

How Do the EM Central Banks talk? A Big Data Approach to the Turkish Central Bank (CBRT)

CBRT Seminar series

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01

Introduction:

Remember that Big Data allows us to use massive flows of data (numbers, text & images...) including new sources of Data

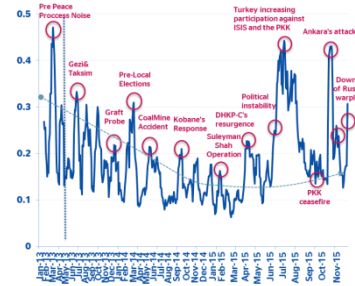
Massive Flows of New Data

On Real Time

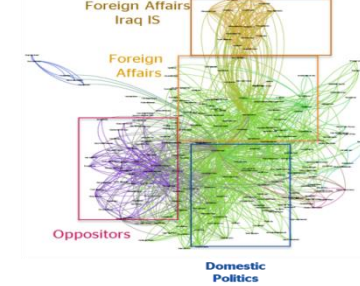
High Definition

New Potential: Texts & Images

Political, Geopolitical Social Indexes (Political Indexes)



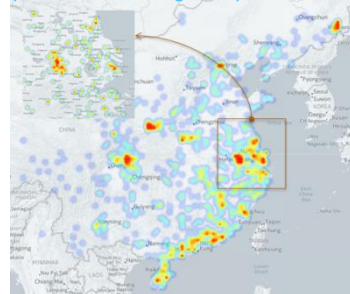
Politics & Financial Networks (Political Networks)



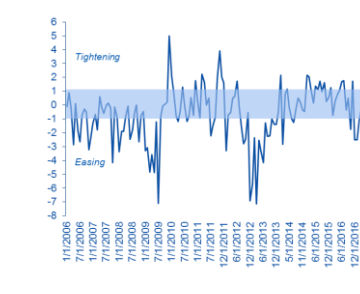
Measuring Sentiments, Narratives on News (sentiment Analysis on Economy and Society News)



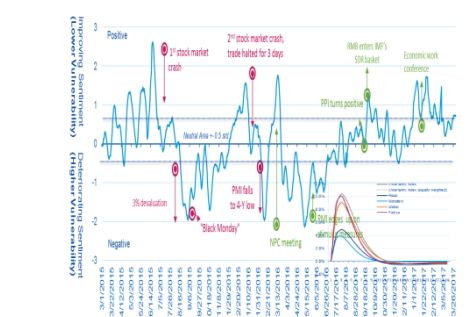
Geographical Analysis Housing Prices (sentiment on Housing Prices)



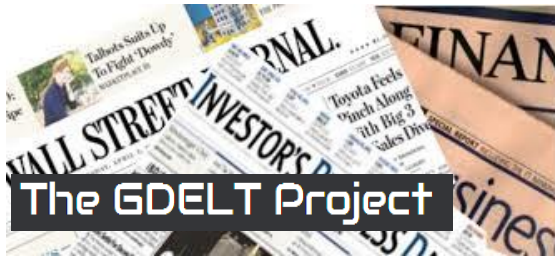
Monetary & Stability tones by Central Banks (sentiment Analysis on Central Bank texts)



Mix Hard data & Sentiment & VAR models (Vulnerability and Risks Index Models)



We have been relying in BigData coming from News... now we add official documents like Central Bank Reports



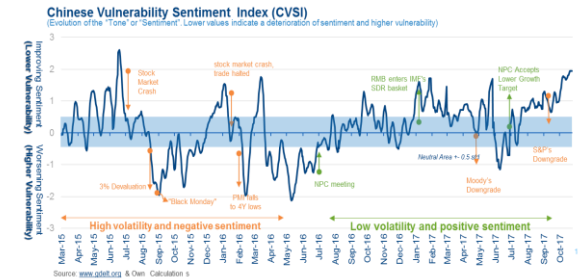
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Tracking China Vulnerability in Real Time Using Big Data: The CVSI Index

Big Data Empirics and Policy Analysis Conference
Bank of England

Alvaro Ortiz, PhD*
BBVA Research

*Casanova, C., La, X, Ortiz, A & Rodrigo, T (2017) 'Tracking China Vulnerability in Real Time Using Big Data: The CVSI Index'. BBVA WP

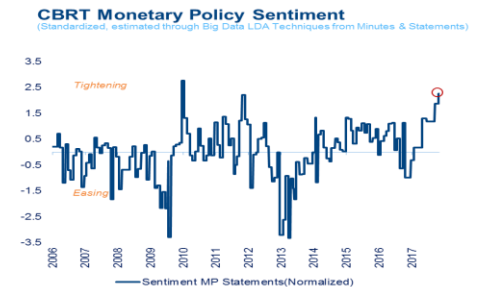


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How Do EM Central Banks talk? A Big Data Approach to the Turkish Central Bank (CBRT)

Alvaro Ortiz, Tomasa Rodrigo and Joaquin Iglesias

October 2017, Hong Kong



Main Goals of the Paper

- ◆ We analyze the CBRT policy Documents through NLP Big Data Techniques to better understand the EM Central Banks Monetary Policy strategy. We focus in “What” and “How” the Central Bank of Turkey talks?
- ◆ We introduce Dynamic Topic Models to understand “What” the CBRT talks while we relied on Sentiment Analysis to understand “How” the CBRT feels about the monetary conditions and policies
- ◆ We check robustness by comparing Algorithms vd Experts results
- ◆ We introduce the BigData results in traditional Macro Techniques (“Event Window Analysis and VAR models”) to evaluate whether the CBRT communication policies can influence the Monetary Transmission Mechanism and have nominal and real macro effects
- ◆ Finally, we present the main conclusions and Further Research

Previous literature

- ◆ **Structural Topic Models** (Roberts et al. 2013) have been applied to a broad list of topics: **economics, social sciences and politics**: Forni et al. (2017), Roberts et al. (2014 and 2016).
- ◆ **Central Bank Communication literature is not new**. A nice review on the topic (Blinder et al, 2008. JEL)
- ◆ Computational linguistics models have been used before mainly to Developed Economies to **analyze the Federal Reserve communication transparency strategy** (Hansen et al, 2014), as well as the **effects of this communication strategy on real economic variables** (Hansen et al, 2015).
- ◆ **Turkish Central Bank Communication Policies have previously researched** (Demiralp, Kara and Özlü, 2012)

02

Empirical Strategy: “What” (Topics) and “How” (Sentiment) is the Central Bank talking about

The Data & the NLP analysis

Text mining makes information extraction from huge volumes of data easier and structures the information as important facts, key terms or persons.

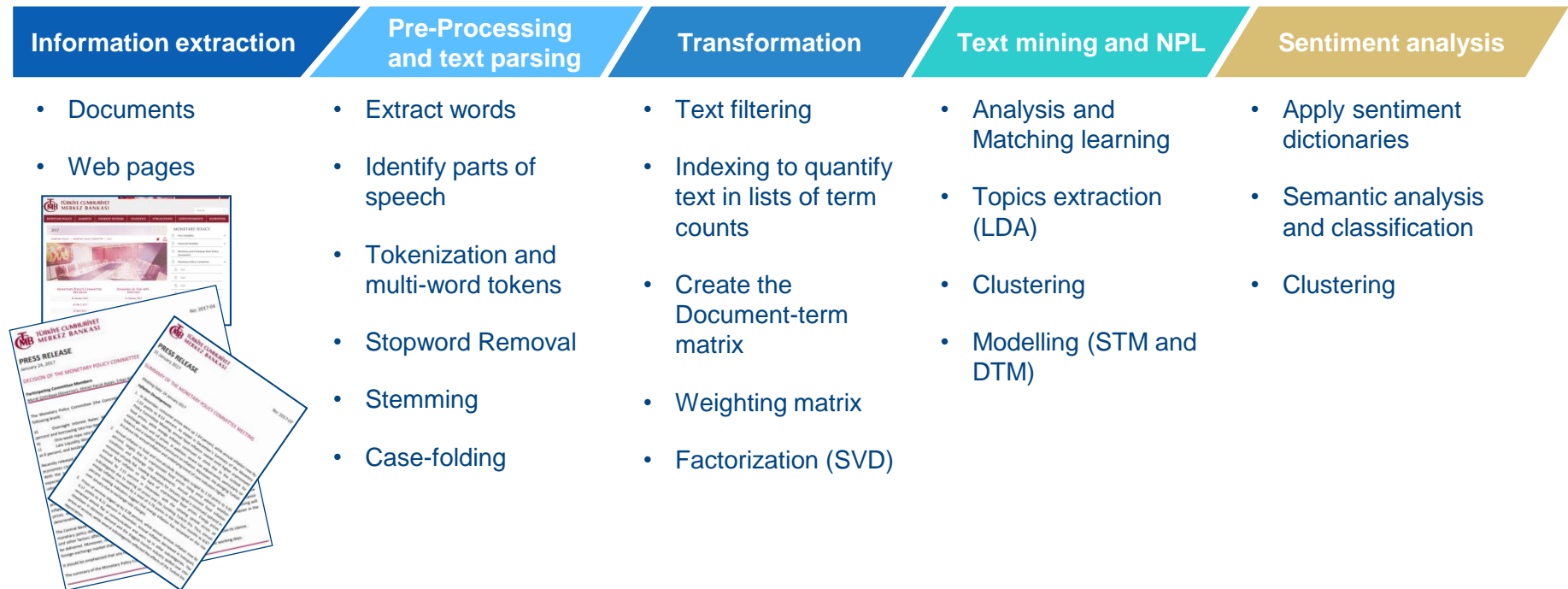


- ◆ We use **“Statements”** and **“Minutes”** of the Central Bank of the Republic of Turkey CBRT from 2006 to October 2017
- ◆ We Analyze **“What”** the CBRT is talking about through Latent Dirichlet Allocation (LDA) and Dynamic Topic Models (DTM)
- ◆ We apply network analysis to understand Monetary Policy Complexity
- ◆ We check **“How”** the Central Bank talks by using Sentiment Analysis (Dictionary Assisted)
- ◆ We design some analytical tools to understand the Monetary Policy of Turkey through the official documents



External databases: web scrapping and NPL techniques

The process Data Mining: From Extraction to Sentiment Analysis



“Parsing” through (LDA): Some Basics

- ◆ **Words (Tokens)**: basic unit of discrete data. Represented as an unit vector with a single 1 entry, and 0 in the remainder, this vector has as many entries as total words under analysis.
- ◆ **Stop Words**: “A”, “the” very frequent but don’t add value in term
- ◆ **Document**: sequence of N words.
- ◆ **Corpus**: a collection of documents.
- ◆ **Document-Term-Matrix**: matrix where each row is the sum of all the words in a given document. As such we have documents in the rows, words in the columns, and each entry in the matrix is the number of occurrences of a word in a given document.

Text Mining: The Latent Dirichlet Allocation (LDA) Model

- ◆ **Latent Dirichlet Allocation (LDA)** (Blei et al. 2003) is a generative probabilistic (hierarchical Bayesian) model of a corpus. Documents are represented as mixtures over latent topics, where each topic is characterized by a distribution over words.

- ◆ Simplified corpus generative process:

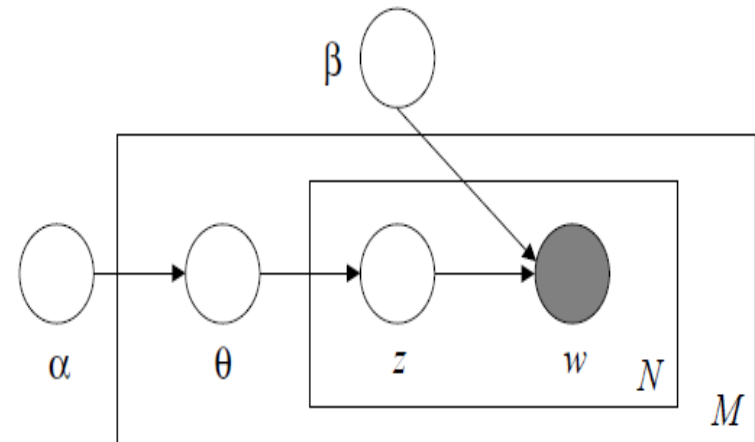
$$N \sim \text{Poisson}(\zeta)$$

$$\theta \sim \text{Dirichlet}(\alpha)$$

for each word w_n

$$\text{topic } z_n \sim \text{Multinomial}(\zeta)$$

$$w_n \sim p(w_n | z_n, \beta)$$



Source: Blei et al. 2003

- ◆ **Bag of Words assumption:** Order of the words is not important, only the occurrence is relevant. This assumption is inherited, as LDA is an extension of the Latent Semantic Indexing algorithm (an SVD on the Document-Term-Matrix).
- ◆ **Words are conditionally Independent and Identically distributed:** Needed when working with latent mixture of distributions, following **de Finetti's theorem** (*exchangeable observations are conditionally independent given some latent variable to which an epistemic probability distribution would then be assigned*).

Extending the LDA: Structural Topic Model & The Dynamic Topic Model

- ◆ **Structural Topic Model** (Roberts et al. 2016) extends the LDA algorithm such that metadata (covariates) can affect the topic distribution. This allows us to introduce time series dependencies, estimating what is known as a **Dynamic Topic Model** (i.e Topics Change over time). Topics can depend on 2 classes of covariates:
 - ◆ Topic Prevalence (each document has P attributes that can affect the likelihood of discussing topic k)
 - ◆ Topic Content (each document has an A-level categorical attribute that affects the likelihood of discussing term v overall, and of discussing it within topic k).

◆ **Dynamic Topic Models** were Γ is a $P \times (K - 1)$ matrix of prevalence coefficients, d indexes documents, n indexes words within documents and k indexes the latent topics.

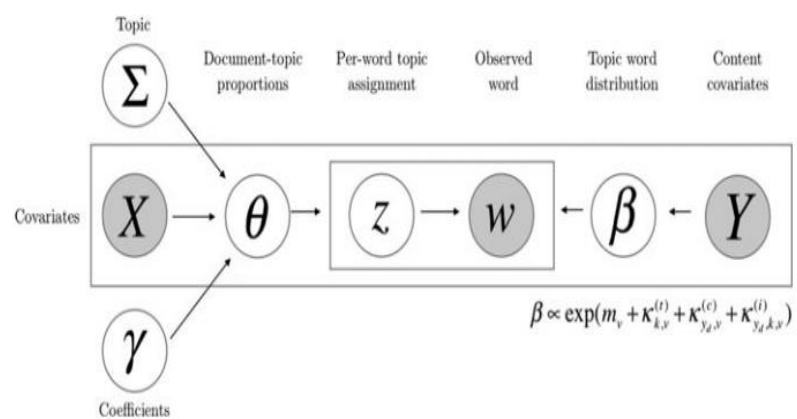
generative process:

$$\gamma_k \sim \text{Normal}(0, \sigma_k^2 I_p)$$

$$\theta_d \sim \text{LogisticNormal}(\Gamma' x'_d, \Sigma)$$

$$z_{d,n} \sim \text{Multinomial}(\theta)$$

$$w_{d,n} \sim \text{Multinomial}(Bz_{d,n})$$



Sentiment Analysis through lexicon methods...

- ◆ **Loughran and McDonald (2011)**, a dictionary for sentiment analysis specifically for financial texts. This dictionary solves a misclassification issue of certain specific financial or economic words in standard sentiment analysis dictionaries (e.g. Harvard Psychosociological Dictionary).

Positive words		Negative words	
achieve	progress	bankruptcy	fallout
benefit	stabilize	bottleneck	imbalance
efficiency	strength	corrupt	monopolize
outperform	versatility	downgrade	stagnant

- ◆ **The FED Financial Stability dictionary (Correa et al, 2017)**.

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

... to get sentiment indices

- ◆ The average tone once the dictionary is applied is computed as follows:

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

- ◆ We build refined indices for each topic of the DTM by weighting the tone of the paragraph by the weight of the tone of the paragraph.

03

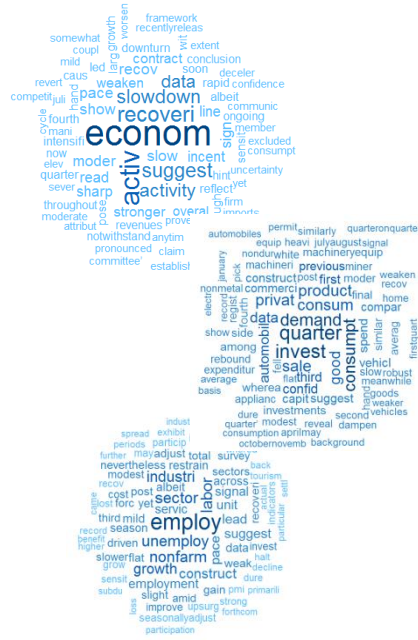
**Inside Turkey's
Monetary Policy: What is the
CBRT talking about ?**

First we identify the topics: Word clouds will help us to understand and identify topics... here there is a big room for the Researcher

Global Flows



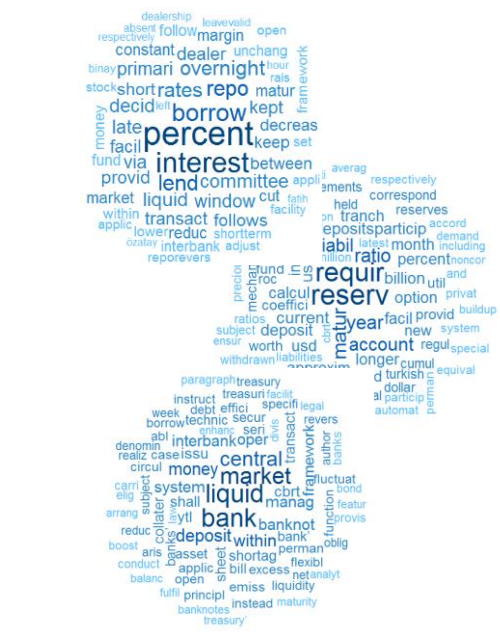
Activity



Inflation



Monetary Policy

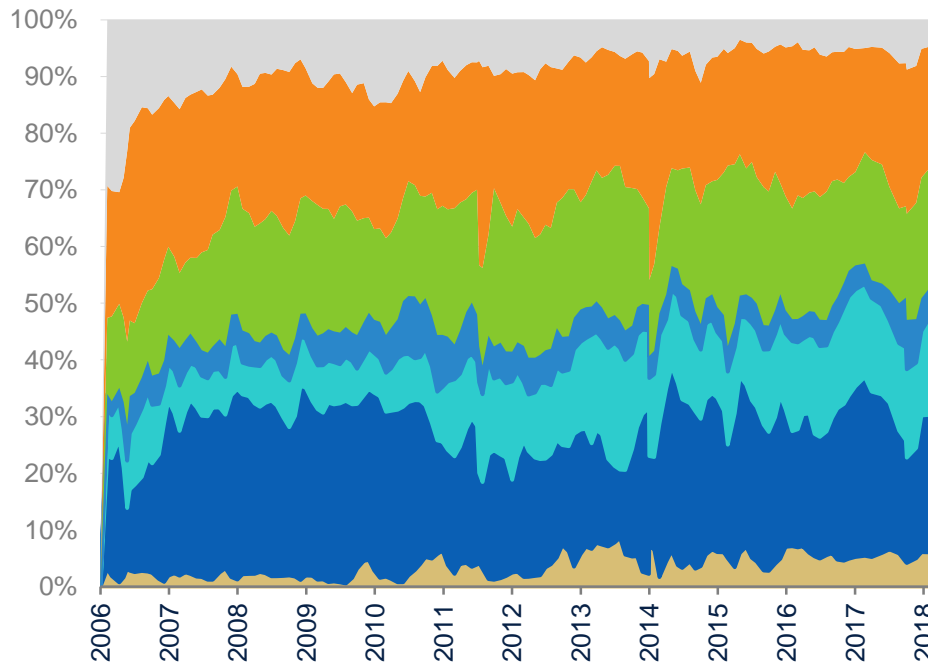


Each word cloud represents the probability distribution of words within a given topic. The size of the word and the color indicates its probability of occurring within that topic

What's the CBRT talking about? We aggregate topics in groups... to see the "Dynamics" of Central Bank Communication over time...

Central Bank of Turkey Topics Evolution

(in % of total)

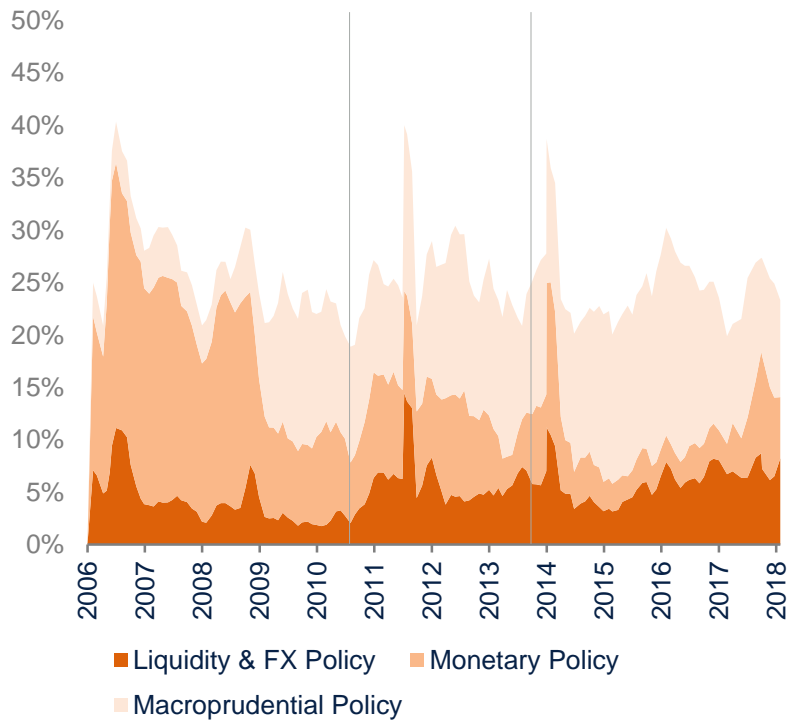


- Global Flows
- Economic Activity
- Labor Market
- Fiscal & Structural Policies
- Inflation Core

- The Unclassified Other has been diminishing
- Monetary Policy topics maintains its share, increasing in "Stress" periods
- Inflation discussions remains stable
- Structural Policies topics remain at minimum
- Employment issues increasing relevance after the financial crisis
- Economic Activity discussions increased after the Crisis gaining relevance recently
- Global Capital flows are increasingly important

...how even the Monetary strategy can change ... this will help us to understand better the CBRT strategy...

CBRT Topics Evolution: Monetary Policy (in % of total Monetary policies)



The macroprudential measures to smooth credit cycle and to contain household debt were implemented in two major steps.

First Round (2011)

- Higher risk weights and provisions for consumer loans.
- Limits to credit card payments
- LTV cap for housing loans

Second Round (2013-2014)

- Caps, limits, and higher risk weights on credit cards
- Maturity restrictions (36 months) for uncollateralized consumer loans
- LTV cap for vehicle loans

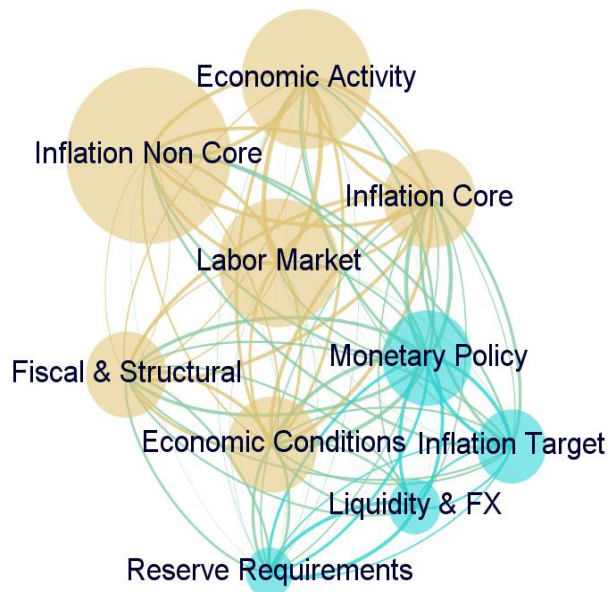
	Previous Approach	New Approach
Objectives	Price Stability	Price Stability Financial Stability
Policy Tool(s)	Policy Rate	Policy Rate Interest Rate Corridor Reserve Req. Policy

Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007)

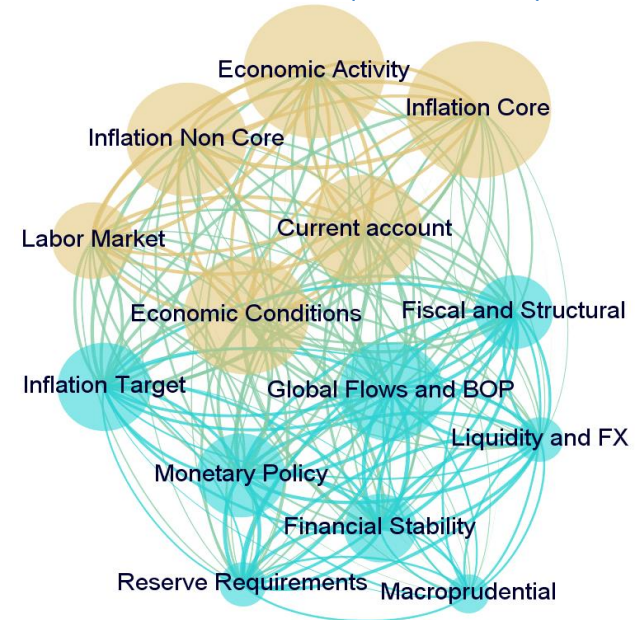
...how the CBRT policies have become more complex after the Global Financial Crisis through our topic network analysis...

Topic Network in the CBRT Statements and Minutes

Full Fledge Inflation Target (2006-2008)



Financial Crisis (2009-2012)



Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007)

The network of the estimated and correlated topics using STM. The nodes in the graph represent the identified topics. Node size is proportional to the number of words in the corpus devoted to each topic (weight). Node color indicates clusters using a community detection algorithm called modularity developed by Blondel et al (2008). Topics for which labeling is Unknown are removed from the graph in the interest of visual clarity. Edges represent words that are common to the topics they connect (co-occurrence of words between topics). Edge width is proportional to the strength of this co-occurrence between topics.

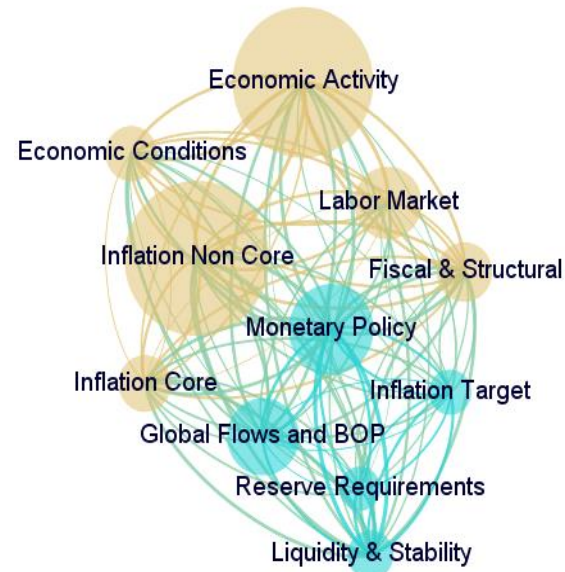
... and how is somehow in a process of continued changes during the recent years

Topic Network in the CBRT Statements and Minutes

Financial Crisis (2009-2012)



The Global Post-Crisis (2012-2017)



Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007)

The network of the estimated and correlated topics using STM. The nodes in the graph represent the identified topics. Node size is proportional to the number of words in the corpus devoted to each topic (weight). Node color indicates clusters using a community detection algorithm called modularity developed by Blondel et al (2008). Topics for which labeling is Unknown are removed from the graph in the interest of visual clarity. Edges represent words that are common to the topics they connect (co-occurrence of words between topics). Edge width is proportional to the strength of this co-occurrence between topics.

04

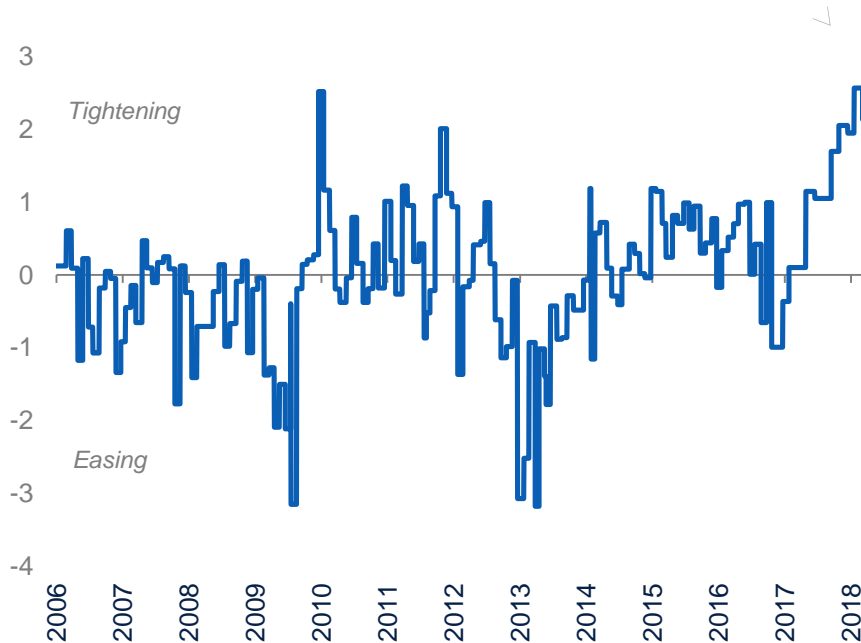
**Inside Turkey's
Monetary Policy: "How" is the
CBRT talking about**

Through Sentiment Analysis we can check “how” the CBRT is talking and obtain some assessment of the monetary policy stance... (they can be different depending on the documents)

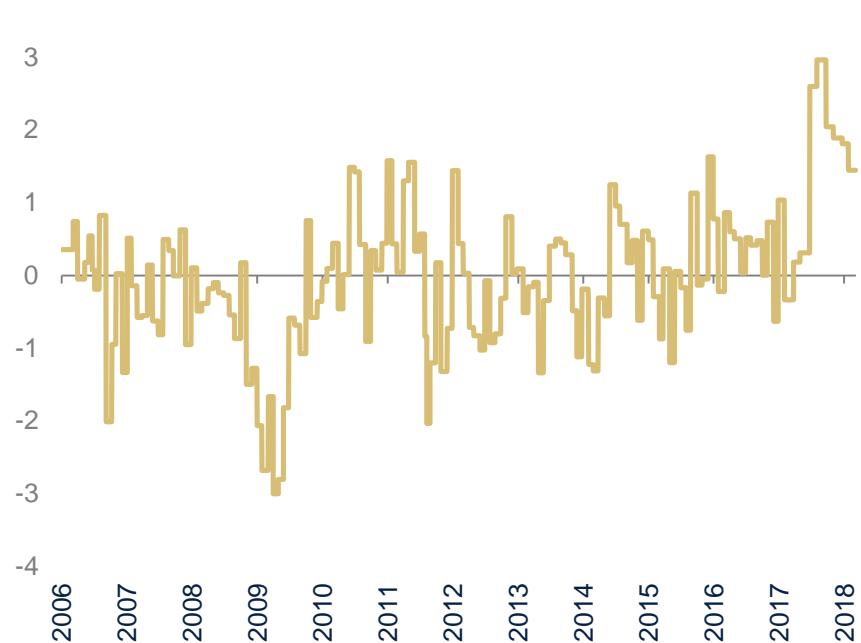
CBRT Monetary Policy Sentiment

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

Monetary Policy “Statements”



Monetary Policy “Minutes”



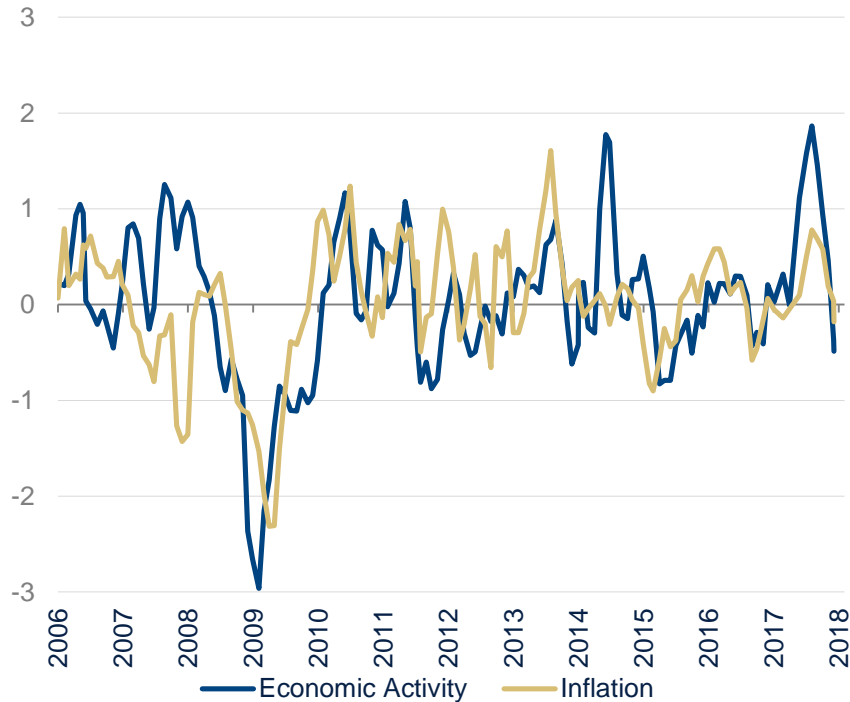
Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007) and CBRT

A more formal Statement...

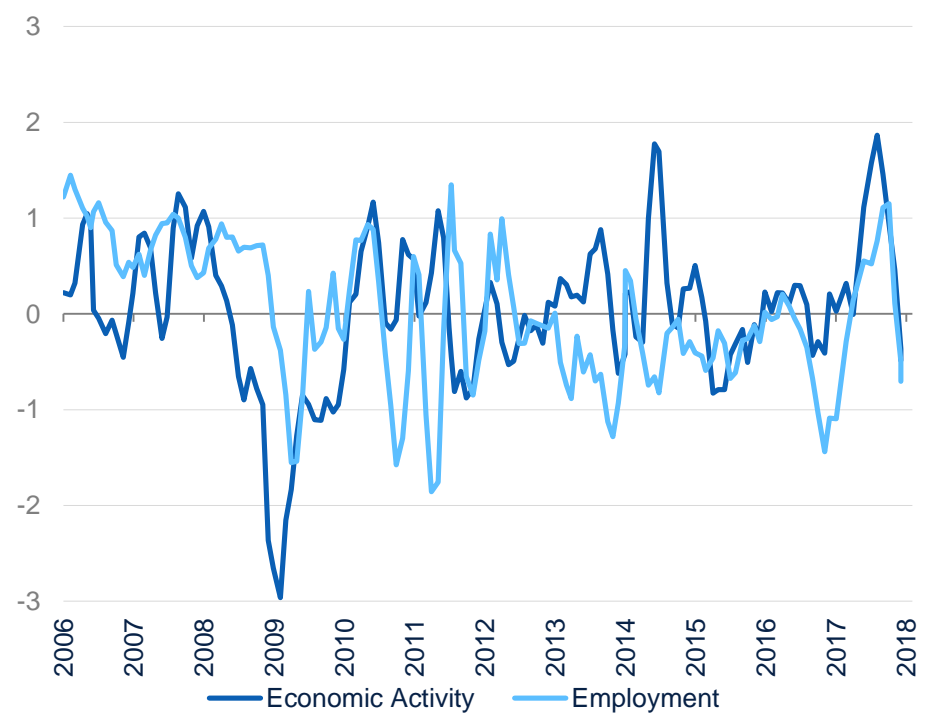
More extensive and analytical...
less volatile

The Phillips Curve looks well alive but unemployment is lagging behind

Economic Activity & Inflation Tone
(tone economic activity and Inflation in the MP Minutes)



Economic Activity & Employment Tone
(tone economic activity and employment in the MP Minutes)

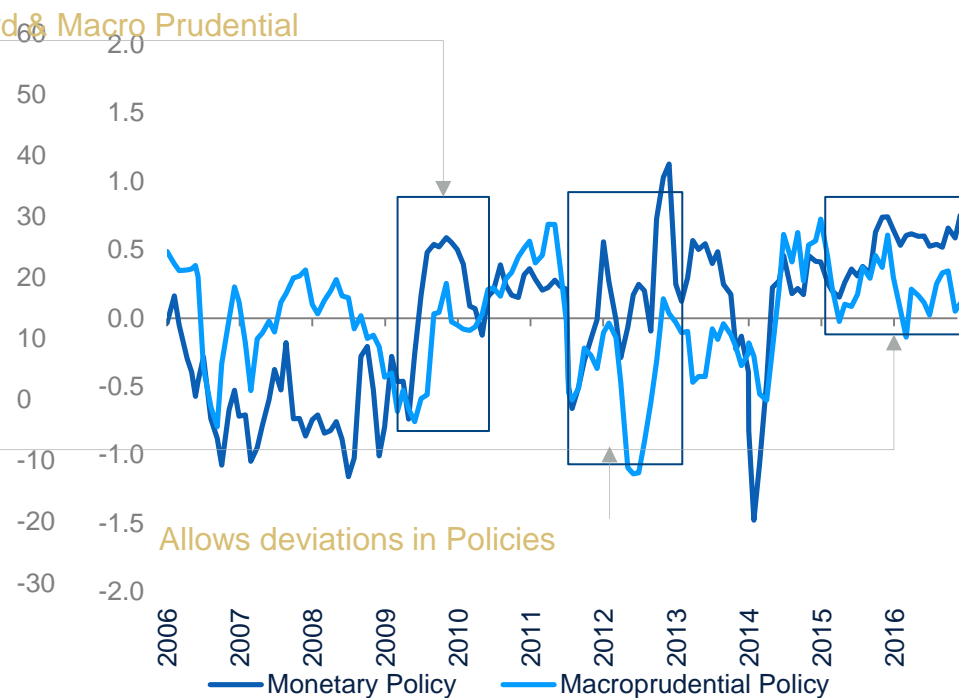
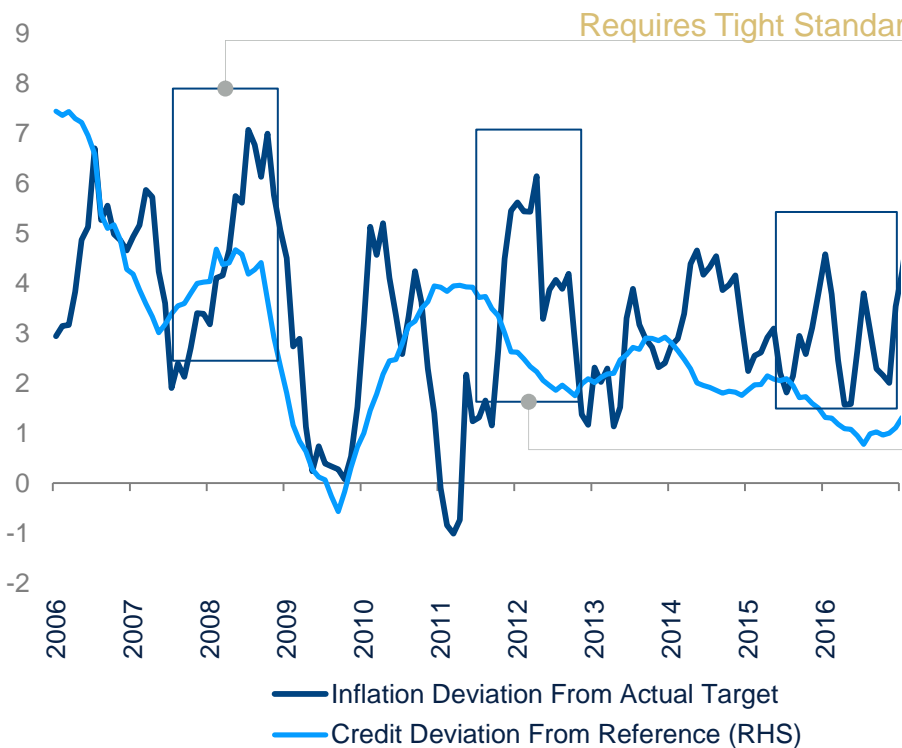


Source: Iglesias, J, Ortiz, A & Rodrigo, T (2017)

Multiple targets lead to different Policies...

Deviation from target(reference): Inflation & Credit
 (FX adj. Loans YoY minus 15% and inflation minus 5%)

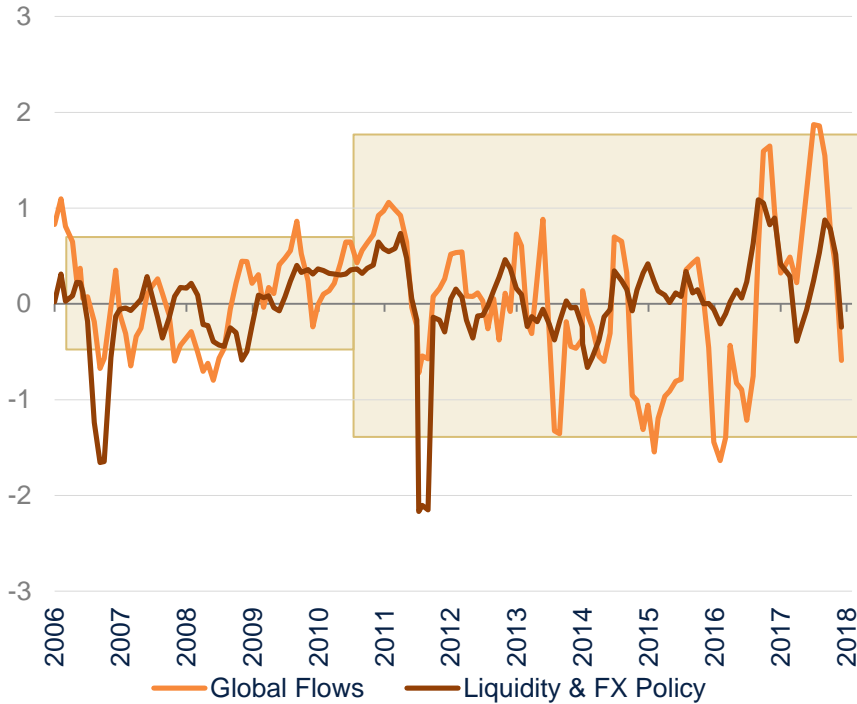
Standard Monetary & Macroprudential policies
 (Sentiments)



Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007)

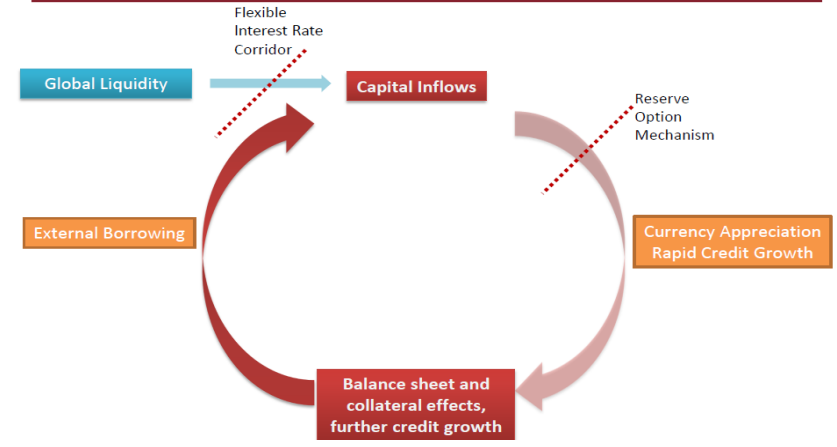
Sentiment about Monetary Policy

Global Flows Sentiment & CBRT Policies
(in % of total Monetary policies)

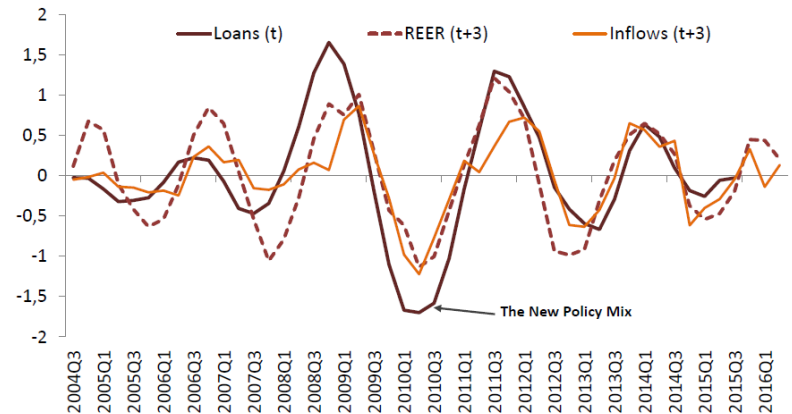


Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007) and CBRT

CBRT has expanded the policy toolkit to weaken the amplification mechanisms triggered by global liquidity cycles.



Capital flows, exchange rate, and credit cycles
(HP filtered, standardized)



Source: CBRT.

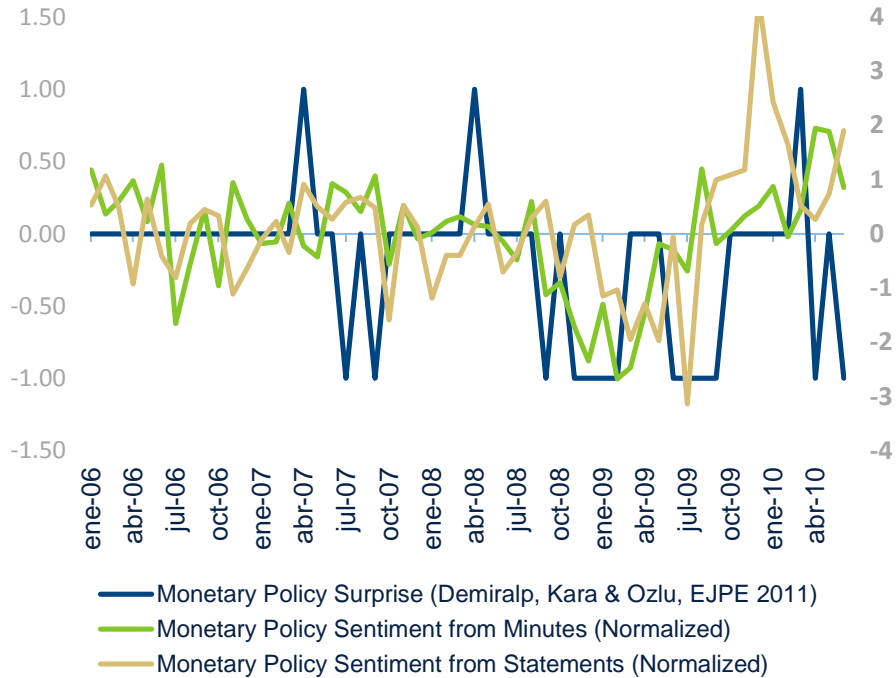
05

**Robustness & Effects of the
CBRT communication Policy
on Markets and the Economy**

We can check whether the sentiment affects analysts (and test the Machines & Dictionary methods compare with Experts analysis)

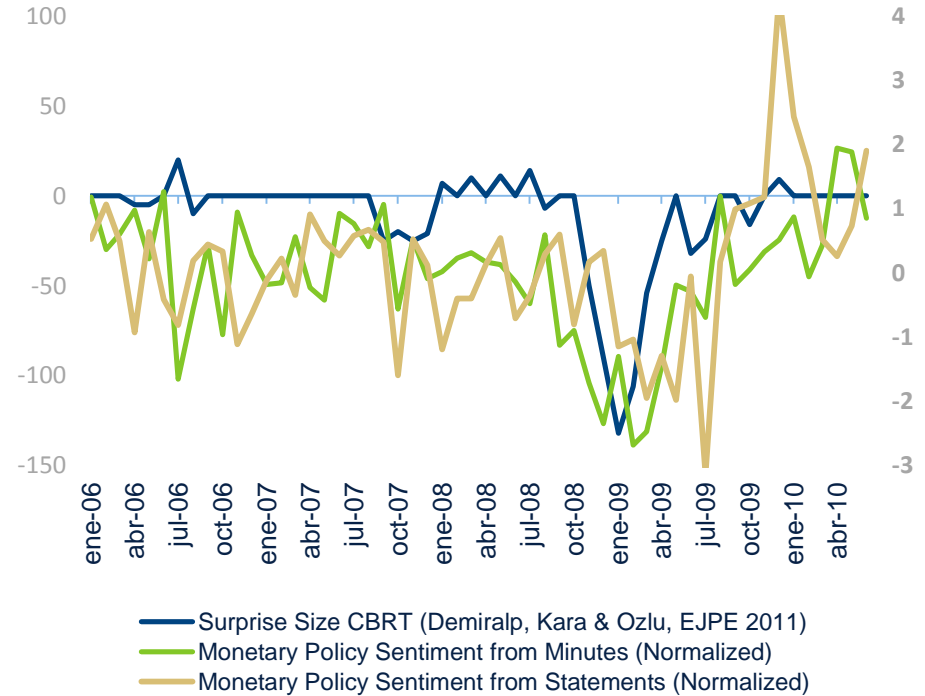
Monetary Policy: Experts vs Algorithms

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



Experts vs Algorithms: Size of Surprises & Sentiments

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

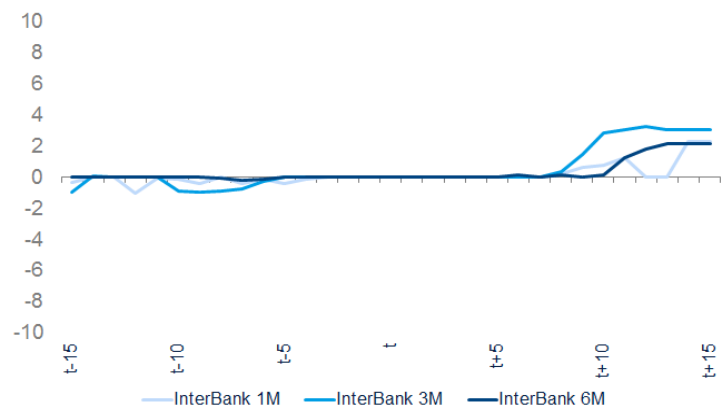


Source: Iglesias, J, Ortiz, A & Rodrigo, T (2007) and Demiralp, Kara & Ozlu (2011)

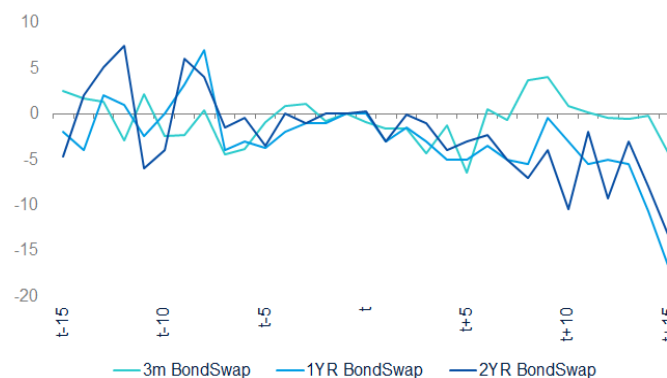
There is a positive influence of CBRT Sentiment on rates specially when changes in sentiments are higher

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

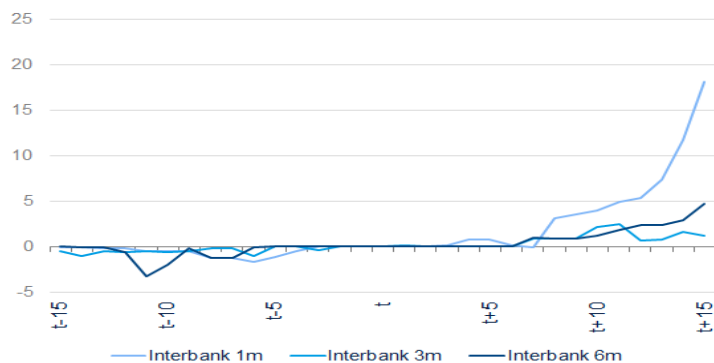
Interbank Rates Response to Mild Change in Sentiment



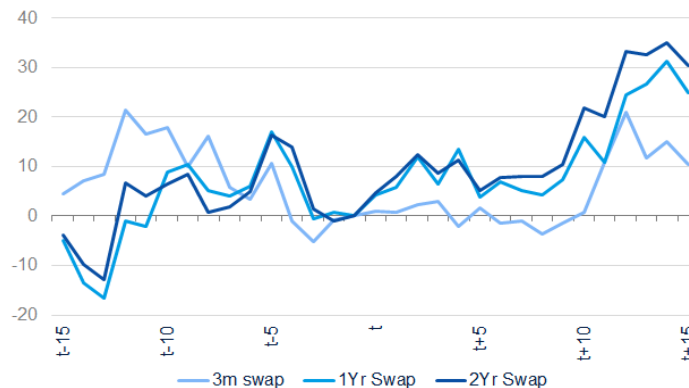
Bond Swaps Response to Mild Change in Sentiment



Interbank Rates Response to Sharp Change in Sentiment



Bond Swaps Response to Sharp Change in Sentiment

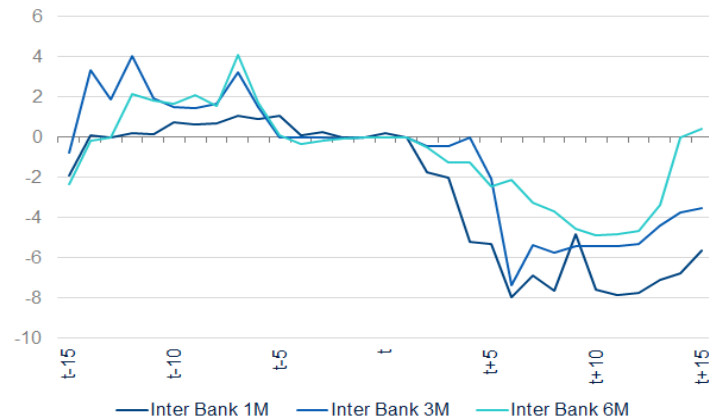


... and negative changes transmit also to negative rates. But some asymmetry remains as the reaction to sharp negative changes looks more sticky in the MTM

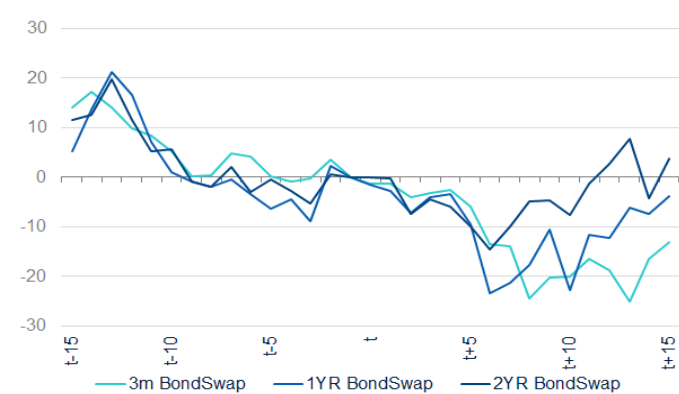
Response to Short term and long term rates to Negative changes in Sentiment

(Response of interbank deposits rates and 2Y BondSwaps to mild and strong changes in sentiment. Changes relative to t-1. T=event)

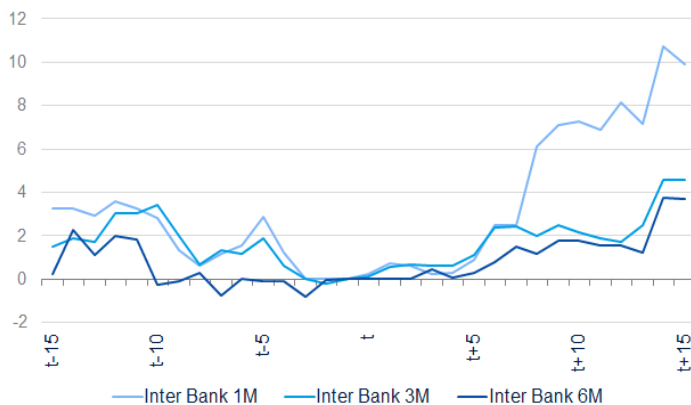
Interbank Rates Response to Mild Change in Sentiment



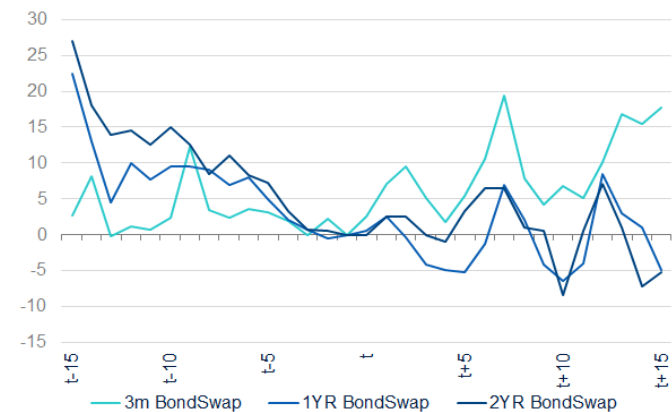
Bond Swaps Response to Mild Change in Sentiment



Interbank Rates Response to Sharp Change in Sentiment



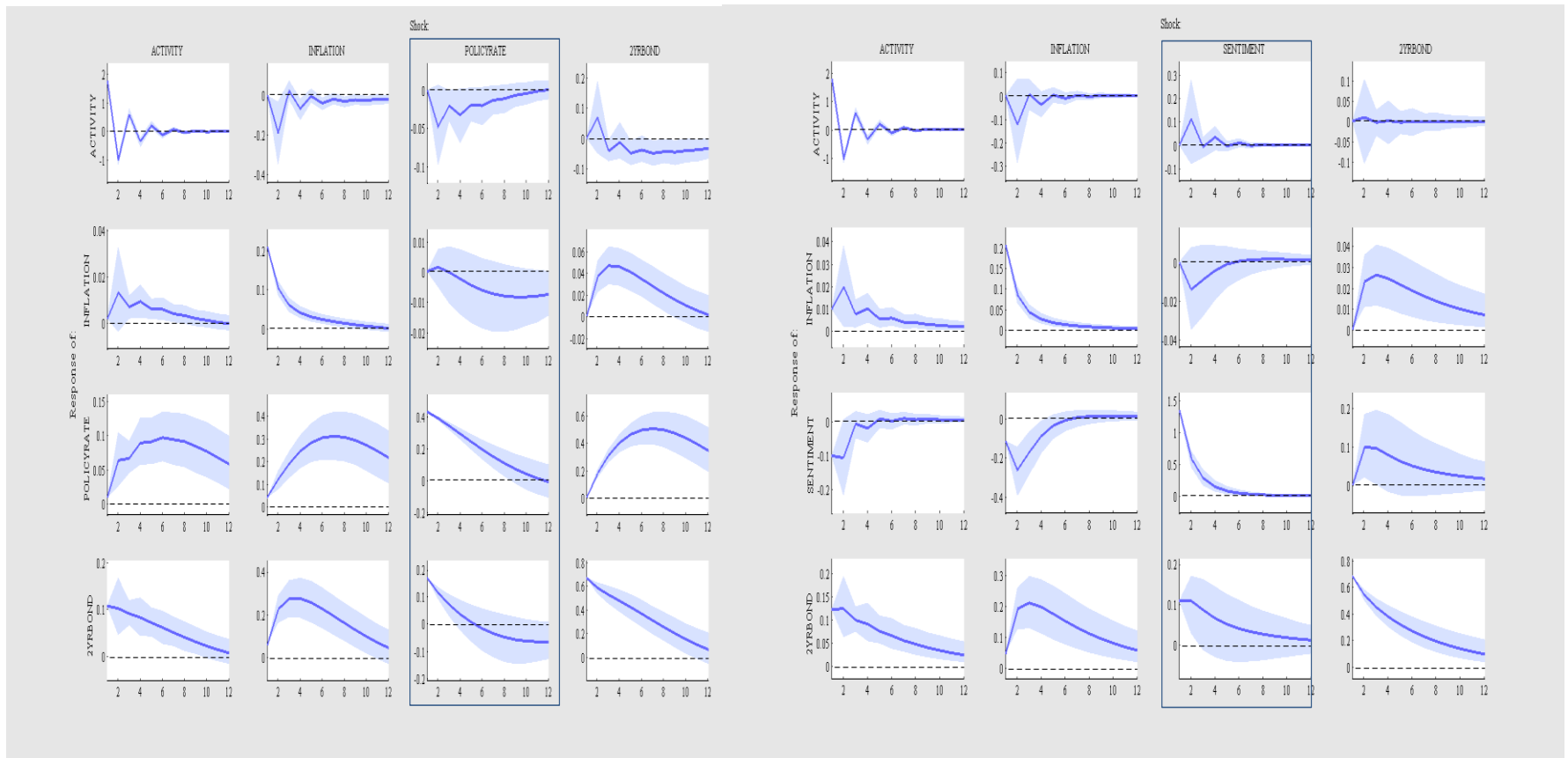
Bond Swaps Response to Sharp Change in Sentiment



Although “verbal” policies can guide the markets they will finally require some commitment to be effective

Monetary Policy Rate Shock

Monetary Policy “Sentiment” Shock



Bayesian VAR Models

Y= (Y, π, Policy, 2yr Bond) Lags=3M, Prior =Whistart

06

Conclusions

Key Analytical Results on Central Bank Communication Policy Research

- ◆ We extend BigData techniques to the analysis of the **communication of the EM Central Banks**. Introducing some novelties as Dynamic Topic Models
- ◆ Central Bank **Communication Policies Matter** thus confirming previous research
- ◆ Turkish Monetary Policy has **oriented to a Macro Prudential Strategy**
- ◆ Monetary policy in Turkey has become **more complex after the Financial Crisis**
- ◆ The CBRT has the ability **to influence the Term Structure of interest rates (thus affecting the MTM)**. There are some **asymmetry** in the reactions
- ◆ But “Verbal” policies **can not affect Real Variables and Inflation**
- ◆ They are somehow limited and **“Material” commitment is needed to be effective**

07

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* *The full reference list can be found in the WP version*

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