

# A Big Data approach to understand Central Banks

Big Data Spain 2018

November 2018

**Creating Opportunities** 



### Summary

- **01** Why is the use of NLP important in economics and Monetary policy?
  - The data and methodology
- **02** Understanding Central Banks: "What", "How" and "Who" is talking (or writing) about?

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# Why is the use of NLP important in economics and Monetary policy?

The data and methodology

### Why is the use of NLP important in economics and Monetary policy? **Text as a key source of information to enrich economic analysis**





The potential use of textual information and text sources improves the understanding of economic and financial systems



to extract meaning from strings of letters



It helps us to understand what drives monetary policy decisions



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**I** 

# 80% of available data

The data and methodology

### **From Extraction to Sentiment Analysis**

Information extraction	Pre-Processing and text parsing	Transformation	Text mining and NPL	Sentiment analysis
Documents	Extract words	Text filtering	<ul> <li>Analysis and Machine learning</li> </ul>	<ul> <li>Apply sentiment dictionaries</li> </ul>
Web pages	Identify parts of speech	Indexing to quantity text in lists of term counts	<ul> <li>Topics extraction (LDA)</li> </ul>	<ul> <li>Semantic analysis and classification</li> </ul>
	<ul> <li>Tokenization and multi-word tokens</li> <li>Stopword Removal</li> </ul>	<ul> <li>Create the Document-term matrix</li> </ul>	<ul> <li>Clustering</li> <li>Modelling</li> </ul>	Clustering
	Stemming	Weighting matrix	(STM and DTM)	
	Case-folding	<ul> <li>Factorization (SVD)</li> </ul>		

### The data and methodology Analyzing central banks' communication: Examined documents

#### Information extraction



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### **Statements / Press Releases**

Immediately after the meeting on monetary policy, a short report about the decision on interest rates is released. If there's a press conference, the president of the CB explains the decision and answer questions from journalists

### Minutes

A more detailed document explaining the monetary policy decision containing an overview of financial market, economic and monetary developments



### **Speeches**

Collection of speeches and articles by senior central bank officials published in the central bank websites

### The data and methodology Analyzing central banks' communication: Cleaning and transforming the text



- Create the Document-term matrix
- Weighting matrix
- Factorization

#### **Preparing it for the analysis**

- Text filtering
- Indexing to quantify text in lists of term counts





#### **Transformation**

### Extracting and organizing the data

- Extract words
- Identify parts of speech
- Stopword Removal
- Case-folding

### **Converting it into numbers**

- Stopword Removal
- Stemming
- Tokenization and multi-word tokens

Text mining and NPL

### The data and methodology Analyzing central banks' communication: Dynamic topic models



### Latent Dirichlet Allocation (LDA) and Dynamic Topic Model (DTM)

### The data and methodology Analyzing central banks' communication: Sentiment analysis

Sentiment analysis

## Loughran and McDonald (2011)

	Ð	<b>e</b>		
Positive words		Negative words		
achieve benefit efficiency outperform	progress stabilize strength versatility	bankruptcy bottleneck corrupt downgrade	fallout imbalance monopolize stagnant	

# **FED Financial Stability dictionary** (2017)

đ		e	
Positive	words	Negative	words
benefit enhance stabilise favorable	improve upgraded smooth strengthened	adverse challenge deteriorate downgrade	escalate stagnation vulnerability worsen

# $Average tone = \frac{\sum Positive words - \sum Negative words}{\sum Total words}$

### Main outputs

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### Analyzing the Central Bank of Turkey, European Central Bank and Federal Reserve

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### Main outputs More than words: Getting the relation between words...



# Main outputs ...their evolution over time...

### Most frequent words by year in the analyzed documents (the case of CBRT)



# Main outputs ....as well as the topical content covered in the text













0.03 0.04 0.05 0.00 0.01 0.02 0.03 0.04















Understanding Central Banks: "What", "How" and "Who" is talking (or writing) about

### We go Inside of the CB Reports to identify the topics using Machine Learning and Dynamic Topic Models. They can be different...



high portfolio advanc conditions normal recently road macroprudenti concerr

#### **Monetary Policy**

ent followmargin constant dealer tranch reserves vprimari overnightho short rates repo matur liabil atest decide borrow kept enotic late percent decreasing facil percent keep a ca Srequir<sub>billion</sub> reserv option und via interestbetween Byear facil provid lendcommittee account regulspecial market liquid window certsulativorth usd transact follows longer<sub>cumul</sub> central money market liquid cbr vil bank

#### **Activity**

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#### Inflation

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#### **Quantitative Easing**

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### **Banking Union**

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#### **Financial Crisis**

recapitalised program unfortunately substant voluntarili allud E foreseen gviable viablo sell ocreditor voluntari hire gassist E big repay imagin recapitalisation sharehold harsh something repeatedly stoppedreached afterward

# Topics are dynamic and can change over time...and the picture can change...particularly if important events hit the economy

### **European Central Banks: Evolution of Topics**



### **Central Bank Of Turkey: Evolution of Topics**



Global Flows
Labor Market
Inflation Core
Other

Economic Activity
Fiscal & Structural Policies
Monetary Policy

# Networks are a useful tool to show the interconnectedness & complexity...helping us to understand "How" the Central Banks talk..

# Monetary Policy in the North (ECB) and in the EM (Turkey): Complexity and interconnectedness (Networks)



### Sentiment analysis reinforces the analysis by describing "How" the Central Bank talks ("tone")

### Turkey (CBRT) : Economic Activity & Inflation Tone

(Tone economic activity and Inflation jn the MP Minutes)



### Turkey (CBRT): Economic Activity & Employment Tone

(Tone economic activity and employment jn the MP Minutes)



# Through Sentiment Analysis we can check the monetary policy stance... how "Tight" or "Ease" is the Wording of the reports

### Central Bank of Turkey: Monetary Policy Sentiment

(Standardized, estimated through Big Data LDA and STM Techniques from Minutes & Statements)



#### **Monetary Policy "Statements"**

#### **Monetary Policy "Minutes"**



### More extensive and analytical...

# And how the market rates react to the Central Bank changes in monetary policy sentiment ...

Response to Short term and Long term interest rates to positive/Negative changes in Sentiment CB Turkey (Response of interbank deposits rates and 2Y BondSwaps to mild and strong changes in sentiment. Changes relative to t-1. T=event)

#### Bond Swaps Response to a Positive Change in Sentiment





#### Bond Swaps Response to Negative Change in Sentiment

# Remember that in the case of Sentiment Analysis, we are using unsupervised methods so...always cross-check for Robustness

### Monetary Policy in Turkey: Experts vs Algorithms

(Sentiments fron LDA Algorithm and MP Surprises by Demiralp et Al. 1=Hawkish, 0= Neutral, -1=Dovish)



### Experts vs Algorithms in Turkey: Size of Surprises & Sentiments

(Sentiments fron LDA Algorithm and MP Surprises by Demiralp et Al)



# Last... but not least ... we are working on the Federal Reserve Board (FED) Topics and Stance...

### Federal Reserve Board (FED) Topics definition



# **FED Hawkish/Dovish index and Fed Funds rate** (Moving average)



-Fed. Funds Rate (right)

# ...complementing our "What" and "How" the Central Banks talk with "who" is talking...

### General and Governor FED Hawkish/Dovish index by speaker over time (Moving average 12 months)



From a EM Crisis Reactive and tigtening... (Mr Greenspan) 1987-2003 To a Governor Managing the crisis... (Mr Bernanke) 2016-2014 To a Lady managing the Exit Strategy... (Mrs Yellen) 2014-2018 To a Normalization Policy (Mr Powell) 2018-

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