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THE ROLE OF FED SPEECH SENTIMENT SIGNALS IN SHAPING US MARKET RESPONSE

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ABSTRACT

The Federal Reserve's communication shapes US investor decisions and market dynamics. This paper examines the impact of the Fed governor speeches' sentiments signals on the US equity market performance from June 1996 to Sep 2023. The sentiment index is calculated using individual Lexicon dictionaries (AFINN, Bing, NRC, and Loughran McDonald) and their combined PCA scores. Our findings revealed a negative relationship suggesting that a positive (negative) sentiment brings a significant decrease (increase) in the cumulative abnormal return on the event window (+2). These results provide valuable insights into the dynamic nature of the US equity market in response to the Federal Reserve's communication for regulators, policymakers, and other stakeholders of the equity market.

Keywords:
US Equity Market, Federal Reserve Communication, Speeches, Lexicon Dictionaries, Sentiment Analysis.

1. Introduction

Central bank communication is used as a tool for financial stability and reducing financial vulnerabilities (Bohl et al., 2023; Born et al., 2014; Čihák, 2006; Correa et al., 2021; Criste & Lupu, 2014; Edge & Liang, 2019; Mosser, 2020; Wullweber, 2020). Previous studies examined different central banks' communication in different contextual settings (Du et al., 2023; Gertler & Horvath, 2018; Liu et al., 2022; Reeves & Sawicki, 2007). Fed communication had far-reaching impacts on international trade, financial markets, and global economic stability by controlling global liquidity (Armelius et al., 2020; Pape, 2022; Pinchetti & Szczepaniak, 2021). Existing literature also showed central bank communication act as signal that influences equity market return (Born et al., 2010; Caiazza et al., 2022; Ehrmann & Fratzscher, 2007b; Gardner et al., 2022; Gertler & Horvath, 2018; Hayo et al., 2010; Rosa, 2011). Central bank official's speeches consider multiple audiences and have a flexible format, are more influential than all other communication channels including minutes and official statements (Bennani & Neuenkirch, 2017; Bohl et al., 2023; Bohl & Siklos, 2000). Speeches offer a more nuanced understanding of individual governors' viewpoints which provide valuable insights to investors and policymakers to clarify their views on policy issues and make more favorable decisions (Moschella & Pinto, 2019; Moschella et al., 2020). Therefore, this study examines the impact of the Fed Reserve governor's speeches sentiment index on the US equity market performance.

There are various channels of communication such as inflation or monetary policy reports, and financial stability reports, among others to keep the general public well-informed and enhance transparency and accountability (Bulíř et al., 2013; Eijffinger & Geraats, 2006; Mishkin, 2004; Montes et al., 2016; Neuenkirch, 2012; Reeves & Sawicki, 2007). These reports provide clear guidance on their policy objectives and strategies, help reduce information asymmetry, and enable market participants to make more informed decisions leading to financial stability (Horváth & Vaško, 2016). Central banks also employ forward guidance[1] as a powerful channel to provide information and guidance about their future monetary policy actions and intentions and reduce

uncertainty about future policy directions (Campbell et al., 2019; Nakata & Sunakawa, 2019; Nelson, 2021). The Fed's communication influences the stock market via policy accommodation and moves it in the intended direction (Cieslak et al., 2019; Hayo et al., 2012, 2015).

This study employs different lexicon dictionaries to quantify Federal Reserve Governors' speeches and after that principal component analysis used to produce an all-encompassing sentiment index. We add to the body of research on central bank communication by examining the effects of Fed Governor speeches on the sentiments of the US equities market.

For the empirical study, we used Lexicon dictionaries (AFINN, Bing, NRC, and Loughran McDonald) to calculate the Federal Reserve Board of Governors speeches corpus textual data sentiment index and their impact on the US equity market. The sample period is from 1st June 1996 to 30th September 2023. After controlling for macroeconomic factors (interest and inflation rates), our results show that AFINN, Bing, and Loughran McDonald dictionaries and overall PCA sentiment index have a significant negative impact on the US equity market in the (+2) event window while the NRC sentiment index show an insignificant reaction.

These findings have important policy implications for regulators, central banks specifically the Federal Reserve System, government, and financial stakeholders. First, in the formulation of policies (i.e. monetary policy), policymakers should consider the erratic behavior of the US equity market to Fed speeches sentiment signals to reduce policy shock. Second, the US equity market reaction needs policymaker’s attention to adjust the content and timing of speeches for their valuable implications. The overall results show US market significantly reacted to Fed speeches on the following day of speech delivery suggesting that the Federal Reserve System’s clear and timely communication is important for managing market expectations and controlling delayed market reactions. Third, descriptive shows negative sentiment in speeches during crisis periods which can worsen the situation. Fed regulators should carefully design their communication strategy during the crisis.

The rest of the paper is structured as follows; Section 2, is a literature review, Section 3 discusses the data set, variable, and methodology, Section 4 consists of results and discussion, and Section 5 is the conclusion of this paper.

2. Literature Review

Central bank communication is broadly classified into monetary and non-monetary communication. Cieslak and Schrimpf (2019) stated that monetary news dominates policy decision announcements and non-monetary components comprising more than half of communication that provides context to policy decisions such as press conferences and minutes. Existing literature unfolds that there is a significant relationship between monetary policy announcements and stock price movement. Kurov (2012) found that monetary policy statements have business cycle-dependent implications for stock prices means stocks react negatively to announcements of high rates in economic expansion and stock react positively in recession. Hussain (2011) investigated the impact of monetary policy surprises on the US and European return and volatility response and their results indicate that monetary policy exerts immediate and significant influence on stock index returns and volatilities in both European and the US markets. They also give additional insight that ECB press conferences following monetary policy decisions have an impact on European index return volatilities. Gürkaynak et al. (2004) investigated the impact of US monetary policy on asset prices and found both monetary policy actions and statements have effects on asset prices. Smales and Apergis (2017) studied FOMC monetary policy-related surprise announcements and complex language in policy statements have significant impacts on financial market liquidity by increasing trading volume, and volatility in stock, bond, and currency markets, and during the crisis period the responsiveness of the financial market to monetary policy statements heightened.

As discussed in (Cieslak & Schrimpf, 2019) central bank press conferences and minutes provide information and signals about monetary policy change. A large body of literature emphasizes the same that central bank informal communication gives clues about monetary policy. Baranowski et al. (2021) found that the ECB communication tone (introductory statements) shock helps in the prediction of ECB monetary policy decisions. El-Shagi and Jung (2015) investigated whether the minutes of the Bank of England's monetary policy committee gave any information regarding the future path of monetary policy, and their findings suggested that the Bank of England's published minutes of monetary policy impact market expectations of future monetary policy decisions. Reeves and Sawicki (2007) revealed that the Bank of England's communication through minutes of the monetary policy committee meetings and the inflation rate report. Another study (Kohn & Sack, 2003), claimed that Federal Open Market Committee released statements

and congressional testimony by Chairman Greenspan significantly affected market interest rates. Bennani et al. (2020) explored how ECB ad-hoc communication by the members of the ECB Governing Council from 2008 to 2016 informs future monetary policy decisions. They constructed a measure for inter-meeting verbal communication to evaluate its inclination towards easing, tightening, or maintaining the monetary policy stance and found that this measure is useful and provides information about future monetary policy decisions. Sturm and De Haan (2011) examined whether or not the ECB President's introductory statement at the press conference after an ECB policy meeting provides additional information about policy decisions and their results indicate that the information added by this communication significantly predicts the ECB's next policy decision.

Ehrmann and Fratzscher (2007a) studied how ECB monetary policy decision explanations at the press conference impact the financial markets and their findings showed that ECB press conferences give additional informational insights to financial markets beyond that contained in the monetary policy decision and had significantly larger effects on financial markets than the corresponding policy decisions. Doh et al. (2022) explained that FOMC statements tone computed the surprise component of monetary policy announcements and stock market declines after unexpected monetary policy tightening. Based on the preceding explanation, monetary policy has a considerable impact on the stock market, and informal central bank communication plays an important role in forecasting future monetary policy. This study also looks into the literature on central bank communication sentiment, as sentiment gives clues about future monetary policy and respective financial market variables in different contextual settings (Bennani, 2019; Bruno & Giuseppe, 2016; Hubert & Fabien, 2017; Mathur & Sengupta, 2019; Petropoulos & Siakoulis, 2021). In recent years, the use of text-mining sentiment has widely increased in financial text corpus (Agarwal, 2023; Agoraki et al., 2022; Koukaras et al., 2022; Qian et al., 2022; Renault, 2020; Swathi et al., 2022; Valle-Cruz et al., 2022).

Existing literature (Bennani & Neuenkirch, 2017) examined ECB Governing Council member speeches by using automated text linguistic approach from 1999 to 2014 and their findings showed that hawkishness of speeches significantly impacts inflation and growth expectations. (Bohl et al., 2023) examined how inflation and unemployment affect the tone of central bank communication via speeches using a text mining approach and their findings revealed that inflation and unemployment expectations significantly affect the tone of speeches. Ahrens et al. (2023)

analyzed US Federal Reserve speeches using a multimodal natural language processing approach to see how they affected financial volatility and that central banker's speeches on monetary policy news explain both equity and bond market volatility.

Petropoulos and Siakoulis (2021) analyzed central bank speeches using different dictionaries and the Extreme Gradient Boosting model for the sentiment index to accurately indicate financial turmoil and they found speeches give useful insight for predicting the future behavior of financial markets. Harmon (2019) demonstrated Fed chair speeches sentiment analysis by using a backing ratio coding scheme and found the reaffirmed assumptions of the monetary policy create uncertainty in the financial market at large. Their results further unfolded that positive emotions present during speech less influence the market reaction as compared to fear or negative emotions. The central bank communicates through a variety of channels, but we use speeches as several studies recommended looking at central bank communication through speeches due to their tendency to explain the Bank's perspective on a broader economic outlook and contain a large range of information that is difficult for market participants to interpret (Moschella & Pinto, 2019; Moschella et al., 2020; Reeves & Sawicki, 2007).

The literature showed the significance of central bank speeches tone in anticipation of future monetary policy by using various sentiment analysis tools. The study examines the impact of Federal Reserve Board of Governors speeches impact on US equity market performance. The novelty of this paper lies in the composition of Principle Component Analysis (PCA) scores based on Lexicon dictionaries (AFINN, Bing, Loughran McDonald, and NRC) scores. We contribute to the strand of literature by unveiling the intricate relationship between central bank communication about monetary policy and the equity market, with a specific focus on the Fed governor speeches and their influence on the US equity market.

3. Data, Variables, And Methodology

To study the Federal Reserve Board of Governors speeches and US equity market nexus, we collected corpus of Federal Reserve governors from the Federal Reserve official website[2] and the US daily S&P500 index resourced from Refinitiv Eikon DataStream database. The sample period is from June 1996 to Sep 2023. The availability of Fed speeches archives influences the sample starting date.

3.1 Speeches Sentiment Index

We calculated the Fed Governor's speeches sentiment index using the lexicon dictionaries (AFINN, Bing, Loughran McDonald, and NRC). The AFINN dictionary calculates the sentiment score for each available speech by assigning average sentiment scores ranging from -5 to +5 to each English word, indicating its positivity or negativity. Bing, Loughran McDonald, and NRC categorize phrases or words as positive, negative, and angry among others (Hu & Liu, 2004; Loughran & McDonald, 2016; Mohammad & Turney, 2013).

We used four different dictionaries for robustness and to enhance the trustworthiness of sentiment analysis. Each dictionary has its algorithm and lexicon. We used multiple dictionaries to cross-verify and compare sentiment indices. It also helps us to control potential bias associated with a single sentiment analysis tool. The agreement of all dictionaries' outcomes validates and adds confidence to sentiment analysis results. We used only positive and negative sentiments from all four Lexicon dictionaries. Initially, we classify words as positive or negative in our context. Then we construct a sentiment index speech based on the number of positive and negative words for each speech by the following (Anastasiou et al., 2023; Bogdan & Borza, 2020) as:

$$Sentiment\ Index = \frac{\#Positive\ words - \#Negative\ words}{\#Positive\ words + \#Negative\ words} \qquad (1)$$

Traditionally sentiment analysis relies on individual Lexicon dictionaries, each with its strengths and weaknesses. This study used Principle Component Analysis (PCA) by following (Anastasiou & Katsafados, 2023; Stolbov et al., 2022) to combine lexicons' sentiment indices scores and create a new sentiment index that allows a more comprehensive and balanced approach to sentiment analysis and reduced biased associated with single dictionary based sentiment scores.

3.2 Abnormal Returns

We used the market model to calculate abnormal returns.

$$R_t = \ln(\frac{P_t}{P_{t-1}}) \qquad (2)$$

R_t is the natural log return of US equity market at time *t.* P_t and P_{t-1} are the index and its lag value of equity market at time *t* and *t-1,* where $t = 1, 2, \ldots, T$ denotes the time horizon. For expected returns estimation we used following regression equation:

$$E(R_t) = \alpha + \beta R_{m,t} + \varepsilon_t \quad (3)$$

The $E(R_t)$ expected returns are derived from both the log return of the S&P 500 and the log return of the MSCI index. The abnormal return is the difference between natural log return R_t and $E(R_t)$. The cumulative abnormal return (CAR) is the summation of daily abnormal returns.

$$AR_t = R_t - ER_t \quad (4)$$

$$CAR_t = \sum_{t=1}^{t} AR_t \quad (5)$$

We used equal non event and event (speech) observations following (Klusak et al., 2019; Tran et al., 2014) in the regression estimation. In this way, the regression coefficient gives a marginal effect of speech sentiment compared to non-speech observations. The non-event observation directly influences results hence, we avoid manual selection of non-event as it may induce selection bias. Therefore we choose non-event observations at random by following (Sahibzada et al., 2022). First, we identify non-event observations after/before event dates in which there is no speech delivered by any Fed Governors. In the next, step random numbers are generated by standard normal (Gaussian) variations which follow a normal distribution with mean=0 and standard deviation=1 assigned to non-event observations. In the last step, these random non-event observations are sorted in descending order, and speech equivalent observations with the highest values of the random variant were retained. It gives random non-event observations without any selection-related biases (hand-picking bias).

We controlled for macroeconomic variables such as interest rate and inflation rate due to their influence on market volatility and stock price (Erdem et al., 2005; Ratanapakorn & Sharma, 2007), and to capture the broader economic outlook (Romer & Romer, 2000).

3.3 Regression model

To test the effect of the Fed Governor speeches sentiment index on the US equity market abnormal returns, we modeled abnormal returns as a function of speeches sentiment indices with control variables as follows:

$$CAR_{t+n} = \alpha_{t+n} + \beta_1 SI_{t+n} + \beta_2 Int_{t+n} + \beta_3 Inf_{t+n} + \epsilon_{t+n} \quad (6)$$

Here, *CAR* is the cumulative abnormal returns over *t+n* number of periods, α is constant, *SI* is the Fed Governor speeches sentiment index obtained from lexicon dictionaries, *Int* stands for interest rate and *Inf* stands for the inflation rate. Interest rate and Inflation rate are macroeconomic variables used as control variables. ϵ is an error term. The coefficient β_1 exhibits the same marginal effect on the *CAR*, whether the speech sentiments are positive or negative.

4. Results and Discussion

This section discusses descriptive statistics, regression results, and robustness checks.

Figure 1 shows Federal Reserve Governor speeches sentiment scores quantified by lexicon dictionaries (AFINN, Bing, Loughran Mcdonald and NRC). AFINN and Bing quantified positive sentiment scores to a major proportion of Fed speeches during the sample period. NRC and LM relatively assigned more negative sentiment scores to these speeches. The GFC started at the end of 2007 and lasted until 2009 (Ando & Kimura, 2012; Claessens et al., 2010). Figure 1 shows extremely negative sentiment relative to the whole sample duration. The severe economic downturn and financial instability worldwide during the GFC influenced the Fed Governors' speeches, which reflected the negative sentiment.

4.1 Robust Regression Result

The sample consists of the event (speech delivered) and non-event (no speech delivered) observations. This study used non-event observations in the sample in addition to event observations. The robust result is a nonparametric bootstrap estimation of Eq. 6. This involves resampling the data by randomly selecting non-events with replacements. The process of replication repeats multiple times typically 1000 replications and provides results based on estimations extracted from these resampled datasets. This method ensures the reliability and robustness of findings.

In Table 1 the bootstrap regression results of Eq. 6 for three windows starting from the same day (+1) up to (+3). The (+2) event window stands for speech event day plus the following working day. The short event window same day (+1) is appropriate to capture the immediate response of the US financial market to the Fed speech delivered. The other event windows provide useful insight into the delayed impact of the Fed Governor speeches sentiment index for up to 3 working days. The US market response to speech sentiments reported using the market model in Table 1 shows that the sentiment index of Fed Governor speeches is non-significant in the (+1)

and (+3) windows but it is significant in the event window (+2). In terms of magnitude, the Bing, LM, AFINN and PCA sentiment index coefficients suggest that there is a negative relationship between speeches sentiment and cumulative abnormal return mean that, on average, a positive (negative) speeches sentiment signal by the Fed brings the cumulative abnormal returns down (up).

On the following day (+2) after speech markets reevaluate their position, the volatility and uncertainty increase leading to a shift in the financial market reaction. Broader market dynamics and risk aversion might overshadow the initial positive sentiment from the speeches. The results of Bing, LM, AFINN, and PCA are statistically significant in the event window (+2) suggesting that it is time-consuming to interpret the content of speeches may be due to the complex or nuanced information in the speeches. The other possible reason for the delayed market response is prevailing sentiments of the market influence the speech to be fully realized by market participants to assess the potential consequences and adjust their strategies accordingly. The market gradually adjusts to new policy changes mentioned or hinted at by Federal Reserve speech and its overall response delay (Lange et al., 2003). The event window (+3) is non-significant in all dictionaries estimations which means the market immediately responds to their speech and there is no delayed impact of their speeches. The findings also suggest that the US market is efficient in processing and reacting to new information. Efficient markets are characterized by the quick and accurate incorporation of new information into asset prices. The efficient market hypothesis (EMH) suggests that in an efficient market, asset prices reflect all available information, and it is difficult to consistently achieve above-average returns through active trading or analysis of public information alone. Although perfect efficiency is an unrealistic benchmark the efficiency of the US market does not imply that it is perfectly efficient or that there are no opportunities for abnormal return. It means that in the real world, the US market is efficient considering all other elements (Lim, 2007).

Although NRC does not give significant results on any window still the overall results of all the dictionaries are majorly consistent on the event window (+2). The coefficient size varies due to differences in the algorithm of these dictionaries but the direction of the relationship is similar in many instances. The results are reliable and mitigate subjectivity issues that arise with individual dictionaries.

The delayed significant reaction suggests that investors and market participants take some time to fully comprehend the content and implications of the speeches. When the central

bank provides clear communication about its policies, decisions, and economic outlook, it helps reduce uncertainty in the market (Bernanke & Mihov, 1998; Mishkin, 2004) and favorable implications on the financial market (Bennani, 2020; Montes & Nicolay, 2017; Montes et al., 2016; Smales & Apergis, 2017). Increased transparency from the central bank may shed light on issues that were previously not as evident or well-understood. As a result, market participants become more sensitive to these potential downsides and uncertainties. Too much transparency may delay favorable market reactions (Dincer & Eichengreen, 2013; Horvath & Katuscakova, 2016). Macroeconomic factors also influence the impact of sentiment on market movements.

Table 1: *US equity market response to Federal Reserve Board of Governors (Simulation Results) - (June 1996- Sep 2023)*

	(1) **CAR +1**	**(2)** **CAR +2**	**(3)** **CAR +3**
Bing			
Sentiment Index	0.00156	-0.0122*	0.000784
Loughran McDonald			
Sentiment Index	0.00053	-0.0117*	-0.0092
NRC			
Sentiment Index	0.00133	0.00136	-0.0014
AFINN			
Sentiment Index	-0.00089	-0.0081**	-0.0017
Combined Lexicon pc1			
Sentiment Index	0.0000583	-0.0029**	-0.00061
No. of Events	1415	1012	1011
No. of Obs.	2830	2024	2022

This table reports the estimation results of Eq. (6) for the US equity market cumulative abnormal returns (CARs) by using market models. All estimations are based on lexicon dictionaries (Bing, LM, NRC, and AFINN). Standard errors are based upon bootstrap estimation with 1000 replications. *, **, *** show significance at 10%, 5%, and 1% levels, respectively.

5. Conclusion

Existing literature studies different central bank communication and link it with the financial markets reactions and stability (Bernanke & Kuttner, 2005; Blinder et al., 2008; Born et al., 2014; Eusepi & Preston, 2010; Woodford, 2005) by using sentiment signals (Gu et al., 2022; Petropoulos & Siakoulis, 2021). However, the relationship between the Fed Governors' speeches sentiment (Lexicon-based) and the US equity market is unexplored. In this study, we investigate the Fed speeches sentiments impact on the US equity market. We based our empirical investigation on using theoretical framework of signaling theory. The finding of this study suggests that Fed

Governor speeches sentiment indices significantly impact the US equity market in the event window (+2). The US equity market abnormal return increase (decrease) with the Fed's negative (positive) sentiment signals.

These findings are vital for investors, regulators, and policymakers as they unfold how central bank communication affect the equity market and adjust their communication accordingly. Our study opens further interesting future research avenues. This study investigates the effect of Fed Governors' speeches sentiment on the US equity market without considering different US sectors, and the cross-country spillover effects with US alliance countries.

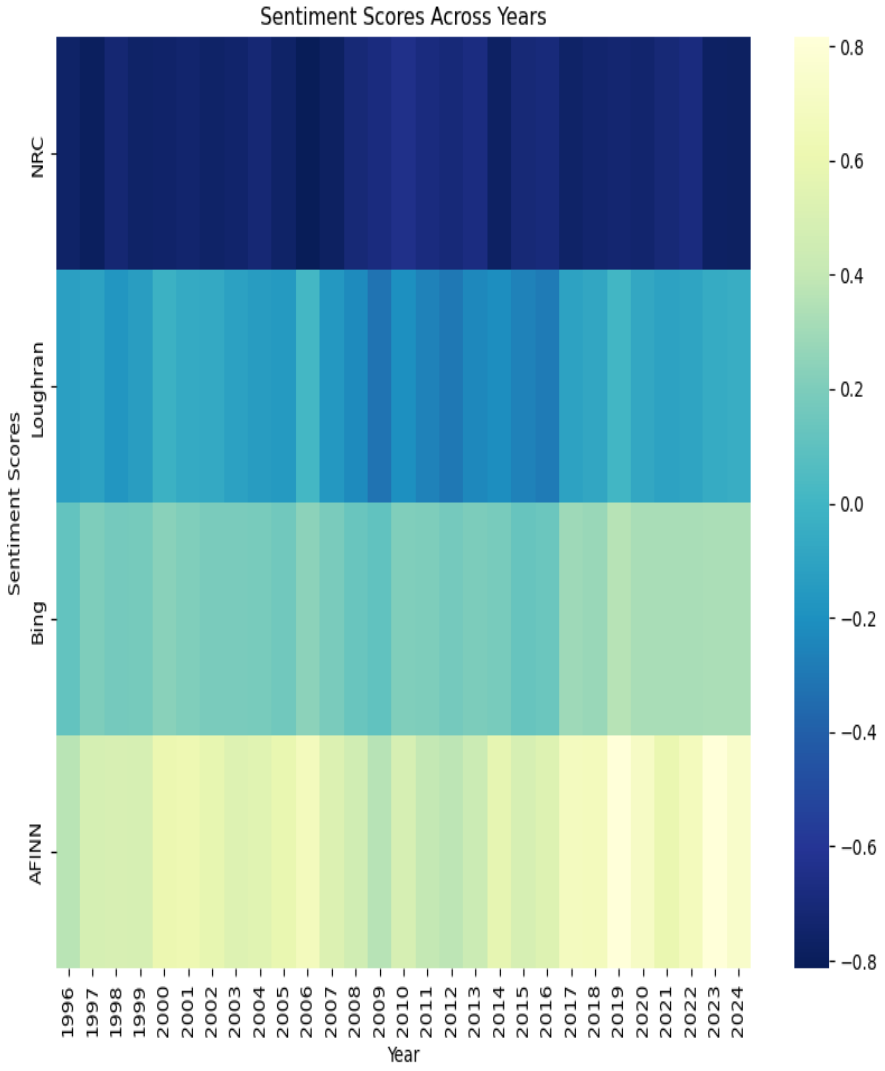

Figure 1 Federal Reserve Governor Speeches Sentiment Scores