

## Quantitative Research

### Hawk-o-meter: An AI approach to FOMC speeches

- An index (Hawk-o-meter) was built to discriminate the hawkish or dovish bias in the speeches of the voting and alternate Fed members
- The speeches were classified using natural language processing (NLP) techniques
- 25 preponderant topics were identified in the semantics of the speeches
- The Hawk-o-meter shows that the speeches of all FOMC members have maintained a significant hawkish bias from Mar'22 to Apr'23

**Hawk-o-meter: An AI approach to FOMC speeches.** This essay proposes a methodology to classify and interpret the speeches of the voting and alternate members of the FOMC. Using techniques for text analysis, relevant qualitative characteristics of the set of communications (corpus) can be extracted with the purpose of achieving an objective interpretation of the communication. In addition, our index confirms whether the bias identified in the speeches of the members is consistent with the position they exercise through their vote in monetary policy decisions.

The speeches of the FOMC members normally function as aggregators of information for qualitative analysis of financial markets. If we consider that the members of the Central Bank share in the speeches their perspective on various topics related to their dual mandate: price stability (inflation) and full employment, then their communication becomes a relevant source of information. Consequently, having an objective classification and interpretation of the speeches is essential, and one method is through NLP techniques.

**The speeches from the FOMC members were classified into 25 preponderant topics.** The topic model was developed based on NLP and ML techniques. A topic modeling tool takes the text and looks for patterns in word usage to find semantic meaning in the vocabulary of that text. In this sense, NLP tools help to analyze and process unstructured data (text, video, images, etc.). The model was developed with the semantics of the speeches of the FOMC 2022 voting and alternate members (January 2013 to August 2022), classifying those speeches into 25 preponderant topics.

April 17, 2023

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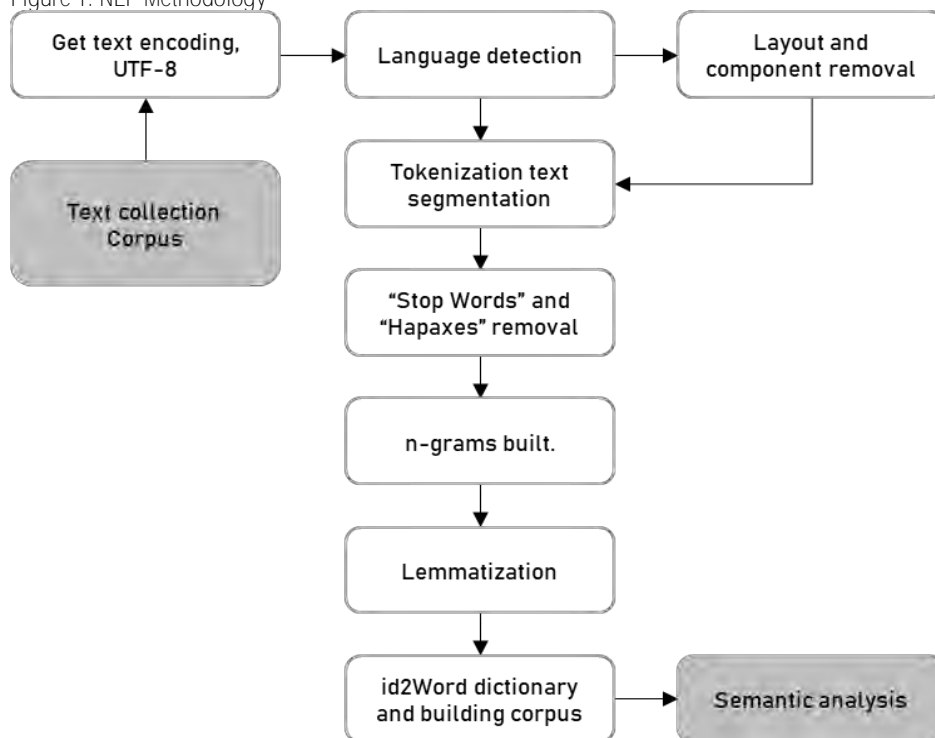
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**High frequency metrics from unstructured data.** Nowadays, the development of metrics in quantitative analysis has taken a new direction given the techniques available for the treatment of massive data. For this reason, today it is possible to incorporate various sources of information (regardless of the format in which they are found) to develop high-frequency metrics that allow more timely monitoring of practically any area of study. Unstructured data has become one of the main sources of information and its growth has been exponential in the last decade. For example, in 2017 a study reported that Google processed close to 40,000 searches on average every second.

For this essay, 981 speeches from the official sites of the U.S Federal Reserve banks were consulted. It is important to highlight that the interviews carried out with the members of the central institute by different media sources such as Bloomberg, CNBC, Yahoo Finance, etc., were not considered to avoid possible biases that could arise from the type of questions interviewers ask. Most of the Minneapolis Fed Chairman's (Neel Kashkari) speeches were the exception because they are in video format. The following diagram shows the data engineering applied to each document:

Figure 1: NLP Methodology



Source: Giuseppe Bruno, Text mining and sentiment extraction in Central Bank documents, IEEE International Conference on Big Data, 2016

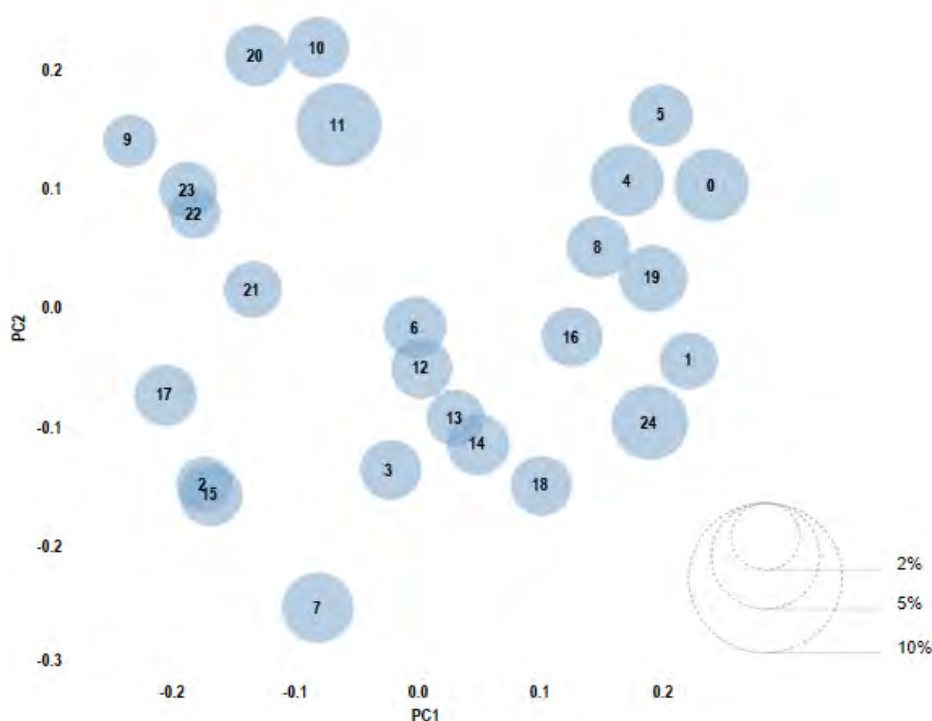
The steps followed in the previous diagram are described below:

- 1) Creation of tokens (minimum unit of information within a sentence or phrase);
- 2) elimination of "stopwords" that do not add value in the context (the, that, all, but, and, those, etc.);
- 3) filtering of words that appear only once in the corpus (hapaxes) and in 100% of the documents;
- 4) construction of n-grams (sequences of 2 or more words) that help in the interpretation of the context, for example: low inflation vs. high inflation, unemployment rate, interest rate, etc.;
- 5) lemmatization to reduce words to their common root (bank, banks, banking), to remove noise from valuable information; and
- 6) the corpus was finally built with all the speeches.

**LDAMallet for topic classification.** To develop topic models there are different techniques. One of the most prominent methods is the use of Latent Dirichlet Distributions (LDA). The LDA model analyzes each document as if it were composed of different topics. In the same way, topics are a mixture of terms or words. Most of the algorithms work in the same way and Mallet is a variant of LDA (For more detail refer to: [“Welcome to the Machine \(Learning\): An NLP framework for analyzing the Fed’s monetary policy statements”](#)).

Prior to topic modeling, a bag of words (BoW) was built to represent the corpus in vector form to feed the classification model developed on the speeches. The chart below is a visual representation of the topics identified by the model:

Chart 1: Intertopic Map  
Multidimensional scale



Source: Banorte

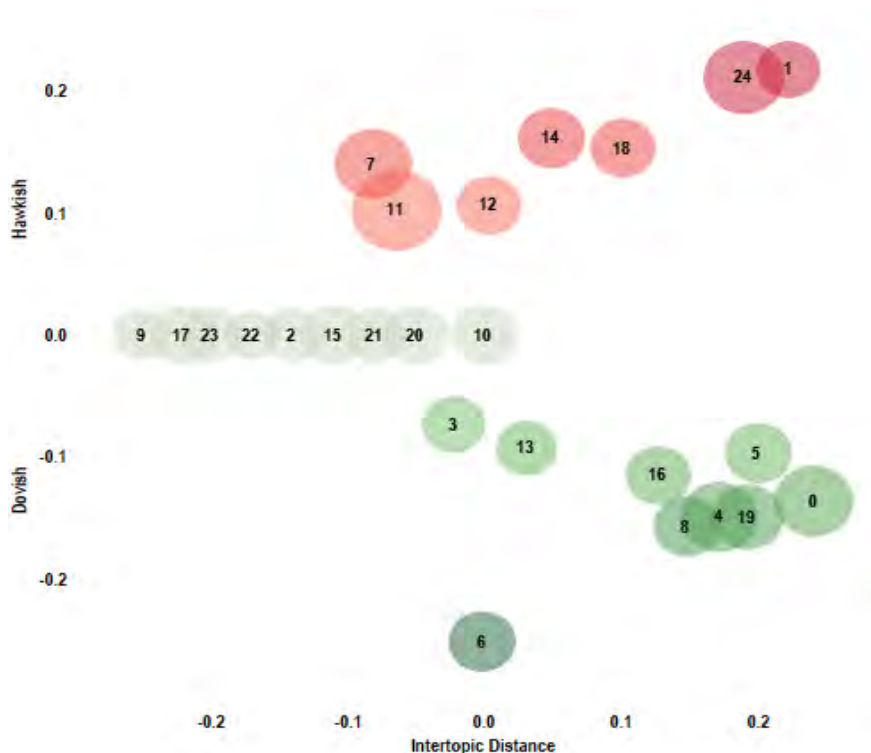
### The Hawk-o-meter helps to identify the biases of the FOMC members.

The index generated through these models, which we have named Hawk-o-meter, helps to measure the bias of the speeches of the FOMC members to identify those with a hawkish tone versus those with a dovish tone. Each one of the 25 preponderant topics identified by the LDAMallet classification model is represented by several head words or terms. From the 10 terms that best describe probabilistically each of the topics, it was possible to build the index.

In order to discriminate the tone, a methodology was developed: 1) For each term, n-grams were built; 2) the relative frequencies within each document were reviewed; 3) a dictionary of terms that allude to restrictive and expansive monetary policies was built, for example: “high inflation”, “labor market conditions”, “economic growth”, “inflationary pressures”, “restrictive policy”, “inflationary expectations”, etc., and 4) the 25 topics were labeled according to their semantic relationship with the dictionaries.

The Hawk-o-meter takes continue values between -1 to 1, where the value 0 corresponds to neutral communication tone, negative values correspond to speeches with a dovish bias, and positive values represent a hawkish bias. It is important to mention that neutral communication will not have any impact on the calculation of the index described due to it corresponds to topics that are not directly related to the dual mandate of the Central Bank. In the following chart we show the ordering of the 25 topics according to the described index.

Chart 2: Intertopic Map (Hawk-o-meter)  
Multidimensional scale



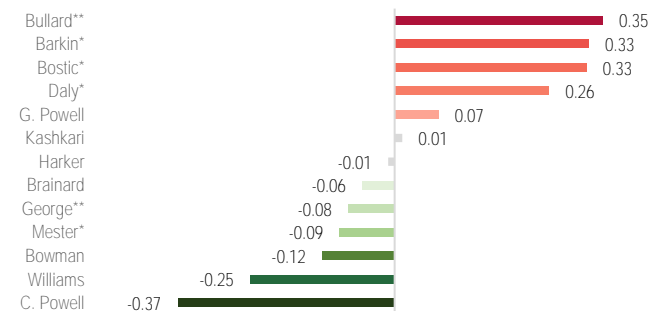
Source: Banorte

Chart 2 shows that 7 of the 25 topics identified by the ML model are semantically related to a hawkish bias, 9 topics are related to a dovish communication tone, and the rest are considered neutral in terms of the monetary policy.

The Hawk-o-meter allows us to analyze historically the bias in the speeches of the FOMC members. The following shows the classification of the bias identified in the speeches made in different periods of time (the speeches of the FOMC voting and alternate members in 2023 were incorporated).

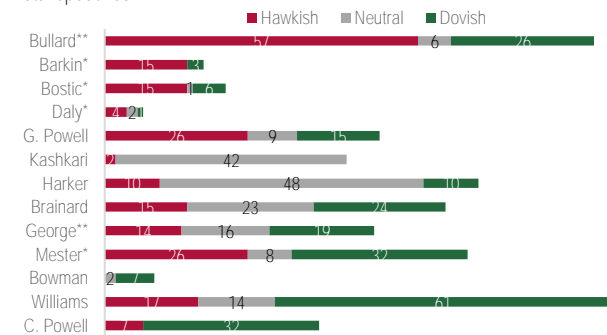
The first observation period corresponds to the speeches delivered since 2013 until January 2020 (the moment when the COVID-19 pandemic was declared; refer to charts 3 and 4). Chart 3 shows the index calculated for each member of the FOMC and the chart 4 is the result of the classification of their speeches in: hawkish, dovish, and neutral tone for a period of 7 years. Some members of the committee, like James Bullard and John Williams, published more than 80 speeches in the analysis period. However, there is a contrast in the communication that each member has exercised, for example, James Bullard showed a restrictive tone in 57 of his speeches made in the observation period vs. 61 speeches by John Williams were classified as dovish in the same period. Similarly, it is worth noting Jerome Powell's change from a neutral bias as a member of the FOMC to a dovish one as Fed Chairman.

Chart 3: Hawk-o-meter – Jan'13 to Jan'20  
Speeches tone



Note: C. Powell speeches are in his role as Fed Chairman  
\* FOMC alternate members in 2023  
\*\* FOMC alternate members in 2024

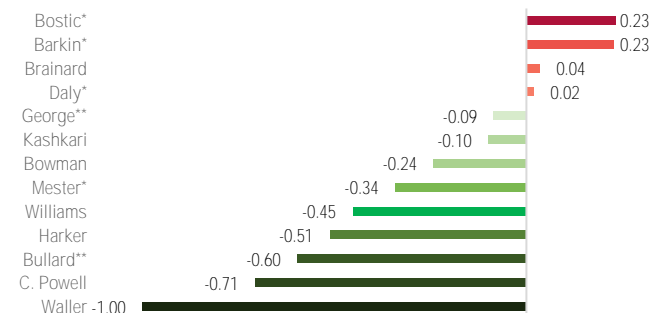
Chart 4: Speeches Classification - Jan'13 to Jan'20  
Total speeches



Source: Banorte; Federal Reserve

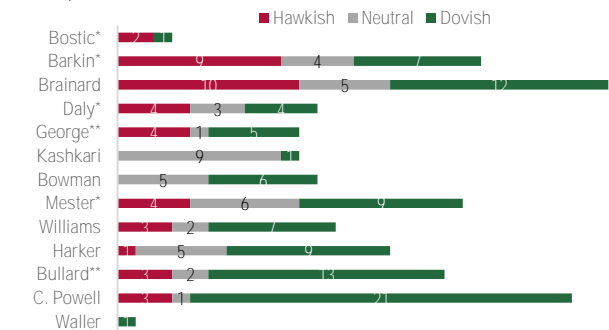
The next period analyzed was the first year of the pandemic (refer to charts 5 and 6). Chart 5 shows that the communication from most FOMC members had a dovish tone. During February 2020 and March 2021, 182 speeches by the committee members were analyzed, of which 96 were classified with a dovish tone and 43 with a neutral tone. It is worth noting that during March 2020 the global economy suffered a significant contraction due to mobility restrictions generated by COVID-19.

Chart 5: Hawk-o-meter – Feb'20 to Mar'21  
Speeches tone



Note: C. Powell speeches are in his role as Fed Chairman  
\* FOMC alternate members in 2023  
\*\* FOMC alternate members in 2024

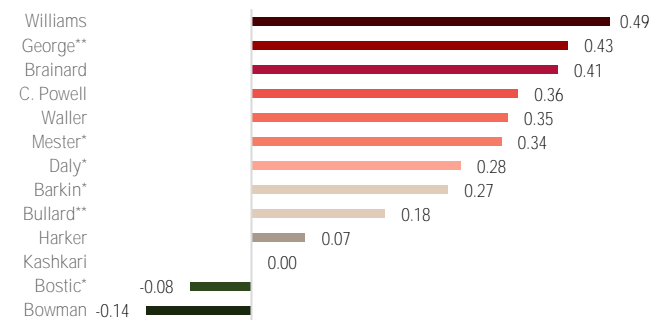
Chart 6: Speeches Classification - Feb'20 to Mar'21  
Total speeches



Source: Banorte; Federal Reserve

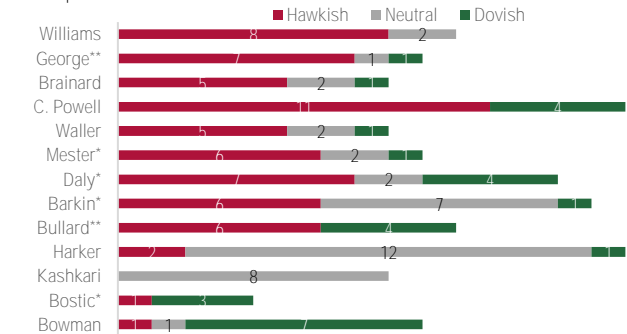
The third period analyzed corresponds to one year after the beginning of the pandemic (refer to charts 7 and 8). It is important to highlight that during 2021 the U.S CPI reached levels above the target established by the Central Bank. Chart 7 shows that most of the FOMC members in general began to show their concerns about the evolution of inflation and this is confirmed by the hawkish bias of their speeches.

Chart 7: Hawk-o-meter – Apr'21 to Feb'22  
Speeches tone



Note: C. Powell speeches are in his role as Fed Chairman  
\* FOMC alternate members in 2023  
\*\* FOMC alternate members in 2024

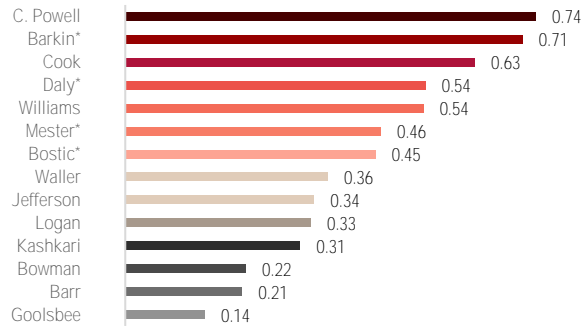
Chart 8: Speeches Classification - Apr'21 to Feb'22  
Total speeches



Source: Banorte; Federal Reserve

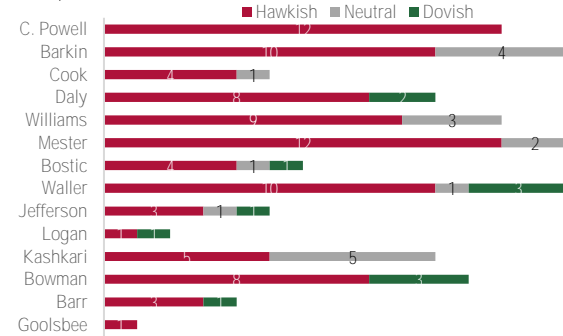
The fourth period of analysis is from the beginning of the rate hike cycle in March 2022 to March 7, 2023 (refer to charts 9 and 10). At the beginning of this cycle, the hawkish tone was widespread in all FOMC members. In this regard, we highlight Powell's significantly hawkish tone regarding past periods.

Chart 9: Hawk-o-meter – Mar'22 to Mar 7, 2023  
Speeches tone



Note: C. Powell speeches are in his role as Fed Chairman  
\* FOMC alternate members in 2023  
\*\* FOMC alternate members in 2024

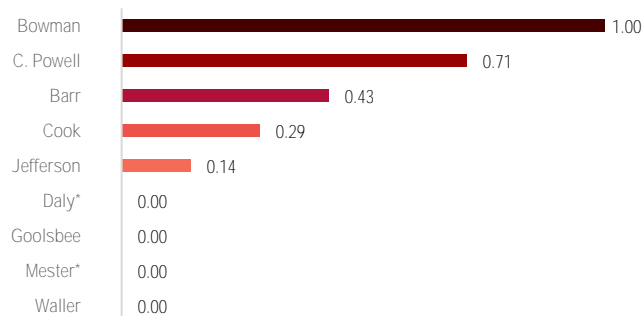
Chart 10: Speeches Classification - Mar'22 to Mar 7, 2023  
Total speeches



Source: Banorte: Federal Reserve

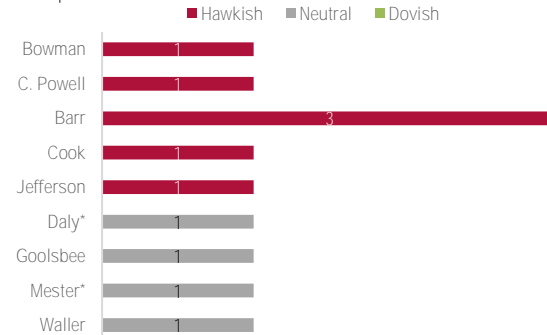
The last period of analysis is from March 8 to April 14, 2023 (refer to charts 11 and 12). Following the insolvency announcement of SVB, most of the FOMC members maintain a hawkish bias (5 of 9 members). In this regard, we highlight Powell's speech just after the FOMC meeting back in March 22, which our model classified it sufficiently hawkish.

Chart 11: Hawk-o-meter – Mar 8 to Apr 14  
Speeches tone



Note: C. Powell speeches are in his role as Fed Chairman  
\* FOMC alternate members in 2023  
\*\* FOMC alternate members in 2024

Chart 12: Speeches Classification – Mar 8 to Apr 14  
Total speeches



Source: Banorte: Federal Reserve

In conclusion, the Hawk-o-meter confirms that the position in the monetary policy decisions of each member of the FOMC has been consistent with the speeches made during the periods of analysis. Going forward, this index will help to identify any change in the bias tone of the Federal Reserve speeches.

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