The Fed and the Wall Street Put*

Jan Harren Mete Kilic Zhao Zhang

May 30, 2025

Abstract

We study the trading behavior of financial intermediaries around Federal Open Market Committee (FOMC) announcements in the S&P 500 index options market using intraday data. In contrast to other days, proprietary trading firms are net sellers of options on FOMC days, with their trading activity concentrated in the morning, well before the announcement. Larger option sales by proprietary trading firms in the morning predict both a more accommodative monetary policy shock later in the day and a subsequent decline in option prices after the policy announcement, rendering morning trades profitable. We decompose monetary policy shocks into three components and evaluate potential explanations for these findings. Our analyses suggest that some financial institutions may have the ability to predict financial markets' reaction to Fed policy announcements.

Keywords: monetary policy, intermediaries, equity options, Federal Reserve, trading profits.

*We are grateful to Heiner Beckmeyer, Nicole Branger, Anna Cieslak, Zhiguo He, Darien Huang, Kris Jacobs (discussant), Kristy Jansen, Michael Johannes (discussant), Chris Jones, Thomas Mertens, Oguzhan Ozbas, Rodney Ramcharan, Lukas Schmid, and seminar participants at the University of Münster, Bilkent University, USC Macro Finance Conference, FSU Truist Conference, and SFS Cavalcade for helpful comments. Harren (jan.harren@wiwi.uni-muenster.de) is at the University of Münster. Kilic (mkilic@marshall.usc.edu) and Zhang (zhao.zhang@marshall.usc.edu) are at the Marshall School of Business, University of Southern California.

1 Introduction

After their scheduled meeting on March 18, 2015, the Federal Open Market Committee (FOMC) issued a statement that financial markets perceived as unexpectedly dovish.[1] Despite no change to the federal funds rate, the Fed's accommodative stance regarding the path of future interest rates led to a decline in market interest rates following the announcement.[2] The dovish monetary policy news spurred a rally in the stock market: S&P 500 futures rose by 1.56% in the announcement window, and the index closed 1.21% higher on the day. The *VIX* index, reflecting investors' risk perceptions and equity option prices, dropped from 16.26 to 14.02 during the FOMC announcement window.

Meanwhile, proprietary trading firms, which are financial institutions without a market-making mandate and trade for profit using their own capital, were net sellers of 127,519 S&P 500 index option contracts to other investor categories.[3] This behavior may indicate a greater appetite for risk in response to the Fed's more accommodative stance. Strikingly, however, these trades occurred entirely within the first 10 minutes after the options exchange opened (9:30 a.m. to 9:40 a.m.), well before the FOMC announcement at 2:00 p.m. This suggests that proprietary traders may have anticipated the market's reaction to the announcement, including the drop in option prices, and capitalized on this expectation for profit.

In this paper, we investigate whether this pattern holds more broadly using daily and intraday trade volume data from the S&P 500 index options market. Specifically, we study monetary policy shocks and the associated trading behavior of financial intermediaries in the options market, such as proprietary trading firms, and other investor types, around FOMC announcements, and whether their trading behavior reflects changes in risk-taking or some

[1] "U.S. Stocks and Bonds Gain as Fed Signals Caution," *The Wall Street Journal*, March 18, 2015.

[2] For example, the 1-year Eurodollar futures fell by 10 basis points in the 30-minute window around the announcement, and the 5-year U.S. Treasury yield fell by 15 basis points throughout the day.

[3] From 2011 to 2023, March 18, 2015, had the fifth-largest negative option demand by proprietary trading firms among 3,268 trading days.

investors' ability to predict the Fed's influence on financial markets.

We assess both the unconditional impact of scheduled FOMC announcements and the effects of unexpected monetary policy shocks, measured by high-frequency market interest rate movements (Gürkaynak, Sack, and Swanson (2005), Nakamura and Steinsson (2018), Bauer and Swanson (2023a)). Our findings reveal that proprietary trading firms without market-making mandate are net sellers of options on FOMC announcement days. These institutions provide significantly more liquidity to other investors when monetary policy is unexpectedly accommodative. Strikingly, option trades by proprietary trading firms occur shortly after the market opens and predict monetary policy shocks as well as subsequent option price movements later in the day, which suggests that some financial institutions may have an advantage about predicting the financial market's response to the forthcoming FOMC statement prior to trading hours. This pattern is driven by FOMC announcements when the Fed releases the Summary of Economic Projections and dot plots, which detail participants' interest rate projections. On the demand side, the primary buyers of options sold by firms are public customers, including retail investors, and professional customers, such as hedge funds, with residual supply absorbed by market makers.[4]

We find that monetary policy shocks have the greatest impact on firm trades in S&P 500 options expiring before the next FOMC announcement rather than those maturing afterward. The demand response is highly nonlinear: accommodative monetary shocks lead to significantly larger option sales, whereas monetary tightening induces comparatively smaller purchases. Additionally, the effects of FOMC day trades in response to monetary shocks persist, influencing firms' option inventories for more than seven trading days.

Our analysis leverages a novel dataset that reports buy and sell trade volumes by investor category at both the daily and intraday 10-minute level, allowing us to pinpoint the timing of option trades around FOMC announcements. Firms in the options trading volume

[4]Throughout the paper, we use "firms" and "proprietary trading firms" interchangeably.

data are institutions engaged in proprietary trading for profit (Pan and Poteshman (2006)). Their activities typically include selling hedging instruments to capture risk premiums or speculative trading based on informed views of future market movements. Unlike designated market makers, firms are not obligated to balance the market by adjusting to exogenous demand and can set the size of options holdings at their own discretion.

During our sample period from 2011 to 2023, there were 103 scheduled FOMC announcements, typically held at 2:00 p.m., with some exceptions that occurred at 2:15 p.m. or 11:30 a.m. The FOMC meets over two days, with the Federal Funds Rate decision and the committee's statement released on the second day. Following Gürkaynak, Sack, and Swanson (2005) and Bauer and Swanson (2023a), we measure monetary policy shocks using changes in Eurodollar futures within a 30-minute window, from 10 minutes before to 20 minutes after the announcement. These shocks reflect the unexpected component of monetary policy news as interpreted by the Eurodollar futures market.

Absent any anticipatory trading in the options market, we would expect firm option trades to respond to monetary policy shocks primarily during or after the announcement, as traders adjust their positions based on the implications of the monetary policy news for market interest rates, expectations, and risk appetite. Our high-frequency volume analysis reveals a striking indication of predictive ability: firms' responses to monetary policy shocks are entirely concentrated in their morning trades between 9:30 a.m. and 9:40 a.m. The relationship between option demand and monetary policy shocks is negligible for the rest of the day, yet the morning trades strongly predict these monetary policy shocks occurring later in the day. Specifically, FOMC meeting days with high firm sell volumes in S&P 500 index options at 9:40 a.m. are significantly more likely to coincide with declines in market interest rates around the FOMC announcements, typically held at 2:00 p.m.

We find that firms' morning trades not only predict monetary policy shocks but also their impact on option prices. Specifically, firms' option demand between 9:30 a.m. and 9:40 a.m. predicts the rate of change in the squared *VIX*—a proxy for the price of a portfolio of S&P 500 options with one month to maturity—from 9:41 a.m. to market close, with a much stronger effect on FOMC announcement days compared to non-FOMC days. That is, when firms sell options in the morning, monetary policy tends to be accommodative, leading to cheaper options later in the day and rendering these trades profitable. Importantly, this predictive ability for option prices is unique to proprietary trading firms and is not observed for other investor types including customers or market makers.

We examine the sources of the predictability of monetary policy shocks using proprietary firms' morning option demand through a conceptual framework decomposing monetary policy shocks into three components. The first component, the "Fed response to news" channel as outlined by Bauer and Swanson (2023a), shows that the correlation between macroeconomic forecast revisions and monetary policy shocks arises from the financial market's belief updates about how the Fed reacts to economic conditions. The second component is the "information channel," which reflects the financial market's biased beliefs about the state of the economy that the Fed considers when formulating policy. This bias may stem from the Fed's superior ability to forecast the economy's trajectory (Romer and Romer (2000), Nakamura and Steinsson (2018)). Finally, the third component is the "Fed shock," comprising unexpected changes in the short-term interest rate that are orthogonal to economic state variables. These shocks correspond to contractionary monetary policy shocks in conventional New Keynesian models (e.g., Christiano, Eichenbaum, and Evans (2005)) and may result from unanticipated changes in the policy rate or the Fed's communication about the future policy rate path.

To examine the Fed response to news channel, we show that firms' morning option demand predicts the component of monetary policy shocks that is orthogonal to publicly available macroeconomic data (Bauer and Swanson (2023b)), thereby indicating a distinct source of predictability separate from the "Fed response to news" channel (Bauer and Swanson (2023a)). Moreover, the predictability evidence is not driven by FOMC announcements preceded by recent macroeconomic data releases, such as GDP or inflation figures. This suggests that the observed patterns are unlikely to be explained by firms' superior ability to anticipate financial markets' errors in the Fed's response function, as posited by the "Fed response to news" channel.

We also find that the predictability is driven by FOMC announcements where news about the interest rate itself dominates over news about the Fed's economic outlook, with the latter giving rise to the Fed information effect (Nakamura and Steinsson (2018), Cieslak and Schrimpf (2019), Jarociński and Karadi (2020)). In other words, firms' predictive ability of monetary policy shocks is not driven by a more accurate estimate of the Fed's economic outlook, which would otherwise lead to belief updates in the financial market. Instead, their advantage lies in anticipating the direct impact on market interest rates.

Finally, our findings are entirely concentrated in FOMC announcements where the target policy rate remains unchanged, with firm trades predicting the expected path of future interest rates. This suggests that firms' predictive ability is likely tied to the Fed's forward guidance communicated through its statements (Gürkaynak, Sack, and Swanson (2005)). Crucially, pre-announcement option trading activity is pronounced exclusively on FOMC days that include the release of the Summary of Economic Projections (SEP) and dot plots, while firm option demand prior to announcements without an SEP release is essentially zero. These scheduled releases provide explicit forecasts from FOMC participants on key macroeconomic variables such as employment and inflation as well as the projected trajectory of policy rates. The predictive power of firm trades is entirely concentrated on FOMC days with an SEP release that includes a change in participants' interest rate projections. Higher interest rates in this context are contractionary, consistent with the Keynesian framework, rather than expansionary as suggested by the information channel. We also evaluate a "market response to news" channel, whereby the overall financial market has access to the same information as firms but underestimates the response of short-term interest rates to the announcement. However, the fact that option prices do not drift in a way that predicts monetary policy shocks, along with the measurement of shocks using equilibrium Eurodollar futures rates, suggests that this explanation is less plausible.

We interpret these findings as evidence that proprietary trading firms may have an advantage in predicting easily interpretable information from the Fed such as participants' policy rate forecasts, which has a clear and direct impact on asset prices. This predictive ability may facilitate their profitable trading in the morning of FOMC days. Indeed, such monetary policy shocks are accompanied by significant movements in the *VIX* index and large morning trades by proprietary trading firms, which prove profitable as subsequent news unfolds and option prices adjust throughout the day.

Monetary policy decisions are among the most influential forces shaping financial markets, affecting risk pricing, capital allocation, and investor strategies. The stock market reacts immediately to unexpected monetary policy shocks, highlighting the financial market's unique role in understanding the transmission of monetary policy before its effects on macroeconomic aggregates are observable (Bernanke and Kuttner (2005)). While much research has focused on equity and fixed-income markets, our analysis using the equity index options market offers a unique setting to study the interplay between policy, investor behavior, and asset prices. The options market not only facilitates hedging against diverse future scenarios but also provides insights into investors' information and speculation about market fluctuations.

The predictive power of firms' morning trades for monetary policy shocks points to the possibility of informal communication of Federal Reserve decisions to financial intermediaries, consistent with evidence from Finer (2018), Cieslak, Morse, and Vissing-Jorgensen (2019), Vissing-Jorgensen (2019), and Ehrmann, Gnan, and Rieder (2023). Specifically, certain financial institutions may gain preferential access to information from FOMC meetings. While we remain agnostic whether firms' predictive advantage stems from access to information or more sophisticated predictions, the timing of trades concentrated in the morning of FOMC announcements suggests that firms obtain the relevant information on the FOMC day prior to trading hours.

Lastly, proprietary trading firms and market makers play critical roles in liquidity provision and risk transfer within the options market. Garleanu, Pedersen, and Poteshman (2009) demonstrate how these intermediaries manage risks and influence option prices, while Chen, Joslin, and Ni (2019) examine the impact of their exposure to market crash risk on pricing. Additionally, Fournier and Jacobs (2020) offer a quantitative model of constrained market makers and their influence on equilibrium option prices. Our analysis reveals significant differences in behavior between proprietary trading firms and market makers on FOMC days. While firms pursue profit-driven strategies, market makers adhere to liquidity provision mandates. These distinctions are essential for understanding how various intermediary types respond to monetary policy shocks.

The paper is organized as follows. Section 2 introduces the data and examines the impact of monetary policy on daily option demand across investor types. Section 3 presents high-frequency trading evidence, focusing on morning trades by proprietary traders on FOMC days, which suggest an informational advantage. Section 4 shows that morning trades by proprietary trading firms predict option price movements, highlighting their profitability. Section 5 introduces a conceptual framework to unpack the drivers of firm trades' predictive power for monetary policy shocks and provides empirical evidence in favor or against potential explanations along with several examples of FOMC announcements that drive our results. Section 6 concludes the paper.

2 Evidence using daily option demand

2.1 Option trade volume data

Our option trade volume dataset is from the Chicago Board Options Exchange (CBOE) Open-Close Interval Volume data.[5] We use all options with trading symbols SPX and SPXW which are the major options with the S&P 500 index as the underlying. For each day, starting from the market open at 9:30 a.m., the dataset provides the cumulative intraday number of contracts bought and sold for each option by investor category at 10-minute intervals. For each investor category, we calculate option demand as the difference between buy and sell volumes. Both open and close trading volumes are included, capturing trades that increase or decrease an option's open interest, respectively. Thus, option demand reflects the net effect of all buy and sell transactions, equal to the change in inventory for each investor category.[6] Finally, we aggregate demand across all options within each investor group to construct a daily dataset. This means that our demand metrics represent the collective trading activities of all investors within a given category, rather than at the individual investor level. For example, a positive firm demand for an option indicates that firms, as a group, have bought more contracts than they have sold. This surplus in firm demand must be offset by a corresponding surplus in sell volume from all other investor categories combined. Since options are in zero net supply, the total demand and inventory for each option sum to zero, both daily and at each 10-minute interval. Trades between investors

[5] See Appendix B for details on data sources and construction.

[6] That is, $\text{Demand}_t^j = \sum_i (\text{All buys})_{i,t}^j - (\text{All sells})_{i,t}^j$ for each option chain i and investor type j. Throughout the paper, "demand" and "net demand" are used interchangeably.

within the same category do not affect the aggregated demand measures.

The dataset categorizes investors into five groups: firms, broker-dealers, customers, professional customers, and market makers. Firms consist of proprietary traders affiliated with Options Clearing Corporation (OCC) clearing members, typically engaging in in-house institutional trading strategies. Broker-dealers execute client orders, which may include those from other institutions or hedge funds. Customers encompass retail traders, hedge funds, or other individual accounts. Professional customers represent hedge funds and high-frequency traders whose daily minimum trading volumes qualify them as institutional participants. Market makers, tasked with providing liquidity, profit from option bid-ask spreads while managing risk exposure through strategies such as delta hedging. Facing an exogenous demand curve, market makers set prices to determine the quantity of options supplied. In contrast, firms, without a liquidity provision mandate, base their trading decisions on internal financial conditions, such as leverage costs, and seek profits through informed or speculative trading and risk taking.

S&P 500 index options span a broad range of expiration dates and moneyness levels for both call and put options. Each contract has a notional value equal to 100 times the S&P 500 index in USD. Aggregating the net demand for all options for each investor category at the daily level yields a dataset with 3,268 observations, spanning from January 2011 to December 2023. During our sample period, there are 103 scheduled FOMC announcements, typically occurring eight times per year.[7] A common method for measuring unexpected monetary policy shocks is to analyze high-frequency changes in yields around FOMC announcements (Gürkaynak, Sack, and Swanson (2007), Nakamura and Steinsson (2018), Bauer and Swanson (2023a)). This approach assumes that interest rate movements within a 30-minute window—from 10 minutes before to 20 minutes after a scheduled an-

[7]One scheduled announcement was canceled in 2020 due to the frequent unscheduled FOMC meetings during the COVID-19 crisis.

nouncement—are driven by the unexpected component of monetary policy news. In our analysis, we use monetary policy shocks (MPS) from Bauer and Swanson (2023a), which are constructed based on high-frequency movements in Eurodollar futures with maturities of up to four quarters, available on the San Francisco Fed's Center for Monetary Research website. For ease of interpretation, we normalize the MPS variable to have zero mean and unit standard deviation on FOMC days, and set it to zero on non-FOMC days.

Appendix Table A.1 presents summary statistics for daily option demand by investor type and normalized MPS. On non-FOMC days, all investor types except market makers exhibit positive net demand on average, indicating that their buy volume, measured in number of contracts across all options, exceeds their sell volume. Market makers, in turn, absorb this demand and act as net sellers, consistent with Garleanu, Pedersen, and Poteshman (2009) and Fournier and Jacobs (2020). Among the investor types, broker-dealers and professional customers display less variation in their option demand compared to others. Average option demand varies significantly on FOMC days: firms switch from net buyers to net sellers, with an average net sale of 3,629 contracts, compared to a net purchase of 5,036 contracts on non-FOMC days. Meanwhile, average customer demand nearly doubles. These figures indicate imbalances among investor types; for example, a sale from firms to customers decreases firm demand and increases customer demand. However, trades between two firms do not influence these metrics.

2.2 Daily option demand and monetary policy

We begin our analysis by regressing daily option demand for each investor category on a dummy variable for scheduled FOMC announcement days and MPS. A negative MPS indicates that the FOMC announcement is perceived as more accommodative than expected by the market, such as through an unanticipated interest rate cut or forward guidance

Table 1

Daily option demand and monetary policy

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
Panel A: All days					
FOMC	-8664.78***	-809.41**	8962.91***	-578.29	1089.88
	[-2.93]	[-2.00]	[2.90]	[-0.34]	[0.34]
MPS	9840.37**	407.76	-2593.07	-3298.46	-4356.60
	[2.45]	[1.00]	[-0.68]	[-1.24]	[-1.08]
Cons.	5036.16***	2613.12***	9859.95***	734.65***	-18244.19***
	[10.05]	[23.36]	[19.49]	[4.38]	[-37.32]
R^2	0.0066	0.0007	0.0033	0.0037	0.0008
Obs.	3268	3268	3268	3268	3268
Panel B: FOMC days					
MPS	9840.37**	407.76	-2593.07	-3298.46	-4356.60
	[2.45]	[1.00]	[-0.68]	[-1.24]	[-1.08]
Cons.	-3628.62	1803.71***	18822.86***	156.36	-17154.31***
	[-1.24]	[4.65]	[6.17]	[0.09]	[-5.46]
R^2	0.0986	0.0105	0.0069	0.0355	0.0182
Obs.	103	103	103	103	103

Notes. Panel A reports results from regressing daily net option demand aggregated by investor type on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

signaling a declining interest rate path.

Panel A of Table 1 shows that firm net demand decreases significantly on FOMC days by 8,665 contracts, turning the average non-FOMC net demand of 5,036 contracts negative. This additional supply of options from firms is largely absorbed by customers, whose net demand increases significantly on FOMC days.

The coefficient on MPS in Panel A of Table 1 indicates that firm option demand on FOMC days is significantly influenced by the unexpected monetary policy shock. Specifically, unexpected monetary easing (lower MPS) leads to larger net sales of options by firms. A one standard deviation decrease in MPS corresponds to an additional net sale of 9,840 contracts by firms to other investor types. Over half of this increased supply is absorbed by higher demand from customers and professional customers, while the remainder is offset by a reduction in supply from market makers.

Panel B of Table 1 replicates the analysis using data exclusively from FOMC days. Firm option demand exhibits the strongest and statistically significant correlation with MPS, indicating that proprietary traders are the most responsive to monetary policy shocks. While their average option demand on FOMC days is not significantly different from zero (as reflected in the constant term of this regression), the magnitude of MPS has a substantial impact on firm demand, with an R^2 of 9.9%.[8]

2.3 The role of option time to maturity

When firms act as net option sellers on days with looser than expected monetary policy, they can provide liquidity to other investors for options with maturities extending up to or beyond the next scheduled FOMC day. This distinction is important for understanding which segment of the options market the proprietary traders are active in. For instance, options expiring before the next FOMC announcement can be utilized to hedge against or leverage stock market risk during the intermediate period, rather than addressing interest rate risk associated with future monetary policy shocks.

We divide the sample of options on FOMC days into two groups: those expiring before the next scheduled announcement (Exp < next FOMC) and those expiring after it (Exp > next FOMC). During our sample period (2011–2023), the number of calendar days between scheduled FOMC meetings ranges from 41 to 56, with one exception: a 91-day interval caused

[8] Appendix Table A.2 shows that the results in Table 1 are robust to using orthogonalized MPS from Bauer and Swanson (2023b).

by a canceled announcement in 2020 during the COVID-19 crisis. On non-FOMC days, we restrict the (Exp < next FOMC) sample to options with less than 56 days to maturity.

Another question is whether firms' trading on FOMC days is concentrated in short-dated options –potentially to capitalize on predictable short-term market movements– or whether their activity is driven by options with maturities extending beyond the immediate impact of the monetary policy announcement. To explore this, we further divide the (Exp < next FOMC) sample into short-term options and the rest. Among options that expire before and closest to the next FOMC day, the shortest time to maturity is 16 days (and typically longer). Therefore, we focus on options with maturities of at least 16 days but expiring before the next FOMC announcement (16 < Exp < next FOMC).

Appendix Table A.3 presents summary statistics for options in the (Exp < next FOMC) and (16 < Exp < next FOMC) groups. Similar to the broader set of options, net demand for these subsets is positive on non-FOMC days for all investor types except market makers. Additionally, the significant shift in firm demand –from positive to negative– on FOMC days is evident in both samples.

Does the response of firm option demand to monetary policy stem from options expiring before or after the next FOMC announcement? The first two columns of Table 2 reveal that both the larger net sales by firms on FOMC days and their strong response to unexpected monetary policy shocks are entirely driven by options expiring before the next monetary policy announcement. Longer-dated options have no significant role in firm behavior on FOMC days.

This evidence suggests that proprietary trading firms' liquidity provision during periods of monetary easing supports the market in sharing stock market risks up to the next FOMC announcement. These trades may result from increased risk-taking by firms as financial conditions loosen or from profit-seeking behavior if firms are better able to predict price

Table 2

Firm option demand by time to maturity and monetary policy

	Exp < next-FOMC	Exp > next-FOMC	16 < Exp < next-FOMC	Exp < 16
		Panel A: All days		
FOMC	-7826.96**	-837.82	-6141.49**	-1685.47
	[-2.57]	[-1.04]	[-2.10]	[-1.17]
MPS	10211.18**	-370.82	10327.92**	-116.73
	[2.35]	[-0.42]	[2.44]	[-0.08]
Cons.	6503.80***	-1467.64***	804.49**	5699.31***
	[13.35]	[-9.55]	[2.27]	[15.51]
R^2	0.0067	0.0003	0.0107	0.0002
Obs.	3268	3268	3268	3268
		Panel B: FOMC days		
MPS	10211.18**	-370.82	10327.92**	-116.73
	[2.35]	[-0.42]	[2.44]	[-0.08]
Cons.	-1323.17	-2305.46***	-5337.00*	4013.83***
	[-0.44]	[-2.92]	[-1.84]	[2.87]
R^2	0.0998	0.0021	0.1082	0.0001
Obs.	103	103	103	103

Notes. Panel A reports results from regressing daily firm net option demand on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. Results are reported separately for the (Exp < next FOMC), (Exp > next FOMC), (16 < Exp < next FOMC), and (Exp < 16) options (defined in the text) separately. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

movements around and after FOMC announcements compared to other investor groups. In either case, the trading activity is concentrated in options that are not exposed to interest rate risks associated with future monetary policy shocks.

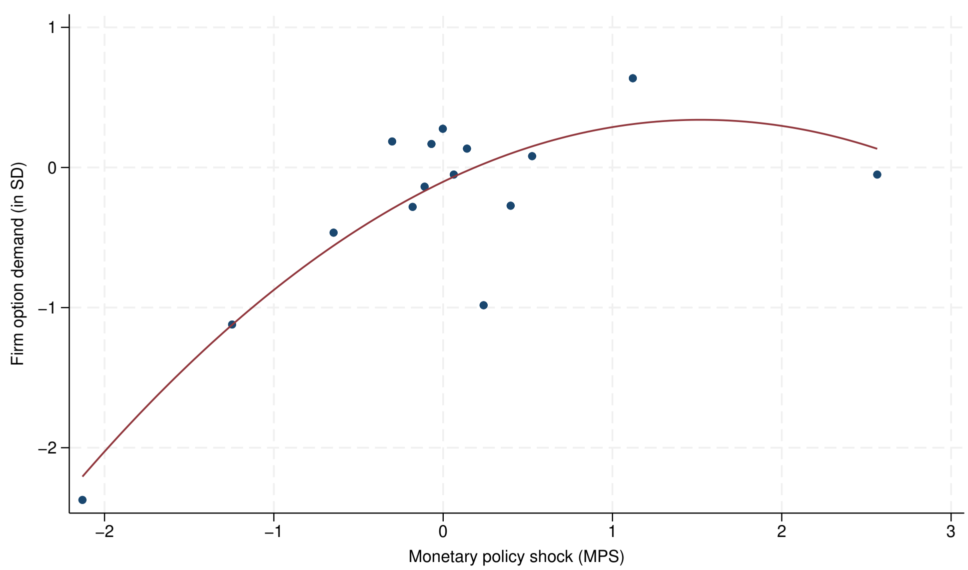
We next examine whether firms' liquidity provision following accommodative monetary policy is driven by options with maturities between 16 days and the next scheduled FOMC meeting, or those with maturities less than 16 days. The last two columns of Table 2 show that firms' response to monetary policy shocks is entirely driven by options in the (16 < Exp

< next FOMC) category. This suggests that, on average, monetary policy easing leads firms to provide liquidity in options with the longest possible maturities up to the next FOMC announcement.

Panel B further indicates that firm option demand in the (16 < Exp < next FOMC) group not only exhibits a strong positive correlation with MPS but is also significantly negative on average on FOMC days. Based on these results, we restrict the sample to (16 < Exp < next FOMC) options for the remainder of our analysis.

2.4 Nonlinear option demand response to monetary policy shocks

Figure 1. Firm option demand and monetary policy shocks



Notes. This figure plots a binscatter of daily firm demand for (16 < Exp < next FOMC) options against monetary policy shocks (MPS) on FOMC announcement days. Each dot represents approximately 7 of the 103 FOMC days in our sample period from January 3, 2011 to December 29, 2023. The red line plots the quadratic fit. Firm option demand is normalized to have mean zero and unit standard deviation in the entire sample including FOMC and non-FOMC days.

We next explore potential nonlinearities in the response of option demand to monetary

Table 3
Nonlinear demand response to monetary policy shocks

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
MPS Low	-26357.38***	1517.19***	11142.10**	2392.19	11305.90
	[-2.58]	[3.17]	[2.00]	[0.48]	[1.50]
MPS Med	-1692.58	612.24***	2553.69	2352.29***	-3825.65*
	[-0.69]	[2.67]	[1.47]	[2.75]	[-1.81]
MPS High	5436.70	-370.00	1889.65	-279.65	-6676.70
	[0.79]	[-1.36]	[0.30]	[-0.05]	[-0.85]
R^2	0.1236	0.0987	0.0302	0.0045	0.0605
Obs.	103	103	103	103	103

Notes. This table reports results from regressing daily net option demand on FOMC days aggregated by investor type on dummy variables for the lowest (MPS Low) and highest (MPS High) quintiles of MPS as well as for the range in between the two (MPS Med). The units are number of contracts. Net option demand is computed as buy minus sell volume. All regressions suppress the constant. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

policy shocks. Specifically, we examine whether the results are driven symmetrically by both positive and negative shocks or are primarily influenced by monetary easing (lower MPS) or tightening (higher MPS).

Figure 1 presents a binscatter of normalized firm option demand on FOMC announcement days as a function of the MPS. The pattern suggests that the positive coefficient of firm option demand on MPS in Tables 1 and 2 is predominantly driven by negative monetary policy shocks, which reflect announcements of accommodative policy. In contrast, the effect is relatively flat for near-zero (MPS ≈ 0) and tightening shocks (higher MPS), resulting in an overall concave relationship between firm option demand and MPS.

Table 3 formalizes the nonlinear response by regressing FOMC day option demand for each investor category on dummies for the lowest (MPS Low), highest (MPS High), and intermediate (MPS Med) quintiles of MPS. These regressions do not include an intercept, so the coefficient estimates reflect the average demand within each MPS category.

In the lowest MPS quintile, firms sell an average of 26,357 option contracts, while their demand is statistically indistinguishable from zero in the other MPS ranges. This negative firm demand is primarily absorbed by customers and market makers. Notably, MPS Low is the only category where customer demand is significantly positive, and market maker demand is also positive. Broker-dealer demand in the MPS Low range is significantly positive but relatively small, averaging 1,517 contracts, compared to the magnitude of firm demand.[9] It is worth noting that S&P 500 option prices decline on FOMC days on average, with larger declines upon accommodative MPS, and relatively flat behavior after tightening shocks (Kilic, Zhang, and Zotov (2024)). As a result, firms may find it most attractive to trade during accommodative shocks where the impact of MPS on option prices is the largest.

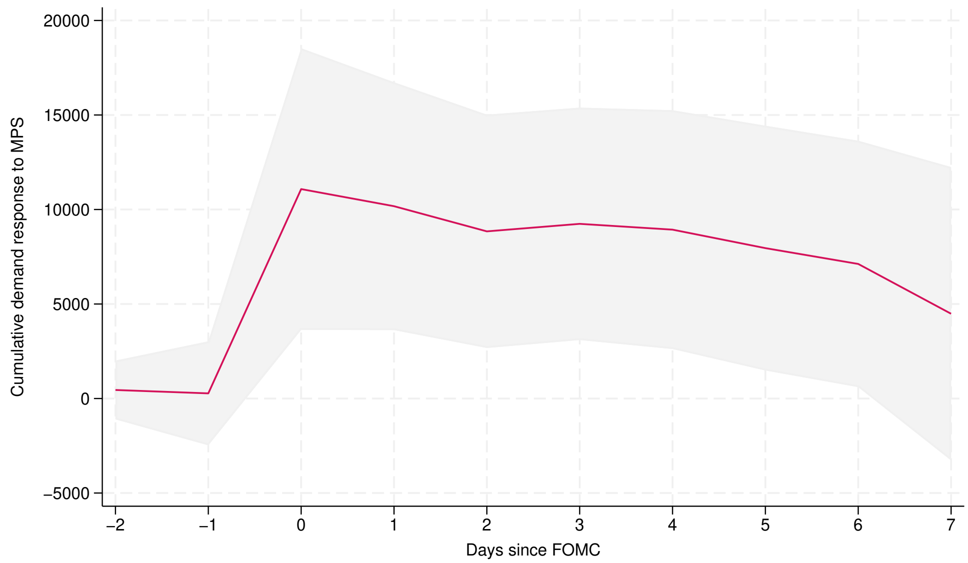
2.5 Persistence of firm demand response to monetary policy

To assess the persistence of the effect of monetary policy shocks on firms' option inventory, we calculate the cumulative net firm demand from two trading days before to seven trading days after the FOMC day for each option in the (16 < Exp < next-FOMC) category on an FOMC day. Importantly, each option is included in this category only once across the 103 FOMC days in our sample period. We then regress the cumulative demand on the MPS and plot the resulting coefficients in Figure 2.

The coefficient is effectively zero on days -2 and -1, indicating that firm option demand during the two trading days before FOMC announcements do not predict the monetary policy shock on day 0. On the FOMC day itself (day 0), cumulative demand responds sharply to MPS, consistent with the findings in the third column of Table 2. For example,

[9] The zero lower bound (ZLB) for interest rates is binding during a large part of our sample period. However, the ZLB does not mechanically influence the direction of MPS because MPS represents changes in the market interest rate relative to expectations formed prior to FOMC announcements. For instance, FOMC members consistently anticipated the tightening to happen sooner than it actually did from 2012 to 2015, generating negative MPS when Fed policy remained unchanged (Cieslak (2018)).

Figure 2. Firm cumulative option demand response to monetary policy shocks



Notes. This figure plots the cumulative firm option demand's response to monetary policy shocks (MPS) from 2 trading days before to 7 trading days after the FOMC announcement. The red line plots the coefficient β_τ for $\tau \in \{-2, -1, ..., 7\}$ from the regression $\sum_{i=-2}^{\tau} \text{demand}_{t,i} = \alpha_\tau + \beta_\tau \text{MPS}_t + \epsilon_{t,\tau}$ where $\text{demand}_{t,i}$ is the firm demand on day $t+i$ for all options in our sample on FOMC day t. The units are number of contracts. Net option demand is computed as buy minus sell volume. The shaded area represents the 90% confidence interval of estimated coefficients.

a one standard deviation negative MPS shock reduces net demand by over 10,000 option contracts.

If firms were to quickly repurchase the options sold on day 0, the cumulative demand response would revert to zero by day 1. However, Figure 2 shows that this is not the case. The impact of FOMC day trades in response to MPS persists, affecting firms' option inventory for up to seven trading days. This persistence suggests that, even if proprietary trading firms' option sales during monetary easing are driven by profit-seeking rather than increased risk appetite, their new positions are maintained well beyond the FOMC day, extending to the end of next week.

In Appendix C, we show that firm demand for both calls and puts moves in the same direction in response to monetary policy shocks. Looser than expected monetary policy leads firms to adjust their positions, increasing their exposure to the risk of significant stock market movements, regardless of the direction.

2.6 Summary of evidence from daily data

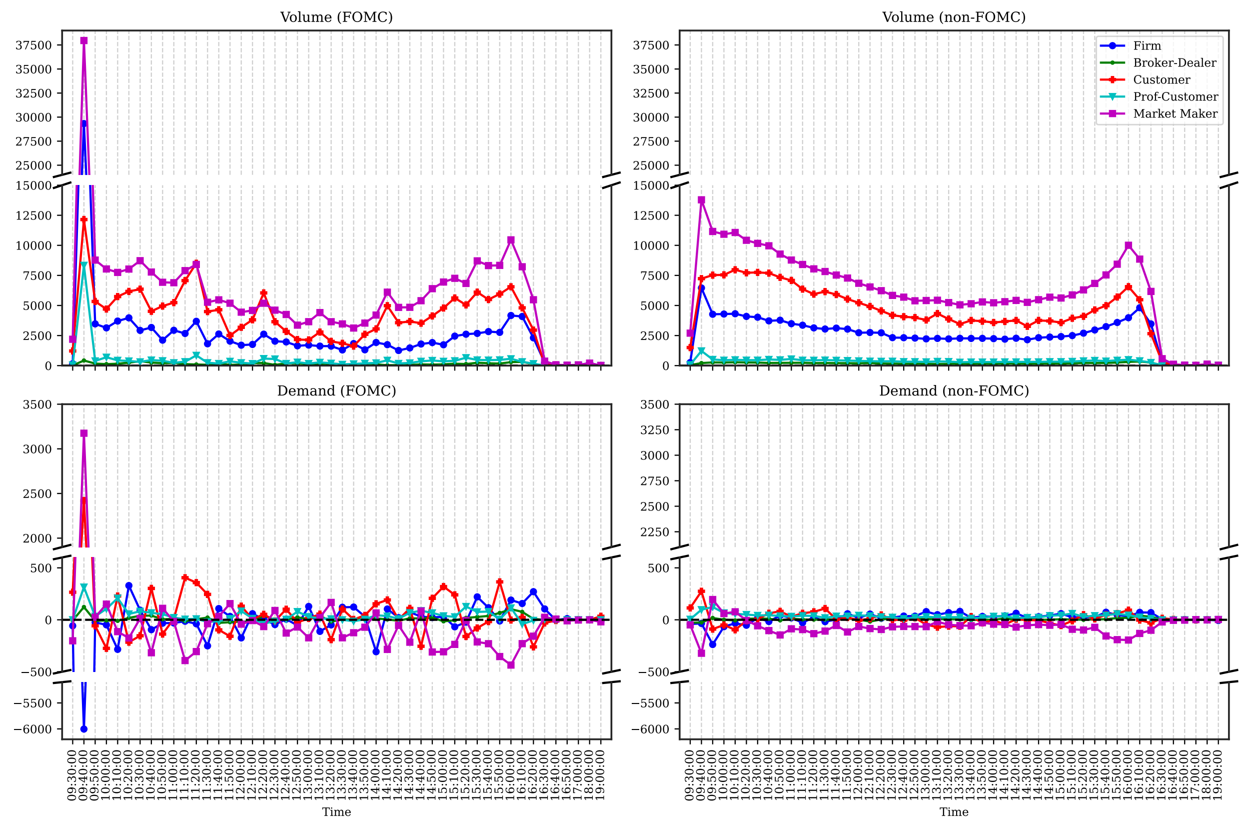
In summary, proprietary trading firms provide liquidity in the S&P 500 options market on FOMC days, particularly by acting as net sellers of S&P 500 index options maturing before next FOMC announcement. Accommodative monetary policy shocks further amplify this liquidity provision.

Our findings suggest that these dynamics may reflect increased risk-taking or predictive ability around FOMC announcements. From a risk-taking perspective, looser monetary policy may enhance the willingness of financial intermediaries to take on more risk, consistent with Kashyap and Stein (2023). This could result in larger negative positions in S&P 500 options, as lower leverage costs increase intermediary wealth, reducing effective risk aversion (He and Krishnamurthy (2013), Kekre and Lenel (2022), Kilic, Zhang, and Zotov (2024)).

Alternatively, some proprietary trading firms may have superior ability to predict the impact of FOMC announcements on interest rates, as captured by Bauer and Swanson (2023a)'s MPS, or on other asset prices. Such predictive ability could arise from informal communication (Finer (2018), Vissing-Jorgensen (2019), Cieslak, Morse, and Vissing-Jorgensen (2019)) or advanced analysis of financial market behavior, enabling firms to adjust their option positions in advance of the announcement in a way that is both profitable and predictive of its market impact.

These channels are not mutually exclusive; firm option demand could be driven by both predictive advantages and changes in risk-taking behavior. High-frequency trade data is critical for assessing these effects, as it allows us to examine how option demand evolves

Figure 3. Average option demand and volume throughout the trading day



Notes. The figure plots the average trading volume (upper panels) and net demand (lower panels) at the 10-minute frequency for FOMC (left panels) and non-FOMC (right panels) days for options expiring after 16 days but before the next FOMCs (16 < Exp < next FOMC). The units are number of contracts. Net option demand is computed as buy minus sell volume. The sample period is from January 3, 2011 to December 29, 2023 out of which 103 are FOMC days and 3,165 are non-FOMC days.

throughout the FOMC day and whether trades correlated with MPS occur before or after the public release of the announcement. To this end, we next analyze intraday trading by proprietary firms and other investor types.

3 Intraday options trading and monetary policy

3.1 High frequency option demand and volume

We analyze intraday trading behavior by investor type on FOMC and non-FOMC days using intraday option trading volume data from CBOE. Figure 3 shows the average trading volume and net demand by investor type in 10-minute intervals throughout the trading day, beginning at 9:30 a.m. For instance, the values at 13:10:00 represent average trading volume and net demand from 1:00 p.m. to 1:10 p.m., across FOMC days (left panels) and non-FOMC days (right panels). Trades recorded at 9:30 a.m. reflect overnight activity from the previous day's market close to the current day's market open. As options are in zero net supply, net demand across all investor types sums to zero in each 10-minute interval.

Figure 3 reveals several patterns common to both non-FOMC and FOMC days. Option trading volume by firms, customers, and market makers dominates the overall trading activity in the S&P 500 options market on both types of days.[10] Trading volume for firms, customers, and market makers exhibits a U-shaped pattern throughout the trading day, similar to the documented stock market patterns in the literature (Jain and Joh (1988), Foster and Viswanathan (1993)). The absolute value of net demand is significantly smaller than trading volume across all investor categories. This difference arises because trading volume includes transactions where the buyer and seller are within the same investor category, while net demand reflects only cases where cumulative buys exceed sells or vice versa. Additionally, high-frequency trades involving the same option contract within a 10-minute interval increase trading volume but do not affect net demand.

Figure 3 also highlights striking differences in options trading patterns between FOMC

[10]Market makers typically exhibit negative net demand, consistent with their role as liquidity providers (Garleanu, Pedersen, and Poteshman (2009), Chen, Joslin, and Ni (2019), Fournier and Jacobs (2020)). Their net sales tend to increase toward the end of the trading day, beginning around 3:30 p.m. Professional customers show a brief spike in trading volume at 9:40 a.m. but contribute only a small fraction of the total trading volume for the rest of the day.

days and non-FOMC days. Trading volume in the first 10 minutes of the trading day (9:30 a.m. to 9:40 a.m., henceforth "morning") is significantly higher on FOMC days. For instance, the average trading volume of firms, representing proprietary traders, is four to five times greater on FOMC days than on non-FOMC days, while their trading volume patterns for the rest of the day are similar. Customers, professional customers, and market makers exhibit similarly large spikes in morning trading volume on FOMC days relative to non-FOMC days.

Net option demand also shows distinct spikes at 9:40 a.m. on FOMC days, while average net demand at the same time on non-FOMC days is relatively muted. Notably, average firm option demand in the morning on FOMC days is highly negative, while all other investor types exhibit larger positive morning demand compared to non-FOMC days. This significant morning spike in firm demand on FOMC days accounts for nearly all of the average negative firm demand observed on FOMC days, documented in Section 2.

In contrast, on non-FOMC days, firms' morning net demand is close to zero, with the only notable pattern being positive net demand from customers, which is offset by market makers. Firms become net sellers around 9:50 a.m. on non-FOMC days, but their net sales are relatively small (approximately 200 contracts) compared to the morning net sales on FOMC days, which average around 6,000 contracts.[11]

Appendix Table A.4 provides detailed insights into firm option demand during the morning period (9:30 a.m. to 9:40 a.m.) and the rest of the trading day on FOMC and non-FOMC days. Consistent with Figure 3, Panel A of Appendix Table A.4 reveals that the first 10 minutes account for 14% of firm trading volume on FOMC days, compared with 3% on non-FOMC days. Panel B shows that the difference in firm option demand between FOMC and non-FOMC days is strikingly similar when comparing daily data (804 vs. -5,337) and the

[11] Using transaction level data from CBOE's OPRA as an alternative, we calculate intraday option trading volume and show that the patterns are very similar across data sources (Appendix Figure A.1). Appendix Figure A.2 shows that intraday median effective spreads for options in our sample, calculated using OPRA data, spike at the market open on FOMC days compared to non-FOMC days. This indicates that trading at the market open on FOMC days does not provide a liquidity advantage.

Table 4
The response of firm demand to monetary policy in the morning and the rest of the day

	Morning			Rest		
	All options	Puts	Calls	All options	Puts	Calls
	Panel A: All days					
FOMC	−5968.16**	−5047.45**	−920.70**	−173.34	−648.32	474.99
	[−2.13]	[−2.12]	[−2.06]	[−0.18]	[−0.72]	[0.89]
MPS	9815.04**	8300.52**	1514.52**	512.88	503.71	9.17
	[2.26]	[2.23]	[2.36]	[0.73]	[0.72]	[0.02]
Cons.	−34.99	−58.40	23.41	839.48**	67.56	771.93***
	[−0.14]	[−0.27]	[0.53]	[2.07]	[0.18]	[5.56]
R^2	0.0184	0.0183	0.0156	0.0000	0.0001	0.0002
Obs.	3268	3268	3268	3268	3268	3268
	Panel B: FOMC days					
MPS	9815.04**	8300.52**	1514.52**	512.88	503.71	9.17
	[2.26]	[2.23]	[2.36]	[0.73]	[0.72]	[0.02]
Cons.	−6003.15**	−5105.85**	−897.29**	666.15	−580.77	1246.91**
	[−2.14]	[−2.14]	[−2.00]	[0.71]	[−0.66]	[2.40]
R^2	0.1053	0.1046	0.0990	0.0029	0.0032	0.0000
Obs.	103	103	103	103	103	103

Notes. Panel A reports results from regressing daily firm net option demand for all options, puts, and calls on a dummy variable for FOMC days and the monetary policy shock (MPS) using data at 10-minute frequency. Morning refers to 9:30 a.m.–9:40 a.m. Rest of day refers to 9:40 a.m.–4:15 p.m. Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

morning period from 9:30 a.m. to 9:40 a.m. (-35 vs. -6,003). In contrast, the difference is much smaller during the rest of the trading day (839 vs. 666). This pattern holds for both puts and calls, as shown in Panels C and D of Appendix Table A.4. In summary, on FOMC days, negative firm demand is larger and more pronounced in the morning compared to the rest of the day or to non-FOMC days.

3.2 Monetary policy shocks and morning trades

Our intraday trading evidence thus far highlights distinctive patterns on FOMC days compared to non-FOMC days. The concentration of trading volume and the pronounced negative firm demand during the morning of FOMC days raise an important question: are these morning trades related to monetary policy shocks that will be revealed later in the day?

In our sample period, most scheduled FOMC announcements (86 out of 103) occurred at 2:00 p.m., while announcements in 2011 and 2012 alternated between 11:30 a.m. and 2:15 p.m. The monetary policy shocks (MPS) used in our analysis are derived from 30-minute Eurodollar futures movements, measured from 10 minutes before to 20 minutes after the announcement. The Eurodollar futures price 10 minutes before the FOMC should have incorporated all publicly available information before the FOMC annoucements and these shocks capture unexpected changes in interest rates driven by FOMC announcements (Bauer and Swanson (2023a)). Noteably, this high frequency change should be unknown to the public as of 9:40 a.m., when firms' option trades on FOMC days are concentrated.

Table 4 examines the relationship between firm option demand during the morning period (9:30 a.m. to 9:40 a.m.) and the rest of the trading day with monetary policy shocks. Panel A shows that all significant effects of monetary policy documented in Section 2 are driven by morning trades. The loading of firm option demand, for both puts and calls, on the FOMC dummy is significantly negative for morning trades and statistically indistinguishable from zero for the rest of the day. This finding aligns with the evidence presented in Figure 3 and Appendix Table A.4. Panel B of Table 4 focuses exclusively on FOMC days. The results in the first column reveal that firm option demand in the morning of FOMC announcement days predicts monetary policy shocks, with an R^2 of 10.5%. Firms are more likely to sell options, both puts and calls, in the morning if the Eurodollar futures market later interprets the FOMC announcement as more accommodative than expected. In contrast, trades during the rest of the day show no significant relationship with monetary policy shocks.[12]

The observation that firms sell both puts and calls ahead of accommodative monetary policy shocks suggests that their trades are primarily driven by expectations of an upcoming decline in volatility, rather than a directional bet on an S&P 500 index spike in response to the accommodative monetary policy shock. In other words, the overall trading position has no clear directional exposure to the underlying index because the opposing sensitivities (deltas) of puts and calls to the index cancel each other out. Instead, firms appear to trade with the intent to profit from the positive correlation between MPS and changes in the *VIX* (Bauer, Bernanke, and Milstein (2023), Kilic, Zhang, and Zotov (2024)). When monetary policy shocks are accommodative, volatility typically declines significantly. This benefits the short positions established in the morning, as falling put and call prices, both of which are positively exposed to underlying volatility due to options' vega, result in gains.

Finally, we examine the role of option inventory prior to FOMC days in Appendix D.2. The results show that firms end the day prior to FOMC announcements with higher inventory levels, but these levels do not predict their morning option demand on FOMC days and do not relate significantly to monetary policy shocks. These findings suggest that the information driving firms' morning trades on FOMC days becomes available to proprietary traders between the market close on the prior day and the market open on the FOMC day. The high inventory levels prior to FOMC announcements and higher sales prior to accommodative shocks suggest that firms position themselves as potential liquidity providers on the FOMC days, and then choose to provide liquidity to other market participants if they anticipate the options in their inventory to lose value after the announcement.

[12]This result is robust to using orthogonalized MPS measures from Bauer and Swanson (2023b) (see Appendix Table A.5).

4 Option prices and option demand on FOMC days

4.1 VIX and option demand

Given that monetary policy shocks are measured using Eurodollar futures in the tight window around the announcement, firms have the capability to predict the high frequency response of market interest rates to FOMC news. However, for option traders, the relevant asset prices are option prices, and their profits from utilizing superior information should be reflected in the returns derived from option trades. Therefore, we next investigate whether morning option trades on FOMC days predict option price fluctuations in the rest of the day. We first use the intraday movements in the squared *VIX* index which is a portfolio of S&P 500 index options with close to one-month to maturity similar to our option sample.

Appendix Table A.6 shows the summary statistics for the percentage change in VIX^2 from prior day's close to current day's 9:41 a.m. (*on*), from current day's 9:41 a.m. to market close (*day*), and in the 30-minute window around FOMC announcements ($fomc$):[13]

$$\begin{aligned} \Delta VIX^2_{t,on} &= VIX^2_{t,9:41} / VIX^2_{t-1,close} - 1 \\ \Delta VIX^2_{t,day} &= VIX^2_{t,close} / VIX^2_{t,9:41} - 1 \\ \Delta VIX^2_{t,fomc} &= VIX^2_{t,+20min} / VIX^2_{t,-10min} - 1 \end{aligned}$$

On average, VIX^2 drops 3% in the FOMC announcement window reflecting the resolution of monetary policy uncertainty. In other words, options become cheaper around the announcement on average. VIX^2 also drops overnight and during the rest of the trading hours on FOMC days after 9:41 a.m. We include the price movement until 9:41 a.m. in the overnight return to use it as a proxy for the period of potential price impact from morning trades.

[13] Assuming that the set of options in the *VIX* calculation remain largely the same, the percentage changes in VIX^2 can be interpreted as the return on an option portfolio that mimics a 1-month S&P 500 variance swap. Therefore, we occasionally refer to ΔVIX^2 as a return.

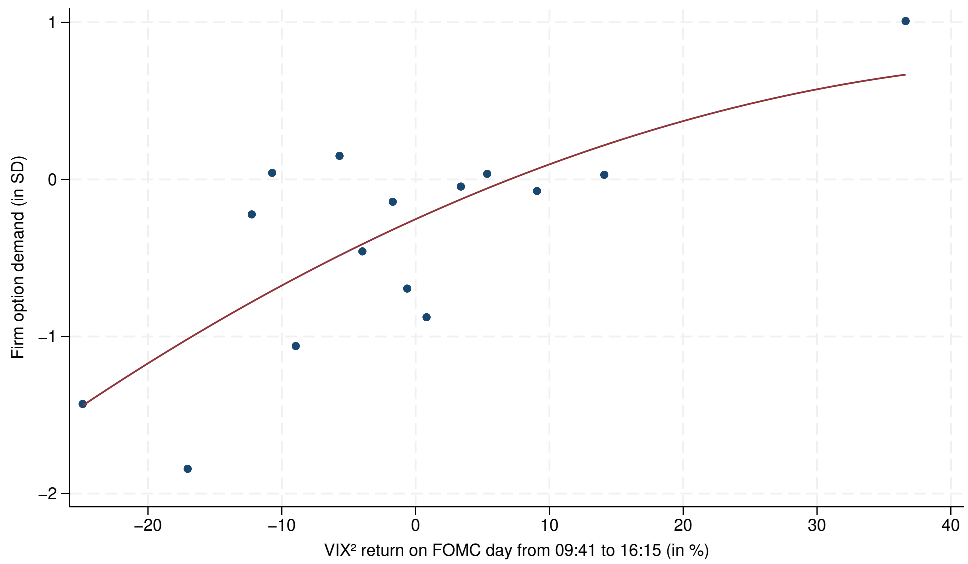
Table 5

Firm option demand in the morning and VIX^2 returns on FOMC days

	ΔVIX^2_{on}	ΔVIX^2_{on}	ΔVIX^2_{fomc}	ΔVIX^2_{fomc}	ΔVIX^2_{day}	ΔVIX^2_{day}
			Panel A: Only demand			
Firm demand	0.66*		0.80**		1.58***	
	[1.91]		[2.00]		[2.85]	
Demand Low		-2.73		-5.30***		-8.00***
		[-1.57]		[-3.32]		[-3.87]
Demand Med		-0.06		-2.25***		0.39
		[-0.04]		[-3.42]		[0.19]
Demand High		-1.38		-2.96*		-0.31
		[-1.03]		[-1.88]		[-0.12]
Cons.	-0.60		-2.70***		-0.84	
	[-0.65]		[-4.42]		[-0.57]	
R^2	0.0201	0.0130	0.0687	0.0374	0.0482	0.0520
Obs.	103	103	103	103	103	103
			Panel B: Including MPS			
MPS	-0.61	-0.18	1.94***	2.20***	-0.17	0.70
	[-1.12]	[-0.34]	[3.25]	[3.47]	[-0.14]	[0.55]
Firm demand	0.76**		0.49		1.61***	
	[2.07]		[1.24]		[2.75]	
Demand Low		-2.75		-5.06***		-7.92***
		[-1.58]		[-4.05]		[-4.02]
Demand Med		-0.05		-2.36***		0.35
		[-0.04]		[-3.62]		[0.17]
Demand High		-1.39		-2.86*		-0.28
		[-1.03]		[-1.83]		[-0.11]
Cons.	-0.57		-2.82***		-0.83	
	[-0.61]		[-4.80]		[-0.56]	
R^2	0.0238	0.0133	0.1563	0.1624	0.0483	0.0543
Obs.	103	103	103	103	103	103

Notes. This table reports results from predictive regressions of ΔVIX^2_{on}, ΔVIX^2_{fomc}, and ΔVIX^2_{day} on firm option demand in the morning (9:30 a.m.–9:40 a.m.) and on dummies for lowest (Demand Low), highest (Demand High) quintiles of firm demand in the morning as well as a dummy for intermediate values of demand (Demand Med) on FOMC days. Firm option morning demand is normalized to have mean zero and unit standard deviation in the entire sample including FOMC and non-FOMC days. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Figure 4. Firm option demand in the morning and VIX^2 return in the rest of the day



Notes. This figure plots a binscatter of morning firm option demand on FOMC days (9:30 a.m. to 9:40 a.m.) against the rate of change in VIX^2 from 9:41 a.m. to market close at 4:15 p.m. Each dot represents approximately 7 of the 103 FOMC days in our sample period from January 3, 2011 to December 29, 2023. The red line plots the quadratic fit. Firm option demand is normalized to have mean zero and unit standard deviation in the entire sample including FOMC and non-FOMC days.

Table 5 shows the relation between ΔVIX^2 and firm option demand on FOMC announcement days. Panel A shows that a one standard deviation increase in firms' morning option demand is associated with a 66 basis point higher overnight return. This result may reflect the price impact of firm trades on FOMC days. Since the VIX index is based on quotes rather than transaction prices, firm trades between 9:30 a.m. and 9:40 a.m. might already influence quotes starting at 9:30 a.m. However, this relationship is statistically weaker compared to the predictive relationship between morning trades and changes in option prices discussed below. This weaker relationship is expected because firm net demand, even if informative about the upcoming shock, remains quite small relative to overall trading volume as can be seen in Figure 3, making a large price impact unlikely.

Strikingly, firm morning trades predict the change in VIX^2 in the FOMC announcement window (80 basis points) and in the rest of the trading day from 9:41 a.m. to market close (158 basis points). The results also show that the effects are primarily driven by large and negative firm option trades in the morning. Panel B controls for the MPS and repeats the regressions in Panel A of Table 5. Firms' morning demand can predict option price changes throughout the day, even after accounting for MPS, indicating that proprietary trades anticipate the market's reaction to FOMC news beyond what MPS captures. This pattern suggests that firms have the ability to predict option market movements in the rest of the day and change their option positions accordingly in the morning on FOMC days. When they predict monetary easing and sell options, option prices depreciate and firms benefit from their sales before the decline.

Figure 4 illustrates the relation between the rate of change in VIX^2 in the rest of the day and firms' morning trades. Negative returns on the S&P 500 option portfolio correspond to particularly negative firm option demand in the morning, explaining our finding in Section 2 that large option sales by firms are concentrated in cases of most accommodative monetary policy announcements. Such announcements lower option prices significantly consistent with Bauer, Bernanke, and Milstein (2023) and firms are able to identify the right time to sell options in their inventory before they lose value in the rest of the day.

4.2 Profits and losses from option trades

To quantify the impact of firm morning option demand on FOMC days, we follow Tian and Wu (2023) and calculate the profit and loss from buying/selling options in the morning, between 9:30 a.m. and 9:40 a.m., and holding the option until the end of the trading day. When an institutional investor buys an option, their risk exposure can vary significantly, depending on whether and how the investor chooses to manage the risk associated with the option contract. Hence, we compute two different strategies: holding a naked position or performing a one-time delta hedge at initiation. The net profit and loss from buying a naked option contract i from 9:41 a.m. to market close is

$$\pi_{t,T}^i = O_T^i - O_t^i e^{r_t(\tau)\tau}, \tag{1}$$

where t is 9:41 a.m., T is the close of the trading day, and O_t^i is the option price. We linearly interpolate a maturity-specific risk-free rate, $r_t(\tau)$, for horizon τ from the zero-curve file provided by OptionMetrics. Compounding ensures that we obtain the P&L net of financing costs.

When performing a one-time Black and Scholes (1973) delta hedge at initiation, the P&L is

$$\pi_{t,T}^i = \left(O_T^i - O_t^i e^{r_t(\tau)\tau}\right) - \Delta_t^i \cdot \left(S_T - S_t e^{r_t(\tau)\tau}\right), \tag{2}$$

where S_t is the underlying SPX level at time t and Δ_t is the high-frequency delta from the Black and Scholes (1973) model, calculated at 9:41 a.m. The second term in Equation 2 captures the static delta position in the underlying SPX.

We multiply $\pi_{t,T}^i$ by the option morning net demand at 9:40 a.m. For each day, we sum up all options' demand-weighted profit and loss and scale it by the absolute dollar volume of all options

$$Profitability_t = \frac{\sum_i \text{Demand}_{t-1}^i \cdot \pi_{t,T}^i}{\sum_i |\text{Demand}_{t-1}^i| \cdot O_T^i}, \tag{3}$$

where $t-1$ refers to morning demand at 9:40 a.m. We calculate $Profitability_t$ separately for puts and calls and for all options and regress it on a dummy variable that equals one on scheduled FOMC announcement days. Table 6 depicts the results.

On non-FOMC days, firms do not profit from buying or selling options in the morning of FOMC days, as the regression constant is near zero and insignificant. However, on FOMC days, firms earn profits from trading put options in the morning (Panel A, Table 6), while

Table 6

Firm profit and loss on FOMC vs. non-FOMC days

	All	Put	Call
Panel A: Naked profit and loss			
FOMC	0.0239	0.0539*	-0.0374
	[1.30]	[1.84]	[-1.11]
Cons.	-0.0004	0.0031	0.0057
	[-0.17]	[0.95]	[1.33]
R^2	0.0011	0.0032	0.0009
Obs.	2451	2451	2451
Panel B: Delta hedged profit and loss			
FOMC	0.0213**	0.0322**	0.0355***
	[2.52]	[2.00]	[3.31]
Cons.	-0.0008	0.0001	-0.0025
	[-0.56]	[0.07]	[-0.85]
R^2	0.0031	0.0066	0.0020
Obs.	2451	2451	2451

Notes. This table reports regression results for the profit and loss (P&L) of firms that hold their morning demand from 09:41 until the end of the trading day. We multiply the change in the option price from 09:41 to the end of the day with the net option demand in the morning of the trading day. Morning refers to 9:30 a.m.–9:40 a.m. The analysis includes both naked (Panel A) and delta-hedged positions (Panel B) and examines the impact on a dummy variable that equals one on scheduled FOMC announcement days. We scale the profit and loss by the absolute dollar morning demand, which is calculated as absolute demand times the mid price of the option. Net option demand is computed as buy minus sell volume. We only include days when we can calculate a P&L for both puts and calls. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to July 31, 2023.

they typically incur losses on naked call positions. The delta-hedged strategy is significantly profitable on FOMC days for both puts and calls, as well as overall (Panel B in Table 6).

5 Inspecting the mechanism

In this section, we decomposes MPS into three components: the Fed response to news channel, the information channel, and Fed shocks, and then analyze which of these components proprietary trading firms' morning trades are able to predict, providing insight into the likely content of these firms' predictive advantage.

5.1 Drivers of monetary policy shocks

Monetary policy shocks (MPS) are defined as the difference between the short-term interest rate, i, observed after the FOMC announcement, and the financial market's expectation of the interest rate, $\mathbb{E}^m[i]$, prior to the announcement:

$$\text{MPS} = i - \mathbb{E}^m[i]. \tag{4}$$

In our empirical analysis, MPS is measured as the change in short-term interest rates within the 30-minute announcement window, inferred from Eurodollar futures with maturities up to one year, following Gürkaynak, Sack, and Swanson (2005), Nakamura and Steinsson (2018), and Bauer, Lakdawala, and Mueller (2022). Thus, MPS reflects unexpected changes in the policy rate and the unforeseen impact of the FOMC announcement on short-term interest rate expectations. We interpret $\mathbb{E}^m$ as the expectations of the overall financial market that determine equilibrium prices, while proprietary trading firms' expectations $\mathbb{E}^f$ may be different from $\mathbb{E}^m$.

Following Bauer and Swanson (2023a), we assume that the Fed sets the interest rate based on a column vector of macroeconomic state variables, x, such as the expected output gap, while allowing for deviations from the normal policy rule represented by ε:

$$i = ax + \varepsilon, \tag{5}$$

where a is a row vector capturing the Fed's policy reaction to the state variables. ε represents the Fed's exogenous random policy deviations from the rule ax and is not known to market participants. For example, the Fed communicates policy rate projections from FOMC participants in specific statements, which affects short-term interest rates in unpredictable ways.

Consider the special case where $\mathbb{E}^m[\varepsilon] = 0$, and the financial market is fully informed about the Fed's policy function, represented by a, as well as the Fed's information about the macroeconomic state x. In this scenario, the financial market can perfectly anticipate the Fed's policy rule, leading to $\mathbb{E}^m[i] = ax$. Consequently, the monetary policy shock simplifies to MPS $= \varepsilon$. We deviate from this special case in three ways. First, we incorporate the Fed information effect by assuming that the financial market's information about the macroeconomy, x^m, differs from the macroeconomic state observed by the Fed, x:

$$x = x^m + \eta^m, \tag{6}$$

where η^m represents additional information used in the policy rule. This may arise from the Fed's superior ability to forecast macroeconomic variables, such as the expected output gap or expected inflation, based on recently available public information (Romer and Romer (2000), Nakamura and Steinsson (2018)). Second, we allow for the "Fed response to news" channel proposed by Bauer and Swanson (2023a), by assuming that the financial market's perceived policy rule, a^m, may differ from the policy rule actually used by the Fed. Finally, we consider the possibility that $\mathbb{E}^m[\varepsilon] \neq 0$, to account for partial anticipation of the Fed's policy rule deviations by the financial market. For instance, this could reflect the impact of the Fed's communication of projected policy rates on short-term interest rates, beyond what is predictable using macroeconomic state variables. Under these assumptions, the market's pre-announcement expectation for the short-term interest rate after the announcement can be expressed as:

$$\mathbb{E}^m[i] = a^m x^m + \mathbb{E}^m[\varepsilon]. \tag{7}$$

The MPS can then be decomposed into three components:

$$\text{MPS} = \underbrace{(a - a^m)x^m}_{\substack{\text{Fed response} \\ \text{to news}}} + \underbrace{a\eta^m}_{\substack{\text{Information} \\ \text{channel}}} + \underbrace{\varepsilon - \mathbb{E}^m[\varepsilon]}_{\substack{\text{Fed} \\ \text{shock}}} . \tag{8}$$

The "Fed response to news channel" captures the difference between the Fed's actual policy function, a, and the financial market's ex-ante perception of that function, a^m. For instance, if the Fed's policy reaction, a, assigns a positive coefficient to the expected output gap in x, and the financial market underestimates this response ($a > a^m$), then the short-term interest rate will adjust by the amount of the market's pre-announcement underreaction following the FOMC announcement. This component of MPS is predictable using the macroeconomic information observed by the financial market, represented by x^m.

The information channel component of MPS arises if the Fed's observation of x differs from the financial market's pre-announcement estimate, x^m. For instance, if the financial market underestimates the expected output gap from the Fed's perspective, this discrepancy contributes to a positive MPS. This occurs because the Fed's policy reacts positively to the expected output gap ($a > 0$), including the component $\eta^m > 0$ unforeseen by the market. For example, the market may revise its expectations about the macroeconomic state upon interpreting the Fed's statement and the accompanying Summary of Economic Projections, leading to an information shock in market expectations of the output gap at the time of the FOMC announcement. As a result, short-term interest rates increase along with upward revisions to expected output growth, as documented by Nakamura and Steinsson (2018). In such cases, a positive MPS may represent good news for the broader economy, signaling stronger-than-expected macroeconomic fundamentals.

The Fed shock component captures unexpected monetary policy shocks that are orthogonal to macroeconomic fundamentals, x, and directly influence interest rates, as modeled in conventional New Keynesian frameworks and VAR studies (e.g., Cochrane and Piazzesi (2002), Christiano, Eichenbaum, and Evans (2005)). This component represents a shock to the economy-wide discount rate and typically has negative effects on the economy, such as a decline in expected output growth. The Fed shock arises not only from the policy rate decision but also from the Fed's communication about the future trajectory of interest rates. For example, on some announcement days, the Fed releases the dot plot alongside its statement, providing FOMC participants' policy rate projections for up to three years. These projections can affect short-term interest rates in ways that are not predictable based on public macroeconomic information or explained by the Fed information effect.

The decomposition of MPS provides a framework to disentangle the sources of proprietary trading firms' ability to predict MPS, as documented in Section 3. Proprietary trading firms' interest rate expectations prior to FOMC announcements can be expressed as:

$$\mathbb{E}^f[i] = a^f x^f + \mathbb{E}^f[\varepsilon], \tag{9}$$

where a^f represents the firms' estimate of the Fed's policy coefficients on macroeconomic variables, x^f denotes the firms' perception of the state variables used in Fed policy, and $\mathbb{E}^f[\varepsilon]$ captures the firms' expectation of the Fed shock. Analogous to the market's estimate of the Fed's information in Equation 6, the relationship between the macroeconomic state vector perceived by firms prior to the announcement, x^f, and the Fed's actual information, x, can be written as:

$$x = x^f + \eta^f, \tag{10}$$

where η^f represents the additional information held by the Fed that is unobserved by proprietary trading firms.

Which component explains proprietary trading firms' ability to predict MPS through their morning trades? The decomposition of MPS suggests that firms may possess a closer estimate of the Fed's policy function ($|a - a^f| < |a - a^m|$), a superior ability to predict the macroeconomic information used by the Fed ($|\eta^f| < |\eta^m|$), or a more accurate forecast of Fed shocks ($|\mathbb{E}[\varepsilon] - \mathbb{E}^f[\varepsilon]| < |\mathbb{E}[\varepsilon] - \mathbb{E}^m[\varepsilon]|$). In the following analysis, we examine which MPS component firms are more likely to predict better than the overall market.

5.2 The Fed response to news channel

The "Fed response to news channel" component of MPS arises from the financial market's systematic under- or overestimation of the Fed's response to macroeconomic state variables, such as the output gap, prior to FOMC announcements. This component of MPS should therefore be predictable using publicly available macroeconomic state variables, x^m, provided that $a - a^m$ remains stable over time. Consistent with this view, Cieslak (2018) and Miranda-Agrippino and Ricco (2021) show that high-frequency interest rate changes around FOMC announcements are indeed predictable, raising questions about their use as exogenous monetary policy shocks.

Motivated by the theoretical link between the predictability of MPS and the Fed response to the news channel, Bauer and Swanson (2023b) construct monetary policy surprises ($\text{MPS}^{\perp}$) that are orthogonalized using publicly available variables prior to announcements. The predictive variables used for the orthogonalization include nonfarm payrolls surprise, employment growth, lagged S&P 500 returns, the yield curve slope, commodity prices, and interest rate skewness.[14] Moreover, Bauer and Swanson (2023b) provide evidence that the Fed has become increasingly responsive to macroeconomic variables, and the financial market

[14]The predictive regression in Bauer and Swanson (2023b) is specified as $\text{MPS}_t = \alpha + \beta' x^m_{t^-} + u_t$, where $x^m_{t^-}$ is the column vector of predictive variables measured prior to the FOMC announcement at t. The variable selection is motivated by the predictability documented in Cieslak (2018) and Bauer and Chernov (2024), with the R^2 of predictive regressions ranging from 16% to 19%, depending on the sample period. Appendix Section E provides a detailed analysis of predictability using monetary policy uncertainty and interest rate skewness.

Table 7
Predictability of monetary policy shock components

	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Demand	0.32***	0.06	0.26***
	[3.46]	[1.52]	[3.08]
R^2	0.1053	0.0205	0.0792
Obs.	103	103	103

Notes. The table reports results from regressing monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

has systematically underestimated this responsiveness. For example, the resulting relationship $a > a^m > 0$ for the output gap aligns with the findings of Schmeling, Schrimpf, and Steffensen (2022).

If proprietary trading firms have a better estimate of the Fed's response to the economy compared to the overall market ($|a - a^f| < |a - a^m|$) and can therefore estimate $a - a^m$, then firms' option demand in the morning of FOMC announcement days may predict the component of MPS driven by publicly available pre-announcement information, namely, $\widehat{\text{MPS}} = (a - a^m)x^m$. Otherwise, firm morning trades predict $\text{MPS}^{\perp}$, which includes the information channel and Fed shock components, as specified in equation 8.

We obtain data on Bauer and Swanson (2023b)'s orthogonalized MPS estimates, $\text{MPS}^{\perp}$, from the San Francisco Fed's website to test whether firm morning trades predict $\text{MPS}^{\perp}$ or $\widehat{\text{MPS}}$. For ease of interpretation, we normalize MPS, $\text{MPS}^{\perp}$, and $\widehat{\text{MPS}}$ by the standard deviation of MPS in our sample from 2011 to 2023. Consistent with Bauer and Swanson (2023b)'s findings in a longer sample, we find that 15% of the variation in MPS is explained by $\widehat{\text{MPS}}$, while 85% is explained by $\text{MPS}^{\perp}$.

Table 7 shows that the predictability of MPS by firm morning demand is driven by the predictability of $\text{MPS}^{\perp}$. A one standard deviation increase in firm option demand in the morning predicts a 0.32 standard deviations higher MPS, with 26% of that prediction attributed to the orthogonal component, which has an R^2 of 7.9%. In contrast, the predictable component $\widehat{\text{MPS}}$ is only weakly associated with firms' morning demand for options. This result aligns with the profit-seeking motives of proprietary trading firms. A one standard deviation higher MPS is associated with a 2.26 percentage point increase in the squared VIX index (ΔVIX^2_{fomc}), with an R^2 of 13.3% in the FOMC announcement window. This change in option prices driving the VIX around FOMC announcements is primarily a reaction to $\text{MPS}^{\perp}$: a one standard deviation higher $\text{MPS}^{\perp}$ is associated with a 2.22 percentage point increase in ΔVIX^2_{fomc} and an R^2 of 11.3%. By contrast, the relationship between ΔVIX^2_{fomc} and $\widehat{\text{MPS}}$ is weak, with an R^2 of only 1.4% and statistically insignificant (Appendix Table A.8).[15]

In summary, the evidence in Table 7 indicates that proprietary trading firms' ability to profitably trade on FOMC mornings is not due to their superior understanding of the Fed's policy reaction to economic changes, represented by a in our framework, i.e., the Fed response to news channel.

We conduct another test to assess whether proprietary trading firms are better able to estimate the Fed's response to the economy by considering other macroeconomic announcements that are relevant to the Fed's decision-making process. Some FOMC announcements are preceded by macroeconomic data releases on the same day or in the days leading up to the announcement. The Fed response to news channel may be influenced by the slow processing of new information and the estimation of the Fed's reaction to the newly available

[15] We also examine whether firm option demand predicts MPS orthogonalized using revisions in professional GDP growth forecasts from Karnaukh and Vokata (2022). In the overlapping period from 2011 to 2015 (39 announcements), a one standard deviation increase in demand predicts 0.28 [$t = 2.71, R^2 = 20.6\%$] standard deviations higher MPS orthogonalized by GDP forecast revisions reinforcing our finding that proprietary traders' demand forecasts the component of MPS that is not predictable using macroeconomic information.

Table 8

Predictability of monetary policy shocks with and without macro announcements

	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Panel A: No macro announcement (1 day)			
Demand	0.32***	0.06	0.25***
	[3.51]	[1.27]	[3.56]
R^2	0.1079	0.0197	0.0779
Obs.	80	80	80
Panel B: No macro announcement (2 days)			
Demand	0.37***	0.05	0.31***
	[4.94]	[0.99]	[5.64]
R^2	0.1915	0.0185	0.1345
Obs.	65	65	65

Notes. The table reports results from regressing monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. We condition on FOMC announcements with no other macroeconomic announcement on the FOMC day (1 day) and the preceding day (2 days). t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

information on macroeconomic state variables, which creates larger discrepancies between a and a^m. For instance, if a CPI report is released on the morning of or the day before an FOMC announcement, the overall market may be slower than proprietary trading firms in assessing how the new data will affect the Fed's upcoming policy. This pattern could enhance the ability of firm trades to predict $\widehat{\text{MPS}}$ and the total MPS for FOMC announcements preceded by macroeconomic releases.

Following Alam (2023), we compile a dataset of macroeconomic releases, including employment, consumer price index (CPI), industrial production and capacity utilization, producer price index (PPI), and gross domestic product (GDP), along with any revisions. Out of 3,268 trading days in our sample period, 731 days include at least one macroeconomic announcement, excluding FOMC announcements. Additionally, 23 out of 103 FOMC announcement days in our sample period feature another macroeconomic announcement, while 38 FOMC days include at least one macroeconomic announcement either on the FOMC day or the preceding day.

Table 8 shows that the predictive power of firm option demand in the morning for MPS persists when the sample is restricted to FOMC days without additional macroeconomic data releases. A one standard deviation increase in firms' morning option demand predicts a 0.32 standard deviation higher MPS on FOMC days with no other macroeconomic announcement on the same day, and a 0.37 standard deviation higher MPS when no macroeconomic data release occurs on the same or the preceding day.[16] Furthermore, the predictive coefficients and accuracy of firm morning demand for $\widehat{\text{MPS}}$ and $\text{MPS}^{\perp}$ in the sample without preceding macro announcements in Table 8 are similar to those in Table 7, suggesting no superior ability of firms to update their Fed policy estimates based on recent information.[17]

A remarkable feature of firm trades' ability to predict MPS is their timing in the morning of FOMC announcement days. This observation is particularly relevant to our analysis, as most macroeconomic announcements occur before trading hours, raising the question of whether firms' morning option trades, which predict MPS, are informed by these announcements, such as inflation or GDP data. Appendix D.2 shows that firms' option inventory at the end of the previous trading day does not predict MPS. Furthermore, firm option demand in the last five days prior to the FOMC announcement also shows no predictive power for MPS (Appendix Table A.9). Hence, firm trades in the morning of FOMC announcement

[16] Appendix Table A.7 shows that our results from the daily analysis (Table 1) remain largely unchanged when we omit all trading days associated with macroeconomic data releases.

[17] Alam (2023) documents that several asset price patterns on FOMC announcement days in the stock and bond markets (e.g., Savor and Wilson (2014), Lucca and Moench (2015), Hillenbrand (2023)) are driven by a small subset of FOMC announcements preceded by other macroeconomic announcements. The results in Table 8 indicate that firms' predictive ability is not explained by the predictability of these patterns.

days are unique in their predictive ability for MPS. While the timing of trades suggests that the information used by firms becomes available prior to trading on FOMC days, and not during the days leading up to the announcement, the evidence in Table 8 indicates that the advantage of firms in their trading decisions does not include recent macroeconomic data releases immediately preceding the spike in trading activity.

5.3 The information channel

The macroeconomic outlook as observed by the Fed is a crucial input into the monetary policy rule. Even if the financial market is fully informed about the Fed's reaction to the economy (a), discrepancies may exist between the state variables observed by the Fed, x, and the financial market's estimate of these variables, x^m. In such cases, MPS is accompanied by an update of the financial market's beliefs about the state of the economy (Romer and Romer (2000), Nakamura and Steinsson (2018)). A positive MPS may therefore signal a better economic outlook from the Fed's perspective, rather than being exclusively contractionary news, as suggested by conventional New Keynesian models.

In our conceptual framework, the information effect is represented by $a\eta^m$ in equation 8. For example, if the financial market underestimates the Fed's employment expectations ($\eta^m > 0$) and the Fed's policy reacts positively to employment ($a > 0$), the information channel component of MPS will be positive. This does not occur because the Fed raises the short-term interest rate unexpectedly beyond what macroeconomic fundamentals predict, but because the FOMC announcement reveals a stronger-than-expected economic state.

Relevant to our study, proprietary trading firms may have an advantage in estimating the Fed's information and accurately forecasting the component of MPS driven by the financial market's expectational error. To explore this possibility, we analyze whether the predictive power of firm trades for MPS is primarily driven by FOMC announcements influenced by the information channel ($a\eta^m$), rather than the Keynesian channel of interest rate shocks (ε).

High-frequency comovement between interest rates and stock market returns provides valuable insight into whether the financial market's response to an announcement is dominated by the Keynesian or information channel (Cieslak and Schrimpf (2019), Jarociński and Karadi (2020)). For instance, under the information channel, a negative MPS may result in a negative S&P 500 response if the accommodative policy news is interpreted as signaling weaker growth expectations. Conversely, under the Keynesian channel, the stock market may react positively to a negative MPS if the accommodative news is perceived as improving financial conditions, enhancing investment and growth expectations, and reducing discount rates for listed firms.

We investigate whether the predictive power of firm option demand for MPS is driven by Keynesian (ε) or information shocks ($a\eta^m$). To do this, we classify announcements where $\text{MPS}^{\perp}$ and the change in S&P 500 E-Mini futures during the 30-minute announcement window have opposite signs as "Keynesian shocks" and those with the same sign as "information shocks" following Cieslak and Schrimpf (2019) and Jarociński and Karadi (2020). Out of 103 scheduled FOMC announcements in our sample period, 57 are categorized as Keynesian shocks, while 46 are classified as information shocks. We observe that MPS is more volatile among Keynesian shocks compared to information shocks.[18]

Table 9 presents results from predictive regressions of MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ on firms' morning demand for options on FOMC days labeled as Keynesian (Panel A) and information (Panel B). In the Keynesian subsample, a one standard deviation increase in firm option demand predicts a 0.44 standard deviation higher MPS, with an R^2 of 17.2%, most of which is attributable to the predictability of $\text{MPS}^{\perp}$. The predictability of $\widehat{\text{MPS}}$, however, is not

[18] In the Keynesian subsample, the standard deviation of normalized orthogonalized MPS is 1.25, compared to 0.57 among information shocks.

Table 9

Predictability of monetary policy shocks: Keynesian vs. Information shocks

	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Panel A: Keynesian shocks			
Demand	0.44***	0.07	0.37***
	[5.87]	[1.53]	[5.48]
R^2	0.1718	0.0366	0.1483
Obs.	57	57	57
Panel B: Information shocks			
Demand	-0.20	0.02	-0.22
	[-1.54]	[0.47]	[-1.45]
R^2	0.0963	0.0010	0.0663
Obs.	46	46	46

Notes. The table reports results from regressing monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. We label announcements where the change in S&P 500 E-Mini futures in the 30-minute announcement window and $\text{MPS}^{\perp}$ have opposite signs as "Keynesian shocks", and "Information shocks" otherwise. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

statistically significant. In contrast, for information shocks, the relationship between firm morning trades and MPS components is not statistically significant, and the point estimates for MPS and $\text{MPS}^{\perp}$ are negative.[19] We further examine the behavior of firm option demand in cases of Keynesian and information shocks in Appendix F. Interestingly, firms' morning trades' ability to predict the change in VIX^2 in the announcement window and in the rest of the day holds for both Keynesian and information shocks. This result can again be understood with the example of a large negative MPS. If the shock is Keynesian, firms tend

[19]Bauer and Swanson (2023b) also document that the empirical evidence for the information channel, based on the correlation between macroeconomic forecast revisions and MPS, weakens when using $\text{MPS}^{\perp}$, suggesting that it is explained by the Fed response to news channel.

Table 10
Predictability of monetary policy shocks with and without policy rate changes

	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Panel A: FFR change			
Demand	-0.27	0.43*	-0.70
	[-0.60]	[1.92]	[-1.38]
R^2	0.0053	0.1378	0.0444
Obs.	23	23	23
Panel B: No FFR change			
Demand	0.34***	0.05	0.29***
	[3.76]	[1.21]	[3.66]
R^2	0.2119	0.0164	0.1691
Obs.	80	80	80

Notes. The table reports results from regressing monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. We report the results in two subsamples: FOMCs with changes of the Federal Funds Rate (FFR) (Panel A) and without rate changes (Panel B). t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

to sell options in the morning and, upon the announcement, *VIX* drops and the S&P 500 index rises. Before information shocks, firms do not engage in option sales in the morning and *VIX* tends to rise while the S&P 500 index declines as we show in Appendix F.

In sum, firms demonstrate a strong ability to predict market movements, with the predictability of MPS from firms' morning trades primarily driven by Keynesian shocks (ε), while the role of information shocks ($a\eta^m$) is not significant. This result suggests that the information utilized by proprietary traders in their trading decisions pertains to the Fed's influence on interest rates, rather than discrepancies between the Fed's economic outlook and the financial market's estimates.

5.4 Fed communication and forward guidance

After finding that neither the “Fed response to news” nor the “information channel” explains our results, we investigate which information released at FOMC announcements induces shocks to the short-term interest rate (the “Fed shock channel”), ε, and is predictable using firms’ option trades in the morning of FOMC days. The Federal Funds Rate (FFR), which determines the overnight lending rate in the financial sector, is the Fed’s most commonly known policy tool. Out of 103 FOMC announcements in our sample period, the Fed changed the target policy rate in 23 cases, while the remaining 80 meetings did not result in a policy rate change.

In Table 10, we show that FOMC days with no change in the FFR drive our results. Firms’ morning option demand exhibits essentially zero correlation with MPS on FOMC days with a rate change (Panel A) but is significantly positively correlated with MPS on FOMC days with no FFR change (Panel B). There is some evidence that firm option demand predicts $\widehat{\text{MPS}}$ on FOMC days with FFR changes; however, this effect is quantitatively small, as $\widehat{\text{MPS}}$ explains little variation in MPS overall. On FOMC days with no rate change, the predictability is driven by $\text{MPS}^{\perp}$: a one standard deviation change in demand significantly predicts a higher $\text{MPS}^{\perp}$ by 0.29 standard deviations while the total predicted increase in MPS is 0.34 standard deviations.

FFR changes by themselves do not necessarily represent shocks, as the market factors the anticipated changes into market prices prior to the FOMC announcement. Moreover, MPS captures not only shocks to the current FFR but also shocks to the future path of policy actions (Gürkaynak, Sack, and Swanson (2005)). For instance, the Fed may leave the policy rate unchanged while communicating an expected policy rate path different from market expectations. This divergence generates variation in the “Fed shock,” ε, within our conceptual framework. Next, we break down MPS into its components to pinpoint what

Table 11

Predicting MPS components using firm option demand

Panel A: Eurodollar futures				
	ED1	ED2	ED3	ED4
Demand	0.32***	0.33***	0.31***	0.30***
	[3.39]	[3.51]	[3.40]	[3.40]
R^2	0.1033	0.1108	0.0970	0.0888
Obs.	103	103	103	103
Panel B: Other MPS				
	NS	Target	Path	TNOTE5
Demand	0.32***	0.02	0.30***	0.24**
	[3.43]	[0.17]	[3.02]	[2.55]
R^2	0.1042	0.0004	0.0925	0.0564
Obs.	103	103	103	103

Notes. Panel A reports results from regressing Eurodollar futures (ED), with maturities of 1 to 4 quarters, on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Panel B reports results from regressing other monetary policy shocks on firm morning option demand. NS is the monetary policy shocks based on Nakamura and Steinsson (2018). Target and Path is the decomposition of NS following Gürkaynak, Sack, and Swanson (2005). TNOTE5 is the 5-year Treasury note future yield responses around FOMC. Morning refers to 9:30 a.m.–9:40 a.m. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

drives the Fed shock predicted by firms.

Panel A of Table 11 shows that firms' morning demand predicts Eurodollar futures rate changes in the FOMC announcement window across all horizons up to four quarters, as included in the MPS computation by Bauer and Swanson (2023b). Furthermore, Panel B of Table 11 demonstrates that firm morning demand predicts the path component rather than the target rate component of MPS, based on updated data from Acosta, Brennan, and Jacobson (2024) utilizing the decomposition in Gürkaynak, Sack, and Swanson (2005). Specifically, the predictability is driven by changes in futures rates at horizons of up to one year, which are independent of changes in the current policy target rate. Lastly, firms' morning trades also predict movements in long-term rates during the FOMC announcement window, as evidenced by the 5-year Treasury Note rate shown in Panel B of Table 11.

Taken together, these results suggest that the Fed shock component of MPS, as predicted by proprietary trading firms, pertains to the Fed's policy communication about future actions rather than imminent changes in the policy rate. A concrete policy tool employed since 2012 is the scheduled release of dot plots as part of the Summary of Economic Projections (SEP), which is published four times a year alongside the FOMC statement. The SEP includes FOMC participants' expectations for macroeconomic variables such as GDP growth and inflation, as well as the dot plot, which provides forecasts of the FFR at horizons of up to three years. The dot plots play a significant role in shaping the financial market's interest rate expectations and can induce variation in ε when the projected policy rate path deviates from market beliefs.

We collect data from 2012 to 2023 on which of the 95 FOMC statements included an SEP and dot plot release from the Fed's website. Since 2012 marks the first year that the Fed introduced dot plots, this period captures all relevant releases. On average, the net option demand of proprietary firms in the morning of FOMC days during this period is -7,440 contracts. Strikingly, almost all variation in option demand stems from the 48 FOMC days with an SEP and dot plot release. Panel A of Table 12 shows that the average option demand is -77 contracts, with a standard deviation of 1,536, on FOMC days without an SEP release. In contrast, the average option demand is -14,650, with a standard deviation of 40,922, on FOMC days with an SEP release. Hence, firm net demand is typically close to zero in the morning of FOMC days where no release of concrete projections for macroeconomic variables and the FFR path is expected.

The fact that almost all variation in firms' morning trades is driven by FOMC announce-

Table 12

Predicting monetary policy shocks with Summary of Economic Projections (SEP)

	All	SEP	No SEP
Panel A: Summary statistics			
Mean	-7440.17	-14650.23	-76.70
SD	29868.37	40922.09	1535.99
Min	-129947	-129947	-5151
Max	86344	86344	4904
Obs.	95	48	47
Panel B: Predicting MPS with SEP			
	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Demand	0.34***	0.07	0.27***
	[2.92]	[1.57]	[2.60]
R^2	0.1178	0.0424	0.0936
Obs.	48	48	48
Panel C: Predicting MPS with no SEP			
	MPS	$\widehat{\text{MPS}}$	$\text{MPS}^{\perp}$
Demand	1.16	−0.83	1.99
	[0.62]	[−1.04]	[0.98]
R^2	0.0129	0.0114	0.0254
Obs.	47	47	47

Notes. Panel A reports summary statistics for firm morning option demand. Panel B and Panel C report results from regressing monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. All results are reported for subsamples of FOMC with and without an SEP release. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2012 to December 29, 2023.

ments with an SEP release suggests that the SEP's influence on financial markets is an input into firms' morning trades on FOMC days. Firms may have better predictive ability or access to this information, utilizing it in morning trades before it is priced in equity and the options markets.

Panel B of Table 12 reports results from predictive regressions of MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ on firms' option demand in the morning, focusing on the subsample of FOMC days with an SEP release. Panel C repeats the analysis for the subsample without an SEP. The results reveal that all of the predictability stems from FOMC announcements with an SEP. While the predictive coefficient for MPS is large on days without an SEP release, it is not statistically significant and economically negligible, given the minimal variation in firm demand on these days, as shown in Panel A. Furthermore, consistent with the evidence from the full sample in Section 5.2, firms' morning option demand predicts $\text{MPS}^{\perp}$ rather than $\widehat{\text{MPS}}$, suggesting once again that the predictability is not driven by the "Fed response to news channel."

Moreover, in most cases of large firm option sales that predict an accommodative MPS, the Fed statement and the chair's press conference mention changes in FOMC participants' policy rate projections (dot plots), as discussed in Section 5.5 below. Therefore, a natural hypothesis is that changes in dot plots are potentially direct sources of Fed shocks captured by ε in our conceptual framework. Firms that can better predict this information than the overall financial market ($|\mathbb{E}[\varepsilon] - \mathbb{E}^f[\varepsilon]| < |\mathbb{E}[\varepsilon] - \mathbb{E}^m[\varepsilon]|$) can profit by adjusting their option positions in anticipation of the upcoming market impact of this Fed shock.

We obtain data from the Fed's website and compute the median two-year policy rate projection from the dot plots. Panel A of Table 13 shows that the predictability of $\text{MPS}^{\perp}$ is driven by the subsample where the median dot plot policy rate projection changes compared to the previous dot plot release. In contrast, there is no predictability, and the correlation between $\text{MPS}^{\perp}$ and firms' morning demand is essentially zero in the subsample where the median policy rate projection remains unchanged.

Finally, we confirm in Panel B of Table 13 that the evidence of predictability for $\text{MPS}^{\perp}$ is

Table 13

Predicting monetary policy shocks accompanied with an SEP release

	$\text{MPS}^{\perp}$	$\text{MPS}^{\perp}$
Panel A: Dot plot change		
	Change	No change
Demand	0.31***	0.05
	[2.60]	[0.62]
R^2	0.1182	0.0063
Obs.	37	11
Panel B: Keynesian vs. information shocks		
	Keynesian	Information
Demand	0.39***	−0.21
	[4.28]	[−1.25]
R^2	0.1712	0.1195
Obs.	35	13

Notes. The table reports results from regressing the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$) on firm morning option demand (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days with an SEP release. Morning refers to 9:30 a.m.–9:40 a.m. MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported in the table. Panel A splits the sample based on whether the median 2-year dot plot policy rate projection changed compared to the last projection. Panel B splits the sample into Keynesian and information shocks. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

driven by Keynesian shocks accompanied by an SEP release, rather than information shocks. This finding suggests that the predictability is not attributable to the financial market's belief updates about economic variables based on the information in the SEP ($a\eta^m$). Instead, it is the Keynesian shocks (ε), which represent interest rate shocks negatively correlated with stock market movements, that drive the observed predictability.

The predictive power of firm trades in the first minutes of FOMC days for MPS suggests the possibility that certain financial intermediaries have a direct informational advantage about the content of the Fed announcement (ε). Despite the existence of a blackout period, the two-day structure of FOMC meetings introduces vulnerabilities to informal communication of policy overnight, consistent with evidence of leaks documented by Cieslak, Morse, and Vissing-Jorgensen (2019). These patterns could result from intentional informal communication by the Fed (Vissing-Jorgensen (2019), Ehrmann, Gnan, and Rieder (2023)), or increased interactions between policymakers and traders in financial institutions (Finer (2018)).

Another potential explanation is that all financial market participants have the same advance access to the upcoming Fed communication, but proprietary trading firms are better at estimating the response of short-term interest rates to the Fed information release compared to other financial market participants. To analyze this possibility, we extend our framework from Section 5.1 and model the short-term interest rate as:

$$i = ax + b\varepsilon, \tag{11}$$

where ax is defined as in equation 5, ε represents the Fed shock, including the Fed's communication of policy rate projections, and b captures how the short-term interest rates implied by Eurodollar futures react to the Fed shock.

To highlight this channel, we assume that the financial market is fully informed about the Fed's policy rule and state variables (ax), as well as the Fed's upcoming communication (e.g., via dot plots) that will impact short-term interest rates ($\mathbb{E}^m[\varepsilon] = \varepsilon$). However, financial market participants are not well-informed about b and estimate the reaction of interest rates to the FOMC announcement using b^m.[20] The financial market's expectation of the short-term interest rate prior to the announcement is then given by:

$$\mathbb{E}^m[i] = ax + b^m\varepsilon. \tag{12}$$

[20]If the financial market estimates b correctly, all three MPS components in equation 8 are equal to zero.

In this case, MPS corresponds to the financial market's expectational error in anticipating the ex-post interest rate response to the Fed shock:

$$\text{MPS} = (b - b^m)\varepsilon. \tag{13}$$

For example, suppose that all market participants, including proprietary trading firms, are aware in advance that the dot plot will reveal a downward revision in FOMC participants' policy rate projections ($\varepsilon < 0$). However, the broader financial market underestimates the response of the short-term interest rate to this news ($b > b^m > 0$), while proprietary trading firms do not. These firms can then exploit this "market response to news" channel by trading in the morning of FOMC days.

In summary, our results are driven by FOMC days where there was no actual change in the policy rate, and market interest rates responded solely to Fed communication. As a result, the predictability arises from the path component of MPS. Specifically, firm option trading activity is concentrated on FOMC days with an SEP release, which communicates FOMC members' forecasts about future policy rates. Advance access to this easily interpretable information prior to trading hours on the second day of the FOMC meeting may create profitable trading opportunities, raising questions about the costs of dot plots as a forward guidance tool employed by the Fed (e.g., Cieslak, Malamud, and Schrimpf (2020)). Another possibility is that the MPS measured using the high-frequency interest rate responses do not represent a surprise to all investors, and some proprietary trading firms have better ability in predicting the market's response to the upcoming FOMC announcement.

5.5 Discussion of FOMC day examples

In this section, we discuss representative FOMC days that align with the patterns documented in our empirical analysis. The first example is March 18, 2015. Referring to the dot plot released with the FOMC statement, the Fed chair mentioned in the press conference that "Compared with the projections made in December, most participants lowered their path for the federal funds rate, consistent with the downward revisions made to the projections for GDP growth and inflation as well as somewhat lower estimates of the longer-run normal unemployment rate." Following the announcement, The Wall Street Journal (WSJ) reported that the announcement "boosted confidence that zero interest rate policy will stay in place for longer." This announcement represented a -1.94 standard deviation monetary policy shock, and the S&P 500 rose by 1.2% over the course of the day. Additionally, ΔVIX^2_{day} was 19.2%, indicating a significant decline in option prices from 9:41 a.m. to 4:15 p.m. On this day, firm net demand for options was -129,447 contracts between 9:30 a.m. and 9:40 a.m., despite firm inventory from the previous day being just 57 contracts. Firms' sales were absorbed by customers (73,135 contracts) and market makers (41,558 contracts), resulting in substantial gains for firms as option prices fell throughout the day.

Next, we examine the numbers for March 16, 2016 which also featured an SEP. The press conference minutes refer to interest rate projections mentioning that "In other words, most Committee participants now expect that achieving economic outcomes similar to those anticipated in December will likely require a somewhat lower path for policy interest rates than foreseen at that time". Following the release of the Federal Reserve's statement, WSJ reported that "the Federal Reserve laid out a more cautious plan for interest-rate increases," after deciding to keep the policy rate unchanged. This announcement resulted in a -2.34 standard deviation monetary policy shock, driven by changes in market participants' interest rate expectations. The S&P 500 rose by 0.6% over the day, while ΔVIX^2_{day} was 9.4%, indicating a significant decline in the market's risk perception and option prices. Consistent with the previous example, firm net demand for options was -107,794 contracts between 9:30 a.m. and 9:40 a.m., representing the sale of nearly all options in inventory from the previous day (111,549 contracts). Customers (53,736 contracts) and market makers (54,038 contracts) were the primary buyers of these trades.

The final example of accommodative monetary policy is June 19, 2019, which features a -2.31 standard deviation MPS. The dot plot in the corresponding SEP included predictions of declining rates which the Fed chair referred to in the press conference: "So, generally, as I mentioned, many on the Committee do see a strengthened case—eight of those, a strengthened case for cutting rates. Eight actually wrote down rate cuts. A number of others see that the case has strengthened." Bond yields fell significantly and WSJ reported that the "Federal Reserve hinted that it could cut interest rates in the coming months if the central bank's economic outlook weakens." Driven by expectations of future rate cuts, the S&P 500 rose by 0.3%, while ΔVIX^2_{day} was 12.3%, again reflecting a notable decline in market risk perception and option prices. Proprietary trading firms positioned themselves profitably in the morning, with a net demand of -113,459 contracts, further adding to their already negative inventory of -84,226 contracts. In this instance, professional customers (37,893 contracts) and market makers (87,532 contracts) were the primary counterparties for firm sales.

While most of firms' ability to predict Fed outcomes and option price movements on FOMC days is concentrated around loosening monetary policy shocks, there are notable exceptions. For example, September 21, 2011, represents a +1.59 standard deviation monetary policy shock. On this day, the S&P 500 fell by 2.9%, driven by the announcement of "Operation Twist", which aimed to increase the share of long-term Treasuries on the Federal Reserve's balance sheet. WSJ reported that investors were skeptical about the operation's potential to meaningfully impact economic growth, employment, or consumer demand for mortgages. Consistent with this skepticism, ΔVIX^2_{day} was 29.1%, indicating a significant increase in option prices. During the morning trading period (9:30 a.m. to 9:40 a.m.), firms exhibited large positive demand, buying 88,784 contracts and nearly closing their previous short inventory of -81,167 contracts. By closing their short positions before the public learned of and reacted to the Fed's policy announcement, firms positioned themselves ahead of the significant rise in option prices.

In summary, these examples show that firm proprietary traders in S&P 500 index options markets correctly anticipate the direction of monetary policy shifts and option prices, especially when the Fed is scheduled to communicate information about the updated policy rate projections of FOMC members.

6 Conclusion

This paper examines the trading behavior of proprietary trading firms in the S&P 500 options market around Federal Open Market Committee (FOMC) announcements. Notably, proprietary trading firms act as net sellers of options on announcement days, in contrast to their behavior on other days. This liquidity provision is concentrated during morning trading and is particularly pronounced when the FOMC announcement later in the day is perceived as unexpectedly dovish and leads to a decline in market interest rates. Such rate declines are typically accompanied by falling option prices and a lower *VIX*, indicating that proprietary trading firms may be better at predicting the market impact of upcoming FOMC announcements, enabling them to trade profitably.

In further analysis, we explore the specific content of proprietary trading firms' predictive ability. We find that firms' morning trades predict the part of monetary policy shocks that is independent of public macroeconomic information. These trades are mainly focused on FOMC announcements where interest rate shocks are contractionary, aligning with New Keynesian models. Furthermore, the predictability is driven by the path component of monetary policy shocks, reflecting the impact of the Fed's communication on expected future policy rates. Larger net option positions by firms before FOMC announcements are concentrated on days when the Fed releases the Summary of Economic Projections, including dot plots that display FOMC participants' policy rate forecasts. These findings suggest that some financial institutions may have superior ability to predict the market impact of the Fed's forthcoming information, such as FOMC members' policy rate projections, which are submitted prior to and released on the second day of the two-day meeting.

While our data are aggregated at the investor-type level rather than at the institution level, the high-frequency nature of our dataset allows us to precisely identify the timing of trading activity on FOMC days. Despite this limitation, our findings highlight how monetary policy announcements provide proprietary trading firms with a distinct trading edge, particularly through their ability to anticipate the market's reaction to Fed communication. Although the Fed's communication is essential for forward guidance and anchoring expectations, our results also reveal inequality among market participants in utilizing this information that is relevant for trading decisions. This asymmetry creates profitable trading opportunities for some, potentially as an unintended consequence of precise and transparent communication that moves financial markets.

REFERENCES

Acosta, Miguel, Connor M Brennan, and Margaret M Jacobson, 2024, Constructing high-frequency monetary policy surprises from sofr futures, *Economics Letters* 242, 111873.

Alam, Zohair, 2023, Learning about fed policy from macro announcements: A tale of two fomc days, *Working paper* .

Andersen, Torben G, Nicola Fusari, and Viktor Todorov, 2015, The risk premia embedded in index options, *Journal of Financial Economics* 117, 558–584.

Bauer, Michael, and Mikhail Chernov, 2024, Interest rate skewness and biased beliefs, *The Journal of Finance* 79, 173–217.

Bauer, Michael D, Ben S Bernanke, and Eric Milstein, 2023, Risk appetite and the risk-taking channel of monetary policy, *Journal of Economic Perspectives* 37, 77–100.

Bauer, Michael D, Aeimit Lakdawala, and Philippe Mueller, 2022, Market-based monetary policy uncertainty, *The Economic Journal* 132, 1290–1308.

Bauer, Michael D, and Eric T Swanson, 2023a, An alternative explanation for the "fed information effect", *American Economic Review* 113, 664–700.

Bauer, Michael D, and Eric T Swanson, 2023b, A reassessment of monetary policy surprises and high-frequency identification, *NBER Macroeconomics Annual* 37, 87–155.

Beckmeyer, Heiner, Nicole Branger, and Thomas Gruenthaler, 2021, Fed tails: Fomc announcements and stock market uncertainty, *Working paper* .

Bernanke, Ben S, and Kenneth N Kuttner, 2005, What explains the stock market's reaction to federal reserve policy?, *The Journal of Finance* 60, 1221–1257.

Black, Fischer, and Myron Scholes, 1973, The pricing of options and corporate liabilities, *Journal of Political Economy* 81, 637–654.

Bollerslev, Tim, and Viktor Todorov, 2011, Tails, fears, and risk premia, *The Journal of Finance* 66, 2165–2211.

Chen, Hui, Scott Joslin, and Sophie Xiaoyan Ni, 2019, Demand for crash insurance, intermediary constraints, and risk premia in financial markets, *The Review of Financial Studies* 32, 228–265.

Christiano, Lawrence J, Martin Eichenbaum, and Charles L Evans, 2005, Nominal rigidities and the dynamic effects of a shock to monetary policy, *Journal of Political Economy* 113, 1–45.

Cieslak, Anna, 2018, Short-rate expectations and unexpected returns in treasury bonds, *The Review of Financial Studies* 31, 3265–3306.

Cieslak, Anna, Semyon Malamud, and Andreas Schrimpf, 2020, Policy announcement design, *Working paper* .

Cieslak, Anna, Adair Morse, and Annette Vissing-Jorgensen, 2019, Stock returns over the fomc cycle, *The Journal of Finance* 74, 2201–2248.

Cieslak, Anna, and Andreas Schrimpf, 2019, Non-monetary news in central bank communication, *Journal of International Economics* 118, 293–315.

Cochrane, John H, and Monika Piazzesi, 2002, The fed and interest rates—a high-frequency identification, *American Economic Review* 92, 90–95.

Ehrmann, Michael, Phillipp Gnan, and Kilian Rieder, 2023, Central bank communication by??? the economics of public policy leaks .

Figlewski, Stephen, 1989, Options arbitrage in imperfect markets, *The Journal of Finance* 44, 1289–1311.

Finer, David Andrew, 2018, What insights do taxi rides offer into federal reserve leakage?, *Working paper* .

Foster, F Douglas, and Subramanian Viswanathan, 1993, Variations in trading volume, return volatility, and trading costs: Evidence on recent price formation models, *The Journal of Finance* 48, 187–211.

Fournier, Mathieu, and Kris Jacobs, 2020, A tractable framework for option pricing with dynamic market maker inventory and wealth, *Journal of Financial and Quantitative Analysis* 55, 1117–1162.

Garleanu, Nicolae, Lasse Heje Pedersen, and Allen M Poteshman, 2009, Demand-based option pricing, *The Review of Financial Studies* 22, 4259–4299.

Gürkaynak, Refet S, Brian Sack, and Eric T Swanson, 2005, Do actions speak louder than words? the response of asset prices to monetary policy actions and statements, *International Journal of Central Banking* 1, 55–93.

Gürkaynak, Refet S, Brian P Sack, and Eric T Swanson, 2007, Market-based measures of monetary policy expectations, *Journal of Business & Economic Statistics* 25, 201–212.

He, Zhiguo, and Arvind Krishnamurthy, 2013, Intermediary asset pricing, *American Economic Review* 103, 732–770.

Hillenbrand, Sebastian, 2023, The fed and the secular decline in interest rates, *Working Paper* .

Jain, Prem C, and Gun-Ho Joh, 1988, The dependence between hourly prices and trading volume, *Journal of Financial and Quantitative Analysis* 23, 269–283.

Jarociński, Marek, and Peter Karadi, 2020, Deconstructing monetary policy surprises—the role of information shocks, *American Economic Journal: Macroeconomics* 12, 1–43.

Karnaukh, Nina, and Petra Vokata, 2022, Growth forecasts and news about monetary policy, *Journal of Financial Economics* 146, 55–70.

Kashyap, Anil K, and Jeremy C Stein, 2023, Monetary policy when the central bank shapes financial-market sentiment, *Journal of Economic Perspectives* 37, 53–75.

Kekre, Rohan, and Moritz Lenel, 2022, Monetary policy, redistribution, and risk premia, *Econometrica* 90, 2249–2282.

Kilic, Mete, Zhao Zhang, and Aleksandr Zotov, 2024, Risk and risk-free rates, *Working paper* .

Lucca, David O, and Emanuel Moench, 2015, The pre-fomc announcement drift, *The Journal of finance* 70, 329–371.

Mertens, Thomas M, and John C Williams, 2021, What to expect from the lower bound on interest rates: Evidence from derivatives prices, *American Economic Review* 111, 2473–2505.

Merton, Robert C, 1973, Theory of rational option pricing, *The Bell Journal of Economics and Management Science* 141–183.

Miranda-Agrippino, Silvia, and Giovanni Ricco, 2021, The transmission of monetary policy shocks, *American Economic Journal: Macroeconomics* 13, 74–107.

Nakamura, Emi, and Jón Steinsson, 2018, High-frequency identification of monetary non-neutrality: the information effect, *The Quarterly Journal of Economics* 133, 1283–1330.

Pan, Jun, and Allen M Poteshman, 2006, The information in option volume for future stock prices, *The Review of Financial Studies* 19, 871–908.

Romer, Christina D, and David H Romer, 2000, Federal reserve information and the behavior of interest rates, *American Economic Review* 90, 429–457.

Savor, Pavel, and Mungo Wilson, 2014, Asset pricing: A tale of two days, *Journal of Financial Economics* 113, 171–201.

Schmeling, Maik, Andreas Schrimpf, and Sigurd AM Steffensen, 2022, Monetary policy expectation errors, *Journal of Financial Economics* 146, 841–858.

Tian, Meng, and Liuren Wu, 2023, Limits of arbitrage and primary risk-taking in derivative securities, *The Review of Asset Pricing Studies* 13, 405–439.

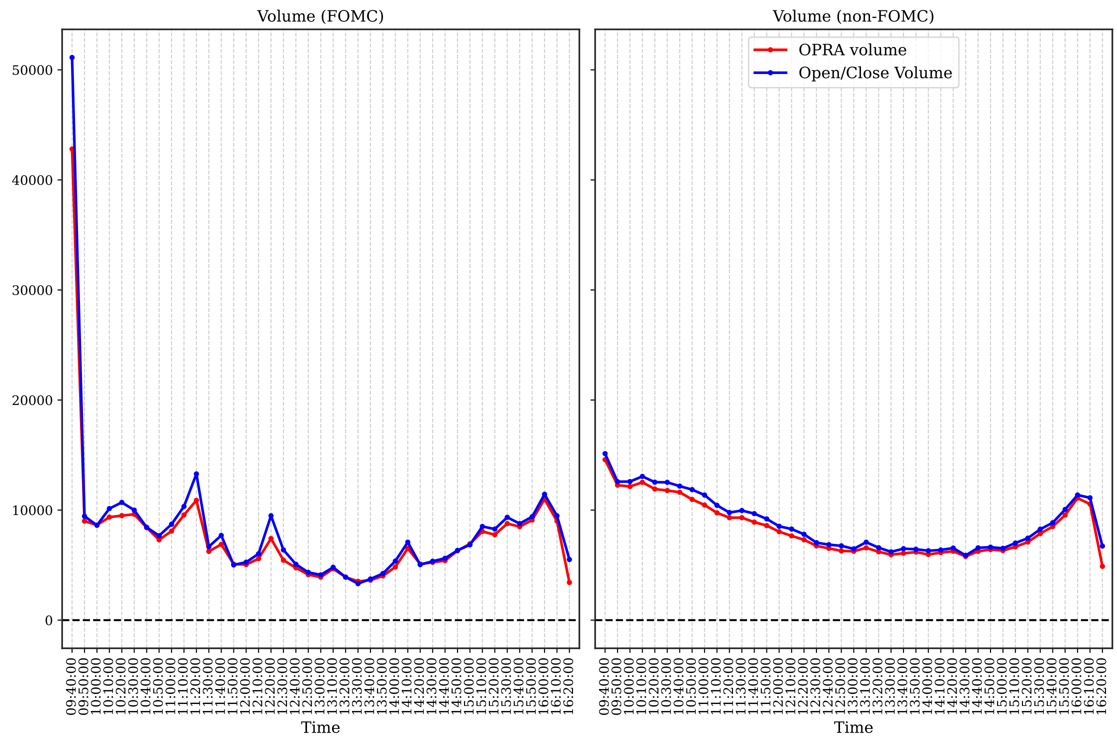
Vissing-Jorgensen, Annette, 2019, Central banking with many voices: The communications arms race, *Conference Proceedings, 23rd Annual Conference of the Central Bank of Chile* .

Appendix

A Additional tables and figures

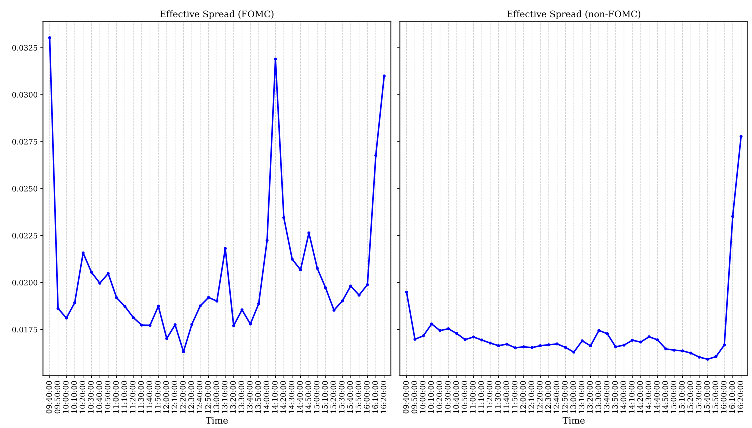
This section includes tables and figures mentioned in the main text.

Figure A.1. OPRA vs. CBOE Open/Close volume data throughout the day



Notes. The figure plots the average trading volume using transaction-level data from OPRA vs. CBOE's Open/Close database at the 10-minute frequency on FOMC (left panel) and non-FOMC (right panel) days for (16 < Exp < next FOMC) options. The sample period is from January 3, 2011 to September 29, 2023, out of which 101 are FOMC days and 3,106 are non-FOMC days.

Figure A.2. OPRA effective median spreads



Notes. This figure plots median effective spreads, calculated from OPRA transaction-level trade data for the subsample of (16 < Exp < Next FOMC) options for FOMC and non-FOMC dates. For each trade k, we calculate $ES_k^O = (2|O_k^P - O_k^M|)/O_k^M$, where O_k^P is the trade price and O_k^M the mid-price of the k^{th} trade. On each day for each 10-minute interval and each option chain O, we calculate $ES^O = \sum_k \mathrm{Vol}_k ES_k^O / \sum_k \mathrm{Vol}_k$, where VOL_k is the trade size of the k^{th} trade. We take the median ES^O for each datetime and compute the mean per time. The sample period is from January 3, 2011 to September 29, 2023 out of which 101 are FOMC days and 3,106 are non-FOMC days.

Table A.1

Summary statistics for daily option demand and monetary policy shocks

		Mean	Std.	5%	95%	Obs.
Firm	non-FOMC	5036.2	28232.1	-34033.4	50565.8	3165
	FOMC	-3628.6	31338.5	-58643.8	25618.2	103
Broker-Dealer	non-FOMC	2613.1	6269.2	-4465.4	14360.8	3165
	FOMC	1803.7	3973.3	-3954.2	8750.0	103
Customer	non-FOMC	9859.9	28296.9	-34837.4	56460.4	3165
	FOMC	18822.9	31218.1	-22235.3	72249.1	103
Prof. Customer	non-FOMC	734.6	9396.6	-12189.2	14524.4	3165
	FOMC	156.4	17509.2	-15291.4	32003.0	103
Market-Maker	non-FOMC	-18244.2	27343.2	-63602.8	17495.6	3165
	FOMC	-17154.3	32317.1	-62864.9	26487.2	103
MPS	FOMC	0.0000	1.0000	-1.8036	1.9937	103

Notes. This table reports summary statistics for daily net option demand aggregated by investor type on non-FOMC and FOMC days. The units are number of contracts. Net option demand is computed as buy minus sell volume. MPS is the standardized monetary policy shock. The sample period is from January 3, 2011 to December 29, 2023.

Table A.2

Daily option demand and orthogonalized monetary policy shocks

	Firm	Broker-Dealer	Customer	Prof-Customer	Market Maker
			Panel A: All days		
FOMC	-6141.49**	398.78**	3684.86*	297.04	1761.17
	[-2.07]	[2.11]	[1.86]	[0.20]	[0.69]
$MPS^{\perp}$	8841.61**	-455.96**	-3313.47	-767.70	-4304.48
	[2.21]	[-2.47]	[-1.24]	[-0.31]	[-1.22]
Cons.	804.49	207.23***	490.92	1552.33***	-3055.34***
	[1.61]	[3.29]	[1.12]	[6.57]	[-8.23]
R^2	0.0086	0.0013	0.0028	0.0004	0.0020
Obs.	3268	3268	3268	3268	3268
			Panel B: FOMC days		
$MPS^{\perp}$	8841.61**	-455.96**	-3313.47	-767.70	-4304.48
	[2.21]	[-2.47]	[-1.24]	[-0.31]	[-1.22]
Cons.	-5337.00*	606.02***	4175.79**	1849.37	-1294.17
	[-1.81]	[3.34]	[2.11]	[1.20]	[-0.51]
R^2	0.0793	0.0574	0.0262	0.0024	0.0265
Obs.	103	103	103	103	103

Notes. Panel A reports results from regressing daily net option demand aggregated by investor type on a dummy variable for FOMC days and the orthogonalized monetary policy shock ($MPS^{\perp}$) from Bauer and Swanson (2023b). Panel B reports results using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.3

Summary statistics for daily option demand by maturity group

			Mean	Std.	5%	95%	Obs.
Firm	Exp < next FOMC	non-FOMC	6503.8	27413.1	-31789.4	51691.4	3165
		FOMC	-1323.2	32322.0	-51352.9	31563.5	103
	16 < Exp < next FOMC	non-FOMC	804.5	19957.9	-19637.8	19456.6	3165
		FOMC	-5337.0	31396.8	-75360.6	15203.8	103
Broker Dealer	Exp < next FOMC	non-FOMC	2790.5	5963.8	-3490.8	14147.0	3165
		FOMC	2313.4	3548.0	-2195.7	8728.0	103
	16 < Exp < next FOMC	non-FOMC	207.2	2969.6	-3018.0	3836.8	3165
		FOMC	606.0	1903.4	-1309.1	4220.5	103
Customer	Exp < next FOMC	non-FOMC	6330.9	27829.2	-37719.6	52342.6	3165
		FOMC	13703.2	27542.1	-22996.2	54457.9	103
	16 < Exp < next FOMC	non-FOMC	490.9	16346.1	-23691.0	25372.4	3165
		FOMC	4175.8	20453.5	-22106.3	35464.2	103
Prof. Customer	Exp < next FOMC	non-FOMC	658.0	9347.1	-12070.0	14508.4	3165
		FOMC	-328.0	17258.9	-15725.6	31753.6	103
	16 < Exp < next FOMC	non-FOMC	1552.3	6917.2	-4309.0	10040.2	3165
		FOMC	1849.4	15711.3	-10611.4	21133.3	103
Market Maker	Exp < next FOMC	non-FOMC	-16283.4	26648.3	-59915.0	17528.0	3165
		FOMC	-14365.4	32125.0	-63167.9	40562.6	103
	16 < Exp < next FOMC	non-FOMC	-3055.3	17792.9	-24875.4	18615.8	3165
		FOMC	-1294.2	26428.0	-35366.7	38945.5	103

Notes. This table reports summary statistics for daily net option demand aggregated by investor type on non-FOMC and FOMC days. The units are number of contracts. Net option demand is computed as buy minus sell volume. Results are reported for the (Exp < next FOMC) and (16 < Exp < next FOMC) options (defined in the text) separately. The sample period is from January 3, 2011 to December 29, 2023.

Table A.4

Summary statistics for firm demand in the morning and the rest of the day

		Mean	Std.	5%	95%	Obs.
Panel A: Share						
Morning volume share	non-FOMC	0.0325	0.0883	0.0000	0.1041	3165
	FOMC	0.1393	0.2311	0.0000	0.7366	103
Panel B: All options						
Morning demand	non-FOMC	-35.0	14097.4	-2269.2	1663.4	3165
	FOMC	-6003.1	30243.5	-75850.6	13148.0	103
Rest of day demand	non-FOMC	839.5	13975.6	-16583.0	17866.8	3165
	FOMC	666.1	9576.8	-14045.0	13193.9	103
Panel C: Puts						
Morning demand	non-FOMC	-58.4	11957.6	-1766.6	1367.4	3165
	FOMC	-5105.9	25668.6	-60743.9	9884.1	103
Rest of day demand	non-FOMC	67.6	12662.1	-15856.2	15127.6	3165
	FOMC	-580.8	8923.8	-15780.5	11434.7	103
Panel D: Calls						
Morning demand	non-FOMC	23.4	2379.6	-1082.2	897.0	3165
	FOMC	-897.3	4812.3	-15248.0	2204.7	103
Rest of day demand	non-FOMC	771.9	6178.6	-8483.4	11046.4	3165
	FOMC	1246.9	5304.4	-7305.1	11146.6	103

Notes. This table reports summary statistics for firm net option demand (buy minus sell) aggregated by investor type on non-FOMC and FOMC days using data at 10-minute frequency. Morning refers to 9:30 a.m. – 9:40 a.m. Rest of day refers to 9:40am–4:15pm. The units are number of contracts. Net option demand is computed as buy minus sell volume. Results are reported for Put and Call options separately and the sample is restricted to (16 < Exp < next FOMC) options. The sample period is from January 3, 2011 to December 29, 2023.

Table A.5

Morning vs. rest-of-day option demand and orthogonalized monetary policy shocks

	Morning	Rest
Panel A: All days		
FOMC	-5968.16**	-173.34
	[-2.10]	[-0.18]
$MPS^{\perp}$	8511.08**	330.53
	[2.09]	[0.46]
Cons.	-34.99	839.48**
	[-0.14]	[2.11]
R^2	0.0151	0.0000
Obs.	3268	3268
Panel B: FOMC days		
$MPS^{\perp}$	8511.08**	330.53
	[2.09]	[0.46]
Cons.	-6003.15**	666.15
	[-2.11]	[0.71]
R^2	0.0792	0.0012
Obs.	103	103

Notes. Panel A reports results from regressing firm option demand on a dummy variable for FOMC days and the orthogonal monetary policy shock ($MPS^{\perp}$) from Bauer and Swanson (2023b). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. Morning refers to 9:30 a.m.–9:40 a.m. Rest of day refers to 9:40 a.m.–4:15 p.m. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.6

Summary statistics for VIX^2 returns

		Mean	Std.	5%	95%	Obs.
ΔVIX^2_{on}	non-FOMC	1.78	10.71	-13.13	19.96	3165
	FOMC	-0.86	9.48	-14.38	9.48	103
ΔVIX^2_{day}	non-FOMC	-0.39	13.53	-15.93	21.00	3165
	FOMC	-1.46	14.62	-19.74	18.32	103
ΔVIX^2_{fomc}	FOMC	-3.01	6.20	-13.33	5.99	103

Notes. This table reports summary statistics from the rate of change in VIX^2 in percent on each day computed from changes in squared VIX index using intraday VIX data. ΔVIX^2_{on} is based on the change of VIX^2 from last day's close to current day's 9:41 a.m. ΔVIX^2_{day} is based on the change of VIX^2 from current day's 9:41 a.m. to market close. ΔVIX^2_{fomc} is based on the change of VIX^2 from 10 minutes before to 20 minutes after the FOMC announcement. The sample period is from January 3, 2011 to December 29, 2023.

Table A.7

Daily option demand, monetary policy, and other macroeconomic announcements

	Firm	Broker-Dealer	Customer	Prof-Customer	Market Maker
Panel A: All days without macro announcement					
FOMC	-5973.12*	519.11***	2720.63	626.35	2107.50
	[-1.78]	[2.76]	[1.19]	[0.32]	[0.75]
MPS	11127.91**	-697.79***	-3439.26	-2755.60	-4235.26
	[2.35]	[-3.36]	[-1.26]	[-0.88]	[-0.99]
Cons.	269.63	205.02***	807.49*	1573.72***	-2856.33***
	[0.54]	[2.92]	[1.76]	[6.41]	[-7.19]
R^2	0.0135	0.0025	0.0021	0.0040	0.0022
Obs.	2537	2537	2537	2537	2537
Panel B: FOMC days without macro announcement					
MPS	11127.91**	-697.79***	-3439.26	-2755.60	-4235.26
	[2.35]	[-3.36]	[-1.26]	[-0.88]	[-0.99]
Cons.	-5703.49*	724.12***	3528.12	2200.07	-748.83
	[-1.71]	[4.05]	[1.54]	[1.11]	[-0.27]
R^2	0.1199	0.1599	0.0260	0.0234	0.0254
Obs.	80	80	80	80	80

Notes. Panel A reports results from regressing daily net option demand aggregated by investor type on a dummy variable for FOMC days and the monetary policy shock (MPS) for days where no other macroeconomic announcement took place. We focus on other macro announcements including unemployment, non-farm payroll, consumer price index, GDP, and industrial production. Panel B runs the regression using data from FOMC days when there were no other macroeconomic announcements. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.8

Comovement of VIX changes and MPS around FOMC

	ΔVIX^2_{fomc}	ΔVIX^2_{fomc}	ΔVIX^2_{fomc}
MPS	2.26***		
	[3.64]		
$\text{MPS}^{\perp}$		2.22***	
		[3.19]	
$\widehat{\text{MPS}}$			1.71
			[0.93]
R^2	0.1332	0.1132	0.0136
Obs.	103	103	103

Notes. The table reports results from regressing the rate of change in VIX^2 from 10 minute before to 20 minutes after the announcement (ΔVIX^2_{fomc}) on monetary policy shocks (MPS), the predictable component of monetary policy shocks ($\widehat{\text{MPS}}$), and the orthogonal component of monetary policy shocks ($\text{MPS}^{\perp}$). MPS, $\widehat{\text{MPS}}$, and $\text{MPS}^{\perp}$ are normalized by the standard deviation of MPS. All regressions include an intercept which is not reported in the table. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.9

Predicting monetary policy shocks with firm morning demand and its lags

	(1)	(2)	(3)	(4)	(5)
Morning Demand	0.32***			0.33***	0.32***
	[3.46]			[3.55]	[3.44]
Demand(-1)		0.23		0.15	
		[0.91]		[0.59]	
Demand(-2)		0.03		0.17	
		[0.10]		[0.63]	
Demand(-3)		-0.14		-0.05	
		[-0.88]		[-0.29]	
Demand(-4)		-0.11		-0.11	
		[-1.41]		[-1.40]	
Demand(-5)		-0.02		-0.04	
		[-0.51]		[-0.76]	
Demand(-5 to -1)			-0.04		-0.02
			[-0.81]		[-0.62]
R^2	0.1053	0.0156	0.0033	0.1183	0.1067
Obs.	103	103	103	103	103

Notes. This table reports results from regressing monetary policy shocks (MPS) on firm option morning demand (Morning Demand) and its lags (-1 to -5) normalized to have zero mean and unit standard deviation on FOMC announcement days. (-5 to -1) refers to the sum of Demand(-1) to Demand(-5). Morning refers to 9:30 a.m.–9:40 a.m. Net option demand is computed as buy minus sell volume. All regressions include an intercept which is not reported here. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

B Data

B.1 Data sources

This section details the data sources and sample periods used in our analysis.

CBOE 10-minute volume. We focus on S&P 500 index options traded exclusively on the CBOE, with data provided by CBOE. Specifically, we analyze SPX and SPXW options, excluding FLEX, SPXQ, and SPXPM options. The open/close data offers detailed 10-minute information on buy and sell trading activity that either increases (opening) or decreases (closing) open interest, broken down by five investor types: firms, broker-dealers, customers, professional customers, and market makers. The sample spans from January 3, 2011, to December 29, 2023. For each day, we compute net demand by summing up buys minus sells for each investor type. As SPX/SPXW options are European, we calculate high-frequency inventory for each contract and participant by aggregating net demand over time, starting from the contract's first trade. A contract exits the inventory upon expiration.

Intraday CBOE *VIX*. We obtain intraday *VIX* index prices from the CBOE for the period spanning January 3, 2011, to December 29, 2023. Data is transmitted at approximately 15-second intervals. Beginning April 15, 2016, *VIX* is also quoted overnight, starting at 3:15 a.m. and continuing until 9:15 a.m. Regular trading resumes at 9:30 a.m. and concludes at 4:15 p.m., aligning with the *VIX* closing price.

B.2 Open/Close 10-minute interval data

Trading intervals. The raw data from CBOE (Link to Cboe website) consists of 41 files covering 10-minute intervals between 9:30 a.m. and 4:20 p.m. U.S. Eastern Time, corresponding to Regular Trading Hours (RTH), which span from 9:30 a.m. to 4:15 p.m. The 9:30 a.m. timestamp exclusively reflects overnight trading activity during Global Trading

Hours (GTH), which run from 8:15 p.m. to 9:25 a.m. Therefore, the 9:40 a.m. timestamp captures trading activity from the first 10 minutes of the RTH session.

CBOE began collecting GTH 10-minute interval data on December 11, 2023. After RTH, the Curb session runs from 4:30 p.m. to 5:00 p.m., with CBOE providing data in four additional 10-minute interval files. Additionally, there are two single files recorded at 6:00 p.m. and 7:00 p.m., respectively.

Aggregation method. Trade count and volume (number of contracts traded) are aggregated by investor types and time intervals throughout the day. For each option traded, CBOE provides the cumulative trade volume data at 10-minute intervals throughout the trading day. To calculate the traded volume for each option chain, we first record the initial trade for each option on a given day. Then, we compute the difference in cumulative volume across intervals to determine traded volume. Finally, the first trade is added back to the option chain to ensure completeness.

C Demand for put and call options

Appendix Table A.10 presents summary statistics for put and call demand. On non-FOMC days, market makers are net suppliers of puts, while other investor types exhibit positive net demand. For calls, market makers display a positive net demand on average, while customers sell more calls than they purchase. Across all investor types, average call demand tends to have smaller magnitudes and standard deviations compared to put demand. On FOMC days, firms shift to being net suppliers of puts, while their call demand decreases but remains positive.

Appendix Table A.11 reports the response of put demand to monetary policy announcements for all investor types. On non-FOMC days, net firm demand for puts is effectively zero, but this changes drastically on FOMC days. Panel B shows that firms exhibit significantly negative net demand for puts on FOMC days, averaging -5,687 contracts, which is offset by significant positive put demand from customers.

Moreover, firm put sales increase sharply in response to loosening monetary policy shocks (MPS < 0). A one standard deviation decrease in MPS more than doubles the new short positions that firms take in S&P 500 puts. Over half of these short positions are offset by customers and professional customers, with the remainder taken on by market makers. Overall, net firm demand for puts shows a stronger correlation with MPS compared to any other investor type, including market makers.

We also find a significant response of firm call demand to MPS, though smaller than the response for puts in terms of the number of contracts, as shown in Appendix Table A.12. On non-FOMC days, firms, professional customers, and market makers are net buyers of calls, while customers are net sellers, as indicated by the regression intercept in Panel A. In contrast, on FOMC days, average call demand is not significantly different from zero for any investor type, as shown by the regression intercept in Panel B. Firms engage in significant call sales in response to negative interest rate shocks, with most of these sales absorbed by professional customers and market makers.

Appendix D.1 provides additional details on firms' put option demand. Specifically, we demonstrate that the results in Appendix Table A.11 are primarily driven by out-of-the-money (OTM) put options. Furthermore, demand for deep OTM puts with moneyness below 90% exhibits a stronger reaction to MPS compared to moderately OTM options, as measured by the number of contracts.

D Additional results on option demand on FOMC days

D.1 Firm demand for OTM and deep OTM puts

Appendix Table A.13 reports the response of firm option demand to monetary policy shocks for out-of-the-money (OTM) and in-the-money (ITM) puts. On non-FOMC days, firm net demand for OTM puts is close to zero, indicating balanced average trading in these options. However, all average option sales by firms, as well as the expansion of short positions in response to negative MPS shocks, are concentrated in OTM puts. Firms are net sellers of ITM puts, but their positions in these options remain unaffected by monetary policy announcements.

Another important consideration is whether firms dynamically hedge the risks associated with their short positions in OTM puts on the S&P 500 index induced by negative MPS shocks. While options are theoretically redundant securities whose risks can be eliminated through delta hedging in the Black and Scholes (1973) and Merton (1973) no-arbitrage framework, transaction costs, limits to arbitrage and higher-order risks constrain investors' ability to fully hedge the risks associated with liquidity provision (Figlewski (1989)).

The inherently unhedgeable portion of option inventory risk has prompted a growing literature on market makers' roles in the option market, highlighting the residual risks of dynamically delta-hedged positions (Garleanu, Pedersen, and Poteshman (2009), Fournier and Jacobs (2020), Tian and Wu (2023)). In particular, Chen, Joslin, and Ni (2019) demonstrate that the effectiveness of dynamic hedging is significantly weaker for deep OTM index put options compared to moderately OTM or ITM options.

We divide the sample into deep OTM options (Moneyness < 0.9) and moderately OTM options ($0.9 <$ Moneyness < 1) and report the results in Appendix Table A.14. The findings indicate that firms are net sellers of deep OTM options and net buyers of moderately OTM options on non-FOMC days. This behavior suggests that firms sell insurance against extreme tail risks while hedging themselves by purchasing insurance against moderate downside risks. Given the downward-sloping implied volatility curve, this strategy can be profitable as it captures the tail risk premium in the S&P 500 index option market documented by Bollerslev and Todorov (2011). Importantly, left tail risk is not fully captured by traditional risk factors in the options market, such as volatility risk (Andersen, Fusari, and Todorov (2015)).

D.2 Option inventory around FOMC announcements

Panel A of Appendix Table A.15 indicates that, while firms generally hold negative average option inventory, they accumulate positive inventory on the day prior to FOMC announcements. This increase in firm inventory corresponds to a decrease in customer inventory, consistent with the findings of Beckmeyer, Branger, and Gruenthaler (2021), who argue that option prices—particularly for options providing tail risk insurance—rise before FOMC days due to reduced option supply. The results in Panel A suggest that the reduced supply to customers is driven by higher firm inventory rather than changes in market maker inventory. Panel B further shows that option inventory for any investor category does not significantly predict monetary policy shocks. This finding suggests an absence of superior information prior to FOMC days.

We also examine whether morning trades on FOMC days can be attributed to mean reversion of inventory from the previous day or if they are instead driven by the upcoming MPS. Appendix Table A.16 shows that morning FOMC demand is not significantly related to lagged inventory. Furthermore, the significant positive relationship between firm morning demand and MPS remains robust after controlling for inventory from the previous day. This suggests that while firms tend to increase inventory prior to FOMC days, the magnitude of this inventory does not explain the relationship between firm morning demand and

MPS. Similarly, other investor categories also show no significant relationship between their morning demand and lagged inventory on FOMC days.

Similarly, Appendix Table A.17 demonstrates that firm inventory does not improve the prediction of monetary policy shocks beyond the information contained in firm morning trades. The only significant predictors of MPS are broker-dealer demand, market maker demand, and firm demand. Among these, firm demand has by far the greatest predictive power, explaining 11% of the variation in MPS (R^2).

E Additional analyses on monetary policy uncertainty and option demand

E.1 Monetary policy uncertainty

We investigate whether the information in firms' morning option demand on FOMC days prevails when monetary policy uncertainty (MPU) is high, using the option implied MPU by Bauer, Lakdawala, and Mueller (2022). These authors apply CBOE's *VIX* methodology to Eurodollar futures to obtain market-based measures of MPU at the daily frequency. [21]

For each scheduled FOMC meeting, we analyze the MPU on the day preceding the announcement to assess the market's uncertainty about the Fed's upcoming decision. Across 103 FOMC days in our sample period, the average MPU on the day before the announcement is 21.0%. Furthermore, MPU is highly right-skewed before FOMC days, with a skewness of 3.21. The median MPU of 7.1% is notably lower than the mean, indicating significant asymmetry.[22] We verify MPU's ability to predict large unexpected monetary policy shocks

[21] Updated data is available from the San Francisco Fed's Center for Monetary Research website. The underlying for the options is the 3-month LIBOR rate until September 2022 and the SOFR rate starting in October 2022. We opt for the interest rate *VIX* that is computed for the 6-month maturity which is obtained by linearly interpolating conditional variances as in CBOE's computation method for the *VIX* index.

[22] The average *VIX* index on the same set of days is 18.3%, with a skewness of 1.56.

by regressing the absolute value of the normalized MPS, |MPS|, on MPU (Column 1 of of Appendix Table A.18), validating its use as a conditional volatility measure for Eurodollar futures rates.

Next, we investigate the information content of MPU and firms' option demand for positive and negative MPS. To do so, we compute $|\text{MPS}|^+ = |\text{MPS}|$ x (MPS $>$ 0) and $|\text{MPS}|^- = |\text{MPS}|$ x (MPS $<$ 0), which are equal to |MPS| if MPS is positive and negative, respectively, and zero otherwise. Column 1 of Appendix Table A.19 shows that MPU predicts the size of positive MPS but |Demand| does not, where Demand is the firms' normalized morning option demand on the FOMC day. However, |Demand| has strong predictive power for negative MPS shocks controlling for MPU. Hence, the predictive abilities of MPU and |Demand| for |MPS| are distinct. While both higher option-implied MPU and greater firm option trading activity predict larger movements in MPS, MPU is more effective at predicting tightening shocks, whereas the large firm option demand regardless of its sign is associated with upcoming monetary easing shocks beyond the predictive ability of MPU.

Bauer, Lakdawala, and Mueller (2022) emphasize that daily changes in MPU are significantly lower on FOMC announcement days consistent with the resolution of monetary policy uncertainty. We compute the daily change in MPU by computing the rate of change in conditional interest rate variance: $\Delta\text{MPU}_t = \text{MPU}_t^2/\text{MPU}_{t-1}^2 - 1$. Consistent with Bauer, Lakdawala, and Mueller (2022), the average ΔMPU_t is lower by 6.1 percentage points on FOMC announcement days compared to other days in our sample period from January 2011 to December 2023.

Columns 1 and 2 in Panel A of Appendix Table A.20 shows that firm option demand in the morning of FOMC announcement days is positively correlated with MPU resolution, also controlling for the level of MPU. This relation is not necessarily predictive given that ΔMPU is measured as the change of MPU^2 from the last day's close to the FOMC day's close while firm demand takes place between 9:30 a.m. and 9:40 a.m. of the FOMC day. However, as a proxy for uncertainty resolution overnight and the rest of the day, we control for ΔVIX^2_{on} and ΔVIX^2_{day} and observe that demand still positively correlated with MPU resolution (Columns 3 and 4 in Panel A of Appendix Table A.20). In sum, firms engage in option sales when a larger fraction of MPU is expected to be resolved, consistent with predicting option selling at a higher price in a case where they are expected to lose value. In addition, Panel B of Appendix Table A.20 shows that the predictability of ΔVIX^2_{day} using firm option demand in the morning of FOMC days is unaffected by controlling for MPU, ΔVIX^2_{on}, and the level of VIX^2 at 09:41 a.m. on FOMC days. Finally, Appendix Table A.21 shows that lagged MPU does not predict MPS and does not interfere with the firm option demand's ability to predict MPS.

As an alternative proxy for monetary policy uncertainty, we compute the difference between the 85^{th} and 15^{th} percentiles (IRRANGE) of the conditional 2-year interest rate distribution using data from Mertens and Williams (2021), where they compute option-implied conditional distributions of interest rates taking the zero lower bound into account.

Appendix Table A.22 shows that IRRANGE, similar to MPU, predicts the absolute value of MPS shocks and that this predictability is stronger for the upside realizations of MPS. Furthermore, Appendix Table A.23 shows that lagged IRRANGE does not predict MPS and does not interfere with the firm option demand's ability to predict MPS.

E.2 Interest rate skewness

Section 3 demonstrates that firms' morning option demand can predict monetary policy shocks, raising the question of whether firms have an informational advantage over other market participants regarding the upcoming interest rate shock induced by the Fed. Measures of forward-looking volatility are not intended to capture asymmetry in interest rate shocks.

To quantify this asymmetry, Bauer and Chernov (2024) compute option-implied interest rate skewness (ISK) using options on 10-year Treasury Note futures. In addition to their findings on the role of conditional skewness for bond risk premia and forecast errors, they show that ISK measured on days prior to FOMC announcements predicts MPS. They argue that some variation in MPS is predictable, raising questions about its suitability as a shock measure. We investigate whether the predictive abilities of firm option demand and ISK for MPS are distinct.

Column 1 of Table A.24 shows that lagged ISK predicts MPS during our sample period from 2011 to 2023, consistent with the findings of Bauer and Chernov (2024) in a longer sample. While firms' morning option demand also predicts MPS (Column 2), ISK and demand capture distinct variations in MPS (Column 3), with only minor differences in predictive coefficients between the univariate and bivariate regressions. Moreover, firm option demand orthogonalized by ISK remains a significant predictor (Column 4). This finding is notable because Bauer and Chernov (2024) demonstrate that ISK's predictive power for MPS is largely driven by loosening monetary policy shocks, similar to firms' option demand. Our results indicate that, although both predict loosening shocks, firms' demand predicts variations in MPS not captured by ISK. Thus, the informational advantage of firms regarding the direction and magnitude of upcoming interest rate shocks is not fully reflected in the information priced into Treasury Note options.

F Keynesian vs. information shocks

In this section, we examine the relation between MPS, option prices, and firm option demand on FOMC days featuring Keynesian and information shocks as defined in Section 5.3.

Appendix Table A.25 presents results from firm's morning option demand's predictive ability for MPS, changes in VIX^2 and S&P 500 on FOMC days.[23] As shown in Appendix Table A.25, the predictive power of morning option demand for orthogonalized MPS with a positive sign is driven by Keynesian shocks. The predictive relation is negative, albeit statistically insignificant, on FOMC days with information shocks. However, firm option demand predicts ΔVIX^2_{fomc} and the high frequency response of S&P 500 during the announcement window regardless of whether the shock is Keynesian or information. This result holds for ΔVIX^2_{fomc} as well.

What explains the result that firms' morning demand on FOMC days go in the right direction of option price changes regardless of the MPS type, even though demand predicts MPS with opposite signs in cases of Keynesian and information shocks? The answer lies in the differential response of option prices to MPS that we document in Appendix Table A.26. There is no significant difference between ΔVIX^2_{fomc} between FOMC announcement with Keynesian and information shocks, and MPS is significantly positively correlated with ΔVIX^2_{fomc} on average (the first two columns in Table A.26). However, accommodating MPS which are accompanied by an increase in the S&P 500 index by construction during Keynesian shocks also lead to a decline in VIX^2 in the announcement window. In contrast, lower MPS are associated with a drop in S&P 500 and an increase in VIX^2 in case of information shocks. This result suggests that the negative correlation between the S&P 500 return and ΔVIX^2_{fomc} holds regardless of the MPS type. Consequently, firm option demand predicts the change in option prices around the announcement with a positive sign regardless of the MPS type as well. When the shock will be Keynesian, firms tend to sell before an accommodative announcement and VIX drops after the announcement. In case of information shocks, an accommodative announcement leads to an increase in VIX and

[23] The dummy variable KEYN for Keynesian shocks can be calculated after the announcement window. As a result, the regressions are not meant to predict whether the shock will be Keynesian or information, but documents differences in predictability after shocks is retrospectively classified into Keynesian and information.

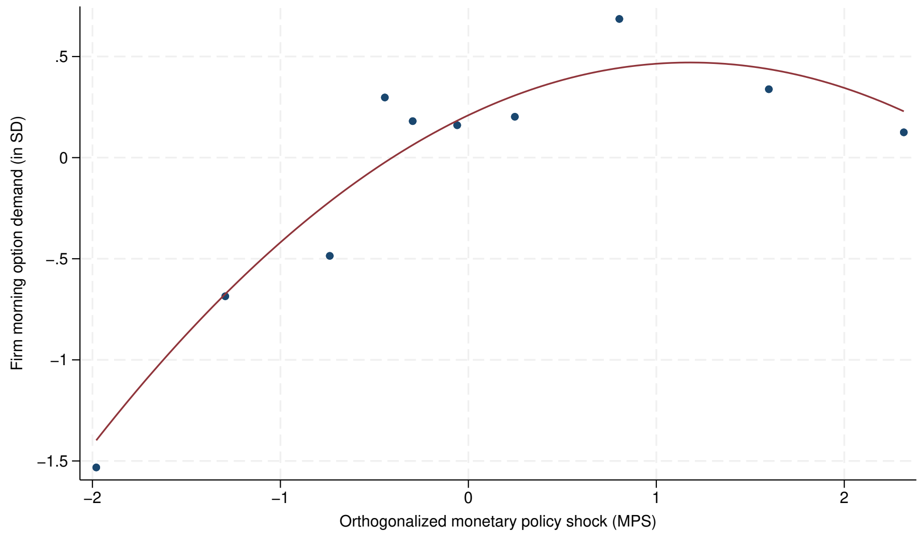
firms' morning demand is higher in these cases.

Finally, Appendix Figure A.3 illustrates the relation between firms' morning option demand and ortgonalized MPS. MPS exhibit higher dispersion during Keynesian shocks exhibiting a positive and concave relation between MPS and demand. However, information shocks are smaller and have a negative relation with firms' morning demand for options on FOMC days.

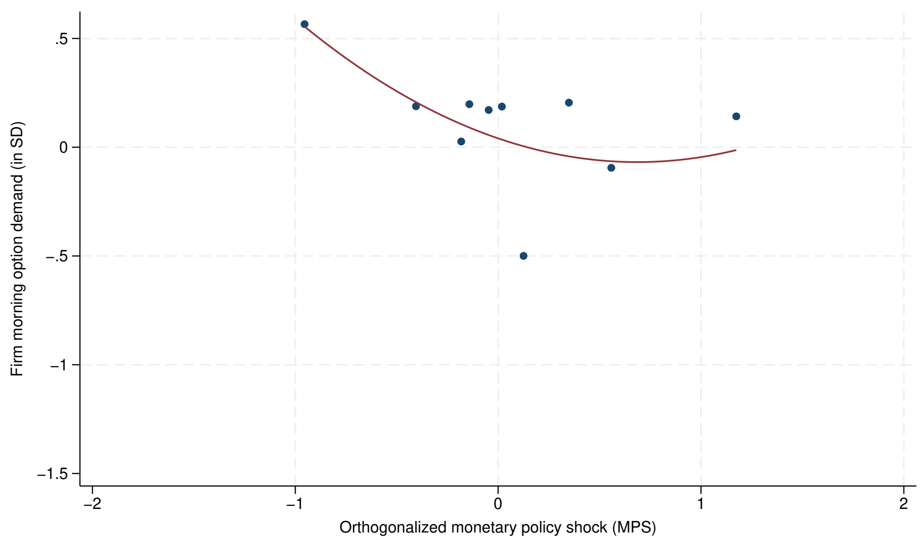
G Appendix tables and figures

This section includes tables and figures mentioned in the Appendix sections.

Figure A.3. Firm Morning Demand as a Function of Orthogonalized MPS Shocks



(a) Keynes channel



(b) Info channel

Notes. This figure shows a binscatter plot of standardized firm morning demand against orthogonalized MPS shocks for the Keynes (Panel A) and Info (Panel B) channels. We label announcements where the change in S&P 500 E-Mini futures and $MPS^{\perp}$ from Bauer and Swanson (2023b) in the 30-minute announcement window have opposite signs as "Keynesian shocks", and "Info shocks" otherwise. Out of 103 scheduled FOMC announcements in our sample period, 57 are classified as Keynesian shocks and 46 as information shocks. The sample period is from January 3, 2011 to December 29, 2023.

Table A.10

Summary statistics for daily put and call demand

		Mean	Std.	5%	95%	Obs.
		Panel A: Puts				
Firm	non-FOMC	9.2	17320.2	-17956.6	16314.0	3165
	FOMC	-5686.6	26675.9	-58520.9	15526.9	103
Broker Dealer	non-FOMC	109.6	3091.6	-3499.6	3862.0	3165
	FOMC	363.7	2458.3	-2467.5	4205.0	103
Customer	non-FOMC	2259.1	13879.6	-17321.0	23768.6	3165
	FOMC	4659.3	18831.0	-15982.9	34518.4	103
Prof. Customer	non-FOMC	1363.9	6490.4	-3759.4	8918.4	3165
	FOMC	1970.2	14087.4	-9605.4	18917.8	103
Market-Maker	non-FOMC	-3742.2	15137.7	-23581.4	13234.6	3165
	FOMC	-1306.5	23017.6	-39731.5	30640.8	103
		Panel B: Calls				
Firm	non-FOMC	795.3	6728.0	-9018.6	11348.0	3165
	FOMC	349.6	7437.5	-13050.1	11999.8	103
Broker Dealer	non-FOMC	97.6	2140.2	-2238.0	2969.8	3165
	FOMC	242.3	1893.5	-1770.9	2814.0	103
Customer	non-FOMC	-1768.2	8282.2	-14641.8	10406.2	3165
	FOMC	-483.5	7613.2	-11700.8	10014.1	103
Prof. Customer	non-FOMC	188.5	1686.4	-2231.4	2921.4	3165
	FOMC	-120.8	2258.5	-3408.6	2577.7	103
Market-Maker	non-FOMC	686.9	7884.5	-11951.6	12405.0	3165
	FOMC	12.3	8095.6	-12014.1	14185.9	103

Notes. This table reports summary statistics for daily net option demand aggregated by investor type on non-FOMC and FOMC days. The units are number of contracts. Net option demand is computed as buy minus sell volume. Results are reported for Put and Call options separately and the sample is restricted to (16 $<$ Exp $<$ next FOMC) options. The sample period is from January 3, 2011 to December 29, 2023.

Table A.11

Daily put demand and monetary policy

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
			Panel A: All days		
FOMC	-5695.78**	254.07	2400.18	606.28	2435.67
	[-2.29]	[1.04]	[1.31]	[0.44]	[1.08]
MPS	8804.23**	-282.84*	-3155.42	-1767.68	-3598.29
	[2.42]	[-1.76]	[-1.35]	[-0.85]	[-1.13]
Cons.	9.15	109.60**	2259.14***	1363.88***	-3742.20***
	[0.03]	[1.98]	[9.13]	[11.82]	[-13.87]
R^2	0.0109	0.0005	0.0025	0.0023	0.0025
Obs.	3268	3268	3268	3268	3268
			Panel B: FOMC days		
MPS	8804.23**	-282.84*	-3155.42	-1767.68	-3598.29
	[2.42]	[-1.76]	[-1.35]	[-0.85]	[-1.13]
Cons.	-5686.62**	363.67	4659.32**	1970.16	-1306.52
	[-2.30]	[1.52]	[2.56]	[1.44]	[-0.59]
R^2	0.1089	0.0132	0.0281	0.0157	0.0244
Obs.	103	103	103	103	103

Notes. Panel A reports results from regressing daily net put option demand aggregated by investor type on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.12

Daily call demand and monetary policy

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
			Panel A: All days		
FOMC	-445.72	144.72	1284.69*	-309.24	-674.51
	[-0.62]	[0.77]	[1.69]	[-1.41]	[-0.84]
MPS	1523.69**	-272.74**	-153.04	-401.08	-696.83
	[2.05]	[-2.04]	[-0.27]	[-1.14]	[-0.80]
Cons.	795.34***	97.63**	-1768.22***	188.45***	686.85***
	[6.67]	[2.56]	[-12.02]	[6.27]	[4.90]
R^2	0.0017	0.0007	0.0007	0.0027	0.0005
Obs.	3268	3268	3268	3268	3268
			Panel B: FOMC days		
MPS	1523.69**	-272.74**	-153.04	-401.08	-696.83
	[2.05]	[-2.04]	[-0.27]	[-1.14]	[-0.80]
Cons.	349.62	242.35	-483.53	-120.79	12.35
	[0.49]	[1.32]	[-0.65]	[-0.55]	[0.02]
R^2	0.0420	0.0207	0.0004	0.0315	0.0074
Obs.	103	103	103	103	103

Notes. Panel A reports results from regressing daily net call option demand aggregated by investor type on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.13

Firm option demand and monetary policy shocks by moneyness

	Moneyness < 1	Moneyness > 1
Panel A: All days		
FOMC	-5638.34**	-57.44
	[-2.24]	[-0.24]
MPS	8960.26**	-156.03
	[2.40]	[-0.76]
Cons.	401.76	-392.61***
	[1.30]	[-7.65]
R^2	0.0111	0.0001
Obs.	3268	3268
Panel B: FOMC days		
MPS	8960.26**	-156.03
	[2.40]	[-0.76]
Cons.	-5236.57**	-450.05*
	[-2.10]	[-1.90]
R^2	0.1104	0.0041
Obs.	103	103

Notes. Panel A reports results from regressing daily firm net put option demand for out-of-the-money (Moneyness<1) and in-the-money (Moneyness>1) options on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.14

Out-of-the-money and deep out-of-the-money put demand and monetary policy shocks

	Moneyness < 0.9	0.9 < Moneyness < 1
Panel A: All days		
FOMC	-4171.63*	-1466.70**
	[-1.89]	[-1.99]
MPS	7702.16**	1258.10**
	[2.32]	[2.04]
Cons.	-1596.02***	1997.78***
	[-5.86]	[15.58]
R^2	0.0097	0.0022
Obs.	3268	3268
Panel B: FOMC days		
MPS	7702.16**	1258.10**
	[2.32]	[2.04]
Cons.	-5767.65***	531.08
	[-2.64]	[0.73]
R^2	0.1066	0.0280
Obs.	103	103

Notes. Panel A reports results from regressing daily firm net put option demand for deep OTM (Moneyness<0.9) and moderately OTM (0.9<Moneyness<1) options on a dummy variable for FOMC days and the monetary policy shock (MPS). Panel B runs the regression using data from FOMC days only. The units are number of contracts. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.15

Lagged inventory, FOMC days, and monetary policy shocks

	Firm		Broker-Dealer		Customer		Prof-Customer		Market-Maker	
	Panel A: All days									
FOMC		20192.17***		230.70		−17929.31**		3034.02		−5528.72
		[3.31]		[0.23]		[−2.19]		[1.51]		[−0.83]
Cons.	−11010.76***	−11647.17***	−3037.84***	−3045.12***	54723.34***	55288.43***	9424.68***	9329.05***	−50109.48***	−49935.23***
	[−2.59]	[−2.70]	[−3.67]	[−3.64]	[8.20]	[8.16]	[5.37]	[5.28]	[−8.70]	[−8.57]
R^2	0.0000	0.0024	0.0000	0.0000	0.0000	0.0009	0.0000	0.0004	0.0000	0.0001
Obs.	3268	3268	3268	3268	3268	3268	3268	3268	3268	3268
	Panel B: FOMC days									
MPS		−2691.01		−1341.02		3852.43		1297.21		−1111.28
		[−0.43]		[−1.19]		[0.46]		[0.53]		[−0.15]
Cons.	8545.00	8545.00	−2814.42**	−2814.42**	37359.12***	37359.12***	12363.08***	12363.08***	−55463.94***	−55463.94***
	[1.38]	[1.38]	[−2.50]	[−2.51]	[4.53]	[4.51]	[5.13]	[5.12]	[−7.60]	[−7.57]
R^2	0.0000	0.0018	0.0000	0.0138	0.0000	0.0021	0.0000	0.0028	0.0000	0.0002
Obs.	103	103	103	103	103	103	103	103	103	103

Notes. This table presents results from regressing daily option inventory at the prior day's close on an FOMC dummy (Panel A) on all days and on MPS on FOMC days (Panel B) for all investor categories. The units are number of contracts. Inventory is computed as cumulative buy minus sell volume. The dependent variable in regressions is inventory at the close of the last trading day. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.16

Morning demand, lagged inventory, and MPS on FOMC days

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
Inventory	-0.13	-0.03	-0.05	0.22	-0.06
	[-0.59]	[-0.72]	[-0.26]	[0.36]	[-0.46]
MPS	0.65**	-0.18	-0.21	-0.51	-0.44
	[2.25]	[-1.25]	[-0.72]	[-1.00]	[-1.53]
Cons.	-0.35*	0.17	0.26	0.02	0.25
	[-1.68]	[1.54]	[1.33]	[0.09]	[1.41]
R^2	0.1086	0.0229	0.0116	0.0274	0.0565
Obs.	103	103	103	103	103

Notes. This table presents results from regressing option demand between 9:30 a.m. and 9:40 a.m. on FOMC days on lagged inventory and MPS. Inventory is from the close of the last trading day. All variables are normalized to have zero mean and unit standard deviation. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.17

Predicting MPS using morning demand and lagged inventory

	Firm	Broker-Dealer	Customer	Prof-Customer	Market-Maker
Inventory	-0.02	-0.14*	0.05	0.07	-0.02
	[-0.27]	[-1.84]	[0.66]	[0.49]	[-0.30]
Demand	0.16***	-0.13*	-0.05	-0.05	-0.13*
	[3.43]	[-1.89]	[-0.65]	[-0.85]	[-1.95]
Cons.	0.07	0.02	0.02	-0.01	0.03
	[0.73]	[0.25]	[0.23]	[-0.05]	[0.35]
R^2	0.1057	0.0364	0.0131	0.0276	0.0562
Obs.	103	103	103	103	103

Notes. This table presents results from regressing MPS on option demand between 9:30 a.m. and 9:40 a.m. for each investor category on FOMC days and lagged inventory. Inventory is from the close of the last trading day. All variables are normalized to have zero mean and unit standard deviation. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.18

Monetary policy uncertainty, firm option demand, and MPS magnitude

	(1)	(2)	(3)	(4)	(5)
MPU	0.35***	0.39***			0.38***
	[3.53]	[3.64]			[3.93]
MPS		-0.16		0.18	0.02
		[-1.23]		[1.07]	[0.11]
MPU x MPS		0.19***			0.10*
		[2.87]			[1.75]
|Demand|			0.22***	0.11	0.16**
			[3.03]	[1.22]	[2.02]
|Demand| x MPS				-0.18**	-0.12*
				[-2.46]	[-1.76]
Cons.	0.64***	0.61***	0.64***	0.59***	0.59***
	[9.53]	[10.22]	[8.85]	[8.00]	[9.70]
R^2	0.2108	0.3201	0.0837	0.1990	0.4418
Obs.	103	103	103	103	103

Notes. This tables reports results from regressing the absolute value of monetary policy shocks, |MPS|, on lagged monetary policy uncertainty, MPU, the absolute value of firm option demand between 9:30 a.m. and 9:40 a.m., |Demand|, and interaction terms on FOMC announcement days. MPU, MPS, and |Demand| are normalized to have zero mean and unit standard deviation. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.19
Predicting absolute positive/negative MPS shocks on FOMC days

	$\lvert MPS\rvert^+$	$\lvert MPS\rvert^-$
	(1)	(2)
MPU	0.23*	0.16**
	[1.82]	[2.16]
|Demand|	−0.01	0.27***
	[−0.16]	[3.25]
Cons.	0.35***	0.29***
	[5.86]	[5.53]
R^2	0.1263	0.2352
Obs.	103	103

Notes. This table reports results from regressing absolute value of normalized monetary policy shock (|MPS|) multiplied by a dummy for MPS > 0 in column (1) or MPS < 0 in column (2) on monetary policy uncertainty (MPU) from Bauer, Lakdawala, and Mueller (2022), and the absolute value of firm option demand between 9:30 a.m. and 9:40 a.m. (|Demand|). Both independent variables are normalized to have zero mean and unit standard deviation on FOMC announcement days. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.20

Resolution of monetary policy uncertainty and option demand

	(1)	(2)	(3)	(4)
Panel A: Predicting MPU resolution				
Demand	1.68***	1.79***	1.74***	1.62**
	[2.68]	[2.81]	[2.74]	[2.49]
MPU		-1.63***	-1.60***	-1.59***
		[-2.74]	[-2.64]	[-2.62]
$\Delta\, VIX^2_{on}$			0.03	0.01
			[0.37]	[0.15]
$\Delta\, VIX^2_{day}$				0.04
				[0.87]
Cons.	-5.43***	-5.43***	-5.40***	-5.35***
	[-7.22]	[-7.39]	[-7.60]	[-7.37]
R^2	0.0458	0.0890	0.0903	0.0966
Obs.	103	103	103	103
Panel B: Predicting ΔVIX^2_{day}				
Demand	3.21***	3.26***	2.71**	2.92**
	[2.85]	[2.85]	[2.20]	[2.18]
MPU		-0.68	-0.28	-0.00
		[-0.51]	[-0.23]	[-0.00]
$\Delta\, VIX^2_{on}$			0.39	0.38
			[1.12]	[1.02]
VIX^2_{0941}				-0.00
				[-0.60]
Cons.	-1.46	-1.46	-1.12	0.49
	[-1.04]	[-1.04]	[-0.76]	[0.21]
R^2	0.0482	0.0504	0.1113	0.1178
Obs.	103	103	103	103

Notes. Panel A reports results from regressing the daily change in MPU ($\Delta\text{MPU}_t = \text{MPU}_t^2/\text{MPU}_{t-1}^2 - 1$) on firm option demand between 9:30 a.m. and 9:40 a.m., lagged MPU (MPU_{t-1}), the rate of change in VIX^2 from last day's close to 9:40 a.m. ($\Delta\, VIX^2_{on}$), and the rate of change in VIX^2 from 9:40 a.m. to current day's close ($\Delta\, VIX^2_{day}$) on FOMC days. Panel B reports results from regressing the change in VIX^2 from 09:41 a.m. to trading close on the FOMC day on firm morning demand, MPU, $\Delta\, VIX^2_{on}$, and the level of VIX^2 at 09:41 a.m. Demand and MPU are normalized to have zero mean and unit standard deviation. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.21

Predicting MPS using MPU and firm option demand

	(1)	(2)
MPU	0.13	0.11
	[0.70]	[0.58]
Demand		0.32***
		[3.39]
R^2	0.0163	0.1166
Obs.	103	103

Notes. This table reports results from regressing MPS on lagged daily MPU and firm option demand between 9:30 a.m. and 9:40 a.m. on FOMC announcement days. Option demand and MPU are normalized to have zero mean and unit standard deviation. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.22

Interest rate range, firm option demand, and MPS magnitude

	(1)	(2)
IRRANGE	0.38***	0.35***
	[4.81]	[4.39]
MPS		-0.71**
		[-2.47]
IRRANGE x MPS		0.20**
		[2.51]
Cons.	-0.23	-0.20
	[-1.56]	[-1.29]
R^2	0.3025	0.4029
Obs.	103	103

Notes. This tables reports results from regressing the absolute value of monetary policy shocks, |MPS|, on lagged interest rate range, IRRANGE, MPS, and interaction terms on FOMC announcement days. IRRANGE and MPS are normalized to have zero mean and unit standard deviation. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.23

Predicting MPS using IRRANGE and firm option demand

	(1)	(2)
IRRANGE	0.14	0.15
	[1.01]	[1.08]
Demand		0.33***
		[3.51]
Cons.	-0.31	-0.34
	[-1.23]	[-1.33]
R^2	0.0232	0.1326
Obs.	103	103

Notes. This table reports results from regressing MPS on lagged daily IRRANGE and firm option demand between 9:30 a.m. and 9:40 a.m. on FOMC announcement days. Option demand and IRRANGE are normalized to have zero mean and unit standard deviation. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.24

Predicting MPS using interest rate skewness and firm option demand

	(1)	(2)	(3)	(4)
ISK	0.77***		0.61***	
	[3.59]		[2.83]	
Demand		0.32***	0.27***	0.25***
		[3.46]	[3.01]	[3.06]
Cons.	-0.05	-0.00	-0.04	0.00
	[-0.56]	[-0.00]	[-0.46]	[0.00]
R^2	0.0900	0.1053	0.1583	0.0710
Obs.	103	103	103	103

Notes. This Table reports results from regressing monetary policy shocks (MPS) on interest rate skewness (ISK) on the day before the FOMC announcement and firm option demand between 9:30 a.m. and 9:40 a.m. (Demand) normalized to have zero mean and unit standard deviation on FOMC announcement days. Demand in Column 4 is the orthogonal component of firm demand with respect to ISK. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.25

Firm morning option demand and asset price changes: Keynesian vs. information shocks

	$\text{MPS}^{\perp}$	$\Delta\, VIX^2_{fomc}$	ΔS&P	$\Delta\, VIX^2_{day}$
KEYN	-0.04	0.28	-0.06	2.36
	[-0.21]	[0.25]	[-0.78]	[0.86]
Demand	-0.23	2.30***	-0.10***	3.49***
	[-1.45]	[3.77]	[-4.51]	[3.22]
KEYN x Demand	0.63***	-0.81	-0.01	-0.20
	[3.60]	[-0.69]	[-0.15]	[-0.11]
Cons.	0.05	-3.21***	0.08**	-2.78
	[0.62]	[-5.39]	[2.10]	[-1.63]
R^2	0.1370	0.0716	0.0693	0.0546
Obs.	103	103	103	103

Notes. This table reports results from regressing several outcome variables on firm morning option demand, a dummy for Keynesian shocks (KEYN), and its interaction. The outcome variables are orthogonal monetary policy shocks $\text{MPS}^{\perp}$, the rate of change in VIX^2 from 10 minute before to 20 minutes after the announcement ($\Delta\, VIX^2_{fomc}$), the change in S&P 500 from 10 minute before to 20 minute after the announcement, and the rate of change in VIX^2 from 9:40 a.m. to current day's close ($\Delta\, VIX^2_{day}$) on FOMC days. We label announcements where the change in S&P 500 E-Mini futures and $\text{MPS}^{\perp}$ from Bauer and Swanson (2023b) in the 30-minute announcement window have opposite signs as "Keynesian shocks", and "Information shocks" otherwise. Out of 103 scheduled FOMC announcements in our sample period, 57 are classified as Keynesian shocks and 46 as information shocks. Morning demand refers to 9:30 a.m.–9:40 a.m. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.

Table A.26

Monetary policy shocks and asset price changes: Keynesian vs. information shocks

	ΔVIX^2_{fomc}	ΔVIX^2_{fomc}	ΔVIX^2_{fomc}	ΔS&P
KEYN	-0.09	0.01	-0.14	-0.04
	[-0.08]	[0.01]	[-0.15]	[-0.67]
MPS$^{\perp}$		2.09***	-4.58***	0.25***
		[3.20]	[-4.11]	[4.15]
KEYN x MPS$^{\perp}$			7.78***	-0.56***
			[6.00]	[-7.69]
Cons.	-2.96***	-3.01***	-2.84***	0.06*
	[-4.65]	[-4.00]	[-5.50]	[1.80]
R^2	0.0001	0.1132	0.3071	0.5192
Obs.	103	103	103	103

Notes. This table reports results from regressing several outcome variables on orthogonal monetary policy shocks (MPS$^{\perp}$), a dummy for Keynesian shocks (KEYN), and its interaction. The outcome variables are the rate of change in VIX^2 from 10 minute before to 20 minutes after the announcement (ΔVIX^2_{fomc}), and the change in S&P 500 from 10 minute before to 20 minute after the announcement (ΔS&P). We label announcements where the change in S&P 500 E-Mini futures and MPS$^{\perp}$ from Bauer and Swanson (2023b) in the 30-minute announcement window have opposite signs as "Keynesian shocks", and "Information shocks" otherwise. Out of 103 scheduled FOMC announcements in our sample period, 57 are classified as Keynesian shocks and 46 as information shocks. Morning demand refers to 9:30 a.m.–9:40 a.m. Net option demand is computed as buy minus sell volume. t-statistics in brackets are based on Newey-West standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The sample period is from January 3, 2011 to December 29, 2023.