.35	**0.04**
ΔIV_{360}	-0.14	-13.60	0.34	**0.05**	0.63	0.54	0.64	0.06	0.09
				ΔRV					
ΔRV_7	-0.23	-19.10	0.45	0.25	1.33	1.54	1.32	**0.03**	0.32
ΔRV_{30}	-0.20	-2.17	-0.13	0.71	0.51	0.50	0.51	0.91	0.37
ΔRV_{60}	-0.13	-1.61	-0.08	0.46	0.32	0.18	0.32	**0.00**	**0.00**
ΔRV_{90}	-0.09	-3.29	0.02	0.09	0.22	0.17	0.23	**0.00**	**0.03**
ΔRV_{180}	-0.09	-1.31	-0.04	0.19	0.13	0.08	0.13	**0.00**	0.33
ΔRV_{270}	-0.50	-0.61	-0.49	0.85	0.07	0.06	0.07	**0.01**	**0.00**
ΔRV_{360}	-0.48	-0.58	-0.47	0.84	0.05	0.05	0.05	0.87	**0.01**

Table 3: Surprise of Federal Fund Rate on er, ΔIV, ΔRV and ΔVRP

The table reports the regression results of Equation (5) which analyze the reactions from ΔIV, ΔRV and ΔVRP to the FOMC surprise. It provides the intercept (α), slope (β) and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

		ΔVRP			ΔIV			ΔRV		
maturity	obs	α	β	Adj. R^2	α	β	Adj. R^2	α	β	Adj. R^2
7	85	-0.0057	0.0145**	0.0745	-0.0079	0.0254**	0.1730	-0.0022*	0.0109**	0.495
		(-1.10)	(2.04)		(-1.34)	(2.11)		(-1.81)	(2.19)	
30	85	-0.0062***	0.0075**	0.1270	-0.0065***	0.0107**	0.2140	-0.0003	0.0032***	0.408
		(-3.01)	(2.12)		(-2.97)	(2.42)		(-0.73)	(3.04)	
60	85	-0.0040***	0.0051**	0.1670	-0.0042***	0.0064**	0.2210	-0.0002	0.0013**	0.491
		(-3.37)	(2.13)		(-3.34)	(2.25)		(-1.38)	(2.45)	
90	85	-0.0029***	0.0021	0.0441	-0.0032***	0.0033**	0.1060	-0.0004**	0.0012**	0.493
		(-3.02)	(1.55)		(-3.23)	(2.06)		(-2.62)	(2.29)	
180	85	-0.0022***	0.0008	0.0033	-0.0023***	0.0014	0.0301	-0.0001**	0.0006**	0.503
		(-2.92)	(0.85)		(-3.05)	(1.34)		(-2.19)	(2.30)	
270	85	-0.0018***	-0.0002	-0.0110	-0.0018***	0.0002	-0.0106	-0.0001*	0.0004**	0.549
		(-2.69)	(-0.21)		(-2.78)	(0.25)		(-1.73)	(2.60)	
360	85	-0.0013**	0.0000	-0.0120	-0.0014**	0.0003	-0.0079	-0.0001*	0.0003**	0.488
		(-2.22)	(0.01)		(-2.31)	(0.48)		(-1.75)	(2.42)	

Table 4: Reactions of Good and Bad Components to FOMC surprise

The table reports the regression results of Equation (5) which analyze the reactions from ΔIV, ΔRV and ΔVRP to the FOMC surprise. It provides the intercept (α), slope (β), R-squared and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0028*	-0.0018***	-0.0012***	-0.0008***	-0.0006***	-0.0005***	-0.0004***	-0.0029	-0.0043***	-0.0029***	-0.0020***	-0.0016***	-0.0013**	-0.0009*
	(-1.80)	(-2.99)	(-3.58)	(-3.42)	(-3.48)	(-3.59)	(-3.57)	(-0.77)	(-2.87)	(-3.21)	(-2.81)	(-2.70)	(-2.41)	(-1.87)
β	0.0015	0.0011	0.0012*	0.0007	0.0003	0.0002	0.0002	0.0129**	0.0064**	0.0039**	0.0014	0.0005	-0.0004	-0.0001
	(0.92)	(1.19)	(1.88)	(1.57)	(1.26)	(1.01)	(1.01)	(2.26)	(2.38)	(2.21)	(1.46)	(0.67)	(-0.48)	(-0.23)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.012	0.035	0.142	0.082	0.045	0.028	0.025	0.123	0.177	0.183	0.045	0.009	0.007	0.001
Adj. R^2	-0.000178	0.0236	0.131	0.0706	0.0334	0.0168	0.0132	0.112	0.168	0.173	0.0334	-0.00315	-0.00534	-0.0110
Panel B: ΔIV														
α	-0.0037*	-0.0019***	-0.0013***	-0.0010***	-0.0007***	-0.0005***	-0.0004***	-0.0042	-0.0045***	-0.0030***	-0.0022***	-0.0016***	-0.0013**	-0.0010*
	(-1.99)	(-3.18)	(-3.54)	(-3.57)	(-3.63)	(-3.66)	(-3.65)	(-1.01)	(-2.84)	(-3.20)	(-2.98)	(-2.78)	(-2.47)	(-1.93)
β	0.0094**	0.0032**	0.0022**	0.0015**	0.0007*	0.0005*	0.0004*	0.0160**	0.0075**	0.0042**	0.0018*	0.0007	-0.0003	-0.0000
	(2.05)	(2.29)	(2.28)	(2.13)	(1.93)	(1.83)	(1.86)	(2.14)	(2.48)	(2.22)	(1.78)	(0.92)	(-0.32)	(-0.05)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.230	0.255	0.306	0.249	0.165	0.130	0.123	0.154	0.207	0.195	0.068	0.017	0.003	0.000
Adj. R^2	0.221	0.246	0.298	0.240	0.155	0.119	0.112	0.143	0.197	0.185	0.0569	0.00473	-0.00925	-0.0120
Panel C: ΔRV														
α	-0.0009	-0.0001	-0.0001	-0.0002**	-0.0001*	-0.0000	-0.0000	-0.0013**	-0.0002	-0.0001	-0.0002***	-0.0001**	-0.0000*	-0.0000*
	(-1.29)	(-0.34)	(-0.98)	(-2.09)	(-1.83)	(-1.42)	(-1.40)	(-2.13)	(-1.05)	(-1.41)	(-2.76)	(-2.22)	(-1.74)	(-1.84)
β	0.0078**	0.0022***	0.0009**	0.0008**	0.0004**	0.0003***	0.0002**	0.0031*	0.0010***	0.0003**	0.0004**	0.0002**	0.0001**	0.0001**
	(2.45)	(3.06)	(2.62)	(2.40)	(2.42)	(2.68)	(2.52)	(1.70)	(2.87)	(2.00)	(2.07)	(2.07)	(2.43)	(2.25)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.600	0.450	0.615	0.591	0.597	0.647	0.596	0.246	0.239	0.162	0.286	0.287	0.313	0.277
Adj. R^2	0.595	0.443	0.610	0.586	0.593	0.643	0.591	0.237	0.230	0.152	0.277	0.278	0.305	0.268

Table 5: Surprise of Federal Fund Rate on Contractionary and Expansionary Policy

The table reports the regression results of Equation (15) which analyze the reactions from ΔIV, ΔRV and ΔVRP depend on contractionary and expansionary policy. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α_0, α_1 and α_2 represent the effect of no surprises days, contractionary policy presence days and expansionary policy presence days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the contractionary and expansionary policy, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

maturity	Obs	α	t-stat	α_1	t-stat	β_1	t-stat	α_2	t-stat	β_2	t-stat	Adj. R^2
						ΔVRP						
7	85	-0.0013	(-0.23)	-0.0075	(-0.98)	0.0017	(0.95)	-0.0662***	(-2.99)	0.0125***	(3.79)	0.119
30	85	-0.0041*	(-1.97)	0.0025	(0.80)	-0.0004	(-0.75)	-0.0461***	(-19.35)	0.0058***	(32.85)	0.315
60	85	-0.0024**	(-2.23)	0.0002	(0.09)	0.0003	(0.58)	-0.0360***	(-9.47)	0.0035***	(6.27)	0.477
90	85	-0.0019**	(-2.29)	0.0012	(0.90)	0.0001	(0.26)	-0.0287***	(-3.07)	0.0001	(0.05)	0.335
180	85	-0.0016**	(-2.27)	0.0009	(0.87)	0.0002	(1.13)	-0.0206***	(-2.96)	-0.0007	(-0.65)	0.248
270	85	-0.0014**	(-2.44)	0.0012	(1.66)	0.0001	(1.24)	-0.0177**	(-2.05)	-0.0018	(-1.38)	0.214
360	85	-0.0010*	(-1.80)	0.0012	(1.04)	0.0000	(0.05)	-0.0148**	(-2.52)	-0.0014	(-1.55)	0.179
						ΔIV						
7	85	-0.0017	(-0.27)	-0.0047	(-0.62)	0.0014	(1.00)	-0.0928**	(-2.17)	0.0240***	(3.66)	0.268
30	85	-0.0040*	(-1.82)	0.0027	(0.94)	0.0005	(0.97)	-0.0515***	(-8.84)	0.0087***	(10.44)	0.402
60	85	-0.0024**	(-2.12)	0.0003	(0.12)	0.0004	(0.80)	-0.0387***	(-24.61)	0.0048***	(28.14)	0.533
90	85	-0.0021**	(-2.33)	0.0012	(0.90)	0.0002	(0.70)	-0.0311***	(-4.46)	0.0014	(1.33)	0.417
180	85	-0.0016**	(-2.28)	0.0010	(0.89)	0.0002	(1.05)	-0.0217***	(-3.76)	-0.0000	(-0.04)	0.298
270	85	-0.0014**	(-2.40)	0.0012	(1.63)	0.0001	(1.31)	-0.0182**	(-2.27)	-0.0013	(-1.09)	0.228
360	85	-0.0010*	(-1.79)	0.0012	(1.04)	0.0000	(0.09)	-0.0154***	(-2.86)	-0.0010	(-1.22)	0.198
						ΔRV						
7	85	-0.0004	(-0.54)	0.0027	(1.38)	-0.0003	(-0.51)	-0.0266	(-1.27)	0.0115***	(3.54)	0.714
30	85	0.0001	(0.31)	0.0002	(0.23)	0.0009***	(9.91)	-0.0054	(-0.83)	0.0029***	(2.87)	0.377
60	85	0.0000	(0.18)	0.0001	(0.52)	0.0001***	(6.07)	-0.0027	(-1.08)	0.0013***	(3.20)	0.606
90	85	-0.0002*	(-1.75)	0.0001	(0.46)	0.0001***	(4.77)	-0.0024	(-1.00)	0.0013***	(3.61)	0.674
180	85	-0.0000	(-1.11)	0.0001	(0.55)	0.0000	(0.29)	-0.0012	(-0.98)	0.0007***	(3.66)	0.682
270	85	-0.0000	(-0.26)	0.0000	(0.17)	0.0000*	(1.80)	-0.0005	(-0.79)	0.0005***	(4.97)	0.725
360	85	-0.0000	(-0.28)	0.0000	(0.26)	0.0000	(1.37)	-0.0006	(-1.24)	0.0004***	(5.09)	0.697

Table 6: Reactions of Good and Bad Component to Surprise of Federal Fund Rate on Contractionary and Expansionary Policy

The table reports the regression results of Equation (15) which analyze the reactions from good and bad components of ΔVRP, ΔIV and ΔRV depend on contractionary and expansionary policy. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, contractionary policy presence days and expansionary policy presence days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the contractionary and expansionary policy, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0016	-0.0014**	-0.0008***	-0.0006***	-0.0004***	-0.0004***	-0.0003***	0.0003	-0.0028*	-0.0016*	-0.0014**	-0.0011**	-0.0011**	-0.0007
	(-0.94)	(-2.19)	(-2.68)	(-2.66)	(-2.80)	(-2.98)	(-3.02)	(0.07)	(-1.77)	(-1.99)	(-2.08)	(-2.07)	(-2.24)	(-1.50)
α_1	-0.0017	0.0013*	0.0005	0.0004*	0.0003	0.0003	0.0002	-0.0058	0.0012	-0.0003	0.0007	0.0006	0.0009	0.0010
	(-0.63)	(1.92)	(1.40)	(1.69)	(1.56)	(1.51)	(1.50)	(-1.07)	(0.47)	(-0.15)	(0.67)	(0.69)	(1.65)	(0.93)
β_1	0.0004	-0.0004***	0.0000	0.0000	0.0001**	0.0000	0.0000	0.0013	-0.0000	0.0003	0.0001	0.0002	0.0001	-0.0000
	(0.53)	(-6.75)	(0.43)	(0.02)	(2.31)	(1.56)	(1.45)	(1.19)	(-0.00)	(0.59)	(0.29)	(0.91)	(1.05)	(-0.09)
α_2	-0.0293***	-0.0148***	-0.0103***	-0.0078***	-0.0050***	-0.0039***	-0.0031***	-0.0370	-0.0314***	-0.0256***	-0.0209***	-0.0156***	-0.0137*	-0.0117**
	(-11.56)	(-4.89)	(-7.07)	(-4.76)	(-4.06)	(-4.24)	(-3.71)	(-1.57)	(-13.16)	(-10.89)	(-2.71)	(-2.73)	(-1.78)	(-2.32)
β_2	-0.0003	0.0004	0.0007***	0.0002	0.0000	-0.0001	-0.0001	0.0128***	0.0054***	0.0028***	-0.0002	-0.0007	-0.0018	-0.0013*
	(-1.01)	(0.86)	(3.37)	(0.91)	(0.26)	(-0.42)	(-0.52)	(3.56)	(19.46)	(8.16)	(-0.13)	(-0.85)	(-1.49)	(-1.72)
Adj. R^2	0.0946	0.229	0.480	0.418	0.329	0.326	0.305	0.138	0.325	0.455	0.291	0.220	0.192	0.152
Panel B: ΔIV														
α	-0.0013	-0.0011**	-0.0007**	-0.0006**	-0.0004***	-0.0003***	-0.0003***	-0.0004	-0.0029*	-0.0017*	-0.0015**	-0.0012**	-0.0011**	-0.0007
	(-0.71)	(-2.02)	(-2.45)	(-2.56)	(-2.72)	(-2.81)	(-2.85)	(-0.09)	(-1.74)	(-1.97)	(-2.18)	(-2.10)	(-2.24)	(-1.51)
α_1	-0.0004	0.0009	0.0004	0.0004	0.0003	0.0002	0.0002	-0.0043	0.0018	-0.0001	0.0008	0.0007	0.0009*	0.0010
	(-0.19)	(1.44)	(1.16)	(1.32)	(1.40)	(1.32)	(1.33)	(-0.77)	(0.78)	(-0.08)	(0.75)	(0.74)	(1.67)	(0.95)
β_1	0.0003	0.0001	0.0001	0.0001	0.0001	0.0001*	0.0000	0.0012	0.0004	0.0003	0.0001	0.0002	0.0001	-0.0000
	(0.69)	(0.94)	(1.42)	(1.33)	(1.65)	(1.67)	(1.51)	(1.11)	(0.95)	(0.70)	(0.55)	(0.87)	(1.09)	(-0.08)
α_2	-0.0432***	-0.0177***	-0.0118***	-0.0091***	-0.0056***	-0.0042***	-0.0034***	-0.0496	-0.0338***	-0.0269***	-0.0220***	-0.0161***	-0.0140*	-0.0120**
	(-3.75)	(-14.98)	(-30.89)	(-32.54)	(-10.97)	(-8.14)	(-6.73)	(-1.59)	(-7.25)	(-16.78)	(-3.24)	(-3.06)	(-1.87)	(-2.45)
β_2	0.0083***	0.0025***	0.0018***	0.0011***	0.0005***	0.0003***	0.0002**	0.0157***	0.0062***	0.0030***	0.0003	-0.0005	-0.0016	-0.0012
	(4.71)	(15.66)	(44.74)	(48.27)	(6.83)	(3.49)	(2.51)	(3.28)	(9.20)	(14.46)	(0.26)	(-0.67)	(-1.40)	(-1.61)
Adj. R^2	0.195	0.348	0.465	0.326	0.238	0.192	0.156	0.421	0.526	0.662	0.605	0.493	0.454	0.449
Panel C: ΔRV														
α	0.0003	0.0003	0.0001*	-0.0000	-0.0000	0.0000	0.0000	-0.0007	-0.0001	-0.0001	-0.0001*	-0.0000	-0.0000	-0.0000
	(1.15)	(0.93)	(1.69)	(-0.73)	(-0.10)	(1.23)	(1.00)	(-1.29)	(-0.56)	(-0.69)	(-1.93)	(-1.35)	(-0.82)	(-0.87)
α_1	0.0012	-0.0004	-0.0001	-0.0000	-0.0000	-0.0000	-0.0000	0.0015*	0.0006	0.0001	0.0001	0.0001	0.0000	0.0000
	(0.88)	(-1.38)	(-1.18)	(-0.84)	(-0.03)	(-0.97)	(-0.86)	(1.82)	(0.88)	(1.27)	(1.29)	(1.01)	(0.92)	(1.00)
β_1	-0.0001	0.0005***	0.0001***	0.0001***	0.0000	0.0000*	0.0000	-0.0002	0.0004***	0.0000***	0.0001***	0.0000	0.0000	0.0000
	(-0.27)	(15.26)	(5.81)	(4.19)	(0.36)	(1.92)	(1.50)	(-0.87)	(3.67)	(4.18)	(5.22)	(0.21)	(1.57)	(1.15)
α_2	-0.0140	-0.0030	-0.0015	-0.0013	-0.0006	-0.0003	-0.0003	-0.0127	-0.0025	-0.0013	-0.0011	-0.0005	-0.0002	-0.0003
	(-1.05)	(-0.74)	(-0.88)	(-0.87)	(-0.83)	(-0.67)	(-1.03)	(-1.64)	(-0.96)	(-1.47)	(-1.21)	(-1.22)	(-1.03)	(-1.64)
β_2	0.0086***	0.0021***	0.0010***	0.0009***	0.0005***	0.0003***	0.0003***	0.0029**	0.0008*	0.0002*	0.0004***	0.0002***	0.0002***	0.0001***
	(4.18)	(3.45)	(3.88)	(4.00)	(4.06)	(5.14)	(5.15)	(2.43)	(1.97)	(1.86)	(2.98)	(2.99)	(4.67)	(4.99)
Adj. R^2	0.792	0.429	0.741	0.783	0.783	0.833	0.815	0.428	0.196	0.204	0.397	0.397	0.412	0.406

Table 7: Asymmetric Reaction to Positive and Negative Surprise

The table reports the regression results of Equation (15) which analyze the reactions from ΔIV, ΔRV and ΔVRP to positive and negative federal fund rate surprise. It provides the intercept, slope and adjusted R-squared and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, positive surprise days and negative surprise days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the positive and negative surprise, respectively. All standard errors are adjusted following White (1980) and robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	Obs	α	t-stat	α_1	t-stat	β_1	t-stat	α_2	t-stat	β_2	t-stat	Adj. R^2
						ΔVRP						
7	85	-0.0100	(-0.76)	0.0067	(0.50)	-0.0055	(-0.82)	0.0272	(1.51)	0.0275***	(12.12)	0.156
30	85	-0.0059	(-1.11)	0.0043	(0.77)	-0.0065	(-1.45)	0.0043	(0.77)	0.0135***	(8.83)	0.274
60	85	-0.0026	(-1.08)	0.0012	(0.44)	-0.0044	(-1.28)	0.0010	(0.37)	0.0092***	(6.39)	0.374
90	85	-0.0023	(-1.18)	0.0012	(0.57)	-0.0031	(-1.22)	-0.0000	(-0.00)	0.0041**	(2.31)	0.128
180	85	-0.0015	(-1.10)	0.0005	(0.32)	-0.0026	(-1.17)	-0.0003	(-0.18)	0.0021*	(1.67)	0.061
270	85	-0.0014	(-1.27)	0.0005	(0.39)	-0.0021	(-1.15)	-0.0006	(-0.35)	0.0004	(0.29)	-0.010
360	85	-0.0015	(-1.47)	0.0013	(1.01)	-0.0020	(-1.17)	0.0002	(0.12)	0.0006	(0.57)	-0.003
						ΔIV						
7	85	-0.0121	(-0.84)	0.0104	(0.71)	-0.0087	(-0.99)	0.0338*	(1.76)	0.0451***	(19.13)	0.325
30	85	-0.0067	(-1.16)	0.0056	(0.93)	-0.0055	(-1.16)	0.0059	(1.00)	0.0177***	(16.84)	0.379
60	85	-0.0029	(-1.12)	0.0017	(0.58)	-0.0045	(-1.24)	0.0018	(0.62)	0.0111***	(8.69)	0.452
90	85	-0.0026	(-1.25)	0.0016	(0.68)	-0.0033	(-1.20)	0.0006	(0.24)	0.0060***	(3.75)	0.242
180	85	-0.0016	(-1.11)	0.0006	(0.37)	-0.0027	(-1.16)	-0.0000	(-0.02)	0.0031**	(2.56)	0.123
270	85	-0.0015	(-1.27)	0.0006	(0.44)	-0.0022	(-1.15)	-0.0004	(-0.23)	0.0010	(0.78)	0.008
360	85	-0.0016	(-1.43)	0.0014	(1.00)	-0.0020	(-1.18)	0.0003	(0.20)	0.0011	(1.12)	0.019
						ΔRV						
7	85	-0.0021	(-1.50)	0.0037**	(2.29)	-0.0033	(-1.34)	0.0066***	(3.56)	0.0176***	(14.99)	0.825
30	85	-0.0007	(-1.35)	0.0013*	(1.82)	0.0009	(0.78)	0.0016**	(2.22)	0.0043***	(8.81)	0.472
60	85	-0.0003	(-1.19)	0.0005*	(1.96)	-0.0001	(-0.33)	0.0008**	(2.62)	0.0019***	(11.64)	0.712
90	85	-0.0003	(-1.56)	0.0004	(1.58)	-0.0003	(-0.96)	0.0006**	(2.40)	0.0019***	(12.03)	0.776
180	85	-0.0001	(-0.92)	0.0001	(0.91)	-0.0001	(-0.95)	0.0003**	(2.24)	0.0010***	(12.27)	0.784
270	85	-0.0001	(-0.87)	0.0001	(1.26)	-0.0000	(-0.64)	0.0002**	(2.44)	0.0006***	(13.69)	0.792
360	85	-0.0000	(-0.20)	0.0000	(0.37)	-0.0001	(-1.13)	0.0001	(1.66)	0.0005***	(18.04)	0.762

Table 8: Asymmetric Reaction of Good and Bad Components to Positive and Negative Surprise

The table reports the regression results of Equation (15) which analyze the reactions from ΔIV, ΔRV and ΔVRP to positive and negative federal fund rate surprise. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α_0, α_1 and α_2 represent the effect of no surprises days, positive surprise days and negative surprise days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the positive and negative surprise, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0038	-0.0017	-0.0008	-0.0006	-0.0005	-0.0003	-0.0003	-0.0061	-0.0042	-0.0018	-0.0017	-0.0011	-0.0011	-0.0012
	(-1.02)	(-1.26)	(-1.31)	(-1.30)	(-1.45)	(-1.41)	(-1.57)	(-0.65)	(-1.05)	(-0.98)	(-1.13)	(-0.99)	(-1.21)	(-1.40)
α_1	0.0022	0.0011	0.0004	0.0003	0.0002	0.0001	0.0001	0.0045	0.0032	0.0008	0.0009	0.0003	0.0004	0.0012
	(0.56)	(0.76)	(0.59)	(0.54)	(0.56)	(0.38)	(0.47)	(0.47)	(0.75)	(0.37)	(0.57)	(0.25)	(0.38)	(1.08)
β_1	-0.0043	-0.0027	-0.0014	-0.0011	-0.0007	-0.0006	-0.0004	-0.0011	-0.0038	-0.0030	-0.0020	-0.0019	-0.0016	-0.0016
	(-1.20)	(-1.54)	(-1.34)	(-1.30)	(-1.25)	(-1.20)	(-1.15)	(-0.31)	(-1.32)	(-1.24)	(-1.16)	(-1.14)	(-1.13)	(-1.17)
α_2	0.0064	0.0010	0.0003	0.0002	0.0001	0.0000	0.0001	0.0208	0.0034	0.0007	-0.0002	-0.0004	-0.0007	0.0001
	(1.18)	(0.64)	(0.44)	(0.33)	(0.26)	(0.16)	(0.43)	(1.61)	(0.81)	(0.33)	(-0.11)	(-0.29)	(-0.45)	(0.04)
β_2	0.0050***	0.0027***	0.0023***	0.0014***	0.0008***	0.0005**	0.0004**	0.0225***	0.0108***	0.0068***	0.0027*	0.0014	-0.0001	0.0002
	(3.61)	(3.61)	(5.24)	(3.57)	(2.92)	(2.51)	(2.23)	(13.27)	(13.65)	(6.90)	(1.95)	(1.33)	(-0.10)	(0.23)
Adj R^2	0.0596	0.148	0.350	0.242	0.169	0.137	0.104	0.192	0.305	0.366	0.0875	0.0330	-0.0205	-0.0123
Panel B: ΔIV														
α	-0.0044	-0.0018	-0.0009	-0.0007	-0.0005	-0.0003	-0.0003	-0.0076	-0.0049	-0.0021	-0.0019	-0.0012	-0.0012	-0.0013
	(-1.09)	(-1.22)	(-1.28)	(-1.34)	(-1.37)	(-1.35)	(-1.42)	(-0.74)	(-1.13)	(-1.06)	(-1.21)	(-1.03)	(-1.23)	(-1.40)
α_1	0.0037	0.0015	0.0005	0.0004	0.0002	0.0001	0.0001	0.0067	0.0041	0.0012	0.0012	0.0004	0.0005	0.0013
	(0.90)	(0.96)	(0.73)	(0.67)	(0.51)	(0.41)	(0.39)	(0.63)	(0.91)	(0.53)	(0.67)	(0.33)	(0.44)	(1.10)
β_1	-0.0051	-0.0020	-0.0014	-0.0012	-0.0008	-0.0006	-0.0004	-0.0037	-0.0035	-0.0032	-0.0022	-0.0020	-0.0016	-0.0016
	(-1.22)	(-1.23)	(-1.26)	(-1.26)	(-1.22)	(-1.19)	(-1.15)	(-0.74)	(-1.12)	(-1.22)	(-1.15)	(-1.14)	(-1.14)	(-1.18)
α_2	0.0106*	0.0016	0.0007	0.0005	0.0002	0.0001	0.0002	0.0232*	0.0043	0.0011	0.0001	-0.0003	-0.0005	0.0001
	(1.88)	(1.07)	(0.93)	(0.83)	(0.59)	(0.47)	(0.64)	(1.69)	(0.96)	(0.50)	(0.06)	(-0.17)	(-0.37)	(0.10)
β_2	0.0170***	0.0055***	0.0037***	0.0026***	0.0014***	0.0009***	0.0007***	0.0281***	0.0122***	0.0073***	0.0033**	0.0017*	0.0001	0.0004
	(21.27)	(12.74)	(11.31)	(9.13)	(6.48)	(5.27)	(4.74)	(14.91)	(19.63)	(7.76)	(2.56)	(1.70)	(0.08)	(0.46)
Adj R^2	0.456	0.473	0.591	0.520	0.389	0.323	0.299	0.256	0.335	0.383	0.135	0.0549	-0.0195	-0.00711
Panel C: ΔRV														
α	-0.0006*	-0.0001	-0.0000	-0.0001	0.0000	0.0000	0.0000	-0.0015	-0.0007	-0.0003	-0.0003	-0.0001	-0.0001	-0.0000
	(-1.71)	(-0.44)	(-0.13)	(-1.53)	(0.36)	(0.12)	(1.03)	(-1.36)	(-1.49)	(-1.29)	(-1.53)	(-1.23)	(-1.08)	(-0.74)
α_1	0.0016***	0.0003	0.0001*	0.0001	-0.0000	0.0000	-0.0000	0.0021*	0.0009*	0.0004*	0.0003	0.0001	0.0001	0.0000
	(3.01)	(1.05)	(1.76)	(1.58)	(-0.50)	(0.76)	(-0.66)	(1.73)	(1.88)	(1.74)	(1.43)	(1.29)	(1.32)	(0.82)
β_1	-0.0007	0.0007	0.0000	-0.0001	-0.0000	0.0000	-0.0000	-0.0025	0.0003	-0.0001	-0.0002	-0.0001	-0.0000	-0.0000
	(-1.08)	(0.97)	(0.36)	(-0.91)	(-0.52)	(0.69)	(-0.90)	(-1.36)	(0.43)	(-0.73)	(-0.97)	(-1.09)	(-1.12)	(-1.19)
α_2	0.0042***	0.0007**	0.0004***	0.0003**	0.0001**	0.0001***	0.0001	0.0024*	0.0009*	0.0004*	0.0003*	0.0002*	0.0001*	0.0001
	(3.98)	(2.11)	(3.05)	(2.62)	(2.25)	(2.75)	(1.62)	(1.91)	(1.86)	(1.77)	(1.84)	(1.86)	(1.82)	(1.40)
β_2	0.0121***	0.0029***	0.0014***	0.0012***	0.0006***	0.0004***	0.0003***	0.0056***	0.0014***	0.0005***	0.0007***	0.0003***	0.0002***	0.0002***
	(14.64)	(9.39)	(11.60)	(11.77)	(11.90)	(12.91)	(15.74)	(15.12)	(7.76)	(11.40)	(12.43)	(12.89)	(15.28)	(23.89)
Adj R^2	0.894	0.510	0.838	0.880	0.880	0.895	0.885	0.518	0.273	0.272	0.481	0.484	0.474	0.454

Table 9: Timing v.s. Level Surprise of Federal Fund Rate on ΔIV, ΔRV and ΔVRP
The table reports the regression results of Equation (5) which use $\Delta i_t^{u,t}$ and $\Delta i_t^{u,l}$ to analyze the reactions from ΔIV, ΔRV and ΔVRP to the FOMC surprise. It provides the intercept (α), slope of timing surprise ($\Delta i_t^{u,t}$) , slope of level surprise ($\Delta i_t^{u,l}$), R^2 and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
				ΔVRP			
α	-0.0047	-0.0058***	-0.0039***	-0.0029***	-0.0022**	-0.0019**	-0.0013**
	(-0.91)	(-2.70)	(-2.94)	(-2.69)	(-2.62)	(-2.52)	(-2.04)
$\Delta i_t^{u,t}$	0.2084**	0.1123**	0.0786*	0.0351	0.0147	-0.0002	0.0011
	(2.30)	(2.07)	(1.93)	(1.13)	(0.65)	(-0.01)	(0.06)
$\Delta i_t^{u,l}$	0.0849	0.0691	0.0585	0.0390	0.0200	0.0131	0.0053
	(0.63)	(0.70)	(0.72)	(0.54)	(0.37)	(0.26)	(0.13)
obs	85	85	85	85	85	85	85
R^2	0.105	0.152	0.186	0.056	0.017	0.017	0.002
Adj. R^2	0.083	0.131	0.166	0.033	-0.007	-0.007	-0.022
				ΔIV			
α	-0.0061	-0.0060***	-0.0040***	-0.0032***	-0.0023***	-0.0019**	-0.0014**
	(-1.05)	(-2.68)	(-2.92)	(-2.84)	(-2.70)	(-2.57)	(-2.08)
$\Delta i_t^{u,t}$	0.3629**	0.1611**	0.0970**	0.0527	0.0236	0.0060	0.0061
	(2.56)	(2.53)	(2.16)	(1.59)	(1.01)	(0.29)	(0.36)
$\Delta i_t^{u,l}$	0.1338	0.1018	0.0673	0.0461	0.0242	0.0167	0.0078
	(0.78)	(0.94)	(0.80)	(0.62)	(0.45)	(0.33)	(0.19)
obs	85	85	85	85	85	85	85
R^2	0.228	0.245	0.246	0.118	0.042	0.011	0.004
Adj. R^2	0.209	0.226	0.227	0.097	0.018	-0.013	-0.020
				ΔRV			
α	-0.0014	-0.0002	-0.0001	-0.0003**	-0.0001*	-0.0001	-0.0000
	(-1.37)	(-0.52)	(-0.99)	(-2.35)	(-1.82)	(-1.35)	(-1.37)
$\Delta i_t^{u,t}$	0.1545***	0.0488***	0.0184***	0.0177***	0.0089***	0.0062***	0.0050***
	(2.79)	(3.20)	(3.03)	(2.91)	(2.85)	(3.17)	(3.00)
$\Delta i_t^{u,l}$	0.0489	0.0327	0.0088	0.0071	0.0042	0.0037**	0.0024*
	(1.01)	(1.18)	(1.27)	(1.37)	(1.57)	(2.54)	(1.83)
obs	85	85	85	85	85	85	85
R^2	0.646	0.447	0.587	0.612	0.600	0.618	0.579
Adj. R^2	0.637	0.433	0.577	0.602	0.590	0.609	0.568

Table 10: Timing v.s. Level Surprise: Reactions of Good and Bad Components

The table reports the regression results of Equation (5) which use $\Delta i_t^{u,t}$ and $\Delta i_t^{u,l}$ to analyze the reactions of good and bad components of ΔIV, ΔRV and ΔVRP to the FOMC surprise. It provides the intercept (α), slope of timing surprise ($\Delta i_t^{u,t}$) , slope of level surprise ($\Delta i_t^{u,l}$), R^2 and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0025	-0.0017***	-0.0011***	-0.0008***	-0.0006***	-0.0005***	-0.0004***	-0.0022	-0.0041**	-0.0028***	-0.0021**	-0.0016**	-0.0014**	-0.0010*
	(-1.57)	(-2.67)	(-3.09)	(-2.97)	(-3.07)	(-3.16)	(-3.19)	(-0.58)	(-2.61)	(-2.83)	(-2.53)	(-2.45)	(-2.31)	(-1.74)
$\Delta i_t^{u,t}$	0.0180	0.0145	0.0186	0.0107	0.0055	0.0033	0.0025	0.1904**	0.0979**	0.0600**	0.0244	0.0092	-0.0035	-0.0014
	(0.65)	(0.88)	(1.63)	(1.25)	(1.00)	(0.77)	(0.75)	(2.62)	(2.43)	(2.03)	(1.07)	(0.53)	(-0.20)	(-0.11)
$\Delta i_t^{u,l}$	-0.0147	0.0005	0.0125	0.0095	0.0056	0.0031	0.0027	0.0997	0.0686	0.0460	0.0295	0.0144	0.0100	0.0026
	(-0.24)	(0.01)	(0.53)	(0.50)	(0.45)	(0.32)	(0.35)	(1.06)	(1.01)	(0.80)	(0.55)	(0.35)	(0.25)	(0.08)
Adj. R^2	0.004	0.030	0.132	0.060	0.022	0.005	0.001	0.120	0.169	0.171	0.023	-0.012	0.007	-0.021
Panel B: ΔIV														
α	-0.0030	-0.0018***	-0.0012***	-0.0009***	-0.0006***	-0.0005***	-0.0004***	-0.0031	-0.0042**	-0.0028***	-0.0022***	-0.0017**	-0.0014**	-0.0010*
	(-1.64)	(-2.80)	(-3.07)	(-3.09)	(-3.16)	(-3.20)	(-3.20)	(-0.75)	(-2.60)	(-2.82)	(-2.65)	(-2.51)	(-2.34)	(-1.78)
$\Delta i_t^{u,t}$	0.1326**	0.0481**	0.0327**	0.0225**	0.0115*	0.0075	0.0058	0.2304**	0.1130**	0.0643**	0.0302	0.0120	-0.0014	0.0002
	(2.39)	(2.35)	(2.30)	(2.07)	(1.76)	(1.58)	(1.55)	(2.59)	(2.61)	(2.08)	(1.29)	(0.69)	(-0.08)	(0.01)
$\Delta i_t^{u,l}$	0.0429	0.0268	0.0209	0.0156	0.0090	0.0058	0.0046	0.0909	0.0751	0.0464	0.0306	0.0152	0.0109	0.0031
	(0.56)	(0.74)	(0.84)	(0.78)	(0.69)	(0.59)	(0.57)	(0.88)	(1.04)	(0.78)	(0.56)	(0.36)	(0.27)	(0.10)
Adj. R^2	0.278	0.271	0.318	0.248	0.151	0.113	0.106	0.170	0.204	0.186	0.045	-0.006	-0.001	-0.023
Panel C: ΔRV														
α	-0.0005	-0.0000	-0.0000	-0.0001*	-0.0000	-0.0000	-0.0000	-0.0009*	-0.0001	-0.0001	-0.0002**	-0.0001*	-0.0000	-0.0000
	(-0.77)	(-0.15)	(-0.53)	(-1.72)	(-1.43)	(-1.00)	(-0.95)	(-1.78)	(-0.79)	(-1.08)	(-2.51)	(-1.87)	(-1.43)	(-1.54)
$\Delta i_t^{u,t}$	0.1146***	0.0337***	0.0141***	0.0119***	0.0060***	0.0042***	0.0033***	0.0399**	0.0151***	0.0043**	0.0058***	0.0028**	0.0020***	0.0016***
	(3.03)	(3.11)	(3.14)	(2.98)	(2.94)	(3.21)	(3.08)	(2.18)	(3.27)	(2.56)	(2.73)	(2.63)	(3.03)	(2.77)
$\Delta i_t^{u,l}$	0.0577*	0.0263	0.0084*	0.0060*	0.0034*	0.0027***	0.0019**	-0.0088	0.0065	0.0004	0.0011	0.0008	0.0010*	0.0006
	(1.90)	(1.41)	(1.82)	(1.90)	(1.98)	(2.80)	(2.37)	(-0.40)	(0.66)	(0.15)	(0.48)	(0.77)	(1.68)	(0.90)
Adj. R^2	0.690	0.453	0.677	0.678	0.666	0.696	0.666	0.418	0.271	0.219	0.383	0.359	0.355	0.334

7 Online Appendix

Table A1: Surprise of Federal Fund Rate on ΔVRP and ΔIV: BN estimator
The table reports the regression results of Equation (5) which analyze the reactions from ΔVRP (in Panel A) and ΔIV (in Panel B) to the FOMC surprise. It provides the intercept (α), slope (β) and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
Panel A: ΔVRP							
α	-0.0056	-0.0056***	-0.0036***	-0.0027***	-0.0020***	-0.0016***	-0.0012***
	(-1.16)	(-3.02)	(-3.41)	(-3.23)	(-3.17)	(-3.06)	(-2.76)
β	0.0136**	0.0062**	0.0044**	0.0023*	0.0010	0.0003	0.0002
	(2.01)	(2.01)	(2.08)	(1.70)	(1.11)	(0.36)	(0.43)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.074	0.105	0.157	0.067	0.017	-0.009	-0.008
Panel B: ΔIV							
α	-0.0079	-0.0059***	-0.0038***	-0.0031***	-0.0021***	-0.0016***	-0.0013***
	(-1.40)	(-2.99)	(-3.38)	(-3.41)	(-3.29)	(-3.15)	(-2.85)
β	0.0246**	0.0094**	0.0056**	0.0035**	0.0016	0.0007	0.0006
	(2.10)	(2.38)	(2.22)	(2.06)	(1.56)	(0.93)	(0.96)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.177	0.201	0.218	0.140	0.056	0.007	0.008

Table A2: Reactions of Good and Bad Components to FOMC surprise: BN estimator

The table reports the regression results of Equation (5) which analyze the reactions from ΔVRP (in Panel A) and ΔIV (in Panel B) to the FOMC surprise. It provides the intercept (α), slope (β) R^2 and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0030*	-0.0020***	-0.0013***	-0.0010***	-0.0007***	-0.0005***	-0.0004***	-0.0027	-0.0036***	-0.0023***	-0.0018***	-0.0013***	-0.0010***	-0.0008**
	(-1.81)	(-3.04)	(-3.59)	(-3.45)	(-3.48)	(-3.58)	(-3.56)	(-0.79)	(-2.85)	(-3.21)	(-3.03)	(-2.95)	(-2.76)	(-2.36)
β	0.0022	0.0015	0.0016**	0.0009*	0.0005	0.0003	0.0003	0.0114**	0.0047**	0.0028**	0.0013	0.0005	-0.0001	-0.0000
	(1.16)	(1.43)	(2.03)	(1.79)	(1.52)	(1.33)	(1.38)	(2.24)	(2.25)	(2.10)	(1.60)	(0.83)	(-0.17)	(-0.06)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.022	0.058	0.180	0.119	0.072	0.054	0.052	0.119	0.138	0.152	0.058	0.014	0.001	0.000
Adj. R^2	0.0101	0.0467	0.170	0.108	0.0609	0.0430	0.0410	0.108	0.128	0.142	0.0466	0.00213	-0.0114	-0.0120
Panel B: ΔIV														
α	-0.0039*	-0.0021***	-0.0014***	-0.0011***	-0.0008***	-0.0006***	-0.0005***	-0.0040	-0.0038***	-0.0024***	-0.0020***	-0.0014***	-0.0011***	-0.0008**
	(-1.97)	(-3.19)	(-3.53)	(-3.57)	(-3.60)	(-3.63)	(-3.61)	(-1.06)	(-2.83)	(-3.21)	(-3.22)	(-3.05)	(-2.82)	(-2.43)
β	0.0101**	0.0037**	0.0025**	0.0017**	0.0009**	0.0006*	0.0005*	0.0145**	0.0057**	0.0031**	0.0017*	0.0007	0.0001	0.0001
	(2.07)	(2.34)	(2.33)	(2.21)	(2.01)	(1.92)	(1.96)	(2.12)	(2.41)	(2.12)	(1.85)	(1.11)	(0.11)	(0.23)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.238	0.274	0.327	0.270	0.183	0.150	0.144	0.153	0.175	0.168	0.088	0.027	0.000	0.001
Adj. R^2	0.229	0.266	0.319	0.261	0.173	0.139	0.134	0.143	0.165	0.157	0.0772	0.0148	-0.0118	-0.0111

Table A3: Surprise of Federal Fund Rate on Contractionary and Expansionary Policy: BN estimator

The table reports the regression results of Equation (15) which analyze the reactions from ΔVRP (in Panel A) and ΔIV (in Panel B) depend on contractionary and expansionary policy. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, contractionary policy presence days and expansionary policy presence days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the contractionary and expansionary policy, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
Panel A: ΔVRP							
α	-0.0013	-0.0038**	-0.0022**	-0.0018**	-0.0014**	-0.0012**	-0.0009**
	(-0.25)	(-2.01)	(-2.33)	(-2.39)	(-2.47)	(-2.58)	(-2.22)
α_1	-0.0072	0.0023	0.0006	0.0010	0.0008	0.0008	0.0007
	(-1.00)	(0.81)	(0.34)	(0.86)	(0.85)	(1.12)	(0.95)
β_1	0.0016	-0.0005	0.0002	0.0001	0.0002	0.0001	0.0001
	(0.94)	(-0.97)	(0.56)	(0.32)	(1.28)	(1.19)	(0.62)
α_2	-0.0682***	-0.0434***	-0.0328***	-0.0259***	-0.0181***	-0.0148***	-0.0124***
	(-3.56)	(-12.37)	(-8.56)	(-3.96)	(-3.41)	(-2.75)	(-3.10)
β_2	0.0113***	0.0044***	0.0028***	0.0007	-0.0003	-0.0010	-0.0008
	(3.96)	(9.63)	(4.94)	(0.65)	(-0.35)	(-1.18)	(-1.34)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.129	0.302	0.479	0.376	0.291	0.251	0.238
Panel B: ΔIV							
α	-0.0017	-0.0037*	-0.0022**	-0.0020**	-0.0015**	-0.0012**	-0.0009**
	(-0.29)	(-1.85)	(-2.20)	(-2.43)	(-2.47)	(-2.53)	(-2.18)
α_1	-0.0045	0.0025	0.0006	0.0011	0.0008	0.0008	0.0007
	(-0.62)	(0.97)	(0.37)	(0.85)	(0.88)	(1.10)	(0.94)
β_1	0.0014	0.0004	0.0003	0.0002	0.0002	0.0002	0.0001
	(0.99)	(0.88)	(0.85)	(0.80)	(1.16)	(1.25)	(0.67)
α_2	-0.0948**	-0.0488***	-0.0356***	-0.0283***	-0.0193***	-0.0153***	-0.0130***
	(-2.39)	(-11.88)	(-23.05)	(-6.78)	(-4.64)	(-3.23)	(-3.70)
β_2	0.0227***	0.0073***	0.0041***	0.0020***	0.0004	-0.0005	-0.0004
	(3.74)	(13.14)	(22.53)	(3.15)	(0.60)	(-0.67)	(-0.81)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.285	0.401	0.542	0.464	0.352	0.282	0.272

Table A4: Asymmetric Reaction to Positive and Negative Surprise: BN estimator
The table reports the regression results of Equation (15) which analyze the reactions from ΔVRP (in Panel A) and ΔIV (in Panel B) to positive and negative federal fund rate surprise. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, positive surprise days and negative surprise days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the positive and negative surprise, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
Panel A: ΔVRP							
α	-0.0094	-0.0053	-0.0024	-0.0020	-0.0014	-0.0012	-0.0011
	(-0.76)	(-1.10)	(-1.11)	(-1.20)	(-1.18)	(-1.28)	(-1.34)
α_1	0.0062	0.0037	0.0011	0.0009	0.0004	0.0003	0.0006
	(0.50)	(0.74)	(0.46)	(0.50)	(0.31)	(0.30)	(0.56)
β_1	-0.0059	-0.0062	-0.0041	-0.0031	-0.0024	-0.0019	-0.0016
	(-0.85)	(-1.47)	(-1.28)	(-1.25)	(-1.18)	(-1.15)	(-1.13)
α_2	0.0253	0.0035	0.0007	0.0002	-0.0002	-0.0003	0.0001
	(1.49)	(0.69)	(0.29)	(0.08)	(-0.12)	(-0.20)	(0.05)
β_2	0.0261***	0.0114***	0.0079***	0.0044***	0.0023**	0.0010	0.0009
	(11.61)	(7.09)	(5.91)	(3.15)	(2.16)	(1.08)	(1.20)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.159	0.247	0.363	0.196	0.103	0.0297	0.0266
Panel B: ΔIV							
α	-0.0115	-0.0060	-0.0027	-0.0023	-0.0015	-0.0012	-0.0011
	(-0.85)	(-1.15)	(-1.15)	(-1.27)	(-1.19)	(-1.28)	(-1.30)
α_1	0.0099	0.0050	0.0016	0.0013	0.0005	0.0004	0.0006
	(0.72)	(0.92)	(0.63)	(0.63)	(0.37)	(0.37)	(0.57)
β_1	-0.0092	-0.0053	-0.0042	-0.0034	-0.0025	-0.0019	-0.0016
	(-1.01)	(-1.17)	(-1.23)	(-1.23)	(-1.17)	(-1.16)	(-1.14)
α_2	0.0319*	0.0051	0.0015	0.0008	0.0001	-0.0001	0.0002
	(1.76)	(0.95)	(0.58)	(0.37)	(0.07)	(-0.05)	(0.16)
β_2	0.0438***	0.0157***	0.0098***	0.0063***	0.0032***	0.0017*	0.0015*
	(20.07)	(13.80)	(8.33)	(5.10)	(3.31)	(1.82)	(1.96)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.339	0.366	0.451	0.325	0.185	0.0760	0.0741

Table A5: Surprise of Federal Fund Rate on ΔIV, ΔRV and ΔVRP: ex ante RV
The table reports the regression results of Equation (5) which analyze the reactions from ΔVRP (in Panel A), ΔIV (in Panel B), ΔRV (in Panel C) to the FOMC surprise. It provides the intercept (α), slope (β) and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
Panel A: ΔVRP							
α	-0.0124*	-0.0072***	-0.0047***	-0.0036***	-0.0025***	-0.0020***	-0.0014**
	(-1.79)	(-3.01)	(-3.41)	(-3.37)	(-3.15)	(-2.94)	(-2.41)
β	0.0371**	0.0112**	0.0080**	0.0049**	0.0022*	0.0007	0.0007
	(2.18)	(2.23)	(2.21)	(2.31)	(1.74)	(0.80)	(0.95)
Obs	85	85	85	85	85	85	85
R^2	0.258	0.209	0.283	0.199	0.087	0.014	0.016
Adj. R^2	0.249	0.200	0.275	0.190	0.0762	0.00203	0.00456
Panel B: ΔIV							
α	-0.0079	-0.0065***	-0.0042***	-0.0032***	-0.0023***	-0.0018***	-0.0014**
	(-1.34)	(-2.97)	(-3.34)	(-3.23)	(-3.05)	(-2.78)	(-2.31)
β	0.0254**	0.0107**	0.0064**	0.0033**	0.0014	0.0002	0.0003
	(2.11)	(2.42)	(2.25)	(2.06)	(1.34)	(0.25)	(0.48)
Obs	85	85	85	85	85	85	85
R^2	0.182	0.223	0.230	0.117	0.042	0.001	0.004
Adj. R^2	0.173	0.214	0.221	0.106	0.0301	-0.0106	-0.00785
Panel C: ΔRV							
α	0.0045***	0.0007**	0.0005*	0.0004*	0.0002**	0.0001**	0.0001*
	(2.83)	(2.21)	(1.88)	(1.90)	(2.14)	(2.09)	(1.83)
β	-0.0117**	-0.0005	-0.0016*	-0.0016**	-0.0008**	-0.0005**	-0.0004**
	(-2.28)	(-0.71)	(-1.71)	(-2.16)	(-2.25)	(-2.17)	(-2.15)
Obs	85	85	85	85	85	85	85
R^2	0.400	0.031	0.323	0.448	0.460	0.454	0.444
Adj. R^2	0.393	0.0191	0.315	0.441	0.454	0.447	0.437

Table A6: Reactions of Good and Bad Components to FOMC surprise: ex ante RV

The table reports the regression results of Equation (5) which analyze the reactions from ΔVRP, ΔIV and ΔRV to the FOMC surprise. It provides the intercept (α), slope (β) R^2 and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0069**	-0.0025***	-0.0016***	-0.0012***	-0.0008***	-0.0006***	-0.0005***	-0.0055	-0.0046***	-0.0031***	-0.0024***	-0.0017***	-0.0014**	-0.0010*
	(-2.58)	(-3.18)	(-3.46)	(-3.44)	(-3.47)	(-3.64)	(-3.61)	(-1.23)	(-2.85)	(-3.28)	(-3.14)	(-2.91)	(-2.56)	(-1.98)
β	0.0182**	0.0042**	0.0031**	0.0024**	0.0012**	0.0008*	0.0006**	0.0189**	0.0071**	0.0049**	0.0025**	0.0011	-0.0000	0.0001
	(2.27)	(2.00)	(2.16)	(2.21)	(2.04)	(1.98)	(2.01)	(2.09)	(2.39)	(2.23)	(2.21)	(1.32)	(-0.05)	(0.22)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.358	0.245	0.351	0.338	0.248	0.211	0.197	0.179	0.184	0.237	0.119	0.037	0.000	0.001
Adj. R^2	0.351	0.236	0.343	0.330	0.239	0.201	0.188	0.169	0.175	0.228	0.108	0.0257	-0.0120	-0.0112
Panel B: ΔIV														
α	-0.0037*	-0.0019***	-0.0013***	-0.0010***	-0.0007***	-0.0005***	-0.0004***	-0.0042	-0.0045***	-0.0030***	-0.0022***	-0.0016***	-0.0013**	-0.0010*
	(-1.99)	(-3.18)	(-3.54)	(-3.57)	(-3.63)	(-3.66)	(-3.65)	(-1.01)	(-2.84)	(-3.20)	(-2.98)	(-2.78)	(-2.47)	(-1.93)
β	0.0094**	0.0032**	0.0022**	0.0015**	0.0007*	0.0005*	0.0004*	0.0160**	0.0075**	0.0042**	0.0018*	0.0007	-0.0003	-0.0000
	(2.05)	(2.29)	(2.28)	(2.13)	(1.93)	(1.83)	(1.86)	(2.14)	(2.48)	(2.22)	(1.78)	(0.92)	(-0.32)	(-0.05)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.230	0.255	0.306	0.249	0.165	0.130	0.123	0.154	0.207	0.195	0.068	0.017	0.003	0.000
Adj. R^2	0.221	0.246	0.298	0.240	0.155	0.119	0.112	0.143	0.197	0.185	0.0569	0.00473	-0.00925	-0.0120
Panel C: ΔRV														
α	0.0032***	0.0006**	0.0004**	0.0002**	0.0001**	0.0001**	0.0001**	0.0013*	0.0001	0.0001	0.0001	0.0001**	0.0000	0.0000
	(3.07)	(2.63)	(2.40)	(2.14)	(2.02)	(2.34)	(2.22)	(1.98)	(0.64)	(1.08)	(1.35)	(2.11)	(1.60)	(1.18)
β	-0.0089**	-0.0009	-0.0010*	-0.0009**	-0.0004**	-0.0003**	-0.0002**	-0.0028*	0.0004***	-0.0007	-0.0007**	-0.0004**	-0.0002**	-0.0002**
	(-2.50)	(-1.29)	(-1.79)	(-2.22)	(-2.08)	(-2.03)	(-2.03)	(-1.75)	(2.64)	(-1.57)	(-2.06)	(-2.49)	(-2.33)	(-2.31)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.472	0.160	0.349	0.430	0.408	0.424	0.415	0.184	0.077	0.240	0.396	0.483	0.452	0.438
Adj. R^2	0.465	0.150	0.341	0.423	0.400	0.417	0.408	0.175	0.0657	0.231	0.389	0.477	0.446	0.432

Table A7: Surprise of Federal Fund Rate on Contractionary and Expansionary Policy: ex ante RV

The table reports the regression results of Equation (15) which analyze the reactions from ΔVRP (in Panel A) and ΔRV (in Panel B) depend on contractionary and expansionary policy. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, contractionary policy presence days and expansionary policy presence days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the contractionary and expansionary policy, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	7	30	60	90	180	270	360
Panel A: ΔVRP							
α	-0.0043	-0.0045*	-0.0027**	-0.0022**	-0.0016**	-0.0014**	-0.0010*
	(-0.62)	(-1.89)	(-2.16)	(-2.27)	(-2.23)	(-2.39)	(-1.77)
α_1	-0.0057	0.0023	0.0001	0.0010	0.0008	0.0011	0.0011
	(-0.61)	(0.74)	(0.06)	(0.69)	(0.72)	(1.50)	(0.98)
β_1	0.0015	0.0005	0.0004	0.0003	0.0002	0.0002	0.0000
	(0.66)	(0.74)	(0.68)	(0.73)	(0.98)	(1.21)	(0.12)
α_2	-0.1045	-0.0525***	-0.0390***	-0.0337***	-0.0237***	-0.0192***	-0.0162***
	(-1.59)	(-5.23)	(-8.08)	(-9.63)	(-5.22)	(-2.73)	(-3.42)
β_2	0.0384***	0.0096***	0.0070***	0.0032***	0.0008	-0.0008	-0.0006
	(3.79)	(6.36)	(9.65)	(6.08)	(1.22)	(-0.73)	(-0.84)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.363	0.375	0.559	0.507	0.371	0.266	0.228
Panel B: ΔRV							
α	0.0026*	0.0006*	0.0003	0.0001	0.0000	0.0000	0.0000
	(1.96)	(1.75)	(1.58)	(0.59)	(0.46)	(0.66)	(0.25)
α_1	0.0010	0.0004	0.0001	0.0002	0.0002	0.0001	0.0001
	(0.29)	(0.50)	(0.33)	(0.73)	(1.01)	(0.76)	(0.91)
β_1	-0.0000	-0.0000	-0.0000	-0.0001	-0.0000	-0.0000	-0.0000
	(-0.03)	(-0.07)	(-0.01)	(-0.66)	(-0.39)	(-0.53)	(-0.35)
α_2	0.0116	0.0009	0.0003	0.0026	0.0020	0.0010	0.0008
	(0.51)	(0.21)	(0.06)	(0.74)	(1.63)	(1.08)	(1.17)
β_2	-0.0144***	-0.0008	-0.0022**	-0.0018***	-0.0009***	-0.0006***	-0.0004***
	(-4.03)	(-1.26)	(-2.45)	(-3.20)	(-4.58)	(-3.72)	(-3.92)
Obs	85	85	85	85	85	85	85
Adj. R^2	0.525	0.0344	0.424	0.582	0.689	0.644	0.647

Table A8: Asymmetric Reaction to Positive and Negative Surprise: ex ante RV

The table reports the regression results of Equation (15) which analyze the reactions from ΔVRP (in Panel A), ΔIV (in Panel B) and ΔRV (in Panel C) to positive and negative federal fund rate surprise. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, positive surprise days and negative surprise days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the positive and negative surprise, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

maturity	Obs	α	t-stat	α_1	t-stat	β_1	t-stat	α_2	t-stat	β_2	t-stat	Adj. R^2
Panel A: ΔVRP												
7	85	-0.0164	(-0.97)	0.0131	(0.77)	-0.0100	(-1.08)	0.0412*	(1.98)	0.0634***	(19.52)	0.438
30	85	-0.0075	(-1.19)	0.0059	(0.90)	-0.0066	(-1.21)	0.0074	(1.15)	0.0192***	(27.24)	0.374
60	85	-0.0034	(-1.16)	0.0020	(0.61)	-0.0049	(-1.26)	0.0032	(1.04)	0.0138***	(18.40)	0.540
90	85	-0.0029	(-1.25)	0.0019	(0.74)	-0.0036	(-1.20)	0.0016	(0.58)	0.0085***	(6.34)	0.383
180	85	-0.0018	(-1.13)	0.0008	(0.43)	-0.0030	(-1.18)	0.0005	(0.24)	0.0044***	(3.83)	0.218
270	85	-0.0016	(-1.27)	0.0007	(0.46)	-0.0023	(-1.16)	-0.0001	(-0.03)	0.0018	(1.46)	0.050
360	85	-0.0016	(-1.40)	0.0014	(0.99)	-0.0021	(-1.18)	0.0005	(0.35)	0.0017*	(1.79)	0.056
Panel B: ΔIV												
7	85	-0.0121	(-0.84)	0.0104	(0.71)	-0.0087	(-0.99)	0.0338*	(1.76)	0.0451***	(19.13)	0.325
30	85	-0.0067	(-1.16)	0.0056	(0.93)	-0.0055	(-1.16)	0.0059	(1.00)	0.0177***	(16.84)	0.379
60	85	-0.0029	(-1.12)	0.0017	(0.58)	-0.0045	(-1.24)	0.0018	(0.62)	0.0111***	(8.69)	0.452
90	85	-0.0026	(-1.25)	0.0016	(0.68)	-0.0033	(-1.20)	0.0006	(0.24)	0.0060***	(3.75)	0.242
180	85	-0.0016	(-1.11)	0.0006	(0.37)	-0.0027	(-1.16)	-0.0000	(-0.02)	0.0031**	(2.56)	0.123
270	85	-0.0015	(-1.27)	0.0006	(0.44)	-0.0022	(-1.15)	-0.0004	(-0.23)	0.0010	(0.78)	0.008
360	85	-0.0016	(-1.43)	0.0014	(1.00)	-0.0020	(-1.18)	0.0003	(0.20)	0.0011	(1.12)	0.019
Panel C: ΔRV												
7	85	0.0044	(1.50)	-0.0027	(-0.87)	0.0013	(0.69)	-0.0074**	(-2.12)	-0.0183***	(-9.88)	0.592
30	85	0.0008	(1.31)	-0.0004	(-0.51)	0.0010	(1.27)	-0.0015**	(-2.01)	-0.0014***	(-3.94)	0.142
60	85	0.0005	(1.26)	-0.0003	(-0.69)	0.0004	(1.12)	-0.0014**	(-2.34)	-0.0028***	(-5.20)	0.535
90	85	0.0003	(1.09)	-0.0003	(-0.95)	0.0002	(0.77)	-0.0009**	(-2.52)	-0.0025***	(-9.55)	0.689
180	85	0.0001	(1.16)	-0.0002	(-1.00)	0.0002	(1.26)	-0.0005***	(-3.31)	-0.0013***	(-23.64)	0.769
270	85	0.0001	(1.04)	-0.0001	(-0.62)	0.0001	(1.02)	-0.0003***	(-3.08)	-0.0008***	(-13.82)	0.746
360	85	0.0000	(0.57)	-0.0000	(-0.29)	0.0001	(1.17)	-0.0002***	(-2.67)	-0.0006***	(-14.99)	0.743

Table A9: Surprise of Federal Fund Rate on er, ΔIV, ΔRV and ΔVRP: Professional Forecasts

The table reports the regression results of Equation (5) which analyze the reactions from ΔIV, ΔRV and ΔVRP to the FOMC surprise. The interest shocks is calculated by professional forecasts rather than the 30-day federal fund futures contracts. It provides the intercept (α), slope (β) and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

		ΔIV			ΔRV			ΔVRP		
Maturity	obs	α	β	Adj. R^2	α	β	Adj. R^2	α	β	Adj. R^2
7	85	-0.0045	0.0150	0.081	-0.0062	0.0207	0.110	-0.0016	0.0057	0.125
		(-0.88)	(1.53)		(-1.05)	(1.36)		(-1.22)	(0.96)	
30	85	-0.0055***	0.0083***	0.160	-0.0057**	0.0098**	0.176	-0.0001	0.0014	0.072
		(-2.78)	(3.14)		(-2.63)	(2.37)		(-0.30)	(0.79)	
60	85	-0.0036***	0.0065***	0.284	-0.0037***	0.0071***	0.282	-0.0001	0.0006	0.102
		(-3.23)	(3.94)		(-3.10)	(3.25)		(-0.82)	(0.87)	
90	85	-0.0026***	0.0050***	0.308	-0.0029***	0.0055***	0.315	-0.0003*	0.0005	0.077
		(-3.14)	(4.45)		(-3.24)	(5.07)		(-1.95)	(0.79)	
180	85	-0.0020***	0.0033***	0.226	-0.0021***	0.0036***	0.245	-0.0001	0.0003	0.088
		(-3.01)	(3.64)		(-3.09)	(4.69)		(-1.56)	(0.82)	
270	85	-0.0016***	0.0027**	0.203	-0.0017***	0.0029***	0.228	-0.0001	0.0002	0.098
		(-2.89)	(2.18)		(-2.96)	(2.70)		(-1.05)	(0.88)	
360	85	-0.0012**	0.0022**	0.153	-0.0012**	0.0023***	0.174	-0.0000	0.0002	0.107
		(-2.24)	(2.47)		(-2.31)	(3.07)		(-1.14)	(0.99)	

Table A10: Reactions of Good and Bad Components to FOMC surprise: Professional Forecast

The table reports the regression results of Equation (5) which analyzes the reactions from ΔVRP (in Panel A), ΔIV (in Panel B), and ΔRV (in Panel C) to positive and negative federal fund rate surprise. The interest shocks is calculated by professional forecasts rather than the 30-day federal fund futures contracts. It provides the intercept (α), slope (β) R-squared and adjusted R^2 and obs represents the number of observation. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

	good							bad						
	7	30	60	90	180	270	360	7	30	60	90	180	270	360
Panel A: ΔVRP														
α	-0.0025	-0.0017***	-0.0011***	-0.0008***	-0.0005***	-0.0004***	-0.0003***	-0.0020	-0.0038**	-0.0025***	-0.0018***	-0.0014***	-0.0012**	-0.0008*
	(-1.66)	(-2.86)	(-3.51)	(-3.49)	(-3.53)	(-3.68)	(-3.68)	(-0.53)	(-2.58)	(-3.03)	(-2.91)	(-2.78)	(-2.59)	(-1.86)
β	0.0045***	0.0021***	0.0017***	0.0013***	0.0008***	0.0006***	0.0005***	0.0105	0.0062**	0.0048***	0.0037***	0.0025***	0.0022*	0.0017**
	(2.93)	(2.87)	(3.97)	(4.72)	(3.83)	(3.64)	(3.59)	(1.19)	(2.57)	(3.79)	(4.15)	(3.44)	(1.90)	(2.21)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.101	0.139	0.284	0.297	0.238	0.224	0.229	0.081	0.165	0.283	0.307	0.225	0.197	0.141
Adj. R^2	0.0899	0.129	0.276	0.289	0.229	0.215	0.220	0.0695	0.155	0.274	0.299	0.216	0.187	0.131
Panel B: ΔIV														
α	-0.0030	-0.0017***	-0.0011***	-0.0009***	-0.0006***	-0.0004***	-0.0004***	-0.0031	-0.0040**	-0.0026***	-0.0020***	-0.0015***	-0.0012***	-0.0009*
	(-1.65)	(-2.84)	(-3.20)	(-3.33)	(-3.49)	(-3.58)	(-3.61)	(-0.75)	(-2.51)	(-2.99)	(-3.04)	(-2.84)	(-2.64)	(-1.91)
β	0.0086*	0.0032***	0.0022***	0.0016***	0.0010***	0.0007***	0.0006***	0.0121	0.0066**	0.0050***	0.0039***	0.0026***	0.0022**	0.0018**
	(1.76)	(2.65)	(2.76)	(3.07)	(3.60)	(3.99)	(4.21)	(1.16)	(2.24)	(3.50)	(4.75)	(3.94)	(2.06)	(2.42)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.195	0.243	0.308	0.300	0.272	0.267	0.280	0.087	0.161	0.274	0.305	0.230	0.205	0.148
Adj. R^2	0.186	0.234	0.300	0.291	0.263	0.259	0.271	0.0760	0.151	0.265	0.297	0.221	0.196	0.138
Panel C: ΔRV														
α	-0.0005	0.0000	-0.0000	-0.0001	-0.0000	-0.0000	-0.0000	-0.0011*	-0.0002	-0.0001	-0.0002**	-0.0001*	-0.0000	-0.0000
	(-0.62)	(0.07)	(-0.34)	(-1.34)	(-1.11)	(-0.66)	(-0.71)	(-1.80)	(-0.75)	(-1.18)	(-2.36)	(-1.86)	(-1.34)	(-1.45)
β	0.0041	0.0010	0.0004	0.0003	0.0002	0.0001	0.0001	0.0016	0.0004	0.0002	0.0002	0.0001	0.0001	0.0001
	(0.98)	(0.84)	(0.87)	(0.80)	(0.82)	(0.87)	(0.96)	(0.88)	(0.69)	(0.86)	(0.76)	(0.81)	(0.88)	(1.04)
obs	85	85	85	85	85	85	85	85	85	85	85	85	85	85
R^2	0.164	0.102	0.134	0.105	0.114	0.126	0.135	0.065	0.036	0.041	0.050	0.057	0.062	0.072
Adj. R^2	0.154	0.0910	0.124	0.0943	0.104	0.115	0.125	0.0537	0.0248	0.0296	0.0387	0.0457	0.0503	0.0608

Table A11: Surprise of Federal Fund Rate on Contractionary and Expansionary Policy: Professional Forecast

The table reports the regression results of Equation (15) which analyze the reactions from ΔIV, ΔRV and ΔVRP depend on contractionary and expansionary policy. The interest shocks is calculated by professional forecasts rather than the 30-day federal fund futures contracts. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, contractionary policy presence days and expansionary policy presence days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the contractionary and expansionary policy, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Maturity	Obs	α	t-stat	α_1	t-stat	β_1	t-stat	α_2	t-stat	β_2	t-stat	Adj. R^2
						ΔVRP						
7	85	-0.0013	(-0.23)	-0.0075	(-0.98)	0.0017	(0.95)	-0.0662***	(-2.99)	0.0125***	(3.79)	0.119
30	85	-0.0041*	(-1.97)	0.0025	(0.80)	-0.0004	(-0.75)	-0.0461***	(-19.35)	0.0058***	(32.85)	0.315
60	85	-0.0024**	(-2.23)	0.0002	(0.09)	0.0003	(0.58)	-0.0360***	(-9.47)	0.0035***	(6.27)	0.477
90	85	-0.0019**	(-2.29)	0.0012	(0.90)	0.0001	(0.26)	-0.0287***	(-3.07)	0.0001	(0.05)	0.335
180	85	-0.0016**	(-2.27)	0.0009	(0.87)	0.0002	(1.13)	-0.0206***	(-2.96)	-0.0007	(-0.65)	0.248
270	85	-0.0014**	(-2.44)	0.0012	(1.66)	0.0001	(1.24)	-0.0177**	(-2.05)	-0.0018	(-1.38)	0.214
360	85	-0.0010*	(-1.80)	0.0012	(1.04)	0.0000	(0.05)	-0.0148**	(-2.52)	-0.0014	(-1.55)	0.179
						ΔIV						
7	85	-0.0017	(-0.27)	-0.0047	(-0.62)	0.0014	(1.00)	-0.0928**	(-2.17)	0.0240***	(3.66)	0.268
30	85	-0.0040*	(-1.82)	0.0027	(0.94)	0.0005	(0.97)	-0.0515***	(-8.84)	0.0087***	(10.44)	0.402
60	85	-0.0024**	(-2.12)	0.0003	(0.12)	0.0004	(0.80)	-0.0387***	(-24.61)	0.0048***	(28.14)	0.533
90	85	-0.0021**	(-2.33)	0.0012	(0.90)	0.0002	(0.70)	-0.0311***	(-4.46)	0.0014	(1.33)	0.417
180	85	-0.0016**	(-2.28)	0.0010	(0.89)	0.0002	(1.05)	-0.0217***	(-3.76)	-0.0000	(-0.04)	0.298
270	85	-0.0014**	(-2.40)	0.0012	(1.63)	0.0001	(1.31)	-0.0182**	(-2.27)	-0.0013	(-1.09)	0.228
360	85	-0.0010*	(-1.79)	0.0012	(1.04)	0.0000	(0.09)	-0.0154***	(-2.86)	-0.0010	(-1.22)	0.198
						ΔRV						
7	85	-0.0004	(-0.54)	0.0027	(1.38)	-0.0003	(-0.51)	-0.0266	(-1.27)	0.0115***	(3.54)	0.714
30	85	0.0001	(0.31)	0.0002	(0.23)	0.0009***	(9.91)	-0.0054	(-0.83)	0.0029***	(2.87)	0.377
60	85	0.0000	(0.18)	0.0001	(0.52)	0.0001***	(6.07)	-0.0027	(-1.08)	0.0013***	(3.20)	0.606
90	85	-0.0002*	(-1.75)	0.0001	(0.46)	0.0001***	(4.77)	-0.0024	(-1.00)	0.0013***	(3.61)	0.674
180	85	-0.0000	(-1.11)	0.0001	(0.55)	0.0000	(0.29)	-0.0012	(-0.98)	0.0007***	(3.66)	0.682
270	85	-0.0000	(-0.26)	0.0000	(0.17)	0.0000*	(1.80)	-0.0005	(-0.79)	0.0005***	(4.97)	0.725
360	85	-0.0000	(-0.28)	0.0000	(0.26)	0.0000	(1.37)	-0.0006	(-1.24)	0.0004***	(5.09)	0.697

Table A12: Asymmetric Reaction to Positive and Negative Surprise: Professional Forecast

The table reports the regression results of Equation (15) which analyzes the reactions from ΔIV, ΔRV and ΔVRP to positive and negative federal fund rate surprise. The interest shocks is calculated by professional forecasts rather than the 30-day federal fund futures contracts. It provides the intercept, slope and adjusted R^2 and obs represents for the number of observation. The coefficients α, α_1 and α_2 represent the effect of no surprises days, positive surprise days and negative surprise days, respectively. The coefficients β_1 and β_2 estimate the response to strength of the positive and negative surprise, respectively. All standard errors are adjusted following White (1980) with robust t-statistics in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

maturity	Obs	α	t-stat	α_1	t-stat	β_1	t-stat	α_2	t-stat	β_2	t-stat	Adj. R^2
						ΔVRP						
7	85	-0.0048	(-0.92)	-0.0124	(-0.63)	0.0392	(0.82)	-0.0169	(-0.91)	0.0097	(1.28)	0.072
30	85	-0.0038*	(-1.70)	0.0014	(0.38)	-0.0063*	(-1.93)	-0.0035	(-0.46)	0.0099***	(3.22)	0.198
60	85	-0.0023*	(-1.93)	0.0001	(0.05)	-0.0035	(-1.28)	-0.0024	(-0.52)	0.0078***	(4.29)	0.358
90	85	-0.0019**	(-2.06)	0.0015	(0.74)	-0.0033	(-1.06)	0.0018	(1.13)	0.0065***	(32.73)	0.387
180	85	-0.0015**	(-2.00)	0.0009	(0.54)	-0.0022	(-0.98)	0.0014	(0.99)	0.0043***	(13.69)	0.279
270	85	-0.0014**	(-2.23)	0.0015	(1.26)	-0.0020	(-0.99)	0.0028	(1.17)	0.0038***	(4.28)	0.248
360	85	-0.0010*	(-1.67)	0.0017	(1.13)	-0.0018	(-0.97)	0.0014	(0.79)	0.0028***	(4.76)	0.175
						ΔIV						
7	85	-0.0053	(-0.92)	-0.0105	(-0.55)	0.0384	(0.81)	-0.0307	(-0.94)	0.0139	(1.01)	0.096
30	85	-0.0041*	(-1.70)	0.0028	(0.80)	-0.0042**	(-2.27)	-0.0072	(-0.64)	0.0105**	(2.22)	0.192
60	85	-0.0023*	(-1.88)	0.0004	(0.13)	-0.0032	(-1.13)	-0.0039	(-0.65)	0.0081***	(3.25)	0.345
90	85	-0.0020**	(-2.06)	0.0016	(0.78)	-0.0037	(-1.33)	0.0003	(0.12)	0.0069***	(9.44)	0.397
180	85	-0.0016**	(-2.00)	0.0009	(0.53)	-0.0023	(-1.05)	0.0008	(0.59)	0.0045***	(24.11)	0.301
270	85	-0.0014**	(-2.18)	0.0015	(1.26)	-0.0021	(-1.07)	0.0023	(1.16)	0.0039***	(5.93)	0.278
360	85	-0.0010	(-1.63)	0.0017	(1.14)	-0.0020	(-1.09)	0.0010	(0.67)	0.0030***	(7.08)	0.203
						ΔRV						
7	85	-0.0005	(-0.73)	0.0019	(0.73)	-0.0008	(-0.21)	-0.0137	(-0.95)	0.0042	(0.67)	0.144
30	85	-0.0003	(-1.02)	0.0013	(0.98)	0.0021	(0.60)	-0.0037	(-0.97)	0.0005	(0.33)	0.087
60	85	-0.0000	(-0.47)	0.0002	(1.06)	0.0002	(0.50)	-0.0016	(-0.96)	0.0004	(0.53)	0.106
90	85	-0.0001	(-1.41)	0.0001	(0.50)	-0.0005	(-1.41)	-0.0015	(-0.92)	0.0004	(0.58)	0.116
180	85	-0.0000	(-1.07)	-0.0000	(-0.17)	-0.0001	(-0.61)	-0.0006	(-0.74)	0.0002	(0.62)	0.098
270	85	0.0000	(0.18)	0.0000	(0.15)	-0.0001**	(-2.17)	-0.0005	(-0.96)	0.0001	(0.65)	0.136
360	85	0.0000	(0.33)	0.0000	(0.11)	-0.0002	(-1.40)	-0.0004	(-0.96)	0.0001	(0.81)	0.172