Tail Risk around FOMC Announcements*

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Abstract

Predictive regressions of returns on (abnormal) option-implied moments measured before pre-scheduled FOMC meetings show that tail risks play an important role in understanding the market risk premium around FOMC announcement days. While volatility predicts the pre-FOMC drift and the announcement day market returns, skewness and kurtosis, which capture investors' expectation of the tails of the return distribution, robustly predict post-FOMC returns both in-sample and out-of-sample. The predictability lasts up to one week and is stronger when the monetary policy shock is expansionary or when the FOMC announcement is not accompanied by a press conference. The tail risks are embedded in pre-FOMC out-of-the-money put prices used by investors to hedge against adverse states of the economy.

Keywords: FOMC Announcements, Tail Risk, Options, Market Risk Premium
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1 Introduction

Federal Open Market Committee (FOMC) announcements are among the most important events in financial markets. With these announcements, the Federal Reserve not only announces its decision on the target interest rate, it also reveals information about the state of the economy. Given the forward-looking nature of options, several studies have used option-implied information to study the pre-FOMC announcement drift and announcement day returns. For instance, Hu et al. (2022) examine the VIX and demonstrate that the risk premium surrounding FOMC announcements is due to the resolution of uncertainty. Liu et al. (2022) recover the risk premia for each FOMC announcement from option prices.

In this paper, we show that option-implied tail risk plays an important role in understanding market risk premiums around FOMC announcements. Higher tail risk before prescheduled FOMC meetings predicts higher post-announcement returns. This predictability lasts up to one week after the FOMC announcements. Our study of post-FOMC announcement returns complements existing studies on risk and associated risk premiums around FOMC announcements, since the existing literature focuses on the pre-announcement drift and announcement day returns instead.[1] Our paper also provides crucial evidence that tail risk is priced before FOMC meetings and tail risk is associated with the outlook of the economy revealed by the Federal Reserve.

Here are two typical examples illustrating the relation between tail risk and FOMC announcements: one is for elevated tail risk and the other is for decreased tail risk. The first example is the FOMC announcement on August 9, 2011. The tail risk we measured on August

[1] A few exceptions include Boguth et al. (2023) who use liquidity demands following the FOMC announcements to explain post-FOMC return reversals, and Ai et al. (2022) who measure the informativeness of FOMC announcements based on option-implied variance and link the informativeness with FOMC announcement-day and post-announcement returns. We, however, focus on how the ex-ante tail risk predicts both the pre-FOMC announcement drift and the post-FOMC announcement returns.

5, 2011 (two business days before the announcement) for the upcoming FOMC announcement is 61.28% higher than other FOMC announcements. The Fed stated that "Information received since the Federal Open Market Committee met in June indicates that *economic growth so far this year has been considerably slower than the Committee had expected*" in the FOMC announcement. Committee members' discussions about the state of the economy reported in the minutes show that: "*The information on economic activity received since the June FOMC meeting was weaker than the staff had anticipated, and the projection for real GDP growth in the second half of 2011 and in 2012 was marked down notably*".

The other example is the FOMC announcement on August 24, 1999. The tail risk we measured on August 20, 1999, for the upcoming FOMC announcement is lower than other FOMC announcements. Committee members' discussions about the economic outlook reported in the minutes show that "*The information reviewed at this meeting suggested that expansion of economic activity remained solid*", and "*with regard to the outlook for key sectors of the economy, members referred to the favorable prospects for continued robust growth in employment and incomes that likely would sustain appreciable further expansion in consumer expenditures*". Since our tail risk measure is associated with the state of the economy revealed by the Fed on the announcement days, we examine the market risk premium associated with the tail risk around the FOMC announcements.[2]

We make three contributions to the literature. First, we directly construct a measure of market-level tail risk before each pre-scheduled FOMC announcement based on model-free option-implied moments. Since skewness and kurtosis capture the distribution of extreme outcomes of stock market returns, we use the relative changes in skewness (and kurtosis) to measure the tail risk. Decreases in skewness relative to its historical level mean that the left

[2]More examples of excerpted FOMC statements and minutes are documented in Appendix Table A.1.

tail of the market return distribution thickens, indicating a higher tail risk. To ensure that the option-implied tail risk is exclusively associated with the upcoming FOMC announcements, we rely on 7 days-to-maturity option-implied moments before the FOMC days. We compute skewness and kurtosis two days before each FOMC announcement and measure them in deviations from their historical levels. We call these measures abnormal skewness and kurtosis. We measure these abnormal moments two days before the FOMC announcements so we can use them to forecast *both* the pre-FOMC drift and post-FOMC returns without look-ahead bias. When option-implied skewness (kurtosis) decreases (increases) compared to its historical level, investors expect a higher tail risk or a higher probability of an adverse state of the economy associated with the upcoming FOMC announcement and therefore demand a higher market risk premium. We find that the abnormal skewness (kurtosis) before pre-scheduled FOMC announcements is 1.80 (1.59) times lower (higher) than the same measure on non-FOMC days, indicating a high level of tail risk before the FOMC announcement days.[3]

Second, we estimate the association between tail risk and risk premia surrounding FOMC announcements. We use the abnormal option-implied moments to predict market excess returns. We confirm the finding in the existing literature that abnormal volatility can significantly predict the pre-FOMC drift and FOMC announcement day returns (e.g., Ai et al. (2022)). Abnormal skewness and kurtosis, on the other hand, robustly predict post-FOMC market return up to one week in-sample and out-of-sample. Abnormal skewness (kurtosis) has a strong negative (positive) relation with subsequent returns following FOMC announcements with an adjusted R-squared up to 13% (12%). Abnormal skewness (kurtosis) continues to predict market returns after we control for abnormal volatility, changes in the economic

[3]We define non-FOMC days as those business days without a pre-scheduled FOMC announcement. We also exclude those business days one- and two-day before the FOMC announcement.

policy uncertainty (EPU), the CBOE volatility index (VIX), and changes in the Aruoba-Diebold-Scotti (ADS) business conditions index.

We next differentiate the FOMC meetings based on the monetary policy shocks (MPS) following Nakamura and Steinsson (2018), who construct a composite measure of policy news shocks surrounding the 30-minute FOMC announcement windows using a basket of five interest rates futures. According to the "Fed information channel", the FOMC announcement reveals the monetary authority's private information about the state of the economy. An expansionary monetary policy shock, evidenced by a surprise decrease in interest rates relative to market expectations, signals that the Federal Reserve is worried about lower future economic growth and is associated with negative revisions of private sectors' forecasts of future economic growth.

We find that higher tail risk before the FOMC announcement days is associated with a higher probability of expansionary monetary shocks, which are the pessimistic signals to the market from the Fed. We further find that abnormal skewness (kurtosis) predicts post-FOMC returns only after the expansionary policy shocks. This finding holds if we use shocks from federal fund rates: abnormal skewness (kurtosis) has a stronger predictive power of post-FOMC returns when the federal fund rate shock is expansionary compared to when it is contractionary. This suggests that tail risk matters more when the economic outlook revealed by the FOMC announcements is weaker than when the outlook is stronger, based on the information content of the monetary policy. The strong impact of tail risk on market returns after the expansionary policy shocks is consistent with the findings of Neuhierl and Weber (2021), who document that market returns continue to drift following an expansionary monetary surprise.

Between 2011 to 2018, the Federal Reserve held a press conference (PC) following some, but not all, FOMC announcements.[4] These PCs were scheduled at least six months before the FOMC announcements, and the schedule does not depend on macroeconomic conditions. The existing literature finds that the information environment is less transparent on days without a PC than on days with a PC (Boguth et al. (2019)). When separating FOMC meetings with a PC from meetings without a PC, we find that the predictability of tail risk is stronger for those announcements without a PC. The predictability of tail risk decreases with monetary policy transparency when the FOMC days are followed by a PC.

Third, we find that following an increase in option-implied tail risk, economic policy uncertainty (EPU) significantly increases, and financial conditions, captured by the Chicago Fed National Financial Conditions Index (NFCI), become significantly tighter around FOMC announcement days. Both indicate a deteriorating state of the real economy. While abnormal skewness (kurtosis) negatively (positively) predicts EPU and its first difference, implied volatility, however, is not significantly correlated with the economic uncertainty after controlling for the tail risk. Higher tail risk also predicts tighter-than-usual financial conditions during the week of the FOMC announcement and the following week. Since uncertain economic policy leads to protracted declines in firm investment and expectations of subsequent weaker economic growth, we interpret these results, along with the tighter financial conditions, as the evidence that tail risk is priced around FOMC announcements because it captures investors' expectations of a more adverse state of the economy.

We find that the role of tail risk is due to the information in OTM puts rather than OTM calls. Skewness inferred from OTM puts captures the tail risk and strongly predicts post-FOMC market risk premium. We also find that the left tail variation from Bollerslev et al. (2015), a measure of market fear, has more predictive power than the right tail variation.

[4] Prior to 2011, FOMC announcements were not accompanied by a PC. After 2018, FOMC announcements are always accompanied by a PC.

This finding is consistent with Wachter and Zhu (2022), who argue that agents learn the probability of an adverse economic state around FOMC announcement days, and therefore demand OTM put options before the FOMC meetings to hedge against those adverse states.

Our paper is related to existing work that studies patterns in market returns around FOMC announcements (e.g., Savor and Wilson (2013); Lucca and Moench (2015); Ai and Bansal (2018); Cieslak et al. (2019); Neuhierl and Weber (2019); Neuhierl and Weber (2021)). Our work is also motivated by the literature that uses option-implied information to study risk premiums associated with FOMC announcements. Amengual and Xiu (2018) and Hu et al. (2022) argue that the FOMC announcement risk premium is due to the resolution of uncertainty by investigating the changes in the VIX. Liu et al. (2022) use option prices just before the event to recover the risk premia for each FOMC announcement. Ai et al. (2023) rely on the dynamics of S&P 500 index options implied volatility to infer investors' preference before FOMC announcements. Our paper differs from these studies because we use option-implied tail risk to predict both pre-FOMC drift and post-FOMC returns. We find that tail risk has differential impacts on the post-FOMC returns depending on the shocks in monetary policy.

We contribute to the literature that shows how higher-order moment risk and tail risk are priced and can predict market returns (e.g., Chang et al. (2013); Bollerslev et al. (2015)). Finally, our results are related to the literature that characterizes and quantifies the real economy's tail risk using index options and studies the contribution of tail risk to the equity premium (e.g., Backus et al. (2011); Schreindorfer (2020); Beason and Schreindorfer (2022)). Our paper also enriches the literature on measuring the aggregate tail risk dynamics based on firm-level information (e.g., Kelly and Jiang (2014)). Our approach allows us to directly measure the tail risk for each upcoming FOMC announcement. We find that tail risk is priced before the FOMC announcement days when the state of the economy is revealed by the Fed. Beckmeyer et al. (2020) argue that left-tail uncertainty is the primary driver of uncertainty dynamics around FOMC announcements, and it predicts future target rate changes. We instead focus on predicting stock market returns using the tail risk measure.

The rest of the paper proceeds as follows. Section 2 introduces the data and methodology for constructing measures of option-implied tail risk before each pre-scheduled FOMC announcement. Section 3 reports on predictive regressions based on the tail risk measures. Section 4 investigates conditions under which the relation between tail risk and post-FOMC returns is stronger, and shows that the tail risk predicts the state of economy around FOMC announcement days. Section 5 reports various robustness results. Section 6 concludes.

2 Data and Methodology

We use daily option prices from OptionMetrics to estimate option-implied moments. The sample period starts on January 04, 1996, the first available day in the data, and ends on December 31, 2021. We also retrieve from OptionMetrics the trading volume, open interest, implied volatility, and the prices of the underlying. OptionMetrics also provides zero bond rates, from which we construct risk-free rates for different maturities. We apply standard filters to the data.[5]

We obtain the S&P 500 index daily return data from CRSP. The FOMC meeting dates are taken from the Federal Reserve's website.[6] The announcement is released on the date when the meeting ends. If the meeting lasts two days, the announcement date is the second day of the meeting. Our sample only includes pre-scheduled FOMC announcements, since

[5]See the Appendix for more details on the data and the filters.

[6]The FOMC meeting dates can be found at `https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm`.

the existing literature has shown that the pre-scheduled meetings convey important macroeconomic information and drive the patterns in stock returns.[7] Our sample period contains 207 pre-scheduled meetings.

We follow the non-parametric method of Bakshi et al. (2003) to estimate the moments from options prices. Bakshi et al. (2003) show that under the martingale pricing measure, the discounted risk-neutral expectations of squared, cubic, and quartic stock returns $R(t,\tau) \equiv \ln[S(t+\tau)] - \ln[S(t)]$ at time t with the forward-looking horizon τ are given by V, W, X:

$$\begin{aligned}
V \equiv E_t^*[R(t,\tau)^2] &= \int_S^\infty \frac{2\left(1-\ln\frac{K}{S}\right)}{K^2} C dK + \int_0^S \frac{2\left(1-\ln\frac{K}{S}\right)}{K^2} P dK \\
W \equiv E_t^*[R(t,\tau)^3] &= \int_S^\infty \frac{6\ln\frac{K}{S} - 3\left(\ln\frac{K}{S}\right)^2}{K^2} C dK + \int_0^S \frac{6\ln\frac{K}{S} - 3\left(\ln\frac{K}{S}\right)^2}{K^2} P dK \qquad (1) \\
X \equiv E_t^*[R(t,\tau)^4] &= \int_S^\infty \frac{12\left(\ln\frac{K}{S}\right)^2 - 4\left(\ln\frac{K}{S}\right)^3}{K^2} C dK + \int_0^S \frac{12\left(\ln\frac{K}{S}\right)^2 - 4\left(\ln\frac{K}{S}\right)^3}{K^2} P dK
\end{aligned}$$

where S is the underlying spot price and K is the strike price. The OTM call and put prices are denoted by C and P, respectively, with maturity τ and strike K. Note that the risk-neutral expectations can be viewed as a weighted sum of OTM call and put prices.

Option-implied moments (volatility, skewness, and kurtosis) can be inferred from these risk-neutral expectations. The τ-period risk-neutral (unstandardized) moments are given by:

$$\begin{aligned}
\text{Vol}(t,\tau) &= e^{r\tau}V - \mu^2 \\
\text{Skew}(t,\tau) &= e^{r\tau}W - 3\mu e^{r\tau}V + 2\mu^3 \qquad (2) \\
\text{Kurt}(t,\tau) &= e^{r\tau}X - 4\mu e^{r\tau}W + 6e^{r\tau}\mu^2 V - 3\mu^4
\end{aligned}$$

[7] Savor and Wilson (2013) show that pre-scheduled economic announcements reveal important information about the economy. They also document a significantly positive average market return on pre-scheduled FOMC announcement days and a negative average return on unscheduled FOMC days. Subsequent work focuses on pre-scheduled meetings, see for instance Nakamura and Steinsson (2018), Gertler and Karadi (2015), and Ai et al. (2022).

where r is the risk-free rate and $\mu = e^{r\tau} - 1 - \frac{e^{r\tau}}{2}V - \frac{e^{r\tau}}{6}W - \frac{e^{r\tau}}{24}X$ is the expected return over period τ. The risk-free rate r with maturity τ is linearly interpolated from the OptionMetrics zero-curve data. These moments can be viewed as options traders' estimates of the risk-neutral distribution shape at day t for the market return over the next τ days.

Note that our definition of the option-implied higher moments (skewness and kurtosis) differs from the one in Bakshi et al. (2003), because they define standardized skewness and kurtosis by dividing by the appropriate power of the second moment (volatility). We instead use the unstandardized moments. The unstandardized third and fourth moments make it easier to focus on the specific information inferred from each moment, without being affected by volatility.

Because the days-to-maturity of traded options change over time, and we are interested in fixed days-to-maturity moments, we construct the implied volatility surface (therefore option price surface) on each day by following Seo and Wachter (2019).[8] We set maturity to 7 days, and the moneyness range from 1/3 to 3, from which we back out the price surface of OTM calls and puts. We then calculate option-implied moments using the generated option prices.[9] Following Ai et al. (2022), we choose the 7-day maturity to focus on short windows just before and after each FOMC announcement. This ensures that the moments exclusively incorporate information about the upcoming FOMC while avoiding being contaminated by other macro announcements or events. To capture the tail risk before each FOMC announcement, we construct the abnormal moments as the abnormal change of the moments two days before the FOMC announcement relative to their historical level. For instance, abnormal skewness

[8] At each date in the sample, we regress implied volatilities on a polynomial in strike price K and maturity T: $\sigma(K,T) = \theta_0 + \theta_1 K + \theta_2 K^2 + \theta_3 T + \theta_4 T^2 + \theta_5 KT + \theta_6 KT^2 + \epsilon_{K,T}$. The implied volatility surface is then generated by the fitted values of this regression.

[9] In section 5.6, we provide evidence that our main findings are robust when using several different methods to calculate the 7-day maturity moments.

is constructed as:

$$\text{Abn Skew}(t) = \text{Skew}(t-2) - \text{Median of Historical Skew} \tag{3}$$

where the Historical Skew is proxied by the skewness from day $t-15$ to day $t-8$. We focus on the moments two days before the FOMC because the pre-FOMC drift starts one day before the announcement. This allows us to use this measure to forecast *both* the pre-FOMC drift and post-FOMC returns without any look-ahead bias. We choose the historical window so that neither the previous nor the upcoming FOMC announcement influences the historical moments. Following Ai et al. (2022), we then use the historical median for each announcement. We verified that our results are robust to the use of a more extended estimation historical window, e.g., $t-22$ to $t-8$, and to the use of the mean instead of the median of historical moments.

In addition, we follow Bollerslev et al. (2015) and estimate another tail risk measure implied from options, the left and right jump variations. While our key measure of tail risk discussed above is model-free, this measure requires parametric specifications. We estimate the two parameters that govern tail events in the one-week risk-neutral return distribution: the tail shape $\alpha^{\pm}$ and the level shift $\phi^{\pm}$.[10] The left and right risk neutral jump variation (LJV and RJV, respectively) at time t over the horizon τ is then given by:

$$\begin{aligned} \text{LJV}(t,\tau) &= \tau \phi_t^- e^{\alpha_t^- |k_t|}(\alpha_t^- k_t(\alpha_t^- k_t + 2) + 2)/(\alpha_t^-)^3 \\ \text{RJV}(t,\tau) &= \tau \phi_t^+ e^{\alpha_t^+ |k_t|}(\alpha_t^+ k_t(\alpha_t^+ k_t + 2) + 2)/(\alpha_t^+)^3 \end{aligned} \tag{4}$$

[10]We apply the formulae of equation 3.3 and 3.4 in Bollerslev et al. (2015) to empirically estimate the two parameters. The left tail event is described by α^- and ϕ^-, while the right tail event is described by α^+ and ϕ^+. For this measure, we use traded option prices and do not construct the implied volatility surface.

where k_t is the cutoff for defining large jumps, empirically ten times the implied volatility of at-the-money (ATM) SPX options as in Bollerslev et al. (2015). The jump variation measures describe the magnitude of the quadratic return variations induced by jumps.[11] Consistent with the calculation of option-implied moments, the horizon of the jump measures is seven days. We construct abnormal changes in LJV and RJV using the same approach as the abnormal skewness.

Table 1 presents the correlations between these different measures. Panel A contains the correlations between the levels, while Panel B is the correlations between the abnormal changes. Skewness is highly negatively correlated with kurtosis and negatively correlated with LJV. The negative correlation between skewness and LJV is consistent with the fact that a left-skewed return distribution has a lower (more negative) skewness and a higher left jump variation. Kurtosis is positively correlated with LJV and RJV, which suggests that the tail measures in Bakshi et al. (2003) and Bollerslev et al. (2015) capture similar information. While we use abnormal skewness (kurtosis) as our main measure of tail risk associated with the upcoming FOMC announcement, we investigate LJV and RJV in the robustness exercise. A low abnormal skewness (kurtosis) indicates a high (low) tail risk.

[Insert Table 1 approximately here]

3 Predicting Returns Using Tail Risk Measures

We first measure the average tail risk surrounding the FOMC announcement days and document the time pattern of tail risk in our sample period. We then investigate if tail risk measured before the FOMC announcement can predict post-announcement market returns.

[11] See equation 2.6 in Bollerslev et al. (2015).

3.1 Tail Risk around FOMC announcements

We start by documenting some stylized facts on how higher moments of market returns and jump measures evolve around the day of FOMC announcements. Figure 1 plots the average of option-implied measures of higher moments over a symmetric window that starts five days before the FOMC announcement day and ends five days after. The horizontal axis shows days, where the FOMC announcement day is normalized as day zero (0). The negative days denote the days before the announcement, and the positive days denote the days after the announcement. The vertical axis measures the magnitude of the moments. We plot the sample averages of the 7-day maturity moments as well as the 90% confidence interval at each time point.

The implied volatility in Panel A peaks just before the announcement day and drops after the announcement. This pattern is consistent with the existing literature, which finds that macroeconomic uncertainty increases before this major Fed event and is resolved after the Fed reveals its decisions.[12]

[Insert Figure 1 approximately here]

The pattern in the unstandardized skewness in Panel B differs from the pattern in volatility. Skewness decreases until two days before the announcement, then increases. After the Fed event, the skewness keeps increasing except for a slight drop three days after the announcement. The confidence interval shows that the average skewness is negative at the two local minimums (day -2 and $+3$) with 10% significance, but the first local minimum (day -2) is considerably lower than the second one (day $+3$). Recall that lower (more negative) skewness indicates a more left-skewed return distribution and higher tail risks. We

[12]See for instance Hu et al. (2022) and Ai et al. (2022).

observe that tail risk is elevated two days before the announcement and continues to decrease after the announcement. This pattern of tail risk also motivates us to measure the announcement-specific tail risk two days before the announcement and study how the tail risk predicts post-announcement market risk premium.

Panel C shows that unstandardized kurtosis also provides additional information beyond the volatility measure. Kurtosis is high before the event, then drops on the announcement day and continues the downward trend. Higher kurtosis is associated with a more fat-tailed return distribution. The patterns in kurtosis confirm our observations based on skewness that tail risk is elevated a couple of days before FOMC announcements.

We also estimate the tail risk measures proposed by Bollerslev et al. (2015). We use the left jump variation (LJV) and right jump variation (RJV) to measure the risk of extreme downward and upward tail events. We once again report the time-series averages of these tail risk measures around the FOMC announcements, using the same setup and windows as in Figure 1.

[Insert Figure 2 approximately here]

Figure 2 reports the results. Consistent with the conclusions from Figure 1, the seven-day forward-looking LJV is higher before the announcement date and lower on the announcement day. This confirms a high level of tail risk before the announcement. The patterns in RJV strongly differ from those in LJV. The high RJV on the announcement day might reflect the expectation of announcement premiums documented in the existing literature. Overall, these tail risk measures support the observation that (left) tail risk is elevated before the FOMC announcement, but the parametric tail risk measure of Bollerslev et al. (2015) is much noisier than our model-free approach.

3.2 Predicting Post-FOMC Announcement Stock Market Returns

We now investigate if tail risk before the FOMC announcement commands the theoretically expected risk premiums. If tail risk rises before the FOMC announcement, investors should require a higher risk premium as compensation. To investigate this hypothesis, we use the following univariate regression framework:

$$R(1,s) = \alpha + \beta \mathrm{Abn}(M) + \epsilon \tag{5}$$

where $R(1,s)$ is the cumulative post-FOMC excess market returns from day 1 to day s after the FOMC announcement. We compute the cumulative returns starting on day 1 to distinguish our study from the existing literature, which examines the pre-announcement drift and the announcement day return (Hu et al., 2022). We use the S&P 500 index return in excess of the risk-free rate as the proxy for the market return.[13] The predictor $\mathrm{Abn}(M)$ is the abnormal change in option-implied moments (volatility, skewness, or kurtosis) relative to their historical levels. We discuss the computation of this abnormal change in the option-implied moments in detail in Section 2. The predictor is estimated at day -2, two days before each upcoming FOMC announcement.

Table 2 presents the results of predicting the post-announcement cumulative returns using option-implied moments in these univariate regressions, for up to seven days. Panel A indicates some predictive power of abnormal volatility for cumulative returns up to day 2 and day 4, but volatility does not have predictive power for most days. This is consistent with the notion that the total uncertainty is resolved after the Fed announcement (Hu et al., 2022).

[13] The S&P 500 index is non-tradeable, but the results are similar if we use the SPY.

[Insert Table 2 approximately here]

Panel B shows that unstandardized skewness strongly negatively predicts future market returns. For future days up to day 7, abnormal skewness negatively predicts post-announcement returns. Lower (more negative) abnormal skewness before the announcement, which indicates a higher level of tail risk, predicts higher returns after the announcement. The negative sign is consistent with a negative price of skewness, reflecting that higher positive skewness is beneficial to investors, who are, therefore, willing to accept a lower return. Alternatively, a decrease in negative skewness (higher tail risk) is detrimental to investors, who therefore demand a higher return. The predictability is significant at a 1% level for days 2, 3, 4, and 5. The predictability is somewhat weaker statistically for the other days. The persistence of this effect indicates that investors' fear of an extreme downside shock is reflected in returns for a long period after the announcement. From an economic perspective, the adjusted R-squared of the predictive regressions is high, ranging from 2.4% to 13.0% after one week of the announcement. Tail risks contribute substantially to return variation following FOMC announcements.

Panel C presents the results of the predictive regression for unstandardized kurtosis. Up to day 7, abnormal kurtosis is positively correlated with post-announcement returns, indicating that investors require higher compensation for fatter tails. Kurtosis has more predictive power than volatility and affects prices more after the announcement, again suggesting that it is the tail risk that is priced in market returns after FOMC announcements.

One potential criticism of the univariate predictive regressions is that the predictive power of the third and the fourth moments may be correlated with the information in the second moment, especially because we use unstandardized moments. To address the concerns, we run the following bivariate regressions:

$$R(1, s) = \alpha + \beta \text{Abn}(M) + \gamma \text{Abn}(Vol) + \epsilon \tag{6}$$

where Abn(M) now represents either abnormal skewness or kurtosis, while controlling for abnormal volatility. All predictors are once again measured two days before the FOMC announcement. Panel A of Table 3 reports the results for skewness, and Panel B for kurtosis. Compared to the univariate regressions in Table 2, the predictive power of the higher moments barely changes. Both t-statistics and the adjusted R-squared are comparable for the two tables. The coefficients of abnormal volatility are not significant anymore with the presence of tail risks. We conclude that tail risks have strong predictive power for post-announcement market returns even after controlling for the information contained in volatility.

[Insert Table 3 approximately here]

We also investigate if the tail risks are priced in the pre-announcement drift. we run the predictive regressions using the cumulative return from day -1 to day 0. Appendix Table A.2 reports the results. Abnormal volatility positively predicts market returns, consistent with the existing literature on the resolution of uncertainty on FOMC announcement days. Abnormal skewness and kurtosis are also related to the pre-announcement drift with the expected sign. However, when we use other methods to calculate the 7-day skewness and kurtosis, which involve either interpolation or extrapolation as the 7-day maturity option is not always available, this result is not very robust. Therefore, we cannot claim that tail risk predicts the pre-announcement drift.

4 The Drivers of Return Predictability

We analyze several channels that drive the magnitude of the relation between tail risk and post-announcement returns. We first investigate the differences between announcements with contractionary and expansionary monetary policy shocks. Then we investigate the impact of press conferences by the Fed's chairperson on the relation between tail risk and post-announcement returns. Next, we show that the option-implied tail risks around FOMC announcements are related to the state of the economy. Finally, we show that the information in tail risks is primarily contained in the OTM puts instead of OTM calls.

4.1 Monetary Policy Shocks

Our results suggest a relation between monetary shocks and post-announcement returns. If higher post-announcement returns are compensation for higher tail risk, it is plausible that such predictability would be driven by meetings that provide pessimistic signals to the market. Investors tend to be more frightened when the Fed implements a monetary policy that signals adverse future economic conditions. Nakamura and Steinsson (2018) argue that a surprise decreases in interest rates or an expansionary surprise signals the Fed's private information about lower future economic growth. Such unexpected rate decreases are associated with negative revisions of the private sector's forecasts of future economic growth. Market participants fear imminent downside interest rate surprises following FOMC meetings and require a higher premium for the associated tail risk.

To test this conjecture, we differentiate the FOMC announcements in our sample into announcements with expansionary and contractionary monetary policy shocks based on Nakamura and Steinsson (2018) and Acosta and Saia (2020). Monetary policy shocks are inferred from a basket of interest rates in a 30-minute window around the FOMC announcement.[14] Table 4 reports the results of univariate predictive regressions using only meetings with expansionary or contractionary monetary policy shocks. Panels A and B show that the negative predictive effect of abnormal skewness on future returns is mainly driven by the announcements with expansionary monetary shocks, although the sign is negative for both types of meetings. Similarly, Panels C and D show that the positive predictive power of kurtosis is largely due to meetings with expansionary policy shocks, although the loadings are positive for both types of meetings. The importance of FOMC meetings with expansionary monetary policy shocks is confirmed in multivariate regressions (not reported in the paper). These results confirm our conjecture that the predictability is due to compensation for tail risks and that the predictability is stronger when the probability of an adverse state of the economy is high.

[Insert Table 4 approximately here]

Neuhierl and Weber (2021) document a stronger post-FOMC drift after an expansionary monetary shock than after a contractionary shock. They define the expansionary monetary policy announcement as an announcement with a rate decision lower than the futures-implied expectation. To relate our results to their findings, we differentiate the announcements by classifying Federal Fund Rate (FFR) shocks as either negative, positive, or zero. This classification identifies meetings with rate decisions that are lower, higher, or the same as the futures-implied expectations. Appendix Table A.3 documents the results of univariate regressions for these different scenarios. Meetings with negative or expansionary FFR shocks

[14]The shock is constructed as the first principal component of the changes of the basket, of five interest rates derivatives: the federal funds rate over the remainder of the month in which the FOMC meeting occurs, the federal funds rate at the time of the next scheduled FOMC meeting, and the price of three Eurodollar futures at the time of the FOMC announcements at horizons of 2, 3, and 4 quarters.

are associated with the strongest negative predictive ability of skewness. Appendix Table A.4 also shows that the predictive ability of kurtosis is strongest for meetings with negative or expansionary FFR shocks. These findings suggest that the post-FOMC drift documented by Neuhierl and Weber (2021) might be related to high tail risk premiums associated with announcements with expansionary monetary policy shocks.

It is also interesting to explore whether the option-implied tail risk can predict monetary policy shocks and, therefore, the state of the economy on announcement days. We apply a Probit model and regress the probability of expansionary policy shocks or FFR shocks on the abnormal moments before the announcement. The results are documented in Appendix Table A.5. We observe a significant negative (positive) relationship between skewness (kurtosis) and the probability of expansionary shocks, suggesting that higher tail risks before the announcements are associated with a higher likelihood of pessimistic signals to the market from the Fed, as indicated in monetary policy shocks or FFR shocks.

4.2 The Role of the Fed Chair's Press Conferences

In an effort to increase transparency, the chairperson of the Federal Reserve held a press conference (PC) following some, but not all, FOMC announcements in the 2011-2018 period. The existing literature has established that the pre-announcement drift is more significant on days with a PC and attributes this to the fact that uncertainty is further reduced through the release of additional information.[15] This difference between PC and non-PC days may be relevant for the pricing of tail risk. Investors may demand a higher tail risk premium when the economic outlook is more opaque if the FOMC meeting has no PC. To test our hypothesis, we repeat the predictive regressions using samples of announcement days with

[15] See Lucca and Moench (2018) and Boguth et al. (2019).

and without a PC.

Table 5 presents the results. The comparison of Panels A and B shows that the negative predictive power of skewness on post-announcement returns is stronger for FOMC meetings without a PC. Similarly, Panels C and D show a stronger positive predictive power of kurtosis on FOMC meetings without a PC. Consistent with our prior, tail risk is priced more significantly for FOMC meetings without a PC, when less macroeconomic information is conveyed.

[Insert Table 5 approximately here]

4.3 Tail Risk and State of Economy

We next investigate whether option-implied tail risk captures the state of the economy around FOMC announcements. We first employ the daily composite economic policy uncertainty (EPU) index proposed by Baker et al. (2016) to proxy for the uncertainty associated with the broad implementation of economic policy. The index is constructed from three types of underlying components: news coverage about policy-related economic uncertainty, tax code expiration data, and economic forecaster disagreement from the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters.

Table 6 relates the abnormal option-implied moments two days before the FOMC announcements to EPU on the announcement days in Panel A (and its first difference in Panel B). Abnormal skewness negatively predicts the uncertainty of economic policy, as well as its daily change on FOMC announcement days. Abnormal kurtosis is positively correlated with policy uncertainty. Higher tail risk predicts higher economic policy uncertainty on FOMC announcement days. Implied volatility, however, is not significantly correlated with this uncertainty measure and its daily change after controlling for tail risk. Since a high economic policy uncertainty leads to protracted declines in firm investment and expectations of subsequent weaker economic growth, we interpret these results as a shred of evidence that tail risk is priced before FOMC announcements because it captures investors' expectations of a more adverse state of the economy.

[Insert Table 6 approximately here]

We second rely on the weekly NFCI to capture the state of the economy around FOMC announcements. The Chicago Fed publishes NFCI on every Wednesday and provides a comprehensive update on U.S. financial conditions in money markets, debt, and equity markets, and the traditional and "shadow" banking systems. A positive value of the NFCI indicates a tighter-than-average financial condition. We use the abnormal volatility, skewness, and kurtosis before each FOMC announcement to predict the NFCI during the week of FOMC announcements and the week afterward. Table 7 reports the results of regressing the NFCI on abnormal option-implied moments. Panel A (B) presents the results of NFCI in the same (next) week of FOMC announcements. Higher tail risk significantly predicts tighter financial conditions during the FOMC announcement week and the week after with adjusted R-squared around 5% to 7%. Abnormal volatility, on the other hand, has no predictive power. We also find that tail risk predicts the adjusted NFCI (ANFCI) in the same way as NFCI (See Appendix Table A.6). ANFCI isolates the component of financial conditions uncorrelated with economic conditions to provide an update on financial conditions relative to current economic conditions.

[Insert Table 7 approximately here]

Overall, higher tail risk before the FOMC announcements suggests that economy-wide uncertainty increases on FOMC announcement days, and the aggregate financial condition becomes tighter than usual. These facts provide evidence that option-implied tail risk reflects the state of the real economy around the FOMC announcements.

4.4 The Information in OTM Puts and Calls

Our results on negative skewness suggest that the post-announcement return predictability may be associated with the left tail of the return distribution, which is largely represented by OTM put options.[16] The literature on the pre-announcement drift argues that put options are more closely related to the evolution of uncertainty than call options before the Fed event occurs. For instance, Wachter and Zhu (2022) find that the resolution of uncertainty upon the announcement is mainly reflected in OTM put options prices, which can be explained by investors who seek to insure the risk of future market crashes around the time of the announcement. Similarly, the tail risks that predict the post-announcement returns might be primarily embedded in put option prices.

The original work of Bakshi et al. (2003) does not provide a way to separate put and call implied moments. We investigate the sources of the predictability by splitting up the risk-neutral expectations of squared, cubic, and quartic returns in equation (1) into a component due to OTM puts and the other due to OTM calls. Table 8 reports the results of univariate regressions that use these two separate components as predictors. Panel A confirms the predictive power of skewness from the information in OTM puts. Interestingly, Panel B shows the opposite predictive power of skewness from the information in OTM calls. One possible explanation is that OTM puts capture investors' demand for crash insurance, while OTM calls are more related to investors' preference for positive skewness and lottery gains.

[16] Recall in equation (1), the risk-neutral expectations of squared, cubic, and quartic return can be viewed as a weighted sum of put prices from $0 \leq K \leq S$ and call prices from $K \geq S$. The left tail is related to OTM puts.

Since tail risk is the summation of OTM put and OTM call components, the association between tail risk and risk premia we documented above is due to the information in OTM puts. Multivariate regression results and tail risks estimated from other approaches confirm these results (not reported in the paper).

[Insert Table 8 approximately here]

Also, in unreported results, we find that the predictive power of skewness on EPU, NFCI, and the probability of expansionary policy shocks is driven by the component from OTM puts. The results further support our argument that the information in OTM puts primarily motivates the link between tail risk and risk premia that we previously observed. In contrast, both the OTM put and call elements contribute to such a predictive power of kurtosis. It is expected, given the two-sided nature of kurtosis.

5 Robustness Check

In this section, we provide various robustness checks on our main results, including controlling for other variables which can predict daily equity market returns as documented in the literature, alternative measures of tail risk, recursive out-of-the-sample prediction, and the 7-day skewness calculated by other methods.

5.1 Including Control Variables

To check the robustness of the predictability recorded in the previous section, we consider the following set of control variables: changes in a news-based measure of economic policy uncertainty (EPU) developed by Baker et al. (2016), which captures uncertainty related to economic policies; the CBOE volatility index (VIX); changes in the Aruoba-Diebold-Scotti (ADS) business conditions index to proxy the latent state of macroeconomic activity; and lagged returns up to five lags.[17] Then we run the following multivariate regression:

$$R(1, s) = \alpha + \beta \text{Abn}(M) + \gamma \text{Controls} + \epsilon \tag{7}$$

using the same setup and sample period as in the univariate regressions. Table 9 reports the regression results and shows that the predictive power of the tail risk measures remains robust.

[Insert Table 9 approximately here]

Another potential concern is seasonality. In unreported results, we repeat the predictive regressions with dummies for weekdays and months. The results do not change.

5.2 Alternative Measures of Tail Risk

Table 10 reports results using the LJV and RJV tail measures instead. Panel A reports on left tail risk, and Panel B reports on right tail risk. The left jump variation strongly predicts the cumulative returns up to day 5. The predictive coefficients of the right jump variation are statistically significant for days 6-7, but the adjusted R-squares are mostly negative. Compared to Table 2, LJV and RJV have a lower predictive power than abnormal skewness and kurtosis since the adjusted R-squared is much lower.

[Insert Table 10 approximately here]

[17] The Federal Reserve Bank of Philadelphia publishes the daily data of ADS on: `https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/ads`. We include the VIX level in the control set. Changes in VIX might not be appropriate due to the inclusion of abnormal changes in implied volatility.

5.3 Recursive Regressions

In the predictive regressions, the predictors are inferred two days before the FOMC announcement using option information from that day only, while the returns are measured after the announcement. Our analyses do not have any look-ahead bias. However, we do run a single predictive regression for the entire sample. Here we present results using the recursive method proposed by Campbell and Thompson (2008). We run the predictive regression from the beginning of the sample (January 1996) through period $s-1$, and compute the out-of-the-sample (OOS) R^2. The OOS R^2 is given by

$$\text{OOS } R^2 = 1 - \frac{\sum_{s=1}^{T}(r_s - \hat{r_s})}{\sum_{s=1}^{T}(r_s - \bar{r_s})} \tag{8}$$

where r_s is the return in period s, $\hat{r_s}$ is the fitted value from a predictive regression estimated through period $s-1$, and $\bar{r_s}$ is the historical average return estimated through period $s-1$. A positive OOS R^2 indicates that the predictive regression has a lower average mean-squared prediction error than the benchmark used by Welch and Goyal (2008).

Table 11 presents the results. The OOS starts from 2014. The OOS R^2 associated with abnormal skewness is positive for all horizons up to day 7. For instance, the predictive regression produces an OOS R^2 of 2.88% for the one-week horizon, which is comparable to 2.40% in-sample in Table 2. The R^2 for kurtosis is mostly positive but much lower. For volatility, the R^2s are mostly negative. These results confirm the predictive power of skewness for post-FOMC announcement returns.

[Insert Table 11 approximately here]

5.4 Alternative Day Before FOMC Announcements

We are particularly interested in the moments measured two days before the FOMC meetings for several reasons. First, we follow Ai et al. (2022) to construct the empirical measure of abnormal moment changes. Second, the patterns shown previously in Fig 1 suggest a peak of tail risk (a trough of skewness and a peak of kurtosis) approximately two days before the meetings. Third, measuring the moments two days before the meetings enables us to investigate the moment predictability without looking-ahead bias of the FOMC drifts, which start one day before the meeting. However, there might still be some concerns about the date selection. To address such concerns, we repeat our empirical analysis with the moments measured one day before the FOMC days. The estimation window of the historical moments remains the same.

Appendix Table A.7 demonstrates the regression results with abnormal moments measured one day before the FOMC announcements. Compared with our main results, skewness possesses a significant but weaker predictability of post-announcement returns. Although the predictability of kurtosis is not significant anymore, it is still positively correlated with the returns after the announcements. The results indicate that the predictability of tail risk on post-announcement returns is robust to the day when we measure tail risks before the FOMC meetings.

5.5 Standardized Moments

In the baseline analysis, we employ unstandardized moments to preclude the potential impact of volatility on higher moments. As a robustness check, we explore how the predictability of higher moments changes on post-announcement returns when using standardized moments.

The standardized moments are given by

$$\begin{aligned} \text{Skew}(t,\tau) &= \frac{e^{r\tau}W - 3\mu e^{r\tau}V + 2\mu^3}{(e^{r\tau}V - \mu^2)^{3/2}} \\ \text{Kurt}(t,\tau) &= \frac{e^{r\tau}X - 4\mu e^{r\tau}W + 6e^{r\tau}\mu^2 V - 3\mu^4}{(e^{r\tau}V - \mu^2)^2} \end{aligned} \tag{9}$$

where the risk-neutral expectation of squared, cubic, and quartic stock returns are defined in equation (1). We calculate the abnormal skewness and kurtosis in the same manner as equation (3). We then repeat the univariate regressions with standardized moments and document the results in Appendix Table A.8. The predictability resembles a negative relationship between abnormal skewness and post-announcement returns in Panel A. We also find a positive relationship between abnormal kurtosis and returns after the meetings in Panel B. However, the predictability is weaker than what we record in the baseline results, potentially suggesting some impact from the second moment.

5.6 Alternative Interpolation Methods

We apply a regression-based method in our primary analysis to fit the implied volatility surface from discrete data points by following Seo and Wachter (2019). To show our main results are independent of the fitting technique, we consider several alternative methods to interpolate/extrapolate the moments or to fit the implied volatility surface.

In the first method, we calculate risk-neutral moments in equation (1) using all available traded option data with different maturity and moneyness. To obtain the fixed 7-day maturity moments, we use the Piecewise Cubic Hermite Interpolating Polynomial (PCHIP) method to interpolate the IV surface from moneyness 1/3 to 3 with 0.001 spacing based on the discrete IV points from traded options data. Then we translate the IV surface into the surface of the call and put prices and compute the implied moments for each maturity with available traded options. After this, we apply this method again to extrapolate or interpolate along the maturity to obtain 7-day moments. However, extrapolations to short maturity occasionally cause negative kurtosis. To keep the extrapolated kurtosis meaningful, we set the low bound of kurtosis to zero.

The second method is PCHIP with the last available short maturity options. Extrapolating moments with short maturity might be problematic due to the lack of information on one direction. This problem is more relevant for the early period of our sample when the number of maturity dates is very limited. To mitigate this problem, we retain short maturity options on previous days and include them in the interpolation on the days without short maturity options. In the implementation, we keep the moments inferred from options with a maturity of fewer than seven days on a given day. If there are no such options the next day, we include the old data of moments in the interpolation. If there are new observations of these short-maturity options, we update the short-maturity moments with the new data.

In the third method, we choose the closest surrounding maturities available on the market for a target maturity. We linearly interpolate or extrapolate between traded options for each maturity to estimate volatility metrics at the desired moneyness level. We then apply linear interpolation and extrapolation between the two estimated values to obtain the moments with the required horizon. We follow Hasler and Jeanneret (2022) and employ the Proximal Trilinear Interpolation Technique (PTIT) first to get the IV surface from moneyness 1/3 to 3 with 0.001 spacing. Then we translate the IV surface into the surface of the call and put prices and compute the implied moments for each maturity with available traded options. Finally, we apply this linear method again to obtain seven-day maturity moments.

The fourth method is Modified Akima piecewise cubic Hermite interpolation (MAKIMA).

The Akima algorithm performs cubic interpolation to produce piecewise polynomials with continuous first-order derivatives. The algorithm avoids excessive local undulations. The original Akima algorithm gives equal weight to the points on both sides, evenly dividing an undulation. When two flat regions with different slopes meet, the modification made to the original Akima algorithm gives more weight to the side where the slope is closer to zero. This modification prioritizes the side closer to horizontal, which is more intuitive and avoids overshoot. In particular, whenever there are three or more consecutive collinear points, the algorithm connects them with a straight line, thus avoiding an overshoot. Compared to PCHIP, the Akima algorithm is less aggressively flattened and can still handle oscillatory data.

We repeat the baseline regressions with moments inferred from alternative interpolation methods. The skewness results are displayed in Table 12. Panels A to D reports the results by using the skewness calculated from the above four methods. Although the results are occasionally less significant, they confirm the negative relationship between abnormal option-implied skewness before FOMC announcements and post-announcement returns.

[Insert Table 12 approximately here]

We also redo the analyses for kurtosis and document our findings in Appendix Table A.9. Panels A to D show the results of the four methods described above. The results affirm the positive correlations between abnormal kurtosis and the post-FOMC announcement returns.

6 Conclusion

We investigate the role of option-implied tail risk around FOMC announcements and show that it is essential in understanding the risk premium around announcement days. We document a high level of tail risk before the FOMC announcement days. Tail risk before the FOMC announcements strongly predicts post-announcement returns. The predictability is robust to various methods of estimating the tail risk and predictive model specifications. We conclude that tail risk is priced around the FOMC announcements.

The predictability of post-FOMC returns is stronger for FOMC meetings with expansionary monetary policy shocks and FOMC meetings that are not accompanied by a press conference. We also document a relationship between higher tail risk measures and higher economic uncertainty, and tighter financial conditions around the FOMC announcements. We interpret these results as evidence that tail risk is priced around FOMC announcements because it captures investors' expectations of adverse future states of the economy associated with the FOMC announcements. It would be interesting to further explore how uncertainty risk and tail risk interact around FOMC announcement days and examine their roles in determining risk premiums. We leave this for future research.

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Figure 1: Option-Implied Moments around FOMC Announcement Days

We report 7-day option-implied moments and the 90% confidence bound around pre-scheduled FOMC announcement days, which we normalize as day 0. We use a symmetric 10-day window. We calculate moments using OTM SPX options following Bakshi et al. (2003). The sample period is from Jan 1996 to Dec 2021.

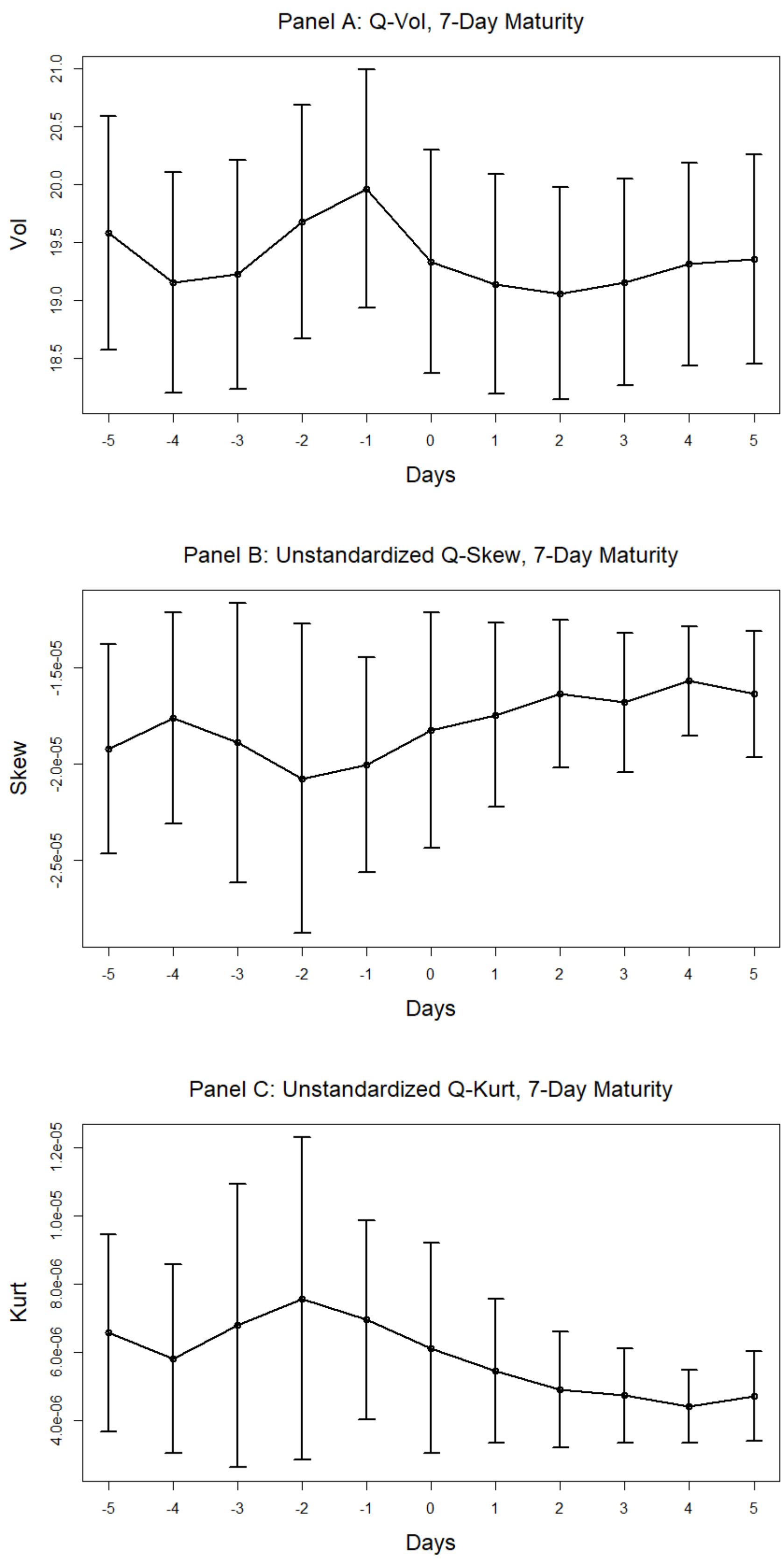

Figure 2: Option-Implied Tail Risk around FOMC Announcement Days

We report 7-day option-implied tail risk measures (Bollerslev et al. (2015)) and the 90% confidence bound around pre-scheduled FOMC announcement days, which we normalize as day 0. We use a symmetric 10-day window. The top (bottom) panel reports the tail risk measures related to large negative (positive) return jump variations. The sample period is from Jan 1996 to Dec 2021.

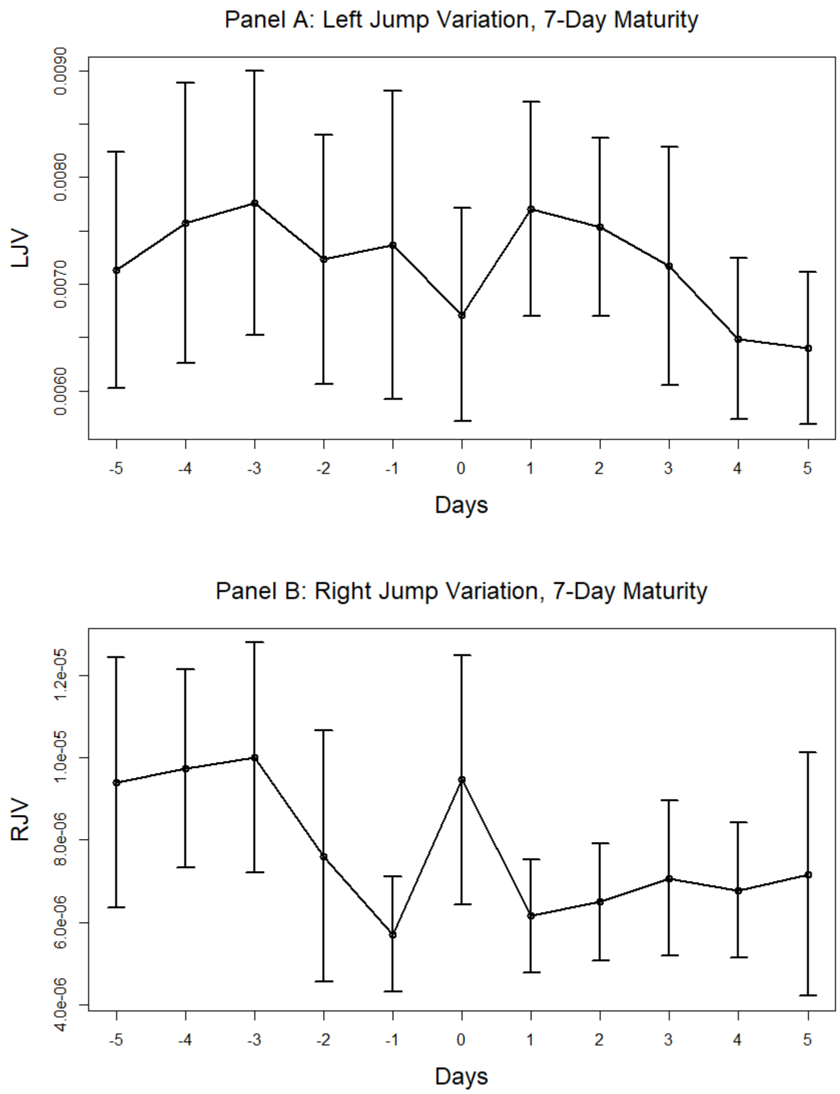

Table 1: Correlation between Option-Implied Moments and Tail Risk Measures

We report correlations between option-implied moments and tail risk measures (Bollerslev et al. (2015)) in Panel A and correlations of abnormal moments and tail risk measures in Panel B. Moments and tail risk measures are computed two days before FOMC announcements. We compute moments with a 7-day maturity. For each FOMC announcement day t, abnormal moments and tail risk are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. The sample period is from Jan 1996 to Dec 2021.

Panel A: Correlations between (Unstandardized) High-Order Moments and Tail Risk Measures

	Vol	Skew	Kurt	LJV	RJV
Vol	1.000				
Skew	−0.731	1.000			
Kurt	0.660	−0.990	1.000		
LJV	0.689	−0.874	0.841	1.000	
RJV	0.026	0.027	−0.020	−0.074	1.000

Panel B: Correlations between Abnormal Changes Between (Unstandardized) High-Order Moments and Tail Risk Measures

	Abn Vol	Abn Skew	Abn Kurt	Abn LJV	Abn RJV
Abn Vol	1.000				
Abn Skew	−0.485	1.000			
Abn Kurt	0.370	−0.982	1.000		
Abn LJV	0.437	−0.746	0.699	1.000	
Abn RJV	0.026	0.009	−0.003	−0.004	1.000

Table 2: Predicting Post-FOMC Announcement Stock Market Returns Using Option-Implied Moments (Univariate Regressions)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1)	(2)	(3)	(4)	(5)	(6)
	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)
Panel A: Abnormal Volatility						
Abn Vol	0.078**	0.075	0.122**	0.069	0.022	−0.016
	(2.11)	(1.53)	(2.30)	(1.32)	(0.47)	(−0.31)
Adj. R^2	0.021	0.014	0.038	0.007	−0.004	−0.004
Panel B: Abnormal Unstandardized Skewness						
Abn Skew	−1.219***	−1.056***	−1.971***	−0.999***	−0.089	−0.398
	(−5.21)	(−4.95)	(−8.93)	(−3.13)	(−0.21)	(−1.39)
Adj. R^2	0.072	0.040	0.130	0.024	−0.005	−0.002
Panel C: Abnormal Unstandardized Kurtosis						
Abn Kurt	2.188***	2.021***	3.703***	1.794***	−0.052	0.633*
	(5.63)	(5.82)	(9.65)	(3.73)	(−0.09)	(1.68)
Adj. R^2	0.061	0.039	0.120	0.020	−0.005	−0.003

Table 3: Predicting Post-FOMC Announcement Stock Market Returns Using Option-Implied Moments (Bivariate Regressions)

We report results from using abnormal skewness (kurtosis) in Panel A (Panel B) to predict cumulative stock market returns seven days after the FOMC announcements while controlling for abnormal volatility. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Abnormal Unstandardized Skewness						
Abn Skew	−1.143***	−0.948***	−1.874***	−0.907***	0.012	−0.614
	(−5.52)	(−4.22)	(−11.23)	(−3.29)	(0.03)	(−1.60)
Abn Vol	0.017	0.024	0.022	0.021	0.023	−0.049
	(0.51)	(0.51)	(0.48)	(0.39)	(0.43)	(−0.85)
Adj. R^2	0.069	0.037	0.127	0.021	−0.009	−0.003
Panel B: Abnormal Unstandardized Kurtosis						
Abn Kurt	1.940***	1.771***	3.363***	1.553***	−0.230	0.856*
	(6.54)	(5.08)	(12.57)	(3.91)	(−0.45)	(1.95)
Abn Vol	0.038	0.038	0.052	0.037	0.027	−0.034
	(1.14)	(0.83)	(1.15)	(0.70)	(0.54)	(−0.62)
Adj. R^2	0.061	0.038	0.123	0.018	−0.008	−0.006

Table 4: Predicting Post-FOMC Announcement Stock Market Returns (Expansionary or Contractionary Monetary Policy Shocks)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. We differentiate monetary policy shocks based on Nakamura and Steinsson (2018) and Acosta and Saia (2020). For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. Monetary policy shock data is from Jan 1996 to Sep 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Expansionary Monetary Policy Shocks and Skewness						
Abn Skew	−1.100***	−1.026***	−1.932***	−0.928***	0.045	−0.407
	(−7.89)	(−4.85)	(−9.98)	(−3.57)	(0.13)	(−1.42)
Adj. R^2	0.149	0.113	0.274	0.054	−0.015	−0.007
Panel B: Contractionary Monetary Policy Shocks and Skewness						
Abn Skew	−1.089	0.136	−1.476	−0.696	−0.401	0.540
	(−0.73)	(0.07)	(−0.74)	(−0.28)	(−0.18)	(0.26)
Adj. R^2	0.000	−0.008	0.003	−0.006	−0.008	−0.007
Panel C: Expansionary Monetary Policy Shocks and Kurtosis						
Abn Kurt	1.876***	1.801***	3.494***	1.590***	−0.285	0.582*
	(11.74)	(7.21)	(13.00)	(4.43)	(−0.65)	(1.73)
Adj. R^2	0.119	0.096	0.251	0.042	−0.014	−0.010
Panel D: Contractionary Monetary Policy Shocks and Kurtosis						
Abn Kurt	6.638	2.862	5.852	3.495	2.261	−1.501
	(1.32)	(0.45)	(0.83)	(0.42)	(0.30)	(−0.20)
Adj. R^2	0.022	−0.004	0.008	−0.004	−0.007	−0.008

Table 5: Predicting Post-FOMC Announcement Stock Market Returns (With or without Press Conference)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. We differentiate FOMC meetings with or without a press conference. Panel A (Panel C) reports the prediction results of skewness (kurtosis) when there is not a press conference following the FOMC meeting, and Panel B (Panel D) reports the prediction results of skewness (kurtosis) when there is a press conference following the FOMC meeting. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Without Press Conference, Skewness						
Abn Skew	-1.897^{***}	-1.329^{***}	-2.698^{***}	-1.568^{***}	-0.956	-1.665^{**}
	(-5.07)	(-3.02)	(-5.08)	(-2.74)	(-1.34)	(-2.50)
Adj. R^2	0.093	0.077	0.159	0.011	0.001	0.035
Panel B: With Press Conference, Skewness						
Abn Skew	-5.458^{***}	-4.961^{*}	-5.328^{***}	-3.383^{*}	-3.685	-5.458
	(-3.17)	(-1.84)	(-3.18)	(-1.74)	(-1.46)	(-1.49)
Adj. R^2	0.117	0.043	0.096	0.036	0.034	-0.037
Panel C: Without Press Conference, Kurtosis						
Abn Kurt	3.409^{***}	2.488^{***}	5.062^{***}	2.923^{***}	1.460	2.995^{**}
	(4.95)	(3.17)	(5.33)	(3.05)	(1.29)	(2.55)
Adj. R^2	0.072	0.072	0.146	0.007	-0.004	0.029
Panel D: With Press Conference, Kurtosis						
Abn Kurt	18.150^{***}	14.260	16.281^{**}	7.887	9.772	16.681
	(3.05)	(1.34)	(2.54)	(1.11)	(1.12)	(1.39)
Adj. R^2	0.109	0.027	0.079	0.021	0.021	-0.049

Table 6: Option-Implied Moments and Economic Policy Uncertainty

We report results from regressing the uncertainty measure (EPU) (or its first difference) on FOMC announcement days on abnormal option-implied moments in Panel A (B). EPU and its first difference ΔEPU are measured on FOMC announcement days and option-implied moments are measured two days before FOMC announcement days. The EPU index is proposed by Baker et al. (2016) to proxy policy-related economic uncertainty. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

Panel A: Level					
	(1)	(2)	(3)	(4)	(5)
	EPU	EPU	EPU	EPU	EPU
Abn Vol	5.640*			4.729	4.880
	(1.88)			(1.53)	(1.60)
Abn Skew		−38.062***		−17.118**	
		(−3.02)		(−2.03)	
Abn Kurt			68.581***		36.478***
			(3.84)		(3.26)
Adj. R^2	0.045	0.022	0.019	0.045	0.046

Panel B: First Difference					
	(1)	(2)	(3)	(4)	(5)
	ΔEPU	ΔEPU	ΔEPU	ΔEPU	ΔEPU
Abn Vol	2.786			2.225	2.332
	(1.48)			(1.09)	(1.19)
Abn Skew		−20.413***		−10.560*	
		(−3.10)		(−1.84)	
Abn Kurt			37.169***		21.830**
			(3.62)		(2.24)
Adj. R^2	0.013	0.006	0.005	0.010	0.011

Table 7: Option-Implied Moments and Financial Conditions

We report results from regressing the weekly Chicago Fed's National Financial Conditions Index (NFCI) on abnormal option-implied moments. Panel A (B) presents the results of NFCI in the same (next) week of FOMC announcements. NFCI is published by the Chicago Fed to provide a comprehensive weekly update on U.S. financial conditions in money markets, debt and equity markets, and the traditional and "shadow" banking systems. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

Panel A: Current Week of FOMC					
	(1)	(2)	(3)	(4)	(5)
	NFCI	NFCI	NFCI	NFCI	NFCI
Abn Vol	0.010			−0.010	−0.005
	(0.82)			(−1.21)	(−0.65)
Abn Skew		−0.328**		−0.371***	
		(−2.57)		(−3.23)	
Abn Kurt			0.694***		0.728***
			(3.27)		(3.82)
Adj. R^2	−0.000	0.054	0.065	0.053	0.062
Panel B: Next Week of FOMC					
	(1)	(2)	(3)	(4)	(5)
	NFCI	NFCI	NFCI	NFCI	NFCI
Abn Vol	0.014			−0.006	−0.001
	(1.10)			(−0.73)	(−0.17)
Abn Skew		−0.350***		−0.377***	
		(−2.89)		(−3.41)	
Abn Kurt			0.731***		0.741***
			(3.63)		(4.06)
Adj. R^2	0.004	0.064	0.074	0.060	0.070

Table 8: Predicting Post-FOMC Announcement Stock Market Returns (Moments Inferred From OTM Put or OTM Call Options)

We report results from using abnormal option-implied moments inferred from OTM put or OTM call options to predict cumulative stock market returns seven days after the FOMC announcements. Panel A (Panel C) reports the prediction results of skewness (kurtosis) inferred from OTM puts, and Panel B (Panel D) reports the prediction results of skewness (kurtosis) inferred from OTM calls. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Abnormal Unstandardized Skewness Inferred from OTM Puts						
Abn Skew	-0.905^{***}	-0.827^{***}	-1.465^{***}	-0.764^{***}	-0.105	-0.248
	(-5.42)	(-5.11)	(-8.76)	(-3.19)	(-0.35)	(-1.17)
Adj. R^2	0.075	0.047	0.135	0.027	-0.004	-0.003
Panel B: Abnormal Unstandardized Skewness Inferred from OTM Calls						
Abn Skew	2.751^{***}	2.896^{***}	4.529^{***}	2.481^{***}	0.513	0.376
	(5.22)	(4.59)	(5.60)	(2.94)	(0.53)	(0.39)
Adj. R^2	0.066	0.056	0.123	0.028	-0.004	-0.004
Panel C: Abnormal Unstandardized Kurtosis Inferred from OTM Puts						
Abn Kurt	2.400^{***}	2.175^{***}	4.061^{***}	1.930^{***}	-0.123	0.702^{*}
	(5.69)	(5.95)	(9.75)	(3.76)	(-0.21)	(1.70)
Adj. R^2	0.059	0.036	0.118	0.019	-0.005	-0.003
Panel D: Abnormal Unstandardized Kurtosis Inferred from OTM Calls						
Abn Kurt	17.038^{***}	17.935^{***}	29.453^{***}	15.423^{***}	1.471	3.979
	(6.36)	(5.98)	(11.39)	(3.95)	(0.29)	(1.05)
Adj. R^2	0.060	0.051	0.125	0.025	-0.005	-0.003

Table 9: Predicting Post-FOMC Announcement Stock Market Returns Using Option-Implied Moments (Including Control Variables)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. In each panel, controlling variables include changes in a news-based measure of economic policy uncertainty (EPU), the CBOE volatility index (VIX), changes in the Aruoba-Diebold-Scotti (ADS) business conditions index, and lagged returns up to five lags. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Abnormal Volatility						
Abn Vol	0.091**	0.097*	0.138**	0.076	0.083	0.052
	(2.45)	(1.82)	(2.15)	(1.03)	(1.14)	(0.71)
Controls	Y	Y	Y	Y	Y	Y
Adj. R^2	0.026	0.055	0.052	−0.011	−0.007	−0.010
Panel B: Abnormal Unstandardized Skewness						
Abn Skew	−1.898***	−1.339***	−2.636***	−1.406***	−0.783	−1.478**
	(−5.55)	(−3.25)	(−5.82)	(−2.73)	(−1.23)	(−2.42)
Controls	Y	Y	Y	Y	Y	Y
Adj. R^2	0.104	0.073	0.147	0.011	−0.009	0.011
Panel C: Abnormal Unstandardized Kurtosis						
Abn Kurt	3.391***	2.444***	4.866***	2.474***	1.007	2.470**
	(5.34)	(3.29)	(6.04)	(2.87)	(1.00)	(2.31)
Controls	Y	Y	Y	Y	Y	Y
Adj. R^2	0.087	0.068	0.132	0.005	−0.014	0.004

Table 10: Predicting Post-FOMC Announcement Stock Market Returns Using Alternative Tail Risk Measures

We report results from using abnormal tail risk measures (Bollerslev et al. (2015)) to predict cumulative stock market returns seven days after the FOMC announcements. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Panel A (B) reports the results of tail risk measures inferred from large negative (positive) return jump variations. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1)	(2)	(3)	(4)	(5)	(6)
	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)
Panel A: Abnormal LJV						
Abn LJV	0.040***	0.044***	0.073***	0.044**	0.024	0.030
	(3.20)	(3.37)	(4.53)	(2.60)	(0.68)	(1.05)
Adj. R^2	0.035	0.032	0.084	0.022	0.002	0.004
Panel B: Abnormal RJV						
Abn RJV	−2.889	−3.113	−3.773*	−4.847	−4.472**	−8.833***
	(−1.06)	(−1.36)	(−1.69)	(−1.51)	(−2.11)	(−3.25)
Adj. R^2	−0.002	−0.003	−0.002	−0.001	−0.002	0.004

Table 11: Out-of-Sample Prediction Results

We report the out-of-sample R^2 statistic for the forecast evaluation period of Jan 2014 to Dec 2021. We first run the predictive regression from the beginning of the sample (Jan 1996) through period $s-1$ and then calculate OOS R^2. We follow Campbell and Thompson (2008) to estimate the OOS R2 given by $1 - \frac{\sum_{s=1}^{T}(r_s - \hat{r_s})}{\sum_{s=1}^{T}(r_s - \bar{r_s})}$, where $\hat{r_s}$ is the fitted value from a predictive regression estimated through period $s-1$ and $\bar{r_s}$ is the historical average return estimated through period $s-1$. Positive OOS R^2 suggests the predictive regression has a lower average mean-squared prediction error than the historical average return proposed by Welch and Goyal (2008).

	(1)	(2)	(3)	(4)	(5)	(6)
Predictor	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)
Abn Vol	0.65%	−2.48%	−3.63%	0.84%	−0.08%	−0.12%
Abn Skew	4.82%	2.19%	5.99%	2.88%	0.02%	0.48%
Abn Kurt	3.76%	1.92%	4.76%	1.94%	−0.11%	0.23%

Table 12: Predicting Post-FOMC Announcement Stock Market Returns with Alternative Calculation Methods (Using Skewness)

We report results from using abnormal option-implied skewness to predict cumulative stock market returns seven days after the FOMC announcements. We apply different calculation methods to infer moments with a seven-day horizon. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1)	(2)	(3)	(4)	(5)	(6)
	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)
Panel A: PCHIP						
Abn Skew	−0.070***	−0.034	−0.095***	−0.114***	−0.095*	−0.101**
	(−3.05)	(−1.37)	(−2.95)	(−2.93)	(−1.86)	(−2.24)
Adj. R^2	0.031	0.002	0.039	0.049	0.028	0.024
Panel B: PCHIP with the Last Available Short-Maturity Options						
Abn Skew	−0.436***	−0.237**	−0.544***	−0.340***	−0.026	−0.077
	(−7.89)	(−2.15)	(−3.90)	(−3.66)	(−0.21)	(−0.61)
Adj. R^2	0.073	0.013	0.077	0.022	−0.005	−0.004
Panel C: PTIT						
Abn Skew	−0.066	−0.033	−0.167**	−0.230***	−0.212**	−0.232***
	(−0.91)	(−0.51)	(−2.15)	(−2.97)	(−2.51)	(−2.86)
Adj. R^2	0.001	−0.004	0.021	0.036	0.026	0.024
Panel D: MAKIMA						
Abn Skew	−0.054***	−0.015	−0.056***	−0.075***	−0.054*	−0.055**
	(−3.58)	(−0.83)	(−2.96)	(−2.73)	(−1.68)	(−2.24)
Adj. R^2	0.030	−0.003	0.020	0.033	0.013	0.010

Appendix

In the appendix, we report the filters we applied for SPX options data, as well as additional tables for various robustness checks.

Filters we applied for SPX options data. We apply the following filters for the data, which are standard methods for data cleaning in the options literature. End-of-day records with apparent errors, such as negative quotes or best bid prices higher than best offer prices, are cleaned. Contracts with unavailable and zero implied volatility are dropped. We focus on OTM options, so we exclude calls with moneyness lower than one and puts with moneyness higher than one, where moneyness is defined as the ratio of strike price over the underlying spot price. Options with zero open interests are usually deemed not to provide information from options traders, so those options are not included in our sample. Finally, we eliminate the observations with zero or negative time value: For call options, the price must be higher than the current price of the underlying minus the strike; For put options, the price cannot be less than the strike price minus the spot price. We are interested in extrapolating options-implied moments to a relatively short horizon; therefore, we retain options with maturities greater than three days.

Table A.1: Examples of Ex-ante Tail Risk and FOMC Announcements

This table reports some examples of FOMC announcements when the ex-ante tail risk is elevated (decreased) in Panel A (B). Along with the tail risk (multiplied by $1e6$) measured two days before the FOMC announcements, we report the post-announcement cumulative market returns (in %), monetary policy shocks (MPS), federal fund rate shocks (FFR), and excerpts from the corresponding FOMC statements and minutes.

FOMC Date	Abn Skew	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)	MPS	FFR	Excerpts from FOMC Statements and Minutes
Panel A: Elevated tail risk before the upcoming FOMC announcements										
11/12/1997	−11.11	2.43	4.38	3.48	4.16	5.72	6.15	−0.0124	−0.0500	
9/24/2002	−2.20	4.34	0.97	−0.52	3.46	1.01	−0.09	0.0052	0.0200	**Statement:** "For the foreseeable future, against the background of its long-run goals of price stability and sustainable economic growth and of the information currently available, the risks are weighted mainly toward conditions that **may generate economic weakness**." **Minute:** "Subsequently, however, a weaker tone to incoming data on production and employment, a gloomier outlook for business profits, and heightening tensions over Iraq seemed to lead investors to **revise down their outlook for the economy**."
10/29/2008	−53.42	4.15	3.88	8.12	2.43	−2.72	0.08	−0.0407	−0.0550	**Statement: "The pace of economic activity appears to have slowed markedly**, owing importantly to a decline in consumer expenditures." **Minute:** "FOMC meeting participants indicated that the worsening financial situation, the slowdown in growth abroad, and incoming information on economic activity had led them to **mark down significantly their outlook for growth**. " "Given the recent intensification and broadening of the global financial crisis, FOMC participants viewed **the outlook for economic growth and employment as having worsened significantly** since June"
11/4/2009	−2.66	2.18	4.45	4.44	4.97	3.89	4.49	−0.0019	−0.0058	
8/9/2011	−5.29	0.01	0.54	2.73	1.73	1.82	−2.72	−0.0076	−0.0070	**Statement:** "Information received since the Federal Open Market Committee met in June indicates that **economic growth so far this year has been considerably slower than the Committee had expected**". **Minute:** "The information on **economic activity received since the June FOMC meeting was weaker than the staff had anticipated, and the projection for real GDP growth** in the second half of 2011 and in 2012 **was marked down notably**. "
3/18/2015	−0.24	0.41	0.23	−0.38	−1.83	−2.06	−1.83	−0.0471	−0.0060	**Statement:** "The Committee anticipates that **it will be appropriate to raise the target range for the federal funds rate when it has seen further improvement in the labor market**." **Minute:** "In the U.S. economic forecast prepared by the staff for the March FOMC meeting, **projected real GDP growth in the first half of this year was lower than in the forecast** prepared for the January meeting."
6/17/2015	−0.24	0.45	1.07	1.13	0.39	0.09	0.05	−0.0265	−0.0058	**Statement:** "The Committee anticipates that **it will be appropriate to raise the target range for the federal funds rate when it has seen further improvement in the labor market**." **Minute:** "**Economic growth** in the second half was projected to be a **little lower than in the projection** prepared for the April meeting."
6/15/2016	−1.18	−0.02	0.56	0.84	0.67	2.01	−1.65	−0.0232	0.0000	

FOMC Date	Abn Skew	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)	MPS	FFR	Excerpts from FOMC Statements and Minutes
Panel B: Decreased tail risk before the upcoming FOMC announcements										
9/29/1998	7.42	−6.01	−4.48	−5.83	−6.22	−7.56	−8.64	0.0310	0.0600	**Minute:** "The information reviewed at this meeting suggested that **economic activity was expanding at a moderate rate**."
2/3/1999	0.94	−2.61	−2.28	−4.47	−3.91	−1.53	−3.43	0.0149	0.0000	**Minute:** "The information reviewed at this meeting suggested that **the economy expanded rapidly** in the closing months of 1998." "In the Committee's discussion of current and prospective economic conditions, members referred to **continuing indications of an exceptional economic performance** that was characterized by the persistence of quite low inflation despite very high and rapidly rising levels of overall output and employment."
8/24/1999	1.56	−0.15	−1.17	−2.97	−3.25	−2.48	−3.38	0.0121	0.0400	**Minute:** "The information reviewed at this meeting suggested that **expansion of economic activity remained solid**." "With regard to the outlook for key sectors of the economy, members referred to **the favorable prospects for continued robust growth** in employment and incomes that likely would sustain appreciable further expansion in consumer expenditures. "
1/31/2001	2.36	−1.25	−0.92	−1.09	−1.94	−2.57	−3.89	0.0035	0.0400	**Minute:** "The prospect that fiscal policy might begin to move in an expansionary direction later in the year was cited as another factor **in the outlook for stronger economic activity**. "
6/23/2010	3.67	−1.40	−1.60	−4.66	−5.62	−5.93	−6.37	0.0121	0.0000	**Statement:** "Information received since the Federal Open Market Committee met in April suggests that the **economic recovery is proceeding** and that the labor market is improving gradually." Minute: "In their discussion of the economic situation and outlook, meeting participants generally saw the incoming data and information received from business contacts as consistent with **a continued, moderate recovery in economic activity**."
12/13/2011	2.07	−0.81	−0.50	−1.66	1.27	1.47	2.31	0.0142	0.0043	**Statement:** "Information received since the Federal Open Market Committee met in November suggests that **the economy has been expanding moderately**, notwithstanding some apparent slowing in global growth." **Minute:** "Regarding the economic outlook, participants continued to anticipate that **economic activity would expand at a moderate rate** in the coming quarters."
9/18/2019	0.54	−0.51	−0.52	−1.37	−0.77	−1.02	−1.56	0.0311	0.0375	**Statement:** "Information received since the Federal Open Market Committee met in July indicates that the labor market remains strong and that **economic activity has been rising at a moderate rate**." **Minute:** "Participants generally viewed **the baseline economic outlook as positive** and indicated that their views of the most likely outcomes for economic activity and inflation had changed little since the July meeting."

Table A.2: Predicting Pre-FOMC Announcement Drift Using Option-Implied Moments

We report results from using option-implied moments to predict the pre-FOMC announcement drift, i.e., market excess returns one day before the FOMC announcement to the announcement day. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1)	(2)	(3)	(4)	(5)
	R(−1,0)	R(−1,0)	R(−1,0)	R(−1,0)	R(−1,0)
Abn Vol	0.071*			−0.005	0.013
	(1.86)			(−0.11)	(0.30)
Abn Skew		−1.404***		−1.426***	
		(−5.14)		(−4.23)	
Abn Kurt			2.869***		2.784***
			(7.81)		(6.66)
Observations	207	207	207	207	207
Adj. R^2	0.019	0.108	0.120	0.104	0.116

Table A.3: Predicting Post-FOMC Announcement Stock Market Returns with Differential Federal Fund Rate Shocks (Using Skewness)

We report results from using abnormal option-implied skewness to predict cumulative stock market returns seven days after the FOMC announcements. We differentiate monetary policy shocks by the sign of Federal Fund Rate shocks (FFR). For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. Monetary policy shock data is from Jan 1996 to Sep 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Negative FFR and Skewness						
Abn Skew	-1.272^{**}	-0.625	-1.807^{***}	-0.889	-0.382	-0.463
	(-2.42)	(-1.20)	(-2.77)	(-1.22)	(-0.48)	(-0.69)
Adj. R^2	0.067	0.077	0.235	0.004	-0.038	0.019
Panel B: Positive FFR and Skewness						
Abn Skew	-3.269^{*}	-0.798	-2.592	-0.172	-1.834	-2.715
	(-1.81)	(-0.34)	(-1.03)	(-0.05)	(-0.64)	(-0.88)
Adj. R^2	0.233	0.223	0.222	0.009	0.044	0.127
Panel C: Zero FFR and Skewness						
Abn Skew	-0.616	1.819	-0.999	-1.444	1.335	4.944
	(-0.39)	(0.87)	(-0.25)	(-0.34)	(0.28)	(0.80)
Adj. R^2	0.013	-0.051	0.011	-0.023	-0.019	0.042

Table A.4: Predicting Post-FOMC Announcement Stock Market Returns with Differential Federal Fund Rate Shocks (Using Kurtosis)

We report results from using abnormal option-implied kurtosis to predict cumulative stock market returns seven days after the FOMC announcements. We differentiate monetary policy shocks by the sign of Federal Fund Rate shocks. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. Monetary policy shock data is from Jan 1996 to Sep 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Negative FFR and Kurtosis						
Abn Kurt	1.994*	0.722	3.273**	1.221	0.078	0.219
	(1.81)	(0.62)	(2.39)	(0.77)	(0.05)	(0.17)
Adj. R^2	0.037	0.067	0.222	−0.006	−0.041	0.015
Panel B: Positive FFR and Kurtosis						
Abn Kurt	13.228**	6.650	9.913	4.353	8.348	9.430
	(2.43)	(0.88)	(1.31)	(0.42)	(0.97)	(0.97)
Adj. R^2	0.268	0.240	0.234	0.015	0.057	0.130
Panel C: Zero FFR and Kurtosis						
Abn Kurt	4.560	−6.458	7.149	6.599	−5.853	−18.867
	(0.78)	(−0.79)	(0.50)	(0.43)	(−0.34)	(−0.84)
Adj. R^2	0.019	−0.052	0.018	−0.020	−0.017	0.043

Table A.5: Option-Implied Moments and Expansionary Monetary Policy Shocks

We report results from using abnormal option-implied moments to predict the probability of expansionary monetary policy shocks (MPS) in Nakamura and Steinsson (2018) and federal fund rate shocks (FFR). For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. Monetary policy shock data is from Jan 1996 to Sep 2021.

	(1) P(MPS<0)	(2) P(MPS<0)	(3) P(MPS<0)	(4) P(MPS<0)	(5) P(MPS<0)
Abn Vol	−0.006			−0.023	−0.018
	(−0.22)			(−0.72)	(−0.59)
Abn Skew		−0.209**		−0.316**	
		(−1.99)		(−2.20)	
Abn Kurt			0.431***		0.558***
			(2.62)		(2.79)
Pseudo R^2	0.000	0.003	0.003	0.005	0.005
	(1) P(FFR<0)	(2) P(FFR<0)	(3) P(FFR<0)	(4) P(FFR<0)	(5) P(FFR<0)
Abn Vol	0.009			−0.003	0.000
	(0.33)			(−0.08)	(0.01)
Abn Skew		−0.203*		−0.216	
		(−1.96)		(−1.59)	
Abn Kurt			0.401**		0.398*
			(2.56)		(1.88)
Pseudo R^2	0.000	0.003	0.003	0.003	0.003

Table A.6: Option-Implied Moments and Adjusted Financial Conditions

We report results from regressing the Chicago Fed's Adjusted National Financial Conditions Index (ANFCI) on abnormal option-implied moments. Panel A (B) presents the results of ANFCI in the same (next) week of FOMC announcements. The adjusted NFCI (ANFCI) isolates a component of financial conditions uncorrelated with economic conditions to provide an update on financial conditions relative to current economic conditions. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

Panel A: Current Week of FOMC					
	(1)	(2)	(3)	(4)	(5)
	ANFCI	ANFCI	ANFCI	ANFCI	ANFCI
Abn Vol	0.011			−0.011	−0.006
	(0.76)			(−1.07)	(−0.58)
Abn Skew		−0.366**		−0.415***	
		(−2.45)		(−3.09)	
Abn Kurt			0.775***		0.814***
			(3.08)		(3.62)
Adj. R^2	−0.001	0.042	0.051	0.040	0.047

Panel B: Next Week of FOMC					
	(1)	(2)	(3)	(4)	(5)
	ANFCI	ANFCI	ANFCI	ANFCI	ANFCI
Abn Vol	0.016			−0.006	−0.001
	(1.04)			(−0.52)	(−0.06)
Abn Skew		−0.386***		−0.411***	
		(−2.76)		(−3.24)	
Abn Kurt			0.807***		0.811***
			(3.43)		(3.84)
Adj. R^2	0.003	0.048	0.057	0.045	0.052

Table A.7: Predicting Post-FOMC Announcement Stock Market Returns Using Option-Implied Moments (Measured on Day $t-1$)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-1$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1)	(2)	(3)	(4)	(5)	(6)
	R(1,2)	R(1,3)	R(1,4)	R(1,5)	R(1,6)	R(1,7)
Panel A: Abnormal Volatility						
Abn Vol	0.051*	0.057**	0.063*	0.038	0.028	−0.011
	(1.68)	(2.06)	(1.68)	(1.09)	(0.86)	(−0.30)
Adj. R^2	0.012	0.012	0.013	0.001	−0.002	−0.005
Panel B: Abnormal Unstandardized Skewness						
Abn Skew	−1.677	−1.547*	−2.231***	−1.614**	−1.464*	−0.633
	(−1.63)	(−1.73)	(−2.80)	(−2.08)	(−1.89)	(−0.53)
Adj. R^2	0.052	0.032	0.062	0.025	0.017	−0.002
Panel C: Abnormal Unstandardized Kurtosis						
Abn Kurt	1.133	1.292	0.340	1.191	2.685*	−0.077
	(0.55)	(0.74)	(0.10)	(0.55)	(1.78)	(−0.04)
Adj. R^2	0.000	0.000	−0.005	−0.002	0.010	−0.005

Table A.8: Predicting Post-FOMC Announcement Stock Market Returns Using Option-Implied Moments (Univariate Regressions and Standardized Moments)

We report results from using abnormal option-implied moments to predict cumulative stock market returns seven days after the FOMC announcements. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: Abnormal Standardized Skewness						
Abn Skew	-4.253^{**}	-3.329	-5.660^{**}	-4.580^{*}	-3.808	-3.373
	(-2.39)	(-1.48)	(-2.39)	(-1.80)	(-1.37)	(-1.11)
Adj. R^2	0.023	0.008	0.028	0.013	0.006	0.002
Panel B: Abnormal Standardized Kurtosis						
Abn Kurt	2.289^{***}	2.258^{**}	3.160^{***}	2.740^{***}	2.824^{**}	2.534^{*}
	(2.82)	(2.44)	(2.87)	(2.86)	(2.32)	(1.77)
Adj. R^2	0.024	0.017	0.032	0.018	0.017	0.009

Table A.9: Predicting Post-FOMC Announcement Stock Market Returns with Alternative Calculation Methods (Using Kurtosis)

We report results from using abnormal option-implied kurtosis to predict cumulative stock market returns seven days after the FOMC announcements. We apply different calculation methods to infer moments with a seven-day horizon. For each FOMC announcement day t, abnormal moments are calculated as the difference between the level of the option-implied moment on $t-2$ and its historical median from $t-15$ to $t-8$. Newey-West t-statistics with 6 lags are reported in parentheses. ***, **, and * indicate the 1%, 5%, and 10% significant levels, respectively. The sample period is from Jan 1996 to Dec 2021.

	(1) R(1,2)	(2) R(1,3)	(3) R(1,4)	(4) R(1,5)	(5) R(1,6)	(6) R(1,7)
Panel A: PCHIP						
Abn Kurt	0.112***	0.047	0.127***	0.106***	0.033	0.052*
	(5.94)	(1.48)	(3.43)	(3.63)	(0.96)	(1.92)
Adj. R^2	0.047	0.002	0.040	0.022	−0.003	−0.000
Panel B: PCHIP with the Last Available Short-Maturity Options						
Abn Kurt	0.534***	0.292**	0.708***	0.340***	−0.107	0.060
	(8.91)	(2.55)	(6.11)	(3.63)	(−0.93)	(0.53)
Adj. R^2	0.067	0.012	0.080	0.012	−0.003	−0.005
Panel C: PTIT						
Abn Kurt	0.300***	−0.078	0.322	0.185	−0.122	0.062
	(2.73)	(−0.42)	(1.45)	(0.94)	(−0.67)	(0.41)
Adj. R^2	0.014	−0.004	0.010	−0.001	−0.003	−0.005
Panel D: MAKIMA						
Abn Kurt	0.065***	0.017	0.052***	0.064***	0.030	0.032
	(4.35)	(0.90)	(2.64)	(2.84)	(1.17)	(1.55)
Adj. R^2	0.039	−0.003	0.014	0.019	−0.000	−0.001