International Central Bank Communication

Christoph Bertsch[1] Isaiah Hull[2] Robin L. Lumsdaine[3] Xin Zhang[1,4]

[1]Sveriges Riksbank

[2]BI Norwegian Business School and CogniFrame, Inc.

[3]American University, Erasmus University, NBER, Tinbergen Institute, and Center for Financial Stability

[4]BIS Innovation Hub Nordic Centre

July 9, 2023

Organization

Overview

1. **Central bank speech archive.**
   - Maintained by Bank for International Settlements (BIS).
2. **Methods and models for text feature extraction.**
   - Collection of large language models (LLMs).
   - Introduced in Bertsch, Hull, Lumsdaine, and Zhang (2022).
3. **Description and visualization of text features from speeches.**

Textual Data

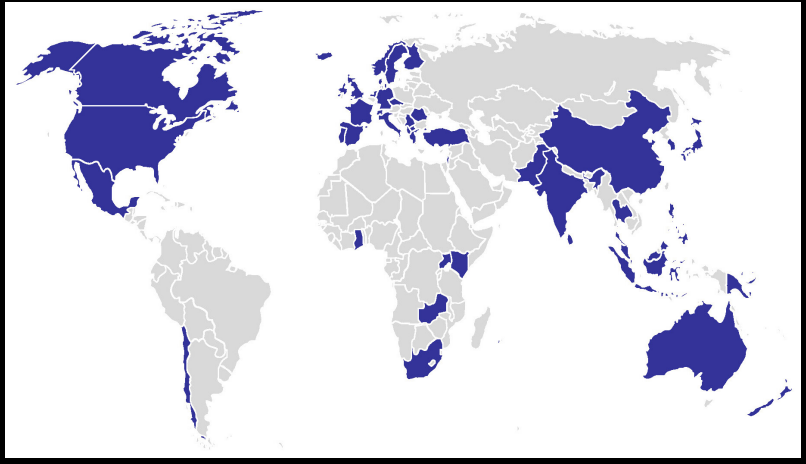
Textual Data

Overview

- **BIS speech archive.**
  - Central bank speeches translated into English.
  - >18,000 speeches; >90 institutions.
  - Covers late 1996 to present.
- **Our coverage.**
  - 53 institutions with >50 speeches.
  - Extract text features using LLMs at paragraph level.
  - Aggregate to quarterly or annual features.

Textual Data

Database Coverage



Methods and Models

Methods and Models

Reference

Bertsch, C., Hull, I., Lumsdaine, R. L., & Zhang, X. (2022). Central Bank Mandates and Monetary Policy Stances: through the Lens of Federal Reserve Speeches. Available at SSRN 4255978.

Methods and Models

Text Feature Extraction: LLMs and Methods

1. **Transformer model.**
   - Maps sequence of embeddings to sequence of contextualized embeddings.
2. **Sentence transformer model**.
   - Maps sequence of embeddings to single embedding.
3. **Feature extraction methods.**
   - Zero shot classification (ZSC), extractive question answering (EQA), and semantic textual similarity (STS).

Methods and Models

Zero Shot Classification

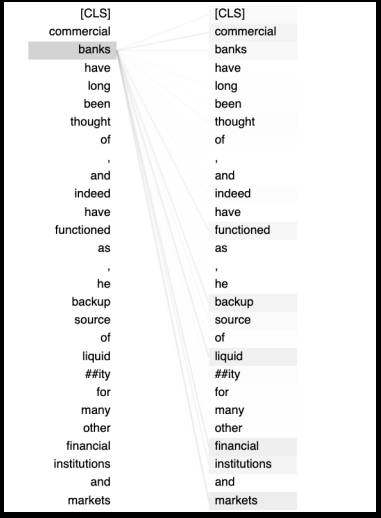
Sequence: *"Banks continue to play this role but it has become more challenging today to do so because some lenders find themselves capital constrained as a result of recent losses and or sizable unanticipated additions to their balance sheets of formerly off balance sheet instruments."*

Candidate Classes: *['financial stability', 'output', 'inflation', 'labor market']*

Scores: *[0.718, 0.203, 0.048, 0.031]*

Methods and Models

Zero Shot Classification: Attention Mechanism Performance



Methods and Models

Extractive Question Answering

Query 1: *What is the most significant concern in the passage?*

Context 1: *"The suspension of the convertibility of the dollar into gold and the imposition of a 10 percent import surcharge last summer ran the risk of mass foreign retaliation in the form of destructive trade barriers."*

Output 1: *mass foreign retaliation*

Semantic Textual Similarity

- **Use contextualized sentence embeddings and semantic textual similarity.**
  - Kiros et al. (2015), Conneau et al. (2017), Cer et al. (2018), Reimers and Gurevych (2019).
  - Train using Siamese and triplet networks (Schroff et al., 2015).
- **Compare sequences from speeches with descriptions of policy objectives or preferences.**
  - *"Monetary policy should be used to achieve financial stability."*
  - *"Banking regulation should be used to achieve financial stability."*

Methods and Models

Extended Pretraining with TSDAE

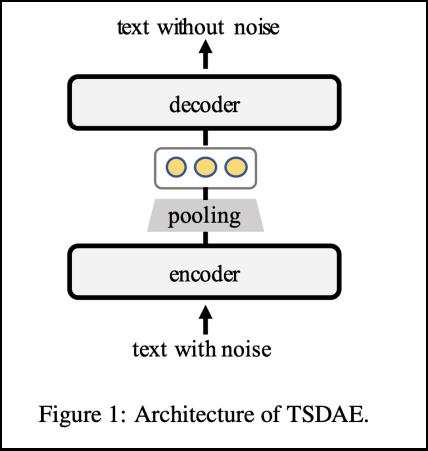


Figure 1: Architecture of TSDAE.

Figure taken from Wang et al. (2021).

Methods and Models

Refine STS Performance with Fine-Tuning

1. Use S2ORC abstracts (Lo et al. 2020).
2. Randomly draw *similar* sequence pairs from the same paper abstract.
3. Randomly wraw *dissimilar* sequence pairs from different abstracts.
4. Train on STS and compare using cosine similarity.

$$sim(S_i, S_j) = \frac{S_i \cdot S_j}{\|S_i\| \|S_j\|} \tag{1}$$

Methods and Models

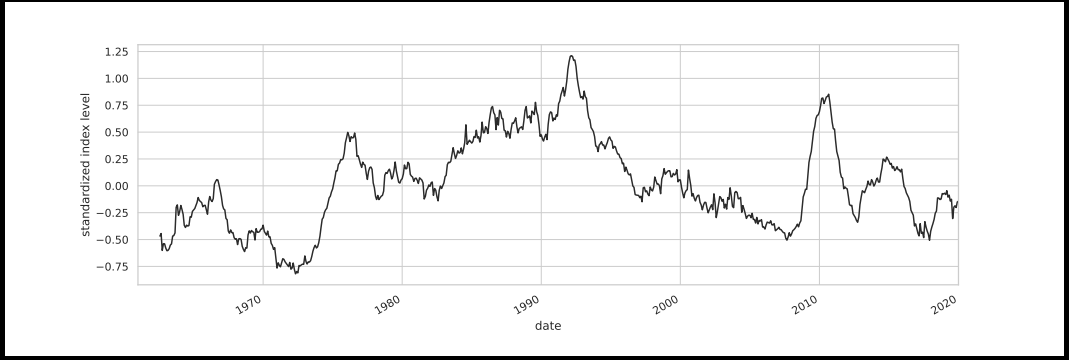
Non-Dual Mandate Content: 1984-2020



- Methods: Zero shot classification and extractive question answering.

Methods and Models

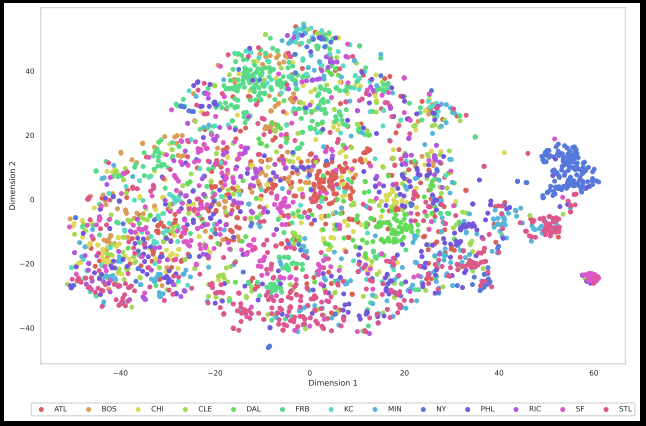
Cosine similarity: Banking Regulation and Financial Stability



- Methods: Zero shot classification and semantic textual similarity.

Methods and Models

t-SNE Plot: Speech Embeddings for Financial Stability Content



- Methods: Zero shot classification and semantic textual similarity.

Dataset

Dataset

Textual Features

- **Text classification.**
  - Financial stability, output and employment, inflation, and exchange rate.
- **Semantic textual similarity.**
  1. Individual features: Monetary policy, financial crisis, bank regulation, bank capital and liquidity, U.S. dollar, international trade, hawkish sentiment.
  2. Policy advocacy: monetary policy and financial stability, bank regulation and financial stability.

Dataset

Documentation

Sheet Name	Coverage	Description	Method	Transformation	Reference
bankreg_finstab	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
monetary_finstab	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
financial_crisis	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
united_states_dollar	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
bank_regulation	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
monetary_policy	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
hawkish_sentiment	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
bank_concern	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
international_trade	1996-2023	This feature measures the extent to w	Semantic textual similarity.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
output_employment	1996-2023	This feature measures the extent to w	Zero shot classification.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
financial_stability	1996-2023	This feature measures the extent to w	Zero shot classification.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
inflation	1996-2023	This feature measures the extent to w	Zero shot classification.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull
exchange_rate	1996-2023	This feature measures the extent to w	Zero shot classification.	Standardized using mean and standard deviation for 1996-2010 period.	Bertsch, Hull

Dataset

Documentation

- **Text features standardized using mean and standard deviation calculated over 1996-2010 period.**
  - Updates to series will not affect past values.
- **Central banks split into annual and quarterly groups.**
  - Quarterly features provided for institutions that give at least two speeches per quarter on average.
- **No data imputation.**
  - Many central banks lack sufficient number of speeches over 1996-2023 period to yield text features for all periods.

Dataset

Heatmap of Exchange Rate Discussion

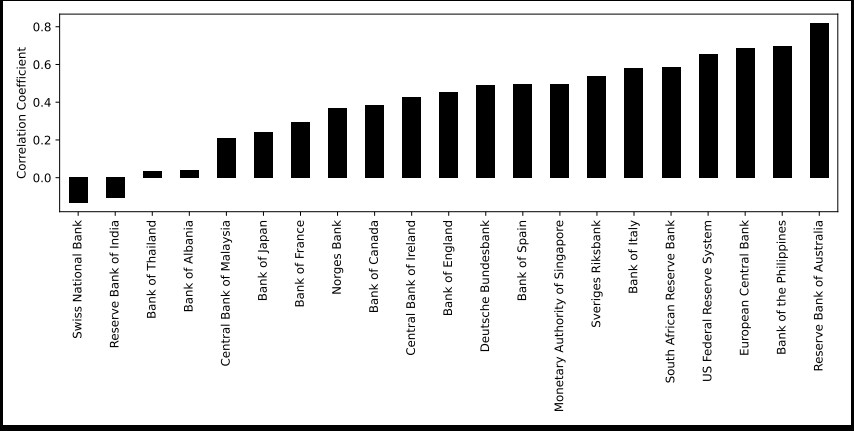


Inflation Feature Principal Components



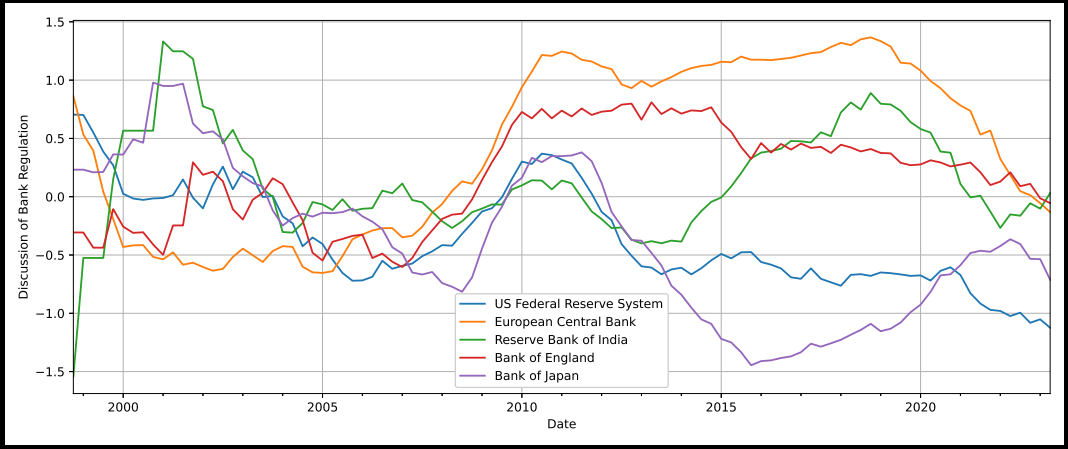
Dataset

Inflation Feature Correlation with PC1



Dataset

Bank Regulation Text Feature



Next Steps

Discussion

- **Models and methods can be applied broadly to extract features from central bank texts.**
  - Text classification, extractive question answering, semantic textual similarity.
- **Additional policy advocacy features under development and available on request.**
  - Capital controls and exchange rates, capital controls and financial stability, monetary policy and exchange rate.
- **Open to accepting input for features to extract from texts.**
  - Can make features available in updates.