SOUTH CENTRAL SAS USER GROUP
CONFERENCE 2018 PAPER

Predicting the Federal Reserve's Funds Rate Decisions

Nhan Nguyen, Graduate Student, MS in Quantitative Financial Economics
Oklahoma State University, Stillwater OK

ABSTRACT

Federal funds rate has a chain impact on major interest rates and performance of the US economy. Predicting the next rate moves by the Federal Reserve, either an accommodative decision (reduce or hold the target federal funds rate) or a restrictive one (increase the target federal funds rate), would be of great significance to various groups of stakeholders, including equity and fixed income investors who wish to manage their investment portfolios effectively. In this project, R and SAS Enterprise Miner are deployed to build models to predict the rate decisions, using past decisions and economic indicators as the main variables. A sentiment measurement, text clusters, and text topics supplement these variables. This unique combination augments modeling and improves accuracy in a contractionary policy but fails to outperform a conventional model with only quantitative variables in an expansionary policy.

INTRODUCTION

The US Federal Reserve (Fed) is the world's most influential central bank. Charged with formulating and executing the country's monetary policy, the Fed seeks to fulfill its mandate of promoting maximum employment, preserving price stability, and maintaining moderate long-term interest rates. The bank conducts the monetary policy through reserve requirements, discount rate, and open market operations. These in turn affect the availability and price of credit to the economy, helping sustain economic growth and a stable environment for consumers and businesses. In open market operations, the Federal Open Market Committee (FOMC) sets a target federal funds rate that banks lend one another and influences the effective rate by buying or selling

government securities. With respect to an expansionary policy to support the economy, the FOMC targets to lower the federal funds rate by buying government securities, driving up securities' prices and thus reducing the interest rate. On the contrary, with a contractionary policy the FOMC sells government securities to suppress prices and thus increase interest rate to fight inflation and contain a hotly growing economy. The federal funds rate broadly impacts other key interest rates such as the prime rate, mortgage rates, credit card rates, and commercial interest rates, and ultimately reaches the labor market and economic performance.

Exhibit 1. Effective Federal Funds Rate 1990-2018
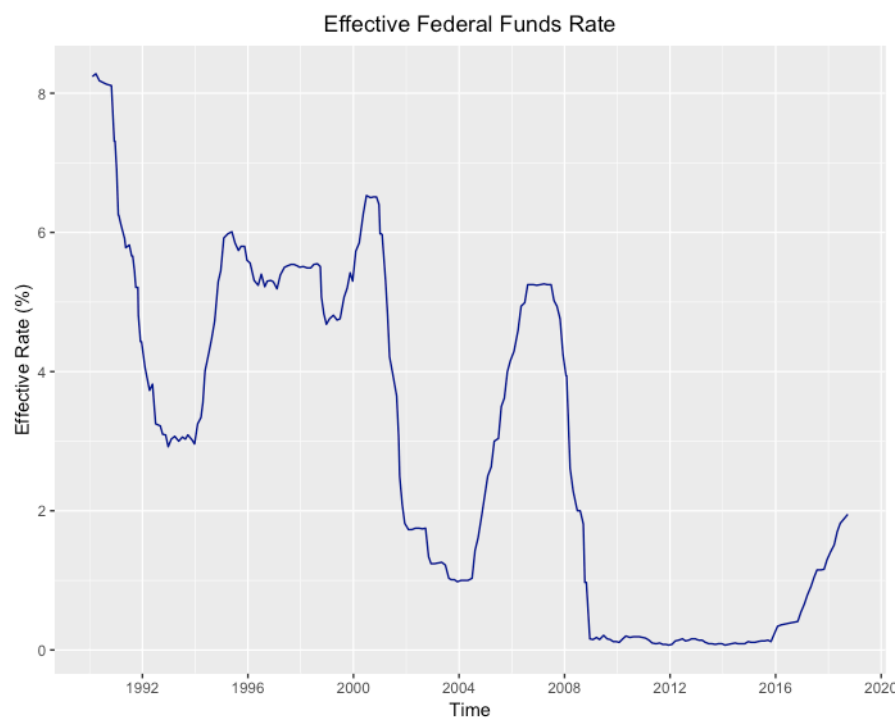
The FOMC meets eight times in a year and has since 1994 improved its communication to the general public through meeting minutes, statements, and press conferences. Market participants closely watch and obsessively attempt to decipher these carefully crafted channels of communication with a hope to identify the signals of the FOMC's next move. This project models the FOMC's rate decisions in 1990-2018 by combining text analytics on the FOMC's meeting minutes with conventional regressions and decision trees using quantitative economic variables. Text analytics plays a central role in this process by helping narrow down the search for relevant quantitative variables and introducing sentiment as a variable. With the help of Enterprise Miner, text topics and clusters are developed and passed to models to enhance model performances.

DATA COLLECTION: FED MEETING MINUTES

In 1990-2018, the FOMC met and conducted conference calls for 241 times and released meeting minutes, statements, and press conferences. Statements are too short and carefully crafted in such a way that it's not easy to generate meaningful differences for statements of closer meeting dates. In this case, the meeting minutes are a good candidate for text mining as they contain reviews and discussions on economic developments and policy directions. Main text bodies on relevant content are manually copied into text files, leaving out irrelevant information such as names of meeting participants and administrative procedures. This helps create a better text corpus and reduce subsequent effort on cleaning and filtering texts.

TEXT ANALYSIS AND SENTIMENT IN R

In this part, R packages tm, tidytext, and SentimentAnalysis are primarily used to do text analytics on the meeting minutes: summarize the most relevant economic and policy discussions and generate sentiment measurement values for the meetings with the finance-domain lexicon by Loughran and McDonald.

The texts are parsed with R package tm with punctuations, digits, stop words, and redundant spaces being removed. In addition, general and descriptive words are eliminated. These words are present in many meeting minutes but do not add real values to content analysis such as names, months, meeting, quarters, etc.

Exhibit 2. Filtered Word Count by Meeting

Starting from 1994, chairman Greenspan decided to increase Fed's communication to the general public. The move increased the filtered word count from around 500 to around 2,000 words per meeting minutes. In the aftermath of the 2008 financial crisis, chairman Bernanke significantly expanded Fed communication with the filtered word count amounting to the 3,000-word territory. This is helpful for text analysis efforts.

Exhibit 3. Word Cloud for Meeting Minutes

The FOMC meetings centers on inflation, economic growth, rate, market, monetary policy, labor, consumer, and some other important words. Word correlations for these words further reinforce the focus of FOMC meetings on fulfilling its mandate. As a result, key quantitative variables related to economic growth, inflation, interest rates, and employment are collected to build the predictive models.

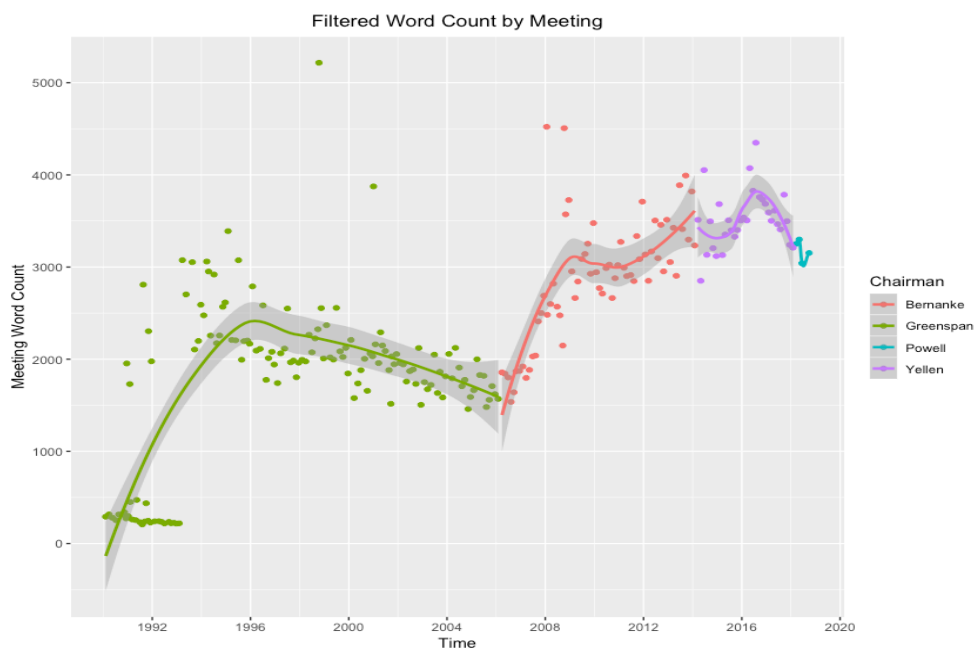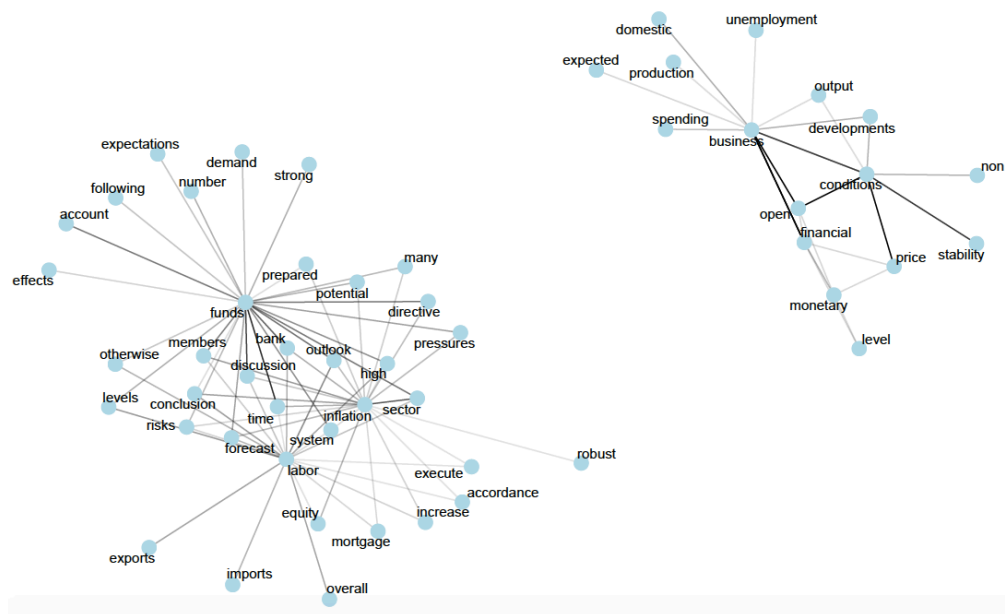**Exhibit 4. Word Correlations for the Most Important Word**

Exhibit 5. Concept Links

The R package SentimentAnalysis generates sentiment measurements of the meetings based on the Loughran-McDonald finance lexicon. In general, sentiment is lower for meetings in which the FOMC decided to decrease the target federal fund rate to support the economy. Meetings in which the FOMC raised the target funds rate have higher sentiment, as the committee is more optimistic with economic growth and employment statistics. Sentiment measurements of meetings in which the FOMC decided to keep the rate unchanged are in the middle. However, the sentiment is mixed in some cases.

Exhibit 6. Sentiment Analysis
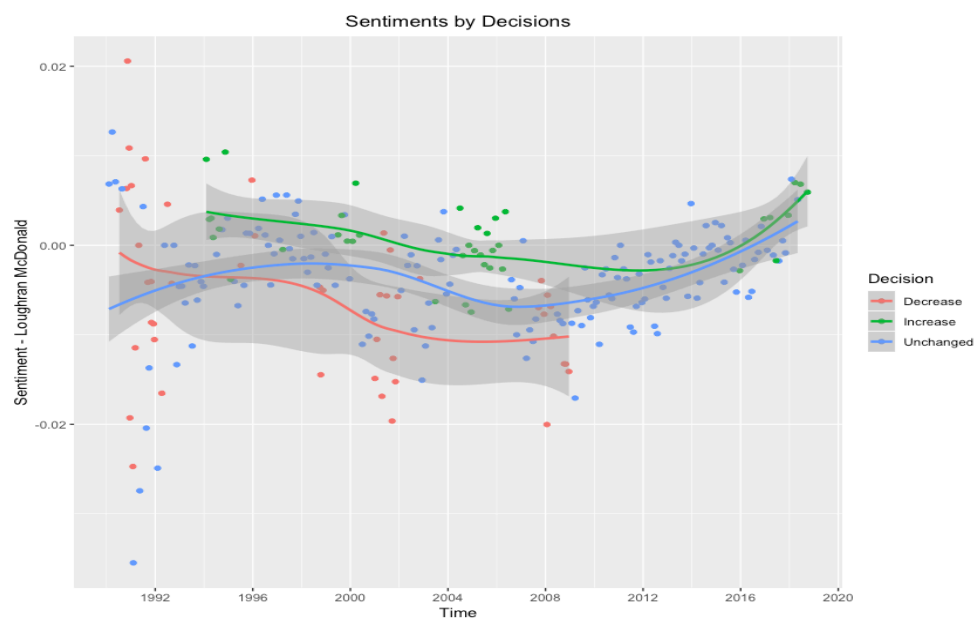
DATA COLLECTION: QUANTITATIVE VARIABLES BASED ON TEXT ANALYSIS

Text analysis guides a focus on selecting quantitative variables in the arenas of economic growth, inflation, employment, and interest rates. For each meeting, the preceding month's data is gathered; as it is often available for the FOMC to make decisions. The source is the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org). Variants of these economic indicators are created because the indicators' levels only don't relate well to what the FOMC sets as expectations.

Economic Growth

- *Gross domestic product (GDP) growth:* quarterly annualized GDP growth (GDPPC1)
- *GDP growth gap:* quarterly annualized GDP growth – 2% as growth rate above 2% tends to be considered getting closer to strong economic growth
- *GDP growth ratio:* quarterly annualized GDP growth/2%
- *Bond yield difference (T10Y2YM):* 10-year treasury yield – 2-year treasury yield. This is a proxy for economic recession signal. Before any economic crisis in the last several decades, this difference got smaller and became negative.

Inflation

- *Inflation:* monthly personal consumption expenditures percentage change from last year (PCEPC1)
- *Inflation gap:* inflation – 2% as the Fed sets 2% as the target long-term inflation
- *Inflation ratio:* inflation/2%

Interest Rates

- *Effective federal funds rate (FEDFUND)*
- *US 10-year treasury yield (DGS10):* this is a proxy for long-term interest rate
- *10-Year treasury yield – inflation*

Employment

- *Unemployment rate (UNRATE):* monthly total unemployed as percent of the civilian work force
- *Unemployment gap: unemployment rate – 4.5%.* The Fed considers 4.5% the long-term optimal rate of unemployment.
- *Unemployment ratio:* 4.5%/unemployment rate
- *Non-farm job creation ratio:* non-farm job creation/12-month trailing average non-farm job creation. The FOMC discusses non-farm job creation in almost all of its meetings.

Besides these variables, one categorical variable of the last decision is created, which includes increase, decrease, or unchanged. Target rate decisions are modeled separately for an expansionary policy and a contractionary policy.

- In meetings that the FOMC decided to decrease the target funds rate, that decision and subsequent decrease or unchanged decisions are classified under expansionary policy. There are 155 observations in this policy. The target variable is decision, a binary one with decrease (1) or unchanged (0).
- When the FOMC decided to increase the target funds rate, that decision and subsequent increase or unchanged decisions are classified under contractionary. This leads to 85 observations in contractionary policy with the binary target variable (1 – increase or 0 – unchanged).
- One outlier observation is deleted. In this case, the FOMC increased the target rate while it had been cutting the rates before and after that.

As the sample size for each type of policy is small, it's not practical and meaningful to partition the data into training and validation datasets. Instead, all the observations are used for training and cross validation is applied in building the models.

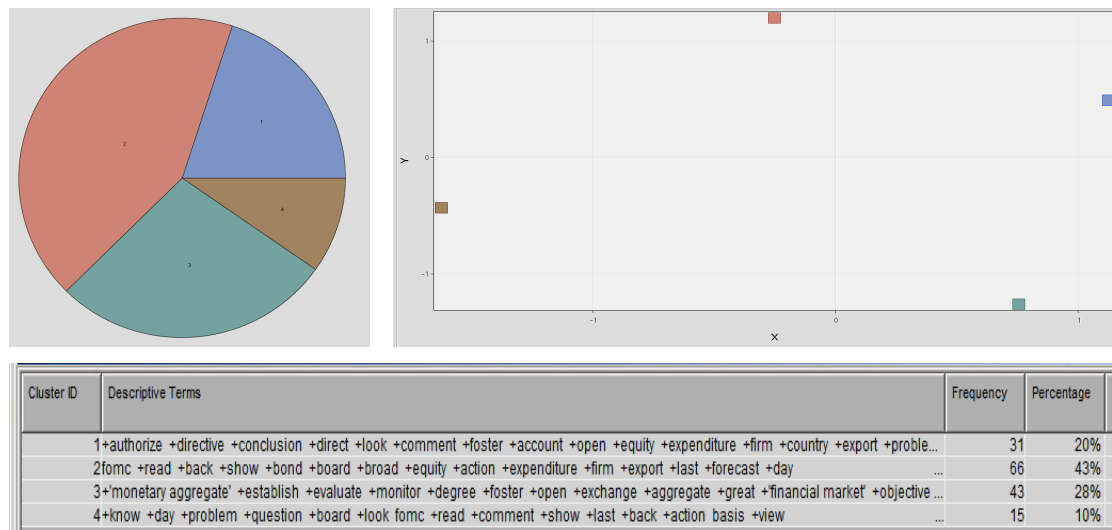**EXPANSIONARY POLICY MODELING IN ENTERPRISE MINER**
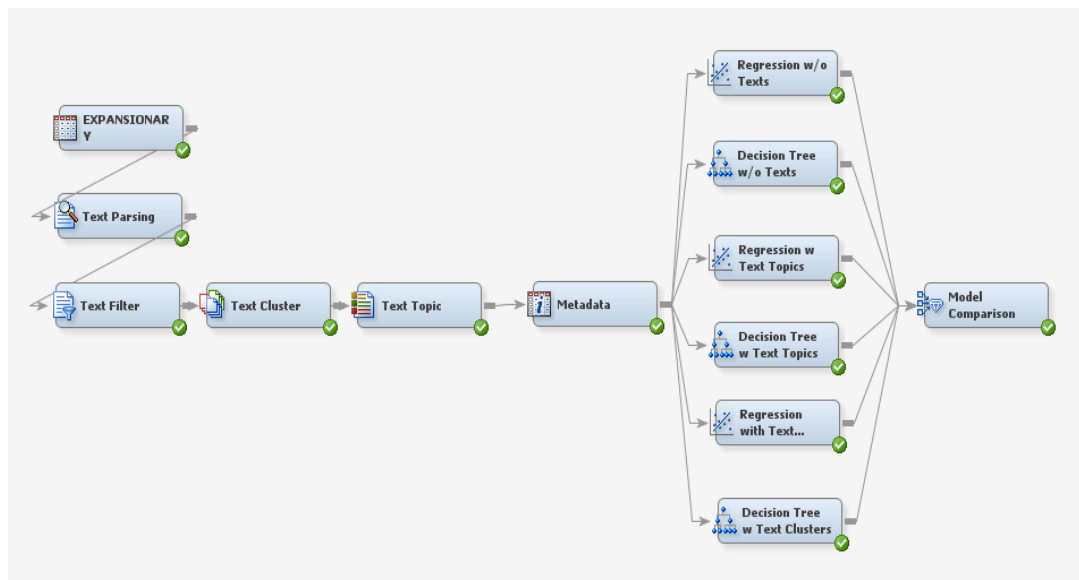
A Text Parsing Node with default options helps parse the meeting minutes and a Text Filter Node filters the parsed texts. Additionally, the Filter Viewer in the Text Filter Node is utilized to remove words that don't really help the analysis such as months, quarters, and some very prudent and neutral words that are typical in every meeting minutes.

Text Clusters

Descriptive terms for the four text clusters are not very informative. These clusters are passed to the models with new roles as input instead of segment.

Exhibit 8. Text Clusters for Expansionary Policy

Cluster ID	Descriptive Terms	Frequency	Percentage
1	+authorize +directive +conclusion +direct +look +comment +foster +account +open +equity +expenditure +firm +country +export +proble...	31	20%
2	fomc +read +back +show +bond +board +broad +equity +action +expenditure +firm +export +last +forecast +day ...	66	43%
3	+'monetary aggregate' +establish +evaluate +monitor +degree +foster +open +exchange +aggregate +great +'financial market' +objective ...	43	28%
4	+know +day +problem +question +board +look fomc +read +comment +show +last +back +action basis +view ...	15	10%

Text Topics

In the Text Topics Node, the number of topics is set to ten in order to keep a small number of topics. Unlike the text clusters, the text topics are much more informative. In these topics, the FOMC is concerned about disinflation (low inflation), underutilization (of labor), labor resource, economic weakness, moderate growth, delinquency, etc. In these meetings, the FOMC is consistently accommodative: decrease the target rate or keep it unchanged in a series of accommodative decisions to support the economy.

| Topic ID	Descriptive Term	Number of Terms	# Doc
1	+disinflation, +equal, +reference, +tax incentive, tax	319	19
2	normalization, +market-base, +underutilization, long-term objective, + labor resource	268	17
3	+know, +right, +think, +talk, people	187	15
4	m3, merchandise trade deficit, +money aggregate, total credit, +velocity	186	29
5	nonconforming, +strain, headline, jumbo, liquidity	315	15
6	upper, nominal deficit, +bias, moderate growth, careful consideration	318	25
7	+delinquency, +mandate, +chain, underlying inflation, +foreclose	335	24
8	+agency, mbs, +agency debt, +tip, +program	302	19
9	+asset purchase, +threshold, guidance, forward guidance, policy restraint	315	23
10	economic weakness, foreseeable, foreseeable future, liquidation, +weight	338	24

These text topics are passed to the models with new role as input instead of segment.

The Selected Model

Text clusters and text topics fail to improve misclassification rate with cross validation. A decision tree model with 5-fold cross validation and 10 repeats without text clusters and text topics is chosen. Sentiment is not selected in this model. We observe this in text analysis: mixed readings of sentiment for decrease and unchanged decisions. Misclassification rate is 10.3% for the chosen decision tree model.

Selected Model	Predecessor Node	Model Node	Model Description	Target Variable	Target Label	Selection Criterion: Train: Misclassification Rate
Y	Tree	Tree	Decision Tree w/o Texts	Decision		0.103226
	Tree2	Tree2	Decision Tree w Text Clusters	Decision		0.103226
	Tree3	Tree3	Decision Tree w Text Topics	Decision		0.103226
	Reg2	Reg2	Regression with Text Clusters	Decision		0.122581
	Reg3	Reg3	Regression w/o Texts	Decision		0.122581
	Reg	Reg	Regression w Text Topics	Decision		0.129032
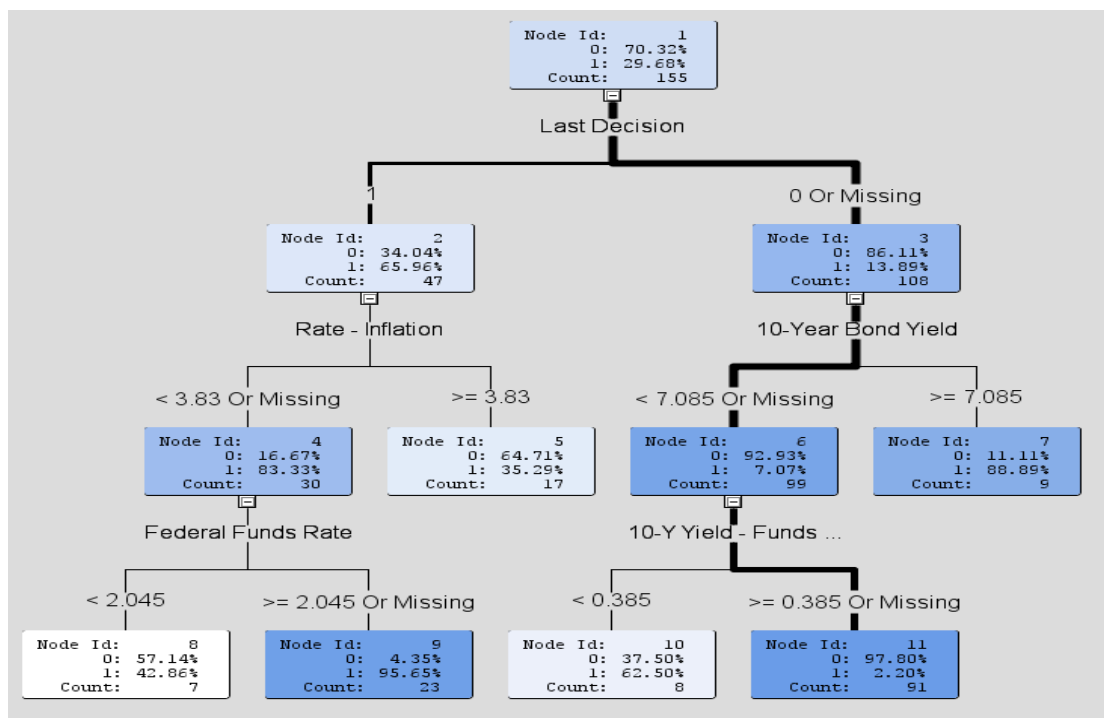
CONTRACTIONARY POLICY MODELING IN ENTERPRISE MINER

The same modeling process is repeated for 85 observations in the contractionary policy.
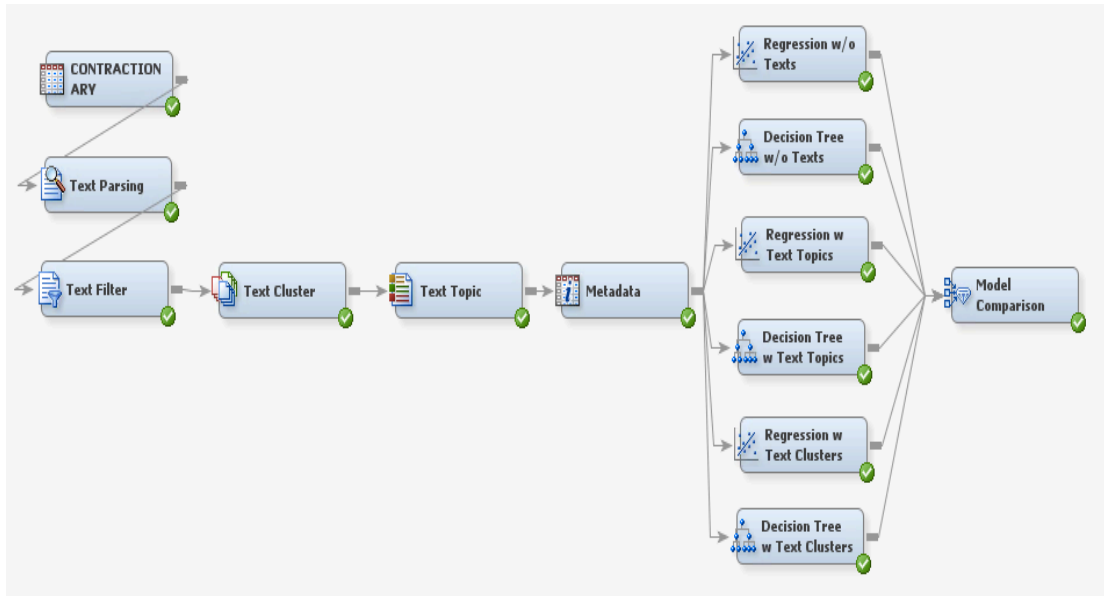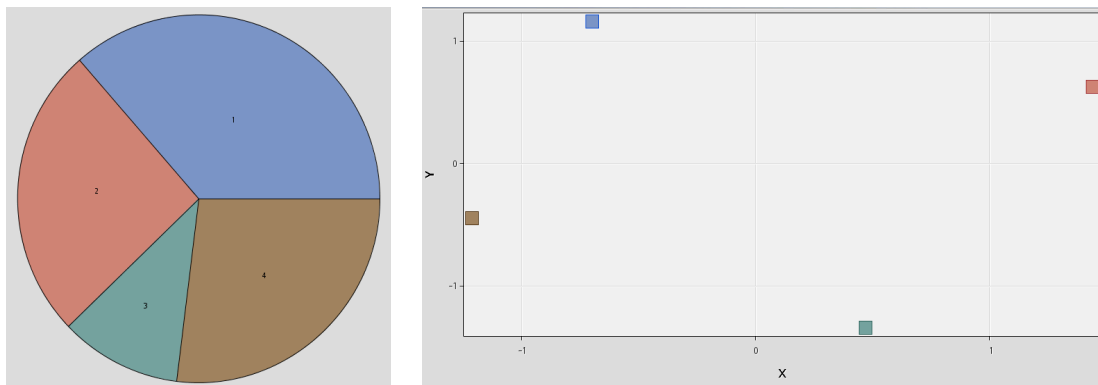

Exhibit 8. Text Clusters for Contractionary Policy

Similar to the results of the expansionary policy modeling, descriptive terms for the four text clusters in the contractionary policy are not very informative. These clusters are passed to the models with new roles as input instead of segment.

Cluster ID	Descriptive Terms	Frequency	Percentage
1	+aggregate +advance +range +point +average reserve +effect +trade +cost +inventory moderate +high +pressure committee +le...	31	36%
2	+run +loan +survey +spread total financial economic +estimate +yield +purchase current elevated +forecast solid percent ...	22	26%
3	+vote +estimate elevated +inventory +house solid +purchase past several +high +home +level +survey reserve +risk ...	9	11%
4	+vote +house +advance +cost reserve +good +inventory +risk percent output +home +effect +yield committee solid ...	23	27%

Text Topics

The ten text topics reveal that in these meetings, the FOMC is upbeat about economic conditions, solid growth, and is concerned about inflation risk and price increase. In these meetings, the committee decided to increase the target funds rate or keep it

unchanged in a series of restrictive decisions to fight high inflation and moderate a hotly growing economy.

Topic ID	Descriptive Term	Number of Terms	# Doc
1	extraction, +vote, +builder, +business condition, median	211	11
2	+inflation risk, uptrend, +lag, +price increase, +deficit	285	13
3	+manufacture, sufficient, +growth rate, +outcome, +above-trend	99	15
4	+develop country, establish, +house price, cautious, +approach	221	13
5	+credit card, nominal, +liquid deposit, +export, solid growth	218	18
6	+motor vehicle, +business condition, +early, +past several year, +further advance	199	14
7	particularly, unsold, +deteriorate, part-time, +hike	126	15
8	tightness, +case, +counter, +reiterate, agricultural sector	208	15
9	+import rose, industrial production, +bank, +business sector, +employ	163	13
10	long-run potential, competitive, gas, +addition, appreciate	208	14

The Selected Model

The text clusters improve accuracy of the regression model with cross validation. Misclassification rate is 9.4% for the logistic regression model with text clusters with four effects: last decision, sentiment, text cluster, and the difference of 10-year treasury yield and federal funds rate. Interestingly, decision tree models with text clusters and text topics using 3-fold cross validation are also better than models without texts.

Selected Model	Predecessor Node	Model Node	Model Description	Target Variable	Target Label ▲	Selection Criterion: Train: Misclassification Rate
Y	Reg3	Reg3	Regression w Text Clusters	Decision		0.094118
	Tree3	Tree3	Decision Tree w Text Clusters	Decision		0.129412
	Tree2	Tree2	Decision Tree w Text Topics	Decision		0.129412
	Reg2	Reg2	Regression w Text Topics	Decision		0.164706
	Tree	Tree	Decision Tree w/o Texts	Decision		0.176471
	Reg	Reg	Regression w/o Texts	Decision		0.2

The selected model, based on the cross-validation misclassification rate, is the model trained in Step 4. It consists of the following effects:

Intercept Last_Decision Sentiment TextCluster_cluster_ _10_Y_Yield_Funds_Rate

        Likelihood Ratio Test for Global Null Hypothesis: BETA=0

    -2 Log Likelihood   Likelihood
   Intercept   Intercept &   Ratio
       Only   Covariates   Chi-Square   DF   Pr > ChiSq

    117.258   38.385   78.8730   6   <.0001

                  Type 3 Analysis of Effects

                                    Wald
Effect   DF   Chi-Square   Pr > ChiSq

Last_Decision   1   6.6082   0.0102
Sentiment   1   7.6258   0.0058
TextCluster_cluster_   3   11.5145   0.0092
_10_Y_Yield_Funds_Rate   1   9.4566   0.0021

                    Analysis of Maximum Likelihood Estimates

                                    Standard   Wald   Standardized
Parameter   DF   Estimate   Error   Chi-Square   Pr > ChiSq   Estimate   Exp(Est)

Intercept   1   1   -4.5405   91.0161   0.00   0.9602   0.011
Last_Decision   0 1   1   2.1271   0.8274   6.61   0.0102   8.390
Sentiment   1   1   434.9   157.5   7.63   0.0058   1.1854   999.000
TextCluster_cluster_ 1 1   1   -1.3511   91.0229   0.00   0.9882   0.259
TextCluster_cluster_ 2 1   1   -1.4944   91.0248   0.00   0.9869   0.224
TextCluster_cluster_ 3 1   1   -8.0449 273.0   0.00   0.9765   0.000
_10_Y_Yield_Funds_Rate 1   1   2.8025   0.9113   9.46   0.0021   1.6213   16.486

		Predicted		
		Increase	Unchanged	**Total**
Actual	Increase	34	5	**39**
	Unchanged	3	43	**46**
	Total	**37**	**48**	**85**

WHAT'S NEXT?

The Fed started to increase the target federal funds rate since December 2015 after a long period of ultra-low interest rate environment. The central bank has increased the rate eight times from 0% to 2% with unemployment being at record low of 3.7%, inflation reemerging to above the 2% level, and GDP growing at solid pace. The Fed is convening on November 7-8 in this contractionary policy territory. Through a Score Node with economic data of October and the meeting minutes of September, the model predicts that the FOMC will increase the target funds rate in this meeting.

CONTACT DETAILS

Nhan Nguyen
Graduate Student, MS in Quantitative Financial Economics
Oklahoma State University, Stillwater OK
nhan.nguyen@okstate.edu
https://www.linkedin.com/in/nhanthynguyen/