

# FedNLP: An interpretable NLP System to Decode Federal Reserve Communications

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### ABSTRACT

The Federal Reserve System (the Fed) plays a significant role in affecting monetary policy and financial conditions worldwide. Although it is important to analyse the Fed's communications to extract useful information, it is generally long-form and complex due to the ambiguous and esoteric nature of content. In this paper, we present FedNLP, an interpretable multi-component Natural Language Processing (NLP) system to decode Federal Reserve communications. This system is designed for end-users to explore how NLP techniques can assist their holistic understanding of the Fed's communications with NO coding. Behind the scenes, FedNLP uses multiple NLP models from traditional machine learning algorithms to deep neural network architectures in each downstream task. The demonstration shows multiple results at once including sentiment analysis, summary of the document, prediction of the Federal Funds Rate movement and visualization for interpreting the prediction model's result. Our application system and demonstration are available at <https://fednlp.net>

### CCS CONCEPTS

• **Computing methodologies** → **Natural language processing**;  
• **Social and professional topics** → **Systems development**.

### KEYWORDS

Federal Reserve; AI Application; Text Analysis; Federal Funds Rate Forecasting; Interpretable Machine Learning

### ACM Reference Format:

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### 1 INTRODUCTION

Over the years, the role of the U.S. Federal Reserve System (the Fed) has expanded due to changes in the monetary and financial conditions globally. The Fed's decisions have a chain effect on a broader range of economic factors like inflation, employment, value of currency, growth and loans [10]. Therefore, it is important to analyse the Fed's communications that anchor and guide market expectations, however, it is generally long-form and complex due to the ambiguous and esoteric nature of content [2, 7]. Additionally, the Fed has increased their interest in research exploring the importance of Natural Language Processing (NLP) for macroeconomics [4]. It is aligned with the remarkable progress in NLP that has seen the emergence of a massive number of model architectures (e.g. Transformers [23]), and pre-trained models (e.g. BERT [6], T5 [16]). Considering the fact that the Fed supervision carries vast amounts of unstructured data, the significant improvement in NLP research could assist their needs. However, there are no pilot studies to identify how NLP components could help end-users analyse Federal Reserve communications.

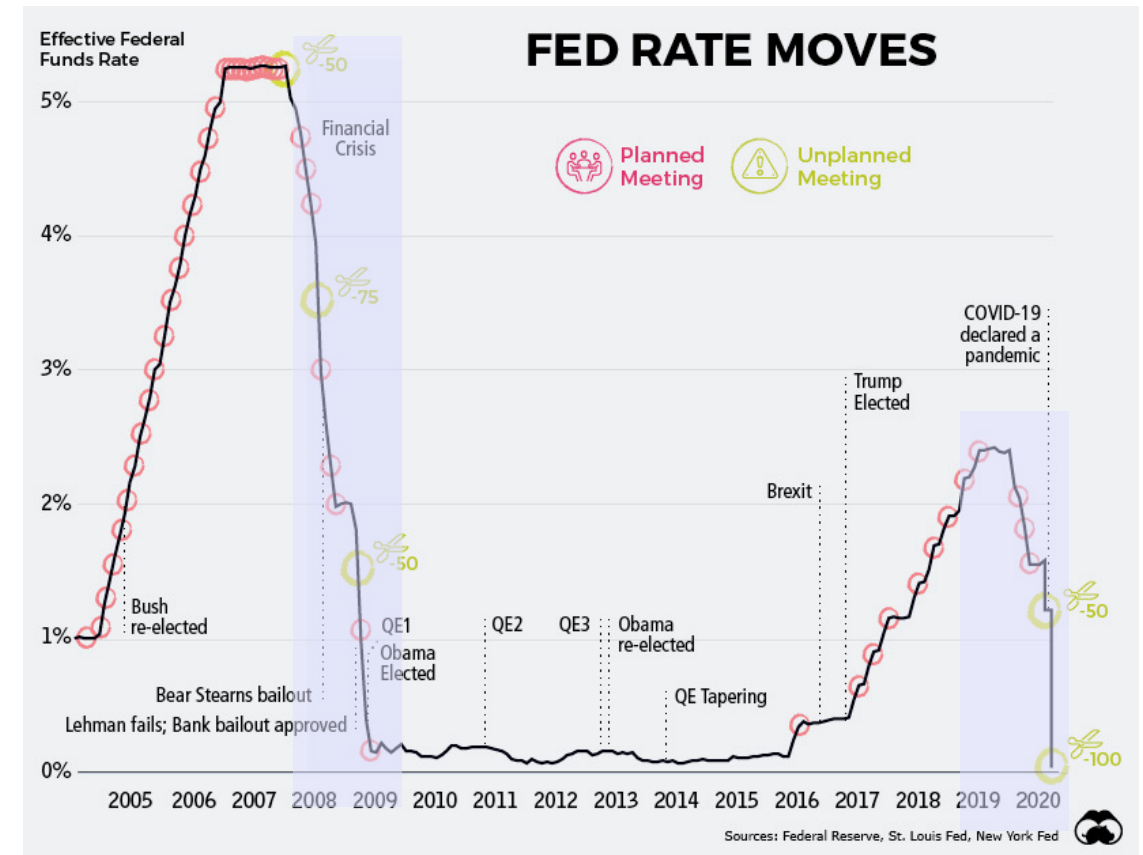
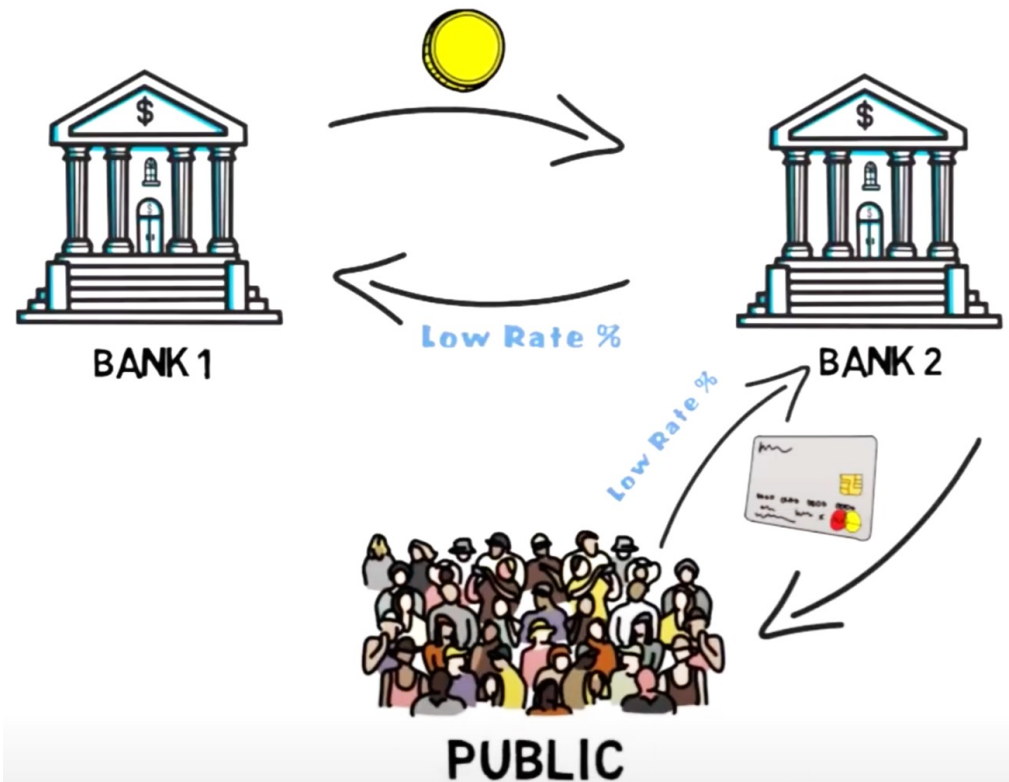
In this paper, we present FedNLP, an multi-component NLP system that aims to decode Federal Reserve communications with NO code. The system is designed for end-users to assist their holistic and intuitive understanding of the Fed's communications through the use of multiple NLP components. We define that an end-user is the person who works within a broad range of business sectors such as finance and accounting, often reads economic and financial news, and has low to no programming skills. Our objectives are to reduce the gap between the advance of NLP technology and the needs for the use of NLP by building a "practical use" of NLP system. Inspired by recent research that combines language tools [22], our system focuses on presenting multiple NLP components such as sentiment analysis [14], prediction [6, 26], explanation [18], and summarization [16] in one application. Fig. 1 shows the functional system flow that consists of NLP and application modules required to deliver a no-code system to an end-user. In each NLP task, multiple models are built and then the final models are selected for web applications.

The main contributions of this paper are as follows:

- To the best of our knowledge, we propose **FedNLP**, the first interpretable multi-component NLP system for decoding Federal Reserve communications that assist end-users.

# Background

Federal Funds Rate (FFR) is decided by the Federal Open Market Committee (FOMC) where the body members set the monetary policies and often speak through the media.



# Background

it is important to analyse the Fed's communications that guide market expectations. However, it is generally long-form and complex due to the ambiguous nature of content.

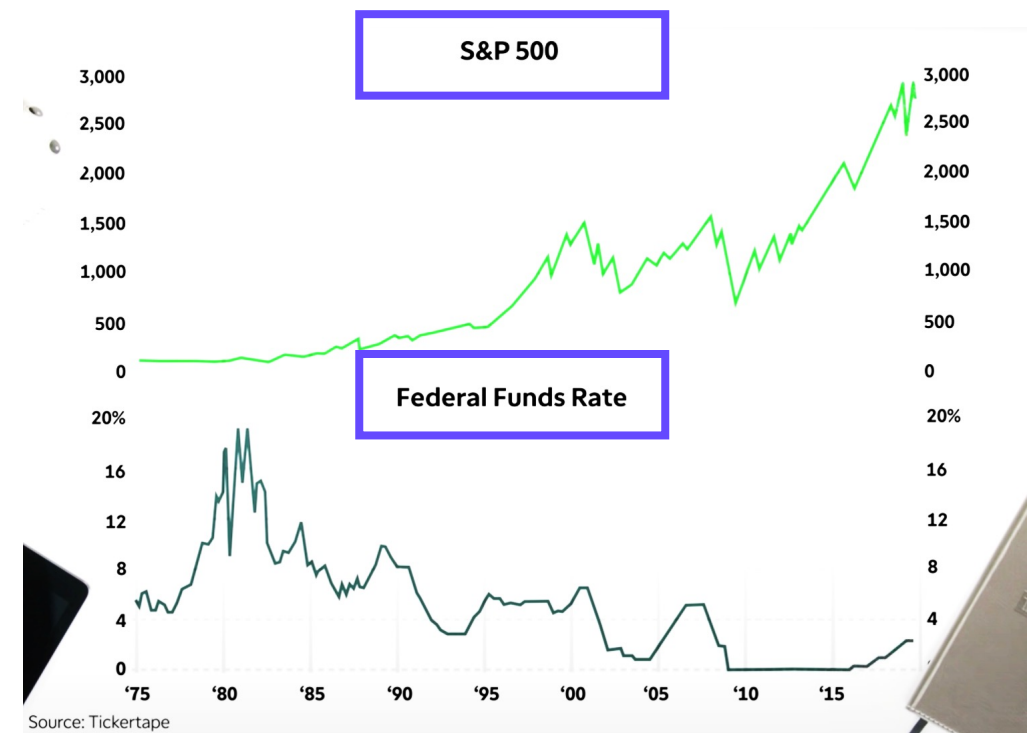
The New York Times

## *Stocks Jump as Fed's Powell Suggests Rates Could Come Down*



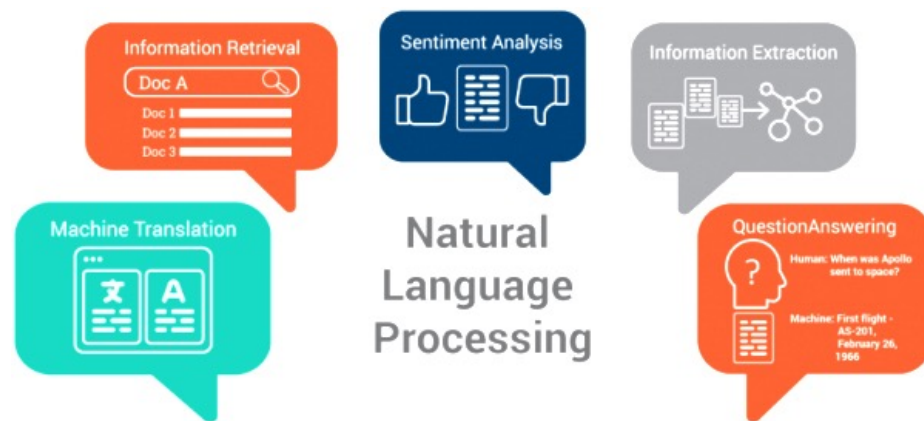
Jerome Powell, the Federal Reserve chairman, said the central bank is prepared to act if trade tension with China and Mexico worsen. Al Drago for The New York Times

"We do not know how or when these issues will be resolved," Mr. Powell said of the United States' trade disputes with Mexico, China and other nations. "We are closely monitoring the implications of these developments for the U.S. economic outlook and, as always, we will **act as appropriate to sustain the expansion,** with a strong labor market and inflation near our symmetric 2 percent objective."

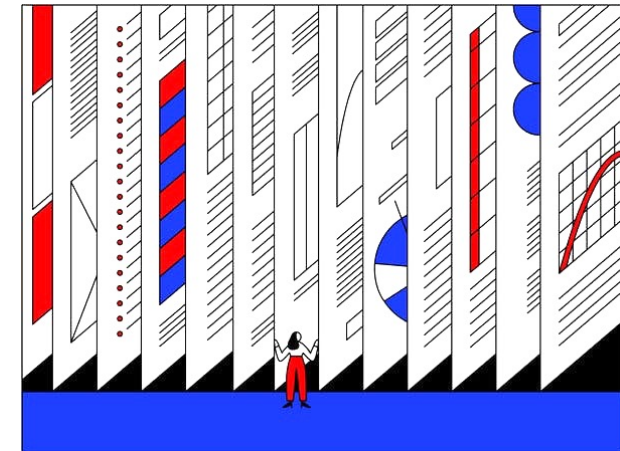


# Problems

The Fed has increased their interest in research exploring the importance of **Natural Language Processing (NLP)** for macroeconomics, but no pilot studies exist performing Interpretable NLP system on the Fed's communications.



*Advance of technology*



*No practical NLP applications  
in finance and economics  
for end-users*

# Contributions

**Our study shows novel uses of Artificial intelligence (AI) in the financial domain and explore how NLP techniques can assist end-users' holistic understanding of the Fed's communication.**



## End-to-End Applications

- As a pilot study, we propose FedNLP, the first interpretable multi-component NLP system for decoding Federal Reserve communications that assist end-users.
- shows novel uses of Artificial intelligence (AI) in the financial domain and explores NLP techniques.



## Multiple NLP components

- We implement the multiple NLP components – Sentiment analysis, Topic Modelling, Summarization, Prediction, Explanation, and Demonstration.
- The components were identified through the preliminary focus group interviews.



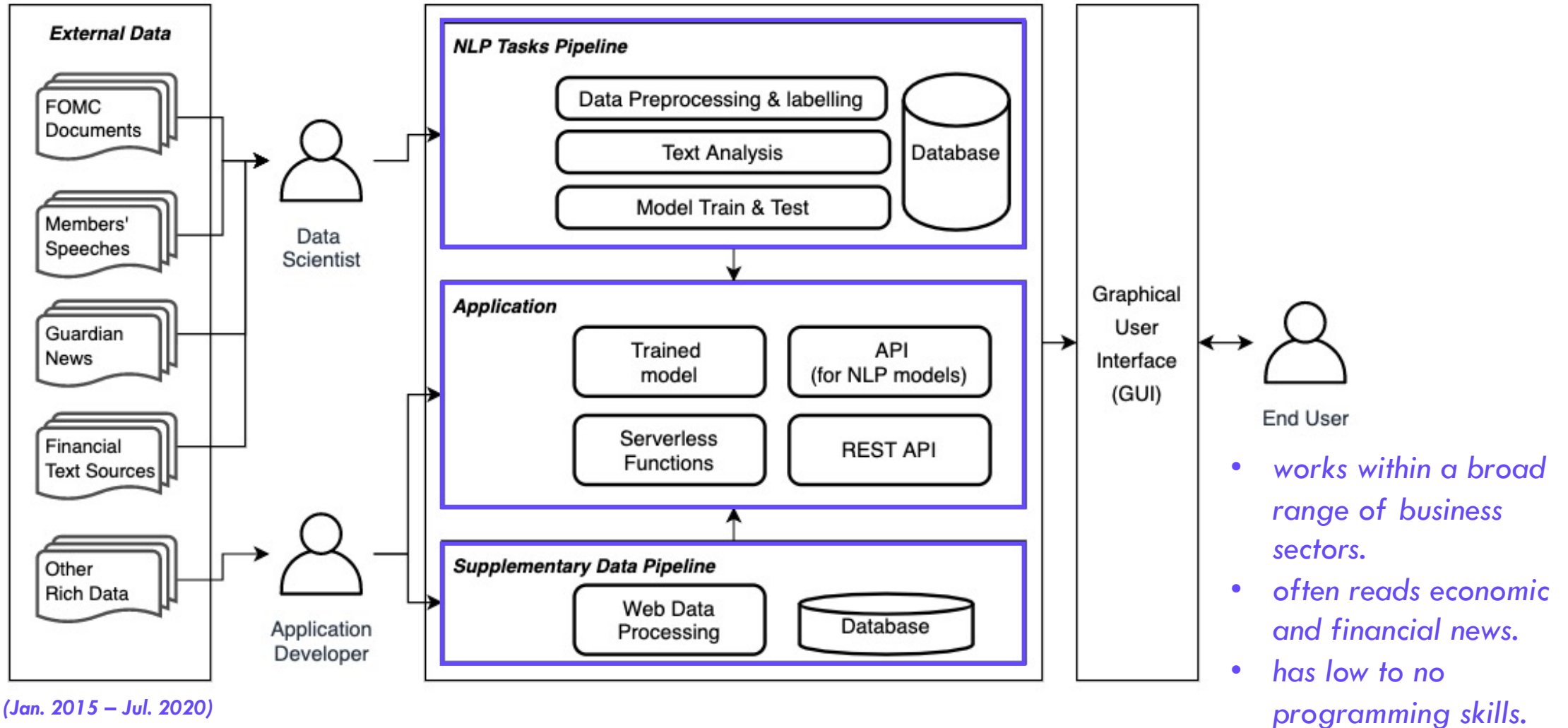
## A Demo for non-coders

- Our demonstration is designed for an end-users as a no-code system..
- By copying any text content, our demo shows the results from eight different NLP models.



# System Design & Implementation

The architecture is designed to be scaled easily, having two main process flow of NLP and Web App.



# System Design & Implementation

Multiple language processing components and algorithms in the proposed FedNLP. "General" denotes general algorithms and "Financial" denotes the financial domain-specific algorithms.

Component	Algorithm	Description	General	Financial
Sentiment Analysis	TextBlob [13]	Returns polarity and subjectivity using TextBlob for general settings.	v	
	LM Sentiment [14]	Returns polarity and subjectivity using LM sentiment for financial settings.		v
Topic Modelling	LDA [17]	Visualizes term clusters and topics in HTML using LDA model.	v	
Prediction	XGBoost [5]	Displays ML model predictions with explanation component.	v	
	FinBERT [26]	Displays model predictions using a fine-tuned FinBERT.		v
Explanation	Lime [18]	Visualizes top 10 highly-contributing features and highlights sentences.	v	v
Summarization	TextRank [15]	Displays an extractive summarization using a graph-based ranking model	v	
	T5 [16]	Displays an abstractive summarization using a fine-tuned T5.		v
Demonstration	Decoupled APIs	Shows multi-components in one webpage that works with new input data.	v	v

# System Walkthrough (List page)

Fed  
NLP

#  
CATEGORIES

🌐  
DOMAINS

👤  
AUTHORS

🔬  
DEMO

## Federal Funds Rate

To predict the decision of changes in target Federal Funds Rate, the various forms of Federal Reserve communications such as post-meeting statements, minutes, and press conferences as well as FOMC member<sup>\*</sup> speeches were collected.

### DOCUMENTS

All Predictions

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#### Rising to the Challenge: Central Banking, Financial Markets, and the ...

John Williams • www.newyorkfed.org • 16 Jul 2020

John Williams, president and chief executive officer, remarks at the 11th meeting of the financial research advisory committee for the Treasury.

MAINTAIN

#### Economic Outlook and Building an Inclusive Recovery

Patrick Harker • www.philadelphiafed.org • 15 Jul 2020

Fed Chair Janet Yellen: We're now about four months into the coronavirus crisis. She says the country has still failed to control the virus....

MAINTAIN

#### Chair's letter to G20 Finance Ministers and Central Bank Governors: J...

Randal Quarles • www.fsb.org • 15 Jul 2020

The FSB is maintaining financial stability during the COVID event by assessing vulnerabilities during the current crisis. Volatility in mark...

MAINTAIN

#### The Impact of COVID-19 on Communities and Small Businesses

Patrick Harker • www.philadelphiafed.org • 14 Jul 2020

Fed Chairman Jerome Powell: Small businesses are the lifeblood of our economy. He says small businesses are integral to our economy and to t...

MAINTAIN

#### Governor Lael Brainard,

Lael Brainard • www.federalreserve.gov • 14 Jul 2020

The recent resurgence in COVID cases is a sober reminder that the pandemic remains the key driver of the economy's course. A thick fog of un...

MAINTAIN

#### The State of the COVID-19 Crisis in the U.S.

James Bullard • www.stlouisfed.org • 14 Jul 2020

Bullard: Progress in managing the health crisis has been substantial, but COVID-19 has proven to be more persistent than many expected. The ...

LOWER

#### 537 Days: Time Is Still Ticking

John Williams • www.newyorkfed.org • 13 Jul 2020

Transition away from the London interbank offered rate is of critical importance to the safety and soundness of the financial system. This i...

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### FEDERAL FUNDS RATE SUMMARY



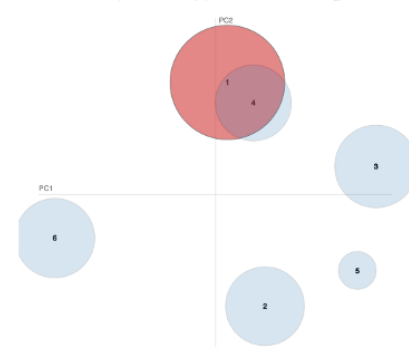
### TOPIC MODELLING

Selected Topic: 1 Previous Topic Next Topic Clear Topic

Slide to adjust relevance metric: (2)

$\lambda = 1$

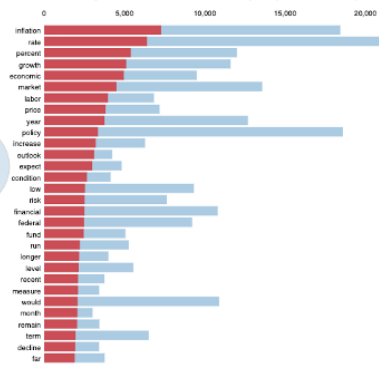
Intertopic Distance Map (via multidimensional scaling)



Marginal topic distribution



Top-30 Most Relevant Terms for Topic 1 (21.1% of tokens)



Overall term frequency  
Estimated term frequency within the selected topic

1.  $\text{salience}(\text{term } w) = \text{frequency}(w) \cdot \left( \sum_i \text{topic}(w) \cdot \text{topic}(i) \right)$  for topics  $i$ ; see Chung et al. (2012)

2.  $\text{relevance}(\text{term } w \text{ to topic } i) = \lambda \cdot \text{topic}(i) + (1 - \lambda) \cdot \text{topic}(i) \cdot \text{topic}(w)$ ; see Blei et al. (2003)



# System Walkthrough (Detail page)

FinVis  
NLP


#  
CATEGORIES

🌐  
DOMAIN

👤  
AUTHORS

🔍  
DEMO

1  
ABOUT



## Jerome Powell

### DOCUMENTS

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<b>Coronavirus and CARES Act</b> Jerome Powell • www.federalreserve.gov • 30 Jun 2020 Jerome H. Powell, Chair of the Coronavirus and CARES Act Committee, testifies before the House Committee on Financial Services. Powell: "We ...	📉 LOWER
<b>Introductory Comments</b> Jerome Powell • www.federalreserve.gov • 19 Jun 2020 Jerome H. Powell: We are meeting on juneteenth amid a renewed reckoning of racial injustice. The pandemic has again exposed a range of troub...	📉 LOWER
<b>Coronavirus and CARES Act</b> Jerome Powell • www.federalreserve.gov • 19 May 2020 Jerome H. Powell: The scope and speed of this downturn are without modern precedent and are significantly worse than any recession since Wor...	📊 MAINTAIN
<b>Current Economic Issues</b> Jerome Powell • www.federalreserve.gov • 13 May 2020 Jerome Powell: The scope and speed of this downturn are without modern precedent. Powell: We are seeing a severe decline in economic activit...	📊 MAINTAIN
<b>COVID-19 and the Economy</b> Jerome Powell • www.federalreserve.gov • 09 Apr 2020 Fed Chair Janet Yellen: The challenge we face today is different in scope and character from those we have faced before. She says we are mov...	📊 MAINTAIN
<b>Fed Chair says U.S. 'May Well Be In A Recession' As C...</b> Jerome Powell • www.youtube.com • 26 Mar 2020 JEROME POWELL, chairman of the FEDERAL RESERVE, gives an exclusive interview to CNN.com. POWELL: FED is willing to put money into the econom...	📊 MAINTAIN
<b>March FOMC Press Conference</b>	

## Coronavirus and CARES Act

### DOCUMENT DETAILS

AUTHOR	Jerome Powell
DOMAIN	www.federalreserve.gov
ORIGINAL SOURCE	<a href="https://www.federalreserve.gov/newsevents/testimony/powell...">https://www.federalreserve.gov/newsevents/testimony/powell...</a>
DOCUMENT DATE	19 May 2020
DECISION DATE	10 Jun 2020

### GENERAL SENTIMENT

0.14  
Polarity

0.42  
Subjectivity

### FINANCIAL SENTIMENT

-0.1  
Polarity

0.09  
Subjectivity

### ORIGINAL DOCUMENT

WORD COUNT: 1953

May 19, 2020 Coronavirus and CARES Act Chair Jerome H. Powell Before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, Washington, D.C. Share Watch Live Chairman Crapo, Ranking Member Brown, and other members of the Committee, thank you for the opportunity to discuss the extraordinary steps the Federal Reserve has taken to address the challenges we are facing. I would like to begin by acknowledging the tragic loss and tremendous hardship that people are experiencing both here in the United States and around the world. The coronavirus outbreak is, first and foremost, a public health crisis, with the most important responses coming from those on the front lines in hospitals, emergency services, and care facilities. On behalf of the Federal Reserve, let me express our sincere gratitude to those individuals who put themselves at risk day after day in service to others and to our nation. The forceful measures that we, as a country, are taking to control the spread of the virus have substantially limited many kinds of economic activity. Many businesses remain closed, people have been advised to stay home, and basic social interactions have been greatly curtailed. People have put their lives and livelihoods on hold at significant economic and personal cost. All of us are affected, but the burdens are falling most heavily on those least able to carry them. It is worth remembering that the measures taken to contain the virus represent an investment in our individual and collective health. As a society, we should do everything we can to provide relief to those who are suffering for the public good. Available economic data for the current quarter show a sharp drop in output and an equally sharp rise in unemployment. By these measures and many others, the scope and speed of this downturn are without modern precedent and are significantly worse than any recession since World War II. Since the pandemic arrived in force just two months ago, more than 20 million people have lost their jobs, reversing nearly 10 years of job gains. This

### DOCUMENT SUMMARY

WORD COUNT: 182

Jerome H. Powell: The scope and speed of this downturn are without modern precedent and are significantly worse than any recession since World War II. Since the pandemic arrived in force just two months ago, more than 20 million people have lost their jobs. The Federal Reserve's response to this extraordinary period has been guided by our mandate to promote maximum employment and stable prices. In March, we lowered our policy interest rate to near zero. We expect to maintain interest rates at this level until we are confident that the economy has weathered recent events. Congress's passage of the Coronavirus Aid, Relief, and Economic Security Act was critical. The cost of borrowing rose sharply for those issuing corporate bonds, municipal debt, and asset-backed securities (ABS) backed by consumer and small business loans. Effectively, creditworthy households, businesses, and state and local governments were unable to borrow. The Federal Reserve is preparing to launch the Main Street Lending Program. The program is designed to provide loans to small and medium-sized businesses. Unlike the 2008 financial crisis, banks entered this period with substantial capital.



THE UNIVERSITY OF  
SYDNEY



**Thank you!**

*A Live demo at*  
**[www.fednlp.net](http://www.fednlp.net)**

**Any questions, please email us!**  
**[caren.han@sydney.edu.au](mailto:caren.han@sydney.edu.au)**