The Voice of Monetary Policy

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Presentation Overview

- **Roles of "The Fed":**
  - Banking for Banks
  - Managing Money Supply
  - Setting Interest Rates
  - Keeping the Economy Stable
  - Regulating Banks

General Informations

Federal Open Market Committee

- **Part of the Fed:** Central body for U.S. monetary policy within the Federal Reserve System.
- **Main Function:**
  - Formulates national monetary policy.
- **Composition:** Comprises 12 members, including the Chair of the Federal Reserve.
- **Impact:** Influences U.S. economic stability, employment, inflation, and currency strength.
- **Meetings and Transparency:**
  - Conducts regular meetings and press conferences.
  - Makes proceedings publicly available, providing insight into monetary policy decisions.

The study : what is it about ?

- Mehrabian's 7-55-38 Rule of Communication (1971):
  - Words: Convey 7% of message.
  - Body Language: Includes gestures, facial expressions, etc., accounts for 55%.
  - Tone of Voice: Delivers 38% of the message's impact.

- Examines the impact of the tone of voice used by Federal Reserve chairs on financial markets during press conferences .

- Utilizes deep learning and natural language processing to analyze emotions in voice tones and text sentiment.

Why Does Nonverbal Communication Matter?

Seeking Additional Information:

- Market participants look for insights beyond scripted information.
- Focus on unscripted aspects: choice of words, tone of voice, and body language of the Fed chair.

Recognition of High Stakes:

- The Fed is aware of the significant impact of its communications.
- Nonverbal cues play a crucial role in conveying economic perspectives.

Why Does Nonverbal Communication Matter?

Janet Yellen's Insight (December 16, 2015):

> *"Okay. Boxed lunches will be available. If anybody wants to watch TV in the Special Library and see me get skewered at the press conference, please feel free. I will do my best to communicate the points that have been made here. END OF MEETING."*

Emotion Detection Using Neural Networks

Neural Network Model Training:

- Utilizes deep learning to recognize emotions.
- Audio segments from FOMC press conferences (April 2011–June 2019) analyzed,based on each question-response interaction.

Voice Characterization Parameters:

- Pitch and frequency analyzed for emotion detection.
- Librosa, a Python package, used for extracting vocal features.

Key Vocal Features Extracted:

- 128 mel spectrogram frequencies for loudness levels.
- 12 chroma coefficients from a chromagram for melodic and harmonic aspects.
- 40 mel-frequency cepstral coefficients (MFCCs) for detailed audio analysis.

Emotion Detection Using Neural Networks

Emotion Classification Datasets:

- RAVDESS and TESS datasets used for matching emotions to audio tracks.
- Focus on five emotions: happy, pleasantly surprised, neutral, sad, and angry.

Model Architecture and Performance:

- Built using Keras and TensorFlow.
- Fully connected network with layers for different emotions.
- Overall accuracy of 84% in emotion prediction.

Advantages of the Approach:

- Objectivity and reproducibility in classifying voice tone.
- Compared to human classification, it's cost-effective and less prone to biases.

Caveats:

- Potential limitations in detecting subtle tone variations compared to human perception.

Emotion Detection Output and Analysis

Neural Network Output:

- Each audio segment assigned one of five emotions: happy, pleasantly surprised, neutral, sad, or angry.

Classification of Emotions:

- Positive: ”happy” or ”pleasantly surprised.”
- Negative: ”sad” or ”angry.”
- Neutral: Remaining unclassified emotions.

Aggregation Method:

- VoiceTone formula:

$$\text{VoiceTone} = \frac{\text{Positive answers} - \text{Negative answers}}{\text{Positive answers} + \text{Negative answers}} \tag{1}$$

- Scale ranges from -1 (negative emotions) to +1 (positive emotions).

Emotion Detection Output and Analysis

Cross-Check with External Sources:

- Bernanke's low score during a defensive press conference (September 18, 2013), reflecting the "taper tantrum".
- Yellen's positive score (0.83) in a press conference on September 17, 2015, indicating a positive economic outlook.
- Powell's scores reflecting his approach in press conferences in March 2018 and 2019.

Consistency with Media Reports:

- Scores generally align with media interpretations and coverage of the press conferences.

Textual Analysis

Importance of Congruent Communication:

- Successful policy communication requires congruence between verbal and nonverbal messages.
- Aims to provide clear guidance without causing confusion.

Sentiment Analysis with BERT:

- Uses Bidirectional Encoder Representations from Transformers (BERT) for text analysis.
- BERT provides contextual word representations, enhancing accuracy.

Customized Training Dataset:

- Utilizes FOMC statements from 1997 to 2010.
- Texts scored by research assistants on a dovish-hawkish spectrum.

Textual Analysis

Classification of Texts:

- Texts categorized as dovish, hawkish, or neutral based on average scores.
- Neural network trained to identify monetary policy sentiment from BERT embeddings.

Model Performance:

- Overall accuracy of 81% in sentiment prediction.
- Breakdown: 85% for hawkish, 79% for neutral, and 77% for dovish texts.

Sentiment Aggregation:

- $\text{TextSentiment} = \frac{\text{Dovish text - Hawkish text}}{\text{Dovish text + Hawkish text}}$.
- Ranges from -1 (hawkish) to +1 (dovish), indicating monetary policy stance.

Sentiment Analysis Output

Comparison Across Fed Chairs:

- Text sentiment during Yellen and Bernanke's terms was more dovish compared to Powell's.
- Reflects the prevalence of policy rate increases during Powell's tenure.

FOMC Meeting statistics

TABLE 1—FOMC MEETING STATISTICS

	All (1)	Bernanke (2)	Yellen (3)	Powell (4)
Meetings	68	25	32	11
Press conferences	36	12	16	8
Panel A. Voice analysis of responses in Q&A during press conferences				
Answers (count)				
Positive	377	200	109	68
Negative	285	43	131	111
Neutral	30	0	28	2
Voice tone				
Mean	0.09	0.64	−0.13	−0.30
Standard deviation	0.75	0.58	0.61	0.82
Panel B. Textual analysis				
Statement				
Hawkish paragraphs	37	8	20	9
Dovish paragraphs	223	105	108	10
Neutral paragraphs	64	6	37	21
Text sentiment				
Mean	0.66	0.86	0.71	0.09
Standard deviation	0.53	0.27	0.34	0.94
Remarks				
Hawkish paragraphs	83	15	47	21
Dovish paragraphs	244	97	106	41
Neutral paragraphs	119	41	50	28
Text sentiment				
Mean	0.50	0.75	0.38	0.35
Standard deviation	0.37	0.24	0.33	0.47
Q&A				
Hawkish answers	233	77	95	61
Dovish answers	339	137	120	82
Neutral answers	120	29	53	38
Text sentiment				
Mean	0.18	0.29	0.11	0.14
Standard deviation	0.30	0.30	0.26	0.35
Statement, Remarks, Q&A				
Text sentiment				
Mean	0.52	0.71	0.50	0.15
Standard deviation	0.40	0.30	0.35	0.52

Voice Tone VS Text Sentiment

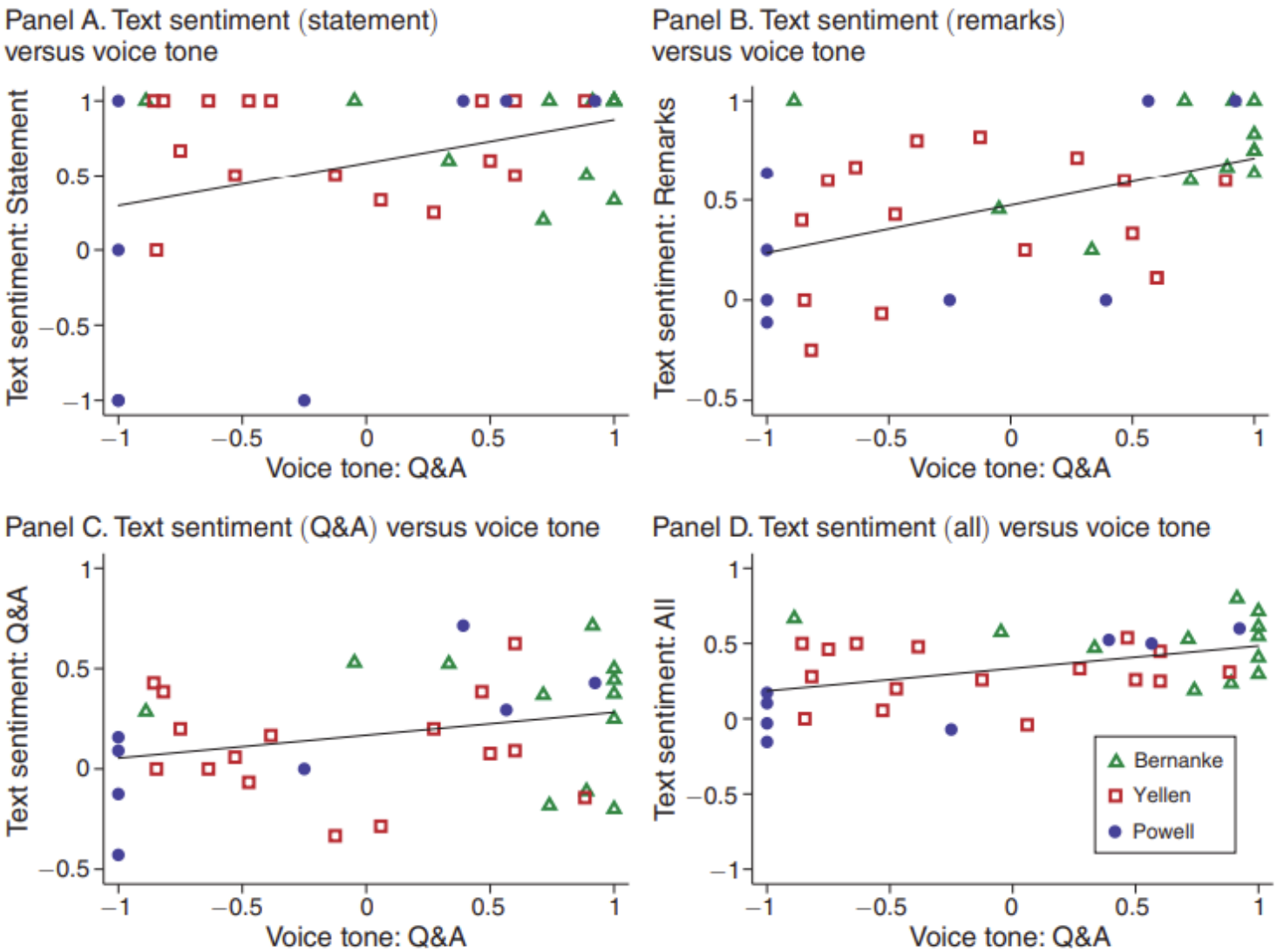


FIGURE 1. VOICE TONE VERSUS TEXT SENTIMENT

Comovement in Policy Actions, Words, and Tone

Relationship Between Text and Voice:

- Not perfectly congruent; demonstrates nuanced interplay between text sentiment and voice tone.
- Positive voice tonality often associated with more dovish text sentiments.

Correlation Analysis:

- Correlation between voice tone in Q&A and text sentiment in statements,in remarks and in Q&A respectively: $\rho = 0.37$, $\rho = 0.48$ and $\rho = 0.29$.
- Indicates that Q&A tone can vary independently from text content.

Policy Shocks

Federal Funds Rate (FFR) Shock:

- Change in the overnight interbank lending rate.
- An FFR shock occurs with unexpected adjustments, influencing the entire economy.

Forward Guidance (FG) Shock:

- Refers to the Fed's communication about future policy actions.
- An FG shock happens with unexpected changes in future policy plans, affecting market expectations and behavior.

Policy Shocks

Asset Purchase (AP) Shock:

- Involves the Fed buying financial assets to inject money into the economy.
- An AP shock occurs with unexpected changes in the scale or rate of these purchases, impacting financial markets and liquidity.

Shadow Rate Shock:

- The shadow rate is used when the actual rate is near zero (zero lower bound).
- A shadow rate shock happens with changes in this estimated rate, influencing expectations and market sentiment during periods of very low interest rates.

Voice Tone VS Policy Shocks

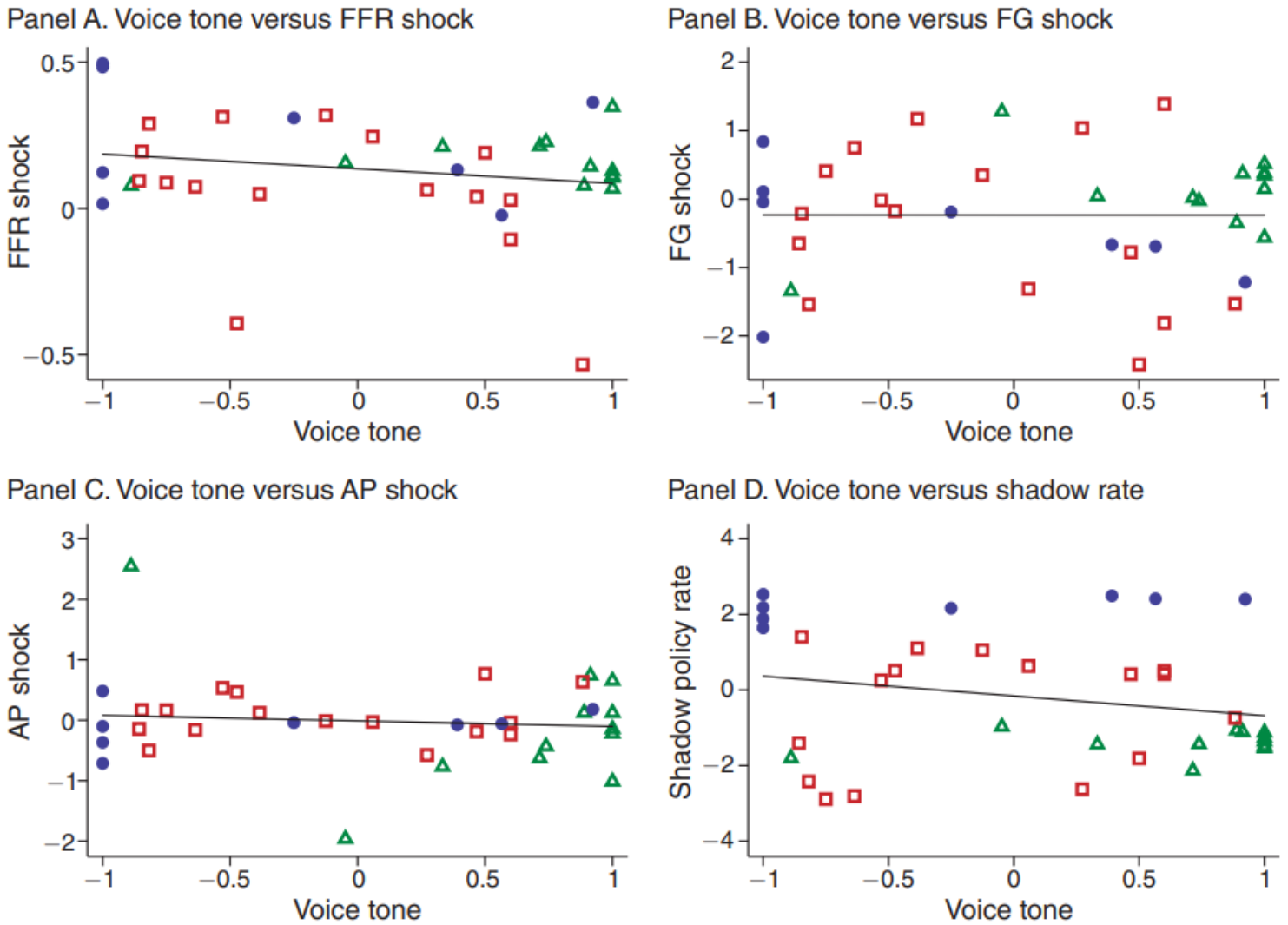


FIGURE 2. POLICY WORDS VERSUS ACTIONS

Policy Shock Correlation

Policy Shock Correlation:

- Weak correlation between tone variation and actual policy shocks (FFR shock, FG shock, AP shock).
- Slightly stronger correlation with the stage of the policy cycle (shadow rate correlation $\rho = -0.23$).

Implications for Communication Analysis:

- Highlights the importance of considering multiple channels of communication for a comprehensive understanding.

Period-Specific Observations:

- The sample period's unique context (e.g., Fed funds rate at the zero lower bound) may influence correlations.
- Offers an opportunity to discern the effects of policy communication more distinctly.

Empirical Analysis of Voice Tone Impact

Investigation Focus:

- Examines the influence of voice tone on SPY.

Study Methodology:

- $\text{Outcome}_{t,t+h}^{\text{SPY}} = \log(\text{SPY}_{t+h}^{\text{close}}) - \log(\text{SPY}_{t}^{\text{open}})$.

- Used to calculate the return on ETFs like SPY (tracking S&P 500) over a specific time horizon.

SPY

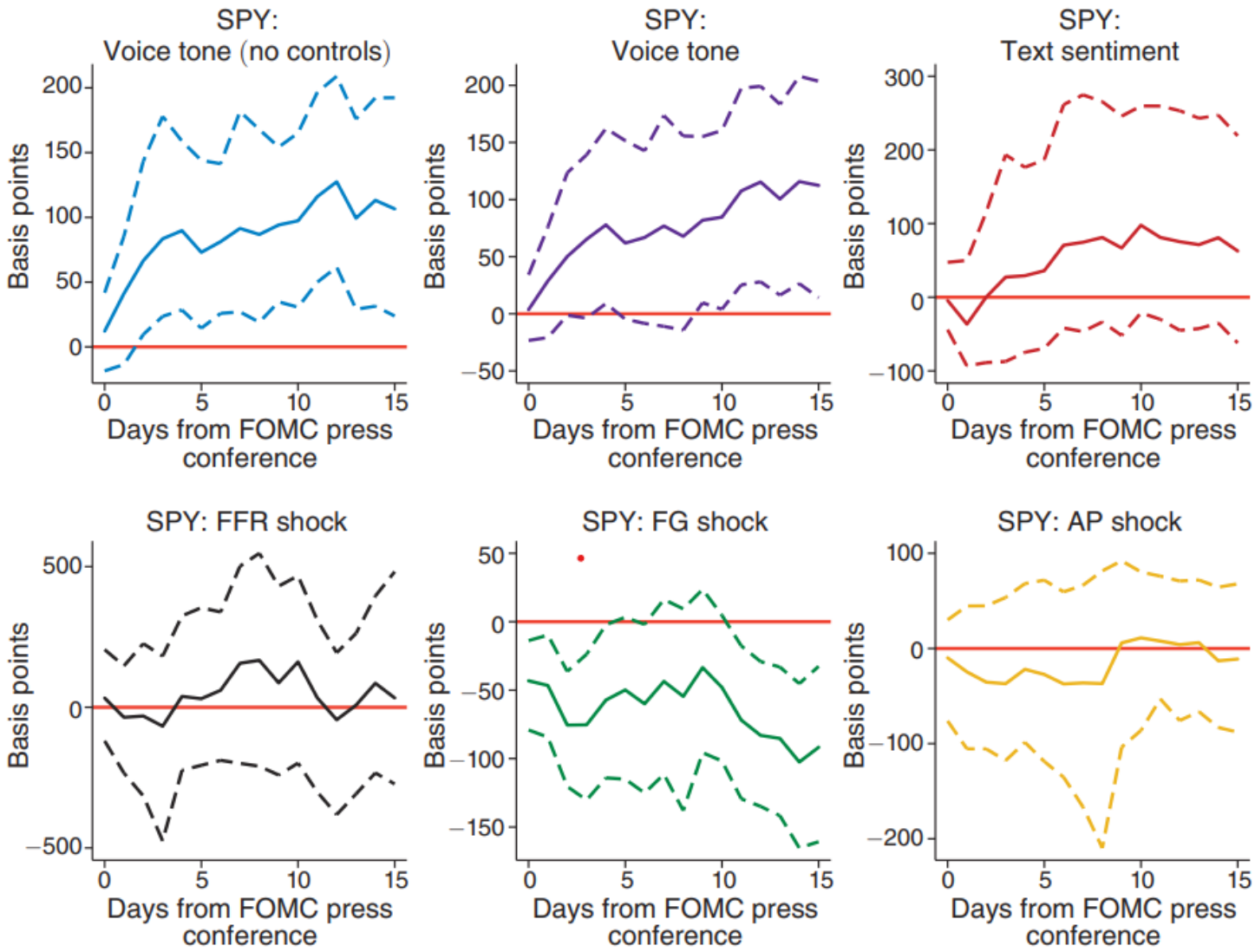


FIGURE 3. RESPONSE OF SPY ETF (S&P 500) TO POLICY ACTIONS AND MESSAGES

SPY

Significant Findings:

- Positive voice tone correlates with an increase in stock prices (SPY ETF as an example).
- Response to voice tone builds up over time; significant impact observed after five days.
- Text sentiment does not show a statistically significant effect on stock market in the sample.

Comparison with Policy Shocks:

- FFR and AP shocks show limited impact on stock market.
- FG shocks lead to a decrease in stock prices, aligning with voice tone effects.

Contribution of Voice Tone:

- Voice tone contributes significantly to variations in financial outcomes, comparable to FG shocks.

Voice Tone Impact on Market Volatility

Investigation Focus:

- Examines voice tone's influence on market volatility indicators like CBOE VIX.

Study of Volatility Indices:

- Uses CBOE VIX to gauge stock market expectations about future volatility.

Findings on Fed Actions and Volatility:

- Fed actions (FFR, FG, AP shocks) generally increase stock market volatility.
- Consistent with studies showing treasury yield responsiveness to macro news and policy uncertainty.

VIX

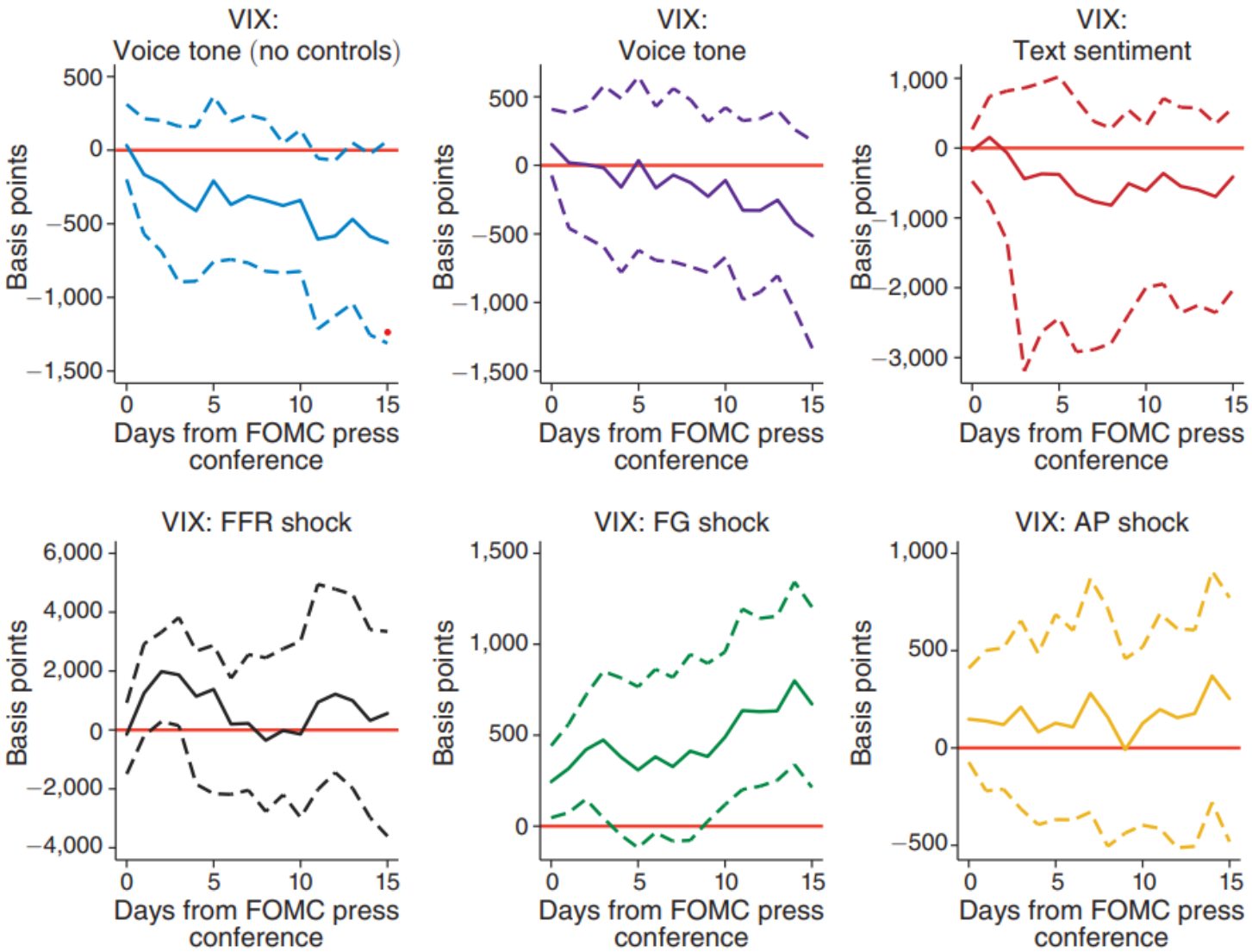


FIGURE 4. RESPONSE OF VIX (CBOE VOLATILITY INDEX) TO POLICY ACTIONS AND MESSAGES

Effect of Voice Tone and Text Sentiment on Volatility

Effect of Voice Tone and Text Sentiment:

- Positive tone and dovish text sentiment correlate with decreased current and anticipated volatility.
- Economically significant: A unit decrease in tone increases volatility akin to a standard deviation FG shock.

Voice Tone Impact on Interest Rate Risk

Investigation Focus:

- Analyzes the effect of voice tone on perceived interest rate risk.

Interest Rate Risk Measurement:

- Formula for Outcome:

$$\text{Outcome}_{t,t+h} = \log\left(\frac{P^{\text{LQD}}_{t+h,\text{close}}}{P^{\text{LQD}}_{t,\text{open}}}\right) - \log\left(\frac{P^{\text{LQDH}}_{t+h,\text{close}}}{P^{\text{LQDH}}_{t,\text{open}}}\right)$$

- Utilizes prices of LQD (investment grade corporate bonds) and interest rate hedged bond LQDH.

Interest Rate

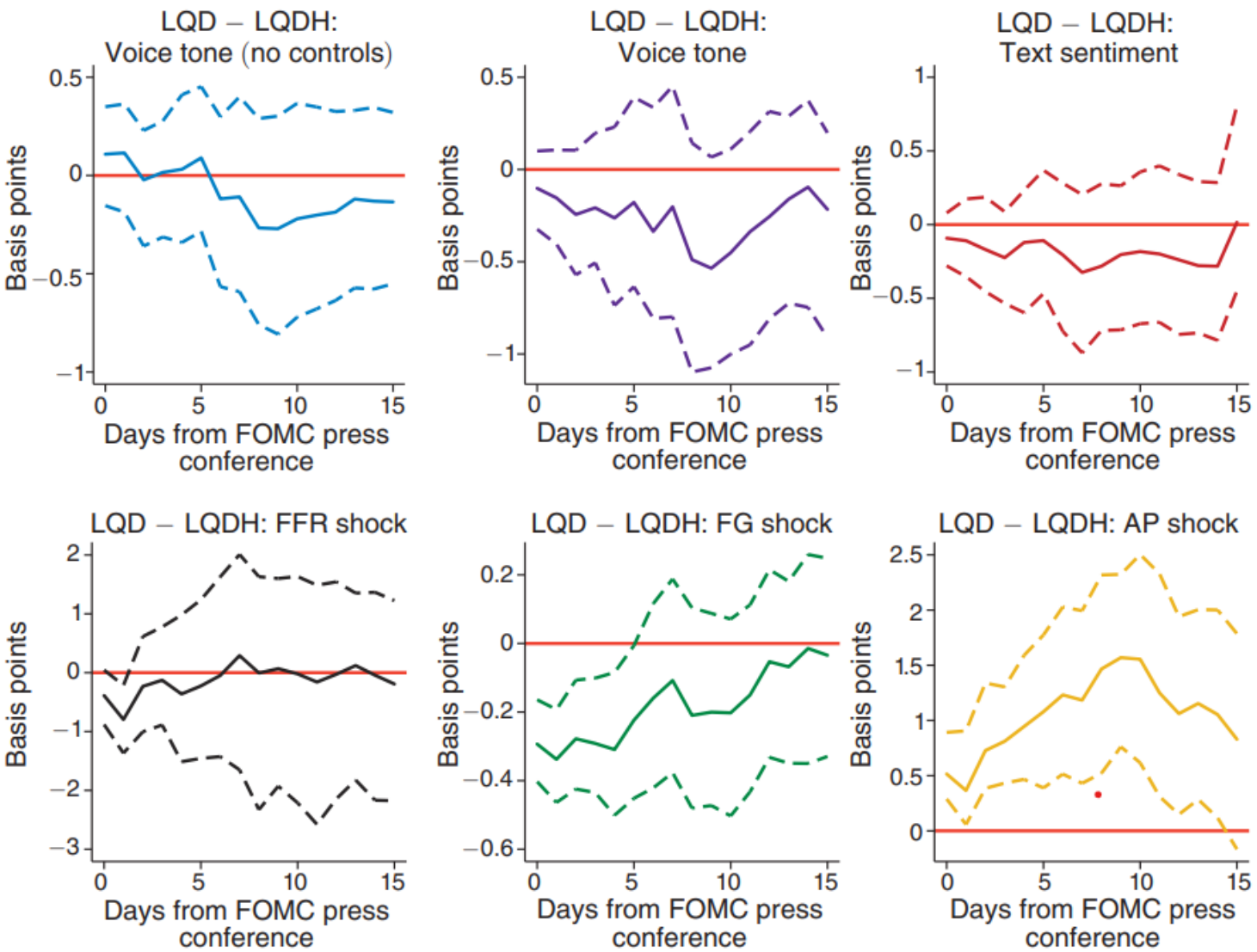


FIGURE 6. RESPONSE OF LQD (INVESTMENT GRADE CORPORATE BOND) MINUS LQDH (INTEREST RATE HEDGED CORPORATE BOND) TO POLICY

Impact of Voice Tone and Policy Shocks

Voice Tone's Influence:

- More positive voice tone leads to a reduction in perceived interest rate risk.
- Comparable to the impact of FG shocks in reducing interest rate uncertainty.

Policy Shock Comparison:

- FG shock reveals Fed's pessimistic view of the economy, similar to the effect of a decrease in voice tone.
- AP shock increases current interest rate risk, indicating uncertainty about future monetary policy.

Bond Market Response to Monetary Policy Shocks and Voice Tone

Bond Market Analysis:

- Investigates the response of GOVT (US government nominal debt fund) to policy shocks and voice tone.

Forward Guidance and Asset Purchase Shocks:

- GOVT price decreases in response to forward guidance shocks (yields rise).
- Increases in response to asset-purchase shocks (yields fall).
- FFR shocks show no significant effect, likely due to the zero lower bound context.

Government Bonds

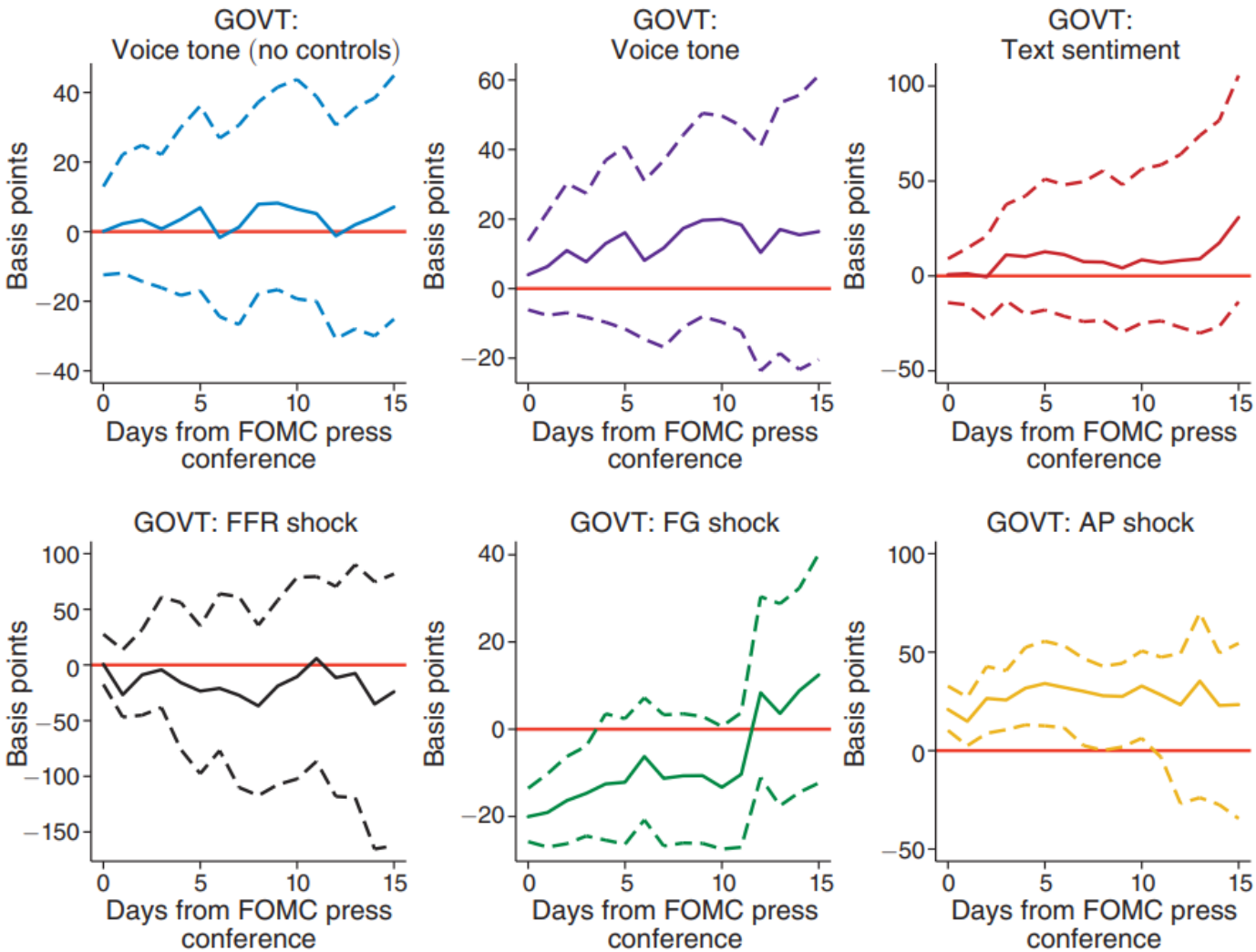


FIGURE 7. RESPONSE OF GOVT (US GOVERNMENT DEBT) TO POLICY ACTIONS AND MESSAGES

Voice Tone and Comparative Bond Market Analysis

Voice Tone and Text Sentiment Impact:

- Voice tone and text sentiment do not significantly impact GOVT prices.
- However, voice tone affects spreads between nominal and real bonds.

Bond Market vs. Stock Market Responses:

- Bond market reactions to Fed communications tend to be weaker than stock market reactions.
- Differential responses across maturity spaces, with smaller magnitude responses for shorter maturities.

Comparison with Previous Studies:

- Consistent with findings that bond market reactions to Fed communications are generally weak.
- Noted distinction from stock market, where pre-FOMC announcement drifts occur but not in US Treasuries.

Impact of Voice Tone and Text Sentiment on Inflation Expectations

Context:

- Management of inflation expectations is crucial in monetary policy.

Metrics for Inflation Expectations:

- Spread between nominal and inflation-protected US government bonds (GOVT-TIP Spread).
- GLD ETF, which tracks the gold spot price as a hedge against inflation.

Methodology:

- Uses formula to measure the spread:

$$\text{Outcome}_{t,t+h} = \log\left(\frac{P^{\text{GOVT}}_{t+h,\text{close}}}{P^{\text{GOVT}}_{t,\text{open}}}\right) - \log\left(\frac{P^{\text{TIP}}_{t+h,\text{close}}}{P^{\text{TIP}}_{t,\text{open}}}\right)$$

- Increase in the spread interpreted as a decrease in expected inflation.

Government Bonds - TIP

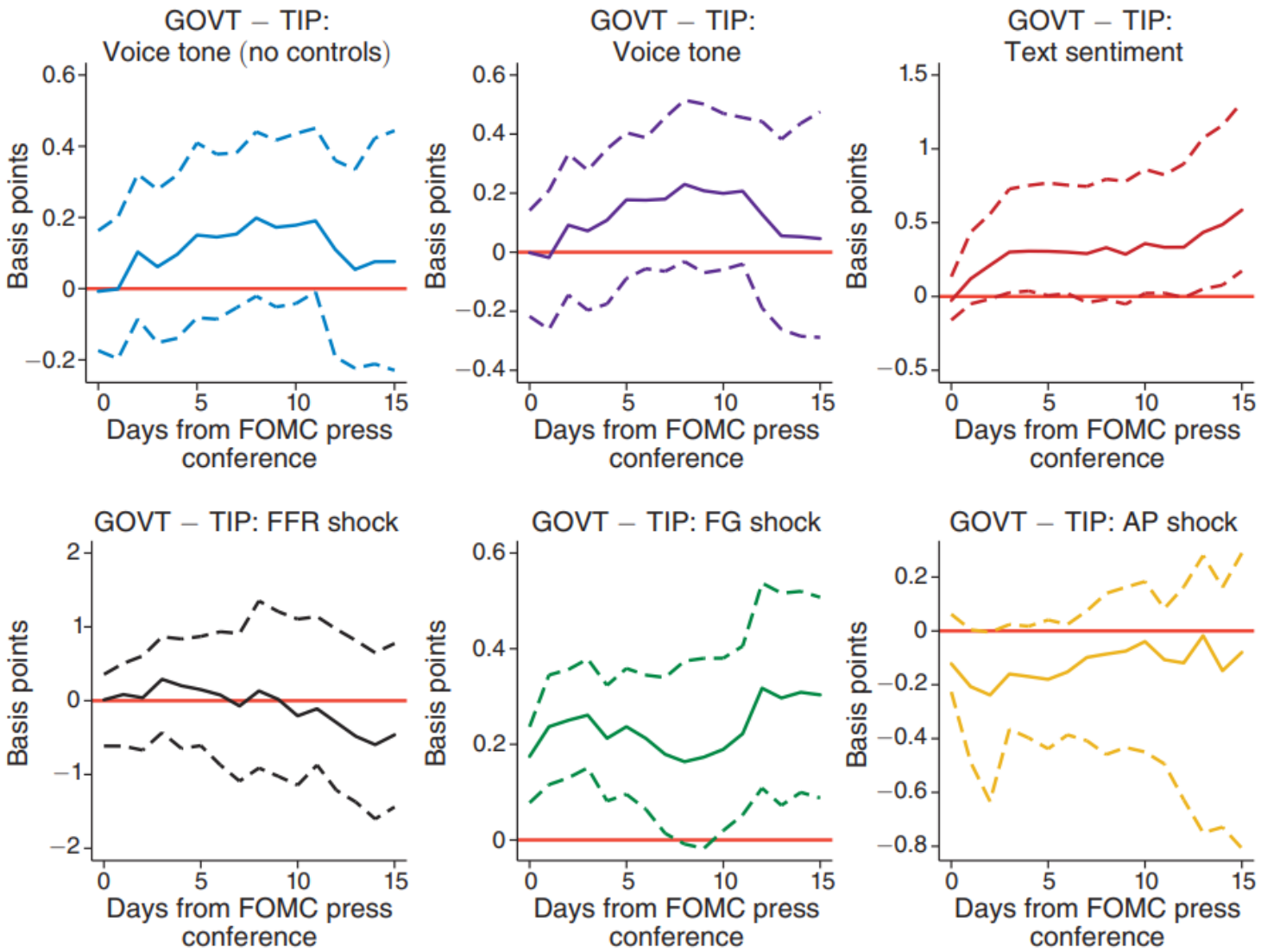


FIGURE 10. RESPONSE OF GOVT (NOMINAL US GOVERNMENT DEBT) MINUS TIP EFT (INFLATION-PROTECTED US GOVERNMENT DEBT) TO POLICY ACTIONS AND MESSAGES

GOLD

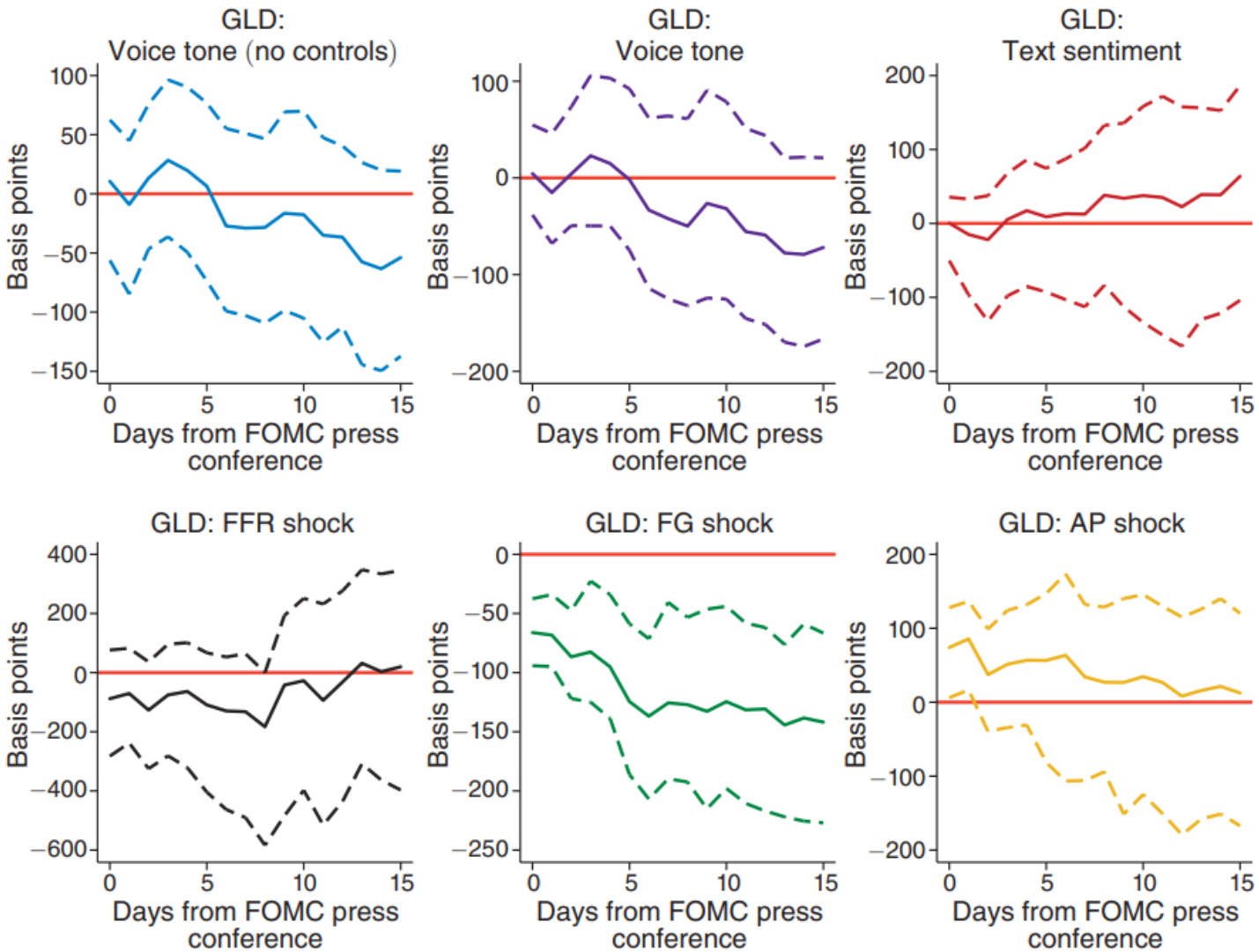


FIGURE 11. RESPONSE OF GLD (GOLD) TO POLICY ACTIONS AND MESSAGES

Findings and Signaling Role of Voice Tone

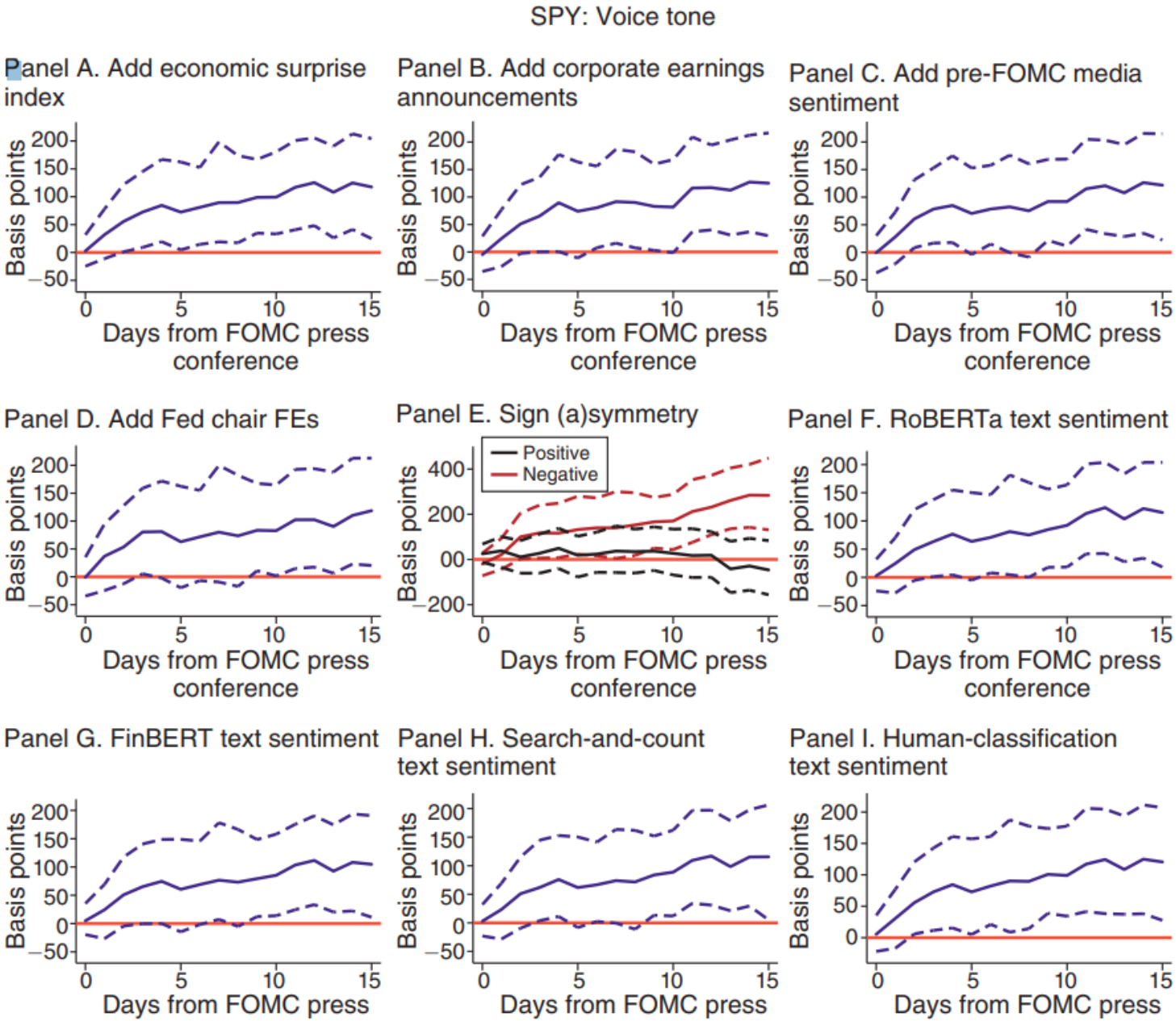
Findings:

- FFR shock shows no clear impact on inflation expectations.
- FG shock lowers, while AP shock raises inflation expectations.
- Dovish text sentiment raises inflation expectations, but not significantly.
- Voice tone gradually increases GOVT-TIP spread, signaling lower expected inflation over time.

Signaling Role of Voice Tone:

- Positive tone may signal satisfaction with future inflation dynamics.
- Independent effect of voice tone on inflation expectations observed.

Robustness checks



High-Frequency Analysis of Voice Tone

Methodology:

- Intraday data analysis of SPY price changes in response to voice tone during FOMC press conferences.

Specifications Used:

- **Flow Specification :** Examines immediate response to individual answers.
- **Cumulative Specification :** Analyzes cumulative response since the start of the press conference.

Key Findings:

- Positive voice tone results in a small, significant immediate rise in stock market prices (about one basis point).
- Gradual increase in market response throughout the press conference, but with imprecise estimates.

Comparative Analysis:

- Lower response magnitude compared to daily data, suggesting markets take time to interpret voice tone signals.

Flow VS Cumulative

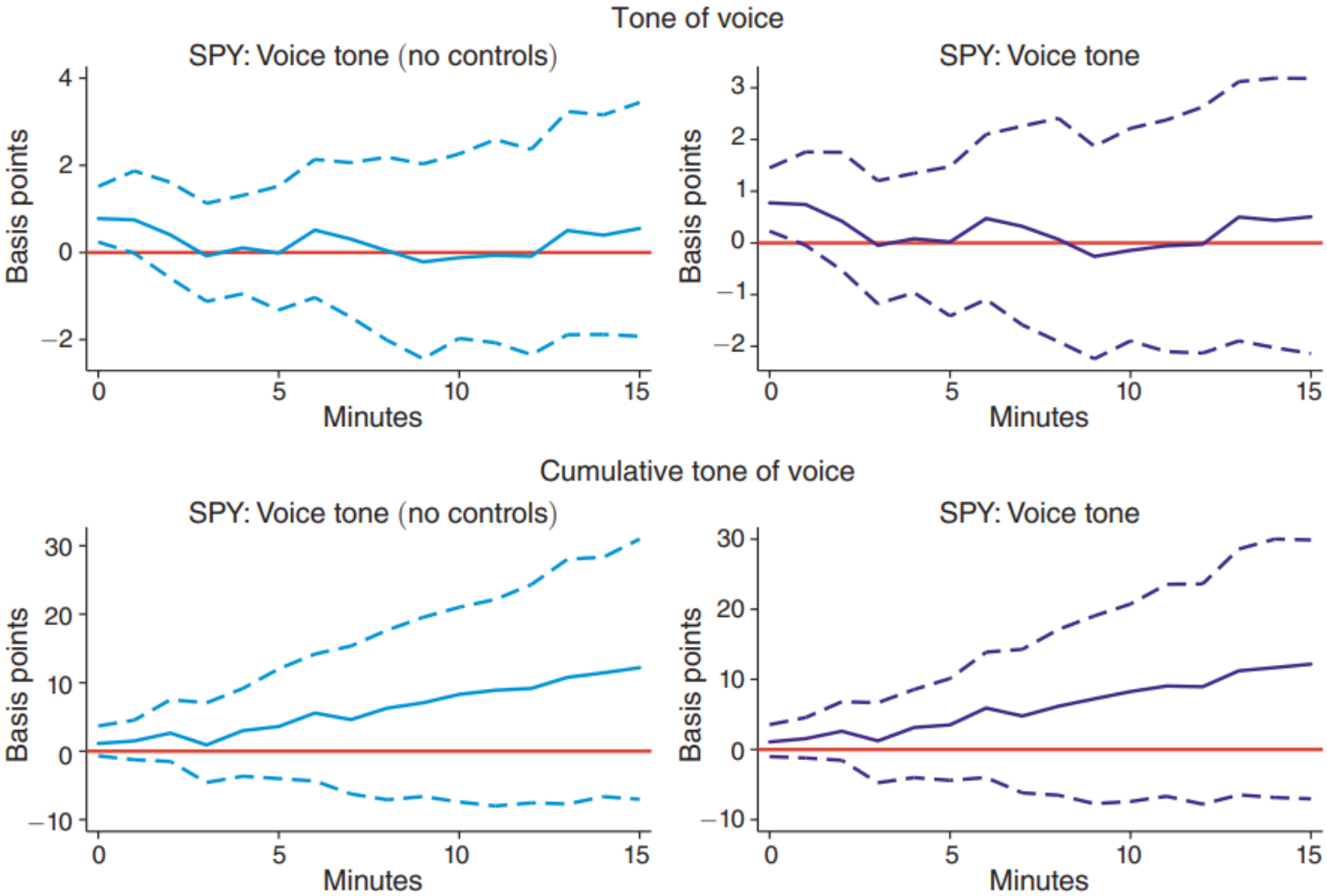


FIGURE 15. INTRADAY RESPONSES OF STOCK PRICES (SPY) TO VOICE TONE

Conclusion

Significance of Press Conferences:

- Vital for delivering monetary policy with a mix of verbal and nonverbal communication.

Impact of Nonverbal Communication:

- Voice tone's effect on the stock market surpasses the impact of the Fed's actions or written texts.

Policy Implications:

- Need for cautious use to avoid unintended effects and enhance effective communication.
- Voice control may become an essential skill for central bankers and public communicators.

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The End

Questions? Comments?