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# **Its not what they say its how they say it – measuring the market effects of ECB communication**

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■ These slides represent the views of the author alone and not the Central Bank of Ireland or Eurosystem

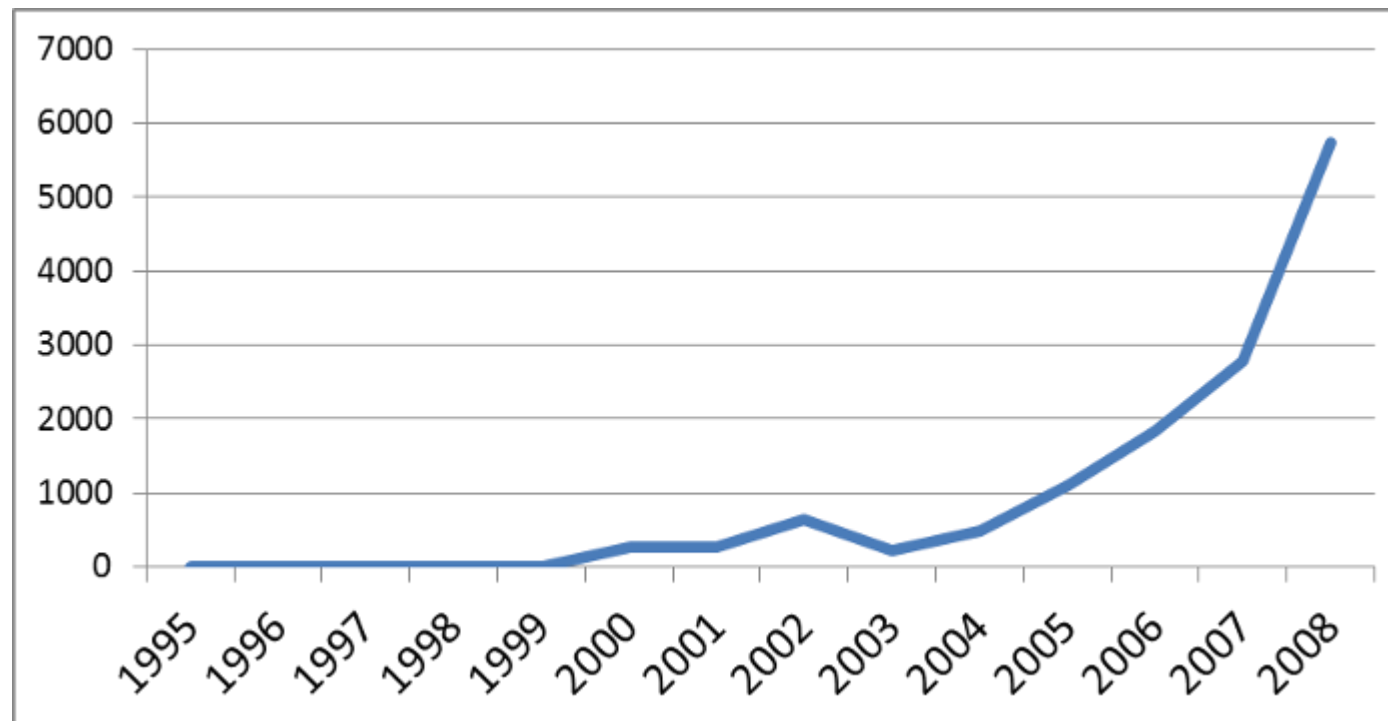


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# Motivation

- Last 20 years – central bank communication has been a major talking point.
- Prior to 2000s, barely any discussion, but since then growth in this field has been exponential.
- Graph from McMahon and Hansen (2015)



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# Motivation

- Communication continues to be discussed as a monetary policy tool itself.
  - Issue – how do we measure the impact of communication?
  - Most central bank communication is released alongside new other information.
  - Governing Council speeches are released alongside interest rate decisions.
  - Other speeches are released alongside macroeconomic projections.
  - How can we measure the impact of communication when there is such muddled information?
- In turn – we may get a net effect of communication, but what precisely drives this? **What are the mechanisms?**



# Contribution and Literature

- This paper focuses on the **mechanisms** through which central bank communication can have an impact on markets.
  1. **Use quantitative measures to “measure” the text contained in ECB governing council speeches.**
    - A. Conventional **sentiment measures**.
    - B. New **novel method of measuring CB communication (hawkish or dovish?)**.
    - C. Complement this with an **LDA Approach to measure the content**.
  2. **Exploit the staggered nature of ECB communication**
    - A. ECB press conference takes place forty five minutes after monetary policy decision announced.
    - B. Use changes in asset prices before and after the press conference **alongside the above measures!**
    - C. Extract a clean communication effect => **Combine event study literature with computational linguistics techniques.**



# Results

## Measurement:

- Traditional measures of “sentiment” are quite noisy => Motivates a monetary policy specific measure.
- The created “Hawk-Dove Index” tracks market expectations of both future monetary policy and current economic expectations quite well.
- New measure **functions well as a measure of market tilt at the zero lower bound!**

## Impact

- A positive effect of more “hawkish” language on stock markets is noted.
- Suggests that markets interpret language signalling a monetary policy tightening as being indicative of the central bank having “positive information”.
- Stronger effect is present pre “formal forward guidance” by the ECB.



# Literature

## ■ Three broad strands of literature:

1. Indirect measures of communication exploiting patterns in high frequency data.
  - Gurkaynak et al. (2005 ) Ehrmann and Fratzscher (2009) Goodhead and Kolb (2018) , Whelan et al. (2017), Altavilla et al. (2019), Kaerssenfischer (2019). Nakamura and Steinsson (2013), Jarocinski and Karadi (2018).
2. Manual coding of central bank text to measure content of interest.
  - Ehrmann and Fratzscher (2009), Rosa and Varga (2007)
  - Manual coding of central bank text to measure content of interest.
3. Techniques from computational linguistics for automated text classification.
  - McMahon and Hansen (2015, 2017, 2018), Tobback et al. (2017) . Jegadeesh and Wu (2018) . Tadle (2019)



# Methodology and Empirical Approach

- Object of Study – ECB Press Conference.
- Sample: 221 Governing Council Meetings
  - **3<sup>rd</sup> November 1998 – 10<sup>th</sup> April 2019**
- ECB monetary policy decisions are published at 13:45 CET on the second day of the Governing Council meeting.
- Press conference begins afterwards at 14:30 CET. Consists of two key parts:
  1. **Introductory Statement.** Outlines the rationale behind the ECB's interest rate decision. Consists of:
    - **Decision Rationale.** (Interest Rates, APP, TLTRO info etc.). Contained explicit forward guidance from July 2013.
    - **Economic Analysis.** Information on GDP, HICP, unemployment etc. From June 2004, 4 a year contained information on **forecasts.**
    - **Monetary Analysis**
    - **Structural reforms and fiscal policies.**
  2. **Questions and Answers.** Much broader – used to clarify decision information.
- Data mined from ECB website and pre-processed





# Measuring Tone

- AFINN Dictionary – Nielsen (2011).
- Not tailored towards finance. Useful, however, as it can deal with the strength of sentiment.
- Takes a list of 2477 words and gives them a score of -5 (highly negative) to +5 (highly positive).
- Takes a running total to get a total positive and negative score.
- For each Governing Council speech at time  $t$ , we calculate

$$AFINN_t = \frac{PositiveScore_t - NegativeScore_t}{WordCount_t}$$



# Measuring Tone

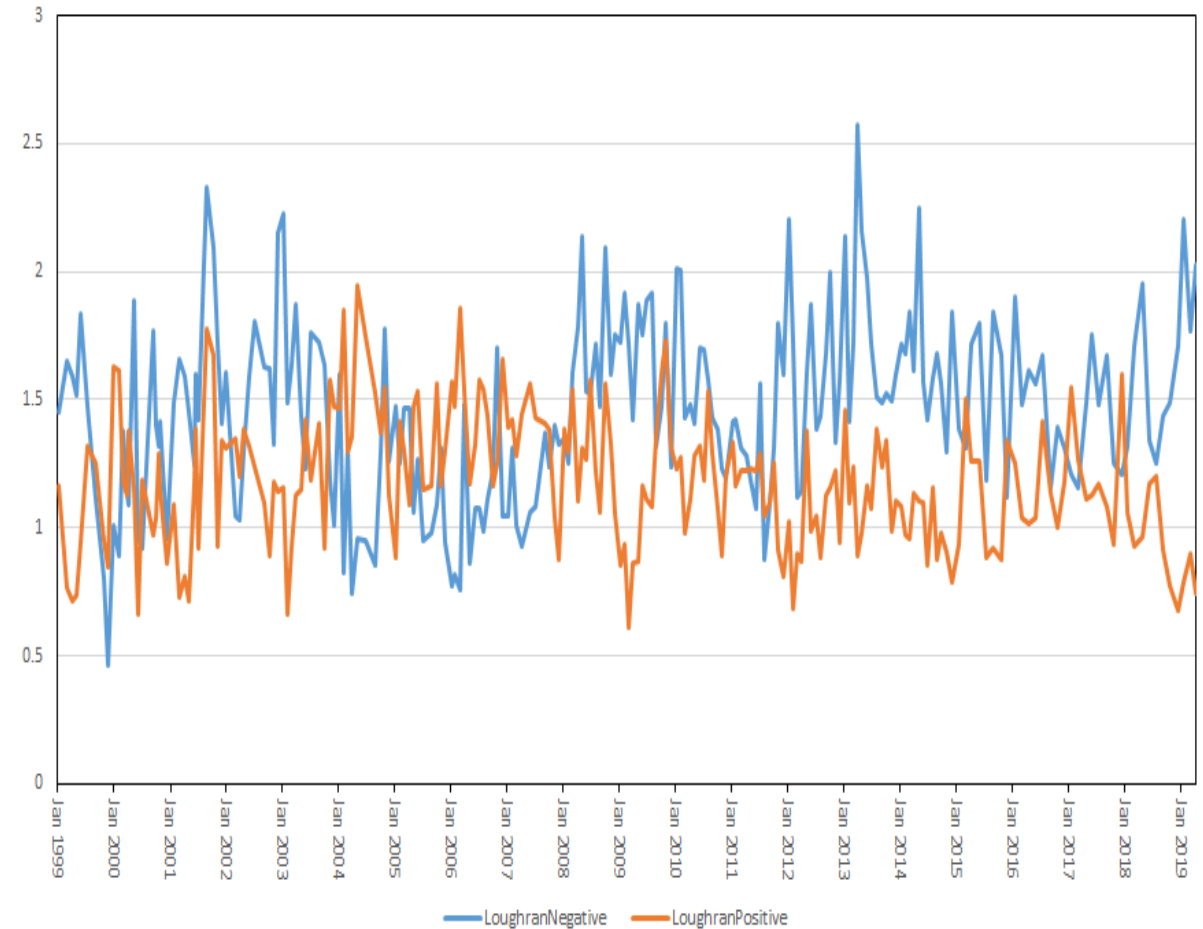
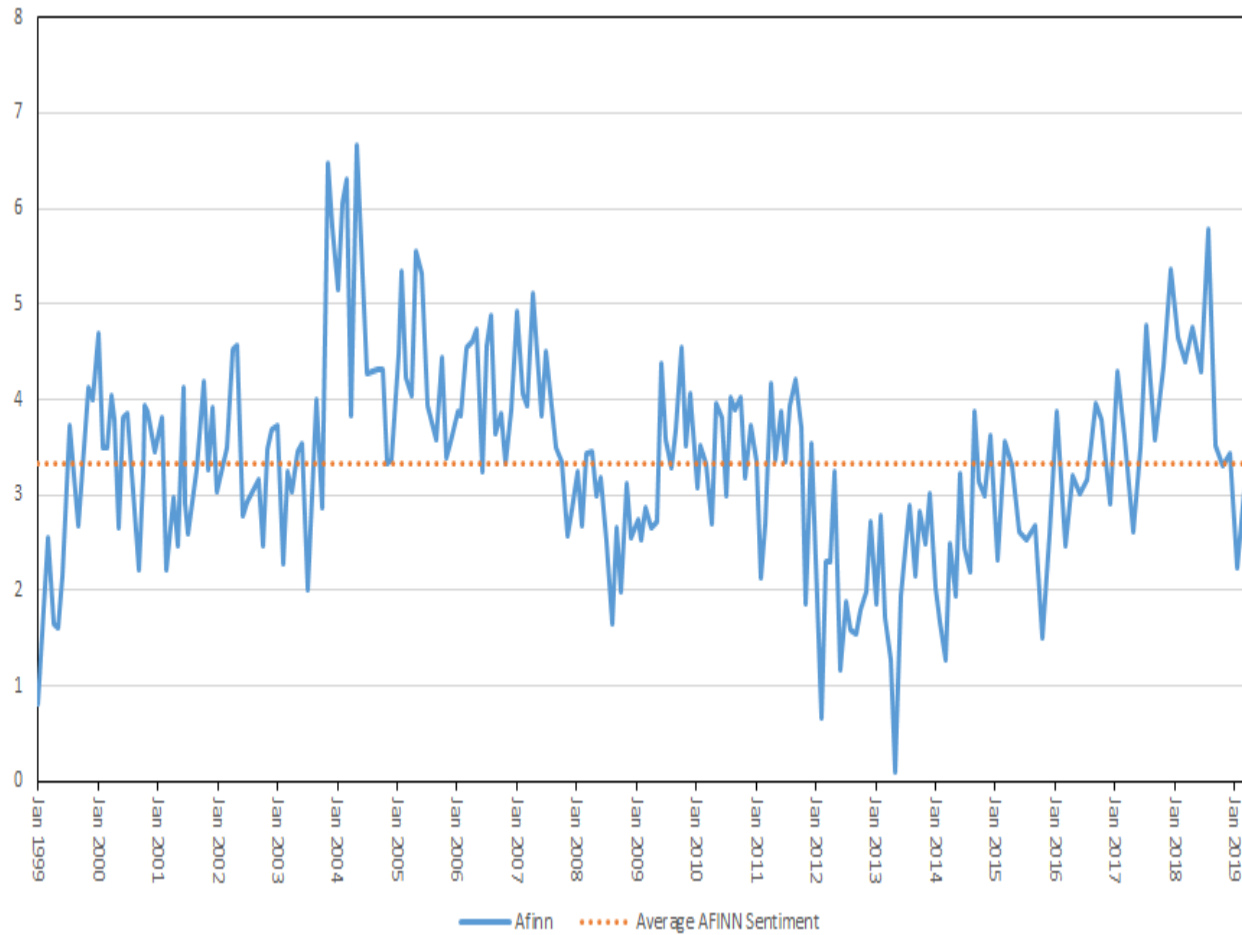
- Alternative approach: Loughran-McDonald Dictionary (Loughran and McDonald, 2011)
- Tailored towards finance.
- Consider the sentence “the tax agency reduced their liabilities”
- Negative in AFINN, but neutral here!
- We get measures of “positive”, “negative” and “uncertain” sentiment using this wordlist.
- For each Governing Council speech at time  $t$ , we calculate

$$LoughranPositive_t = \frac{NumberPositiveTerms_t}{WordCount_t}$$

- With analogous calculations for negative, uncertain and “net polarity” (positive – negative).
- Applied to ECB speeches by Schmelling and Wagner (2019) – method only concentrates on changes in negative terms between Governing Councils...



# Descriptive Results – Sentiment Measures



# Hawk-Dove Index

- Adapted from Tadle (2019).
- Tailored towards monetary policy in particular.
- Consider the sentence “the likelihood of a **recession** has **fallen**”
- We need to control for this. Use a new monetary policy dictionary.
- Create a list of “hawkish” and “dovish” terms.
- Create a list of “positive” and “negative” terms.
  
- These terms were identified from a wide range of **monetary policy specific statements!** (Most of us know central bankers use slightly different language to the rest of the world!).

[Word List](#)



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## More formally:

- Algorithm splits the document into sentences.
- The algorithm checks the number of (i) hawkish and (ii) dovish terms in a sentence.
- If the number of hawkish terms is greater than the number of dovish terms, this gets a base score of being “hawkish” and vice versa. Otherwise the sentence is classed as neutral.
- Next, the polarity of the sentence is checked.
- If the number of positive terms exceeds the number of negative terms, then keep the classification of the above, otherwise, if the sentence is negative, a “hawkish” base sentence, is classified as dovish.
  
- To illustrate.....



# Hawk-Dove Index

- Consider the following, with hawkish terms in blue, dovish terms in orange, positive terms in green and negative in red.
  1. Growth in inflation has increased
  2. Growth in inflation has fallen
  3. The risk of recession is elevated
  4. The risk of recession has fallen



# Hawk-Dove Index

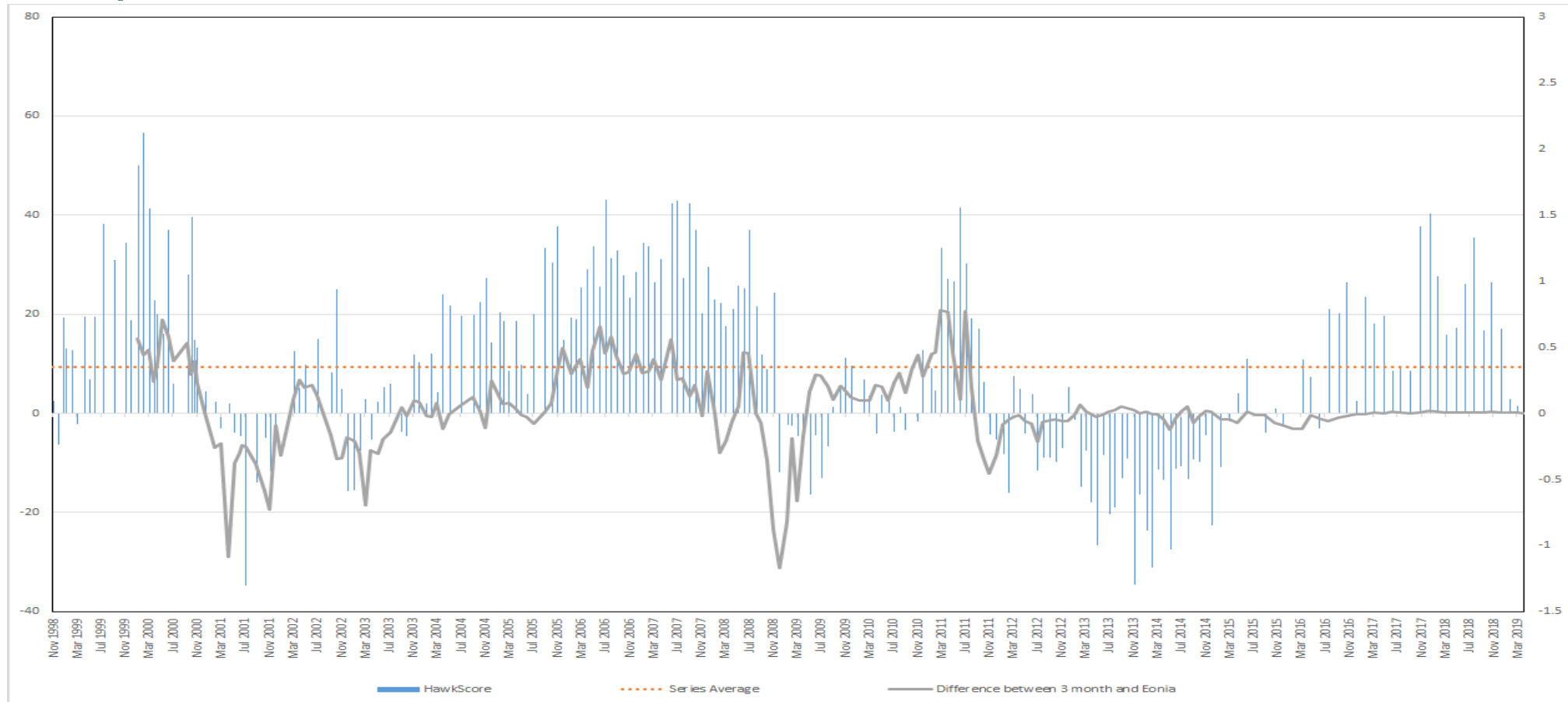
- Formally, let  $sent_{i,t}$  be the “sentiment score” of “sentence  $i$ ” in document  $t$ .
- Let  $pos_{i,t}$ ,  $neg_{i,t}$ ,  $hawk_{i,t}$ ,  $dove_{i,t}$  be the number of words in each sentence in each given category.
- Let  $K$  denote the number of sentences in each document which have at least one hawkish or dovish term.  
Other sentences are deemed non informational
- Then:

$$sent_{i,t} = \begin{cases} 1 & \text{if } hawk_{i,t} > dove_{i,t} \text{ and } pos_{i,t} > neg_{i,t} \\ -1 & \text{if } hawk_{i,t} > dove_{i,t} \text{ and } pos_{i,t} < neg_{i,t} \\ 1 & \text{if } hawk_{i,t} < dove_{i,t} \text{ and } pos_{i,t} < neg_{i,t} \\ -1 & \text{if } hawk_{i,t} < dove_{i,t} \text{ and } pos_{i,t} > neg_{i,t} \\ 0 & \text{otherwise} \end{cases}$$

$$HawkScore_t = 100 \times \frac{\sum_{i=1}^K (sent_{i,t})}{K}$$



# Descriptive Results – Hawk-Dove Index



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## Descriptive Results – Hawk-Dove Index

|                | HawkDoveScore       | HawkDoveScore        | LoughranSentiment         | LoughranSentiment            | AFinnSentiment          | AFinnSentiment              |
|----------------|---------------------|----------------------|---------------------------|------------------------------|-------------------------|-----------------------------|
| diffeonia      | 28.54***<br>(3.583) |                      | 0.00733***<br>(0.000869)  |                              | 0.00823***<br>(0.00160) |                             |
| zew            |                     | 0.259***<br>(0.0164) |                           | 0.0000355***<br>(0.00000663) |                         | 0.0000624***<br>(0.0000143) |
| Constant       | 7.575***<br>(1.112) | 14.99***<br>(0.987)  | -0.00293***<br>(0.000299) | -0.00187***<br>(0.000340)    | 0.0334***<br>(0.000727) | 0.0348***<br>(0.000681)     |
| Observations   | 202                 | 211                  | 202                       | 211                          | 202                     | 211                         |
| R <sup>2</sup> | 0.233               | 0.439                | 0.209                     | 0.111                        | 0.055                   | 0.070                       |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

- Relative R-square values as expected:
- HawkDoveIndex >> Loughran >> AFINN
- Particular difference can be seen for ZEW Scores!



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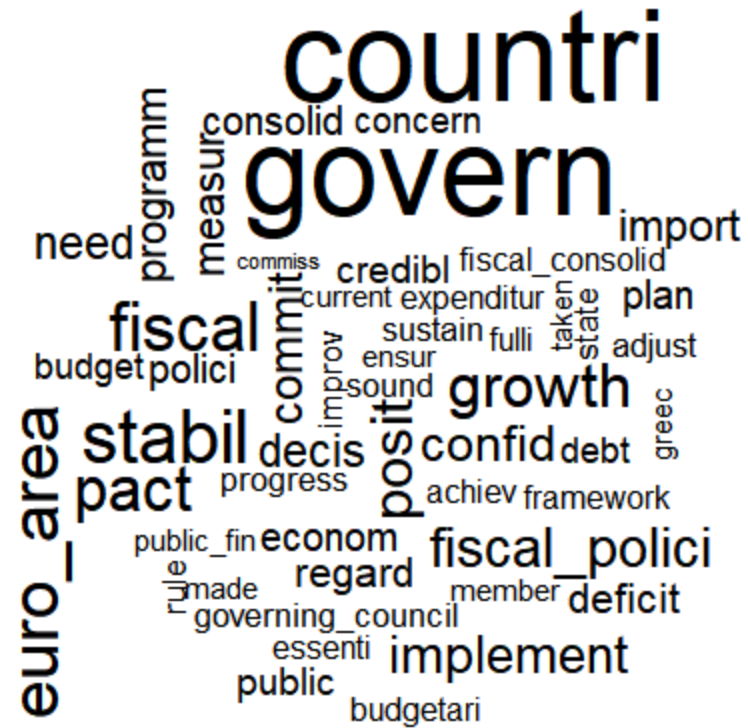
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# Measuring topic – Latent Dirichlet Allocation

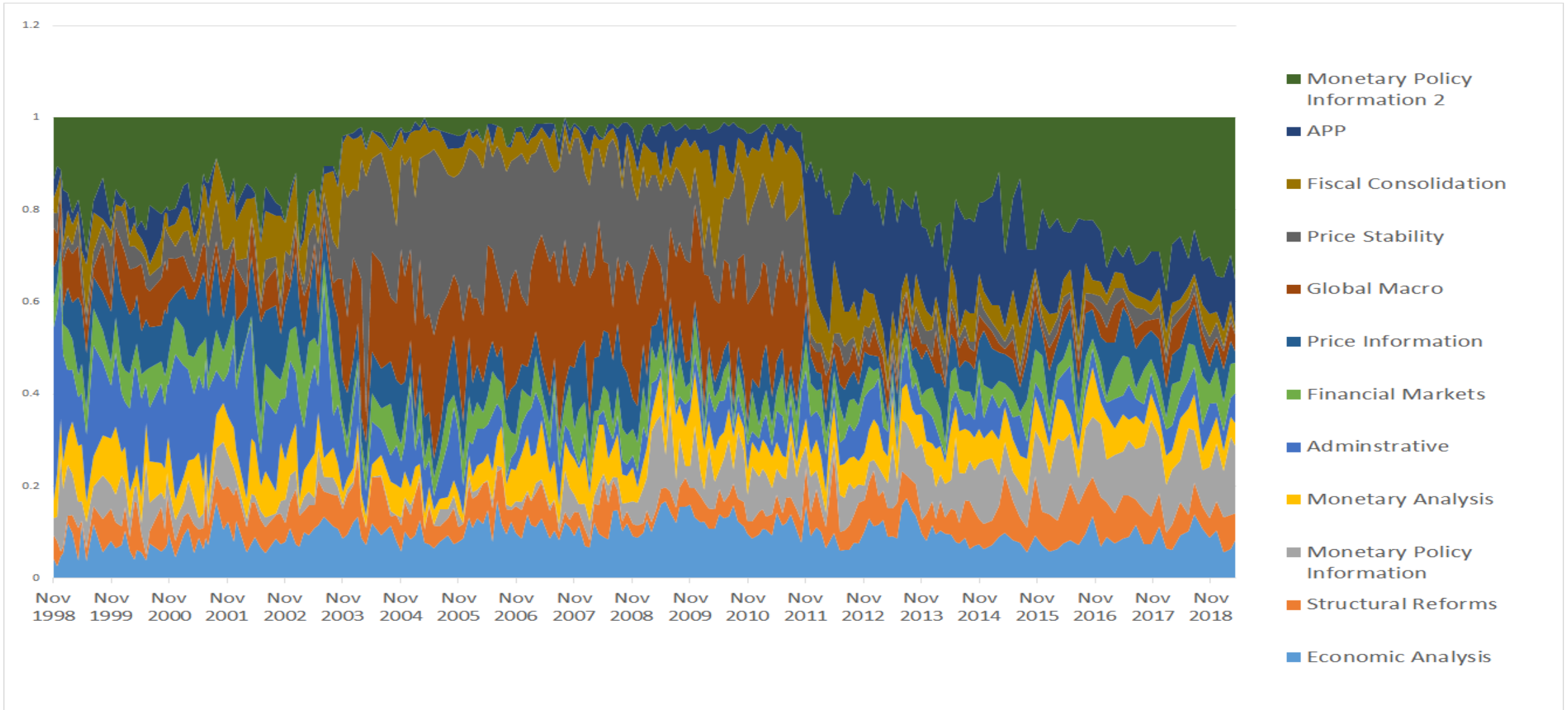
- Now that we have measures of tone, how can we measure the topical content of ECB speeches?
- Large amount of data – how can we get a quantitative measure of the variation in the proportion of topics dedicated to certain topics?
- We could manually pick keywords.... But this is highly sensitive to bias from the list creator.
- Topic modelling provides a solution – **Latent Dirichlet Allocation** (Blei et al., 2003).
  
- We divide each Governing Council speech into paragraphs. These create our corpus of documents. We have “n=9412” documents.
- Each of these is analysed to check for words which commonly occur together. Words which commonly occur together are grouped together as “topics”.



## A Sample Topic



# Descriptive Results – Topics



# Event Study Approach

- Uses a new dataset put forward by Altavilla et al. (2019) – the “EA-MPD” database.
- Looks at changes in asset prices in the interval just before the press conference to just after the press conference.
- Crucially, this is free of any monetary policy decision – the decision is taken independently an hour before the press conference. We see a **pure informational effect**.
- We have 5 variables of interest:
  - The eurostoxx index
  - The SX7E Index of bank stocks
  - EUR USD Exchange Rate
  - EUR GBP Exchange Rate
  - OIS 1Y Interest Rate Swaps



# Event Study Approach

$$\Delta MarketVariable_t = \beta_0 + \beta_1 HawkDoveScore_t + \Omega X_t$$

Where  $X_t$  is a vector of control variables.

We also look at topic and other tone measures.



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# Results

|                 | Eurostoxx               | Sx7e                   | EURUSD                | EURGBP                 | OIS1Y                |
|-----------------|-------------------------|------------------------|-----------------------|------------------------|----------------------|
| Hawk-Dove Index | 0.00599***<br>(0.00228) | 0.00856**<br>(0.00384) | -0.00371<br>(0.00278) | -0.000280<br>(0.00151) | -0.00148<br>(0.0165) |
| Constant        | -0.114**<br>(0.0537)    | -0.190**<br>(0.0898)   | -0.0116<br>(0.0354)   | 0.00220<br>(0.0280)    | 0.109<br>(0.227)     |
| Observations    | 211                     | 211                    | 211                   | 211                    | 211                  |
| $R^2$           | 0.032                   | 0.028                  | 0.014                 | 0.000                  | 0.000                |

- \*\*\*, \*\*, \* denotes significance at 1, 5 and 10% levels respectively.
- Appears to be some baseline effect on stocks! Significant at 1% level.
- Moreover, the relevance of our measure is further motivated by the lack of response of conventional sentiment measures.
- Average movement over the course of the press conference is 0.05 percentage points – a movement on HawkDoveScore of 10 points is equivalent to this. A non trivial effect.



# Results - Topics

|                               | Eurostoxx          | Sx7e                | EURUSD             | EURGBP             | OIS1Y               |
|-------------------------------|--------------------|---------------------|--------------------|--------------------|---------------------|
| Economic Analysis             | -0.205<br>(1.235)  | -1.806<br>(1.951)   | 1.279<br>(1.003)   | 0.820<br>(0.710)   | -4.177<br>(7.318)   |
| Structural Reforms            | -0.558<br>(1.518)  | 0.202<br>(2.006)    | 0.398<br>(1.252)   | 1.040<br>(0.780)   | 23.93**<br>(10.31)  |
| Monetary Policy Information   | 0.830<br>(0.683)   | 0.897<br>(0.966)    | -1.031<br>(0.801)  | -0.0754<br>(0.448) | -2.535<br>(4.452)   |
| Monetary Analysis             | -0.203<br>(1.461)  | -0.370<br>(2.015)   | 0.307<br>(1.033)   | -0.0643<br>(0.795) | 9.209<br>(10.32)    |
| Administrative                | -0.746<br>(0.492)  | -0.490<br>(0.544)   | 0.507<br>(0.356)   | 0.131<br>(0.256)   | 4.854<br>(3.390)    |
| Financial Markets             | 1.337<br>(1.583)   | 0.189<br>(2.072)    | -1.701<br>(1.606)  | -0.643<br>(0.904)  | -8.884<br>(9.186)   |
| Price Information             | 0.796<br>(1.120)   | 1.800<br>(1.607)    | 0.00407<br>(0.862) | -0.714<br>(0.623)  | 8.860<br>(7.776)    |
| Global Macro                  | 0.170<br>(0.492)   | 0.174<br>(0.707)    | 0.158<br>(0.424)   | 0.0149<br>(0.281)  | -3.317<br>(3.658)   |
| Price Stability               | 0.446<br>(0.351)   | 0.531<br>(0.499)    | 0.138<br>(0.326)   | -1.30<br>(0.204)   | -4.705**<br>(2.187) |
| Fiscal Consolidation          | -1.519*<br>(0.806) | -2.777**<br>(1.247) | 1.343*<br>(0.789)  | 0.462<br>(0.476)   | -4.239<br>(6.433)   |
| APP                           | -0.393<br>(0.708)  | -0.736<br>(1.297)   | -0.103<br>(0.519)  | -0.0876<br>(0.386) | 0.473<br>(2.177)    |
| Monetary Policy Information 2 | -0.0311<br>(0.419) | 0.221<br>(0.576)    | -0.511<br>(0.523)  | 0.0711<br>(0.247)  | 3.698<br>(2.632)    |
| Observations                  | 211                | 211                 | 211                | 211                | 211                 |



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# Robustness – Additional Controls

- Add Controls for the following:
  - Change in the DFR rate in the prior announced decision
  - Binary variable for if projections were released
  - The change in inflation and GDP forecasts
  - Monetary policy shock estimate (calculated using method of Altavilla et al., 2019).
  - Topical Content
  - Interaction between the Hawk-Dove Index and monetary policy shock.



# Robustness – Market Variables

|  | Eurostoxx               | Eurostoxx               | Eurostoxx               | Eurostoxx               | Eurostoxx              | Eurostoxx             |
|--|-------------------------|-------------------------|-------------------------|-------------------------|------------------------|-----------------------|
| Hawk-Dove Index                          | 0.00599***<br>(0.00228) | 0.00598***<br>(0.00226) | 0.00597***<br>(0.00228) | 0.00631***<br>(0.00232) | 0.00638**<br>(0.00278) | 0.00700*<br>(0.00382) |
| ChangeDFR                                |                         | 0.00310<br>(0.257)      | 0.00196<br>(0.258)      | 0.0138<br>(0.254)       | -0.0371<br>(0.325)     | -0.0246<br>(0.356)    |
| ProjectionsReleased                      |                         |                         | 0.0264<br>(0.0917)      | 0.0273<br>(0.0917)      | 0.0660<br>(0.0932)     | 0.0341<br>(0.0978)    |
| MedTermInflationRevision                 |                         |                         |                         | -0.248<br>(0.306)       | -0.207<br>(0.311)      | -0.105<br>(0.321)     |
| MedTermGDPRevision                       |                         |                         |                         | 0.00768<br>(0.182)      | 0.00859<br>(0.187)     | -0.0112<br>(0.197)    |
| MonetaryPolicyShock                      |                         |                         |                         |                         | 0.00458<br>(0.0446)    | 0.0103<br>(0.0454)    |
| MonetaryPolicyShock<br>× Hawk-Dove Index |                         |                         |                         |                         | -0.00122<br>(0.00207)  | -0.00137<br>(0.00209) |
| Constant                                 | -0.114**<br>(0.0537)    | -0.114**<br>(0.0533)    | -0.121**<br>(0.0575)    | -0.124**<br>(0.0581)    | -0.160**<br>(0.0668)   | -1.523**<br>(0.755)   |
| Observations                             | 211                     | 211                     | 211                     | 211                     | 178                    | 178                   |
| R <sup>2</sup>                           | 0.032                   | 0.032                   | 0.033                   | 0.037                   | 0.042                  | 0.081                 |

- Final column controls for topics
- Remains positive and significant.
- No evidence of an interaction with the shock series!
- [Results Similar for SX7E](#)



# Robustness – Forward Guidance

- ECB Introduced explicit forward guidance in 2013.
- This may have mitigated the effects of “communication surprises”
- ECB policy became to be more clear with information – as such the press conference content should not have surprised as much – clearer consistent communication.
- Expect stronger effects before forward guidance.



## Robustness – Before Forward Guidance

|                                      | Eurostoxx               | SX7E                  | EURUSD                   | EURGBP                  | OIS1Y              |
|--------------------------------------|-------------------------|-----------------------|--------------------------|-------------------------|--------------------|
| Hawk-Dove Index                      | 0.0101***<br>(0.00338)  | 0.0101**<br>(0.00500) | -0.00180<br>(0.00279)    | -0.00194<br>(0.00245)   | 0.0237<br>(0.0297) |
| ChangeDFR                            | -0.193<br>(0.290)       | -0.0861<br>(0.525)    | -0.101<br>(0.164)        | -0.136<br>(0.193)       | -4.000*<br>(2.125) |
| ProjectionsReleased                  | 0.210**<br>(0.0963)     | 0.229<br>(0.177)      | 0.0244<br>(0.0705)       | 0.0259<br>(0.0557)      | 1.287<br>(1.019)   |
| MonetaryPolicyShock                  | 0.0688*<br>(0.0365)     | 0.0799<br>(0.0716)    | 0.0484***<br>(0.0167)    | 0.0359***<br>(0.0125)   |                    |
| MonetaryPolicyShockx Hawk-Dove Index | -0.00346**<br>(0.00171) | -0.00461<br>(0.00302) | 0.00227***<br>(0.000696) | 0.00137**<br>(0.000582) |                    |
| MedTermInflationRevision             | -0.682**<br>(0.331)     | -0.407<br>(0.751)     | -0.120<br>(0.229)        | -0.0261<br>(0.151)      | 3.049<br>(3.083)   |
| MedTermGDPRevision                   | 0.0624<br>(0.195)       | -0.0647<br>(0.386)    | 0.0315<br>(0.129)        | 0.0680<br>(0.0796)      | -1.259<br>(1.643)  |
| Observations                         | 130                     | 130                   | 130                      | 130                     | 163                |
| R <sup>2</sup>                       | 0.271                   | 0.190                 | 0.359                    | 0.315                   | 0.121              |

- Stronger and more significant positive reactions of the stock market variables
- Monetary policy shocks had more of an effect – significant negative interaction between shocks hawkdove index for Eurostoxx – suggests that if the tone of the press conference was hawkish, but there was a dovish surprise, the impact is more positive, and vice versa. Less of an effect if there is a “hawkish surprise” with “hawkish tone”.
- Currency responses are also interesting – currency appreciates during a tightening, and “hawkish” language reinforces this effect. This is as expected, but interestingly does not appear post forward guidance.



# Robustness – During Explicit Forward Guidance

|                                       | Eurostoxx             | SX7E                  | EURUSD               | EURGBP                | OISTY               |
|---------------------------------------|-----------------------|-----------------------|----------------------|-----------------------|---------------------|
| Hawk-Dove Index                       | 0.00384<br>(0.00812)  | 0.0113<br>(0.0128)    | -0.0104<br>(0.0109)  | 0.00626<br>(0.00548)  | 0.00291<br>(0.0172) |
| ChangeDFR                             | 7.000<br>(4.478)      | 5.105<br>(6.017)      | -8.751<br>(8.188)    | 2.656<br>(3.739)      | 3.073<br>(17.18)    |
| ProjectionsReleased                   | -0.269<br>(0.225)     | -0.921**<br>(0.355)   | 0.227<br>(0.343)     | 0.000597<br>(0.165)   | 0.938*<br>(0.526)   |
| MonetaryPolicyShock                   | -0.332***<br>(0.100)  | -0.197<br>(0.132)     | 0.252**<br>(0.121)   | 0.195***<br>(0.0681)  |                     |
| MonetaryPolicyShock × Hawk-Dove Index | -0.00754<br>(0.00944) | -0.000562<br>(0.0138) | 0.00300<br>(0.00690) | 0.000358<br>(0.00615) |                     |
| MedTermInflationRevision              | 0.192<br>(0.569)      | 0.390<br>(0.896)      | 0.241<br>(0.892)     | -0.345<br>(0.401)     | -1.336<br>(1.488)   |
| MedTermGDPRevision                    | 1.819*<br>(0.955)     | 2.370*<br>(1.186)     | -2.606**<br>(1.126)  | -0.663<br>(0.479)     | -1.745<br>(1.859)   |
| Observations                          | 48                    | 48                    | 48                   | 48                    | 48                  |
| R <sup>2</sup>                        | 0.563                 | 0.485                 | 0.503                | 0.485                 | 0.339               |

- Tone becomes insignificant
- Only item that matters are “shocks”.
- Seems to suggest that clear guidance had the desired effects – tone anticipated by markets and a lot more managed.



# Summary

- I present a new measure of the tone of ECB statements, and a way of modelling the topical content.
- This measure of hawkishness and dovishness is consistent with market interpretations of the current ECB policy stance, as well as current assessments of economic conditions.
- More hawkish sentiment is associated with positive stock market reactions.
- This effect is stronger before explicit forward guidance was adopted by the ECB.
- Effects are stronger if they oppose the direction of the “monetary policy shock” observed as a result of the prior interest rate decision.
- More hawkish tone reinforces the currency appreciation effect of a tightening shock, **but only prior to 2013**. No evidence of an effect thereafter.



# ANNEX



# Hawk-Dove Index

Table 1: Hawkish Terms

|               |            |             |           |
|---------------|------------|-------------|-----------|
| business      | businesses | demand      | economic  |
| economy       | employment | energy      | equities  |
| equity        | expansion  | financial   | growth    |
| housing       | income     | indicators  | inflation |
| inflationary  | investment | investments | labour    |
| manufacturing | outlook    | output      | price     |
| prices        | production | recovery    | resource  |
| securities    | slack      | spending    | target    |
| toll          | wage       | wages       |           |

Table 2: Dovish Terms

|               |              |          |
|---------------|--------------|----------|
| accommodation | devastation  | downturn |
| recession     | unemployment |          |





# Hawk-Dove Index

Table 3: Positive Terms

|              |             |           |              |            |
|--------------|-------------|-----------|--------------|------------|
| abating      | accelerated | add       | advance      | advanced   |
| aumented     | balanced    | better    | bolsters     | boom       |
| booming      | boost       | boosted   | eased        | elevated   |
| elevating    | expand      | expanding | expansionary | extend     |
| extended     | fast        | faster    | firmer       | gains      |
| growing      | heightened  | high      | higher       | improved   |
| improvement  | improving   | increase  | increased    | increases  |
| increasing   | more        | raise     | rapid        | rebounded  |
| recovering   | rise        | risen     | rising       | robust     |
| rose         | significant | solid     | sooner       | spike      |
| spikes       | spiking     | stable    | strength     | strengthen |
| strengthened | strengthens | strong    | stronger     | supportive |
| up           | upside      | upswing   | uptick       |            |

Table 4: Negative Terms

|             |              |               |             |                  |
|-------------|--------------|---------------|-------------|------------------|
| adverse     | back         | below         | constrained | contract         |
| contracting | contraction  | cooling       | correction  | dampen           |
| damping     | decelerated  | decline       | declined    | declines         |
| declining   | decrease     | decreases     | decreasing  | deepening        |
| depressed   | deteriorated | deterioration | diminished  | disappointing    |
| dislocation | disruptions  | down          | downbeat    | downside         |
| drop        | dropping     | ebbed         | erosion     | fade             |
| faded       | fading       | fall          | fallen      | falling          |
| fell        | insfficient  | less          | limit       | low              |
| lower       | moderated    | moderating    | moderation  | reduce           |
| reduced     | reduction    | reluctant     | removed     | restrain         |
| restrained  | restaining   | restraint     | resumption  | reversed         |
| slack       | slow         | slowd         | slower      | slowing          |
| slowly      | sluggish     | sluggishness  | slumped     | sloft            |
| softened    | sftening     | stimulate     | strained    | strains          |
| stress      | subdued      | tragic        | turmoil     | underutilization |
| volatile    | vulnerable   | wary          | weak        | weakened         |
| weaker      | weakness     |               |             |                  |

[Word List](#)



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# Measuring topic.

- When measuring topic, further preprocessing steps were taken:
  1. A list of common stopwords were dropped from the text (the, and, or etc. – list of English stopwords taken from the Quanteda R package).
  2. A list of ECB stopwords were removed: *Duisenberg, Noyer, Draghi, Trichet, said, see, regard, fact, mention, particular, time, know, look, also, number, since, m, month, January, February, March, think, one, discuss, April, May, June, July, August, September, October, November, December, way, now, want, first, Ladies, Gentlemen, today, here, ladies, gentlemen, question, disposal, questions, answer, answers, let, welcome, statement, press, second, report, take, say, clear, go, can, point, just, discussion.*
  3. Remove all punctuation.
  4. Each press conference is split into **paragraphs**. This is our unit of analysis for topic.
  5. Common n-grams are identified and treated as a single word. For example “asset purchase programme” would be read as “asset\_purchase\_programme”. Full list on next slide.
  6. The document is stemmed – words with common roots are matched. For example “inflation”, “inflationary” would both be coerced to their stem word “inflat”.



Table 3: Common programs

|                                 |                                   |                                   |  |
|---------------------------------|-----------------------------------|-----------------------------------|--|
| euro area                       | interest rate                     | fiscal policy                     | business cycle                             |
| Governing Council               | GDP growth                        | banking system                    | firm anchoring                             |
| price stability                 | outlook price                     | yield curve                       | futures prices                             |
| monetary policy                 | real economy                      | disposable income                 | global imbalances                          |
| interest rates                  | nonfinancial corporations         | monetary developments             | financial system                           |
| medium term                     | financing conditions              | monetary accommodation            | economic expansion                         |
| inflation expectations          | fiscal policies                   | asset purchases                   | financial environment                      |
| structural reforms              | labour market                     | low inflation                     | Executive Board                            |
| inflation rates                 | balance sheet                     | purchasing power                  | strong growth                              |
| exchange rate                   | commodity prices                  | full allotment                    | potential growth                           |
| monetary analysis               | downside risks                    | accommodative monetary            | labour costs                               |
| HICP inflation                  | money market                      | world economy                     | price inflation                            |
| economic growth                 | firmly anchored                   | Central Bank                      | sustained adjustment                       |
| price developments              | macroeconomic projections         | social partners                   | monetary growth                            |
| private sector                  | inflationary pressures            | economic developments             | productivity growth                        |
| central banks                   | inflation rate                    | gradual recovery                  | consumer prices                            |
| economic analysis               | economic recovery                 | European Council                  | global demand                              |
| oil prices                      | oil price                         | Monetary Union                    | inflationary pressure                      |
| annual growth                   | credit growth                     | monetary credit                   | credit risk                                |
| real GDP                        | financial stability               | asset purchase                    | nonstandard monetary                       |
| United States                   | nonstandard measures              | developments remain               | financial conditions                       |
| policy measures                 | sustainable growth                | wage developments                 | wage growth                                |
| press conference                | inflationary expectations         | Federal Reserve                   | Euro area                                  |
| central bank                    | European Union                    | Inflation expectations            | employment growth                          |
| annual HICP                     | European Commission               | European Parliament               | monetary union                             |
| job creation                    | labour markets                    | structural reform                 | risk premia                                |
| financial markets               | headline inflation                | excess liquidity                  | capital markets                            |
| upside risks                    | public finances                   | single currency                   | consumer confidence                        |
| fiscal consolidation            | global economy                    | monetary aggregate                | longerterm inflation                       |
| financial market                | bank lending                      | private consumption               | structural unemployment                    |
| automatic stabilisers           | monetary policy strategy          | longerterm inflation expectations | oil price developments                     |
| ECB interest rates              | annual inflation rates            | oil price increases               | higher oil prices                          |
| annual HICP inflation           | asset purchase programme          | credit private sector             | HICP inflation rate                        |
| monetary policy measures        | bank lending survey               | fixed rate tender                 | exchange rate policy                       |
| real GDP growth                 | nonstandard monetary policy       | labour market reforms             | Federal Reserve System                     |
| staff macroeconomic projections | HICP inflation rates              | sustainable economic growth       | remain broadly balanced                    |
| interest rates unchanged        | adjustment path inflation         | potential output growth           | anchor inflation expectations              |
| growth rate loans               | Eurosystem staff projections      | balance sheet adjustment          | support economic recovery                  |
| remain firmly anchored          | longerterm refinancing operations | marginal lending facility         | upside risks price stability               |
| national central banks          | annual growth rates               | domestic price pressures          | ECB staff macroeconomic projections        |
| economic data                   | longterm interest                 | banking union                     | core inflation                             |
| wage moderation                 | labour product                    | fiscal imbalances                 | fiscal framework                           |
| excessive deficit               | upward risks                      | foreign demand                    | emerging markets                           |
| labour productivity             | liquidity conditions              | price rises                       | Eurosystem staff macroeconomic projections |
| current account                 | credit standards                  | European economy                  | deposit facility rate                      |
| market expectations             | growth prospects                  | appreciation euro                 |  |
| economic conditions             | stress tests                      | inflationary risks                |  |
| monetary aggregates             | lending rates                     | Annual growth                     |  |
| negative rates                  | liquidity situation               | money markets                     |  |



## Measuring topic.

- We identify 12 distinct topics – the number of topics is, however, a user defined input. As such, a tradeoff has to be made between interpretability of topics and the sheer amount of them. 12 is consistent with other LDA applications to monetary policy.
- Once topics are identified, each paragraph is given a probability of belonging to a given estimated topic. As such, for each paragraph  $d$  in press conference  $t$ , the probability of it belonging to topic  $i$  is defined as  $\theta_{i,d,t}$ .
- For each press conference we thus calculate:

$$TopicProportion_{i,t} = \sum_{d=1}^D \theta_{i,d,t} \times \frac{WC_{d,t}}{WC_t}$$

- Where  $D$  is the number of paragraphs in a given document, and  $WC$  denotes wordcounts. Scaling by the second term allows us to control for the relative prominence of a paragraph in a document.



## Measuring tone of topic

- As an additional exercise, we calculate the **tone** of a given topic in each Governing Council speech.
- Let  $q=\{\text{positive, negative, net polarity, uncertain}\}$  as defined under the Loughran-McDonald dictionary. We thus calculate the topic tone as being:

$$TopicTone_{i,t,q} = \sum_{d=1}^D \theta_{i,d,t} \times WordCount_{d,t,q} \times \frac{WC_{d,t}}{WC_t}$$

- Where  $WordCount_{d,t,q}$  is the total number of words in a given category  $q$  in paragraph  $d$  in press conference  $t$ . We weight these by the topic probability assigned to each given paragraph to give a Topic Tone score for topic  $i$  in each Governing Council Speech.



## Descriptive Results – Topics

| 1. Econ Analysis | 2. Structural Reforms | 3. MPOL Info      | 4. Monetary Analysis | 5. Admin          | 6. Financial Markets |
|------------------|-----------------------|-------------------|----------------------|-------------------|----------------------|
| euro_area        | euro_area             | decis             | m                    | governing_council | risk                 |
| continu          | structural_reform     | monetary_polic    | rate                 | ecb               | project              |
| remain           | countri               | governing_council | loan                 | meet              | euro_area            |
| quarter          | growth                | measur            | growth               | euro              | growth               |
| econom           | need                  | oper              | continu              | member            | relat                |
| expect           | competit              | decid             | credit               | confer            | uncertainti          |
| support          | economi               | rate              | increas              | s                 | outlook              |
| price_st         | market                | interest_r        | remain               | vice-presid       | develop              |
| medium_term      | increas               | taken             | corpor               | outcom            | broad                |
| assess           | product               | continu           | non-financi          | presid            | assess               |

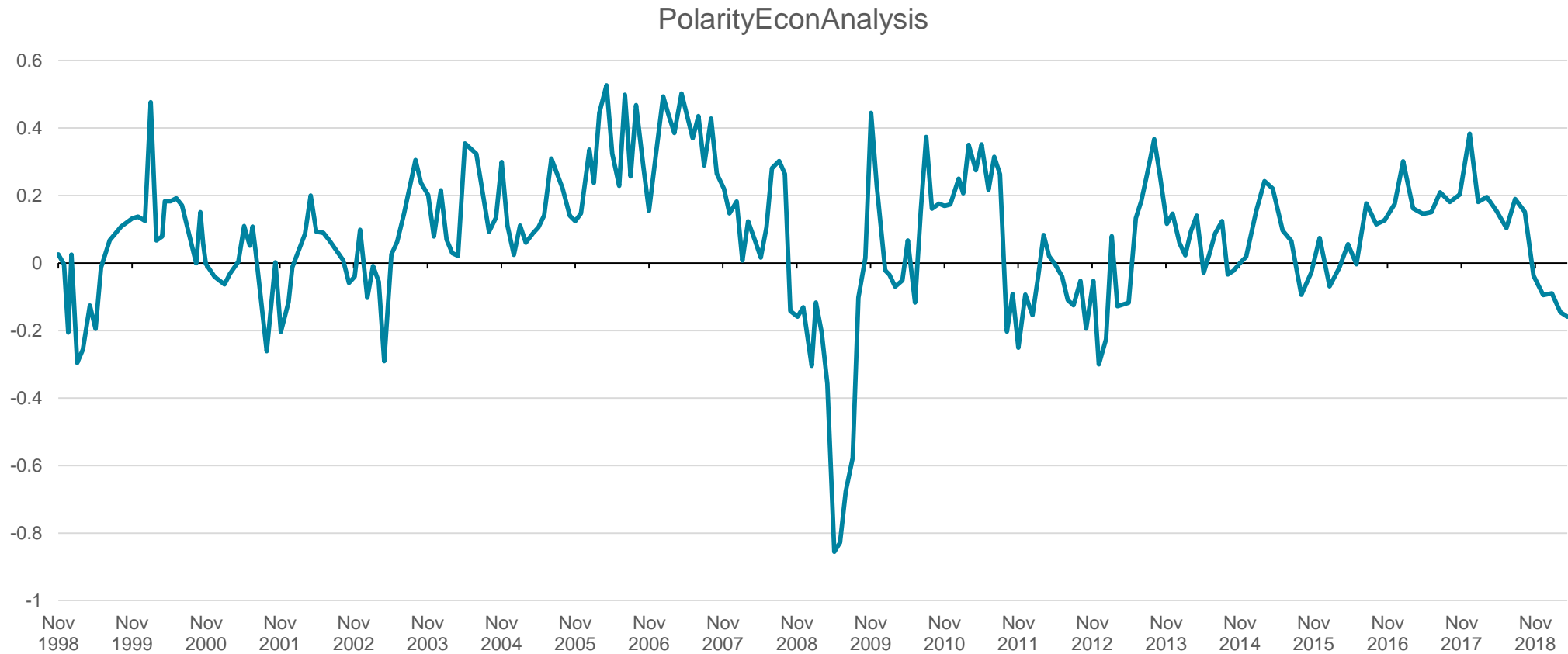


## Descriptive Results – Topics

| 7. Price Information | 8. Global Macro | 9. Price Stability | 10. Fiscal Consolidation | 11. APP  | 12. MPOL Info (2) |
|----------------------|-----------------|--------------------|--------------------------|----------|-------------------|
| price                | import          | price_st           | countri                  | bank     | year              |
| inflat               | respons         | regard             | govern                   | bond     | certain           |
| increas              | economi         | deliv              | stabil                   | ecb      | well              |
| expect               | level           | market             | euro_area                | programm | differ            |
| effect               | us              | observ             | fiscal                   | condit   | go                |
| remain               | regard          | rate               | pact                     | market   | last              |
| month                | market          | us                 | growth                   | credit   | actual            |
| year                 | europ           | figur              | posit                    | risk     | come              |
| energi               | cours           | decis              | fiscal_polici            | issu     | thing             |
| current              | world           | consid             | implement                | govern   | now               |



# Descriptive Results – Tone of Topics

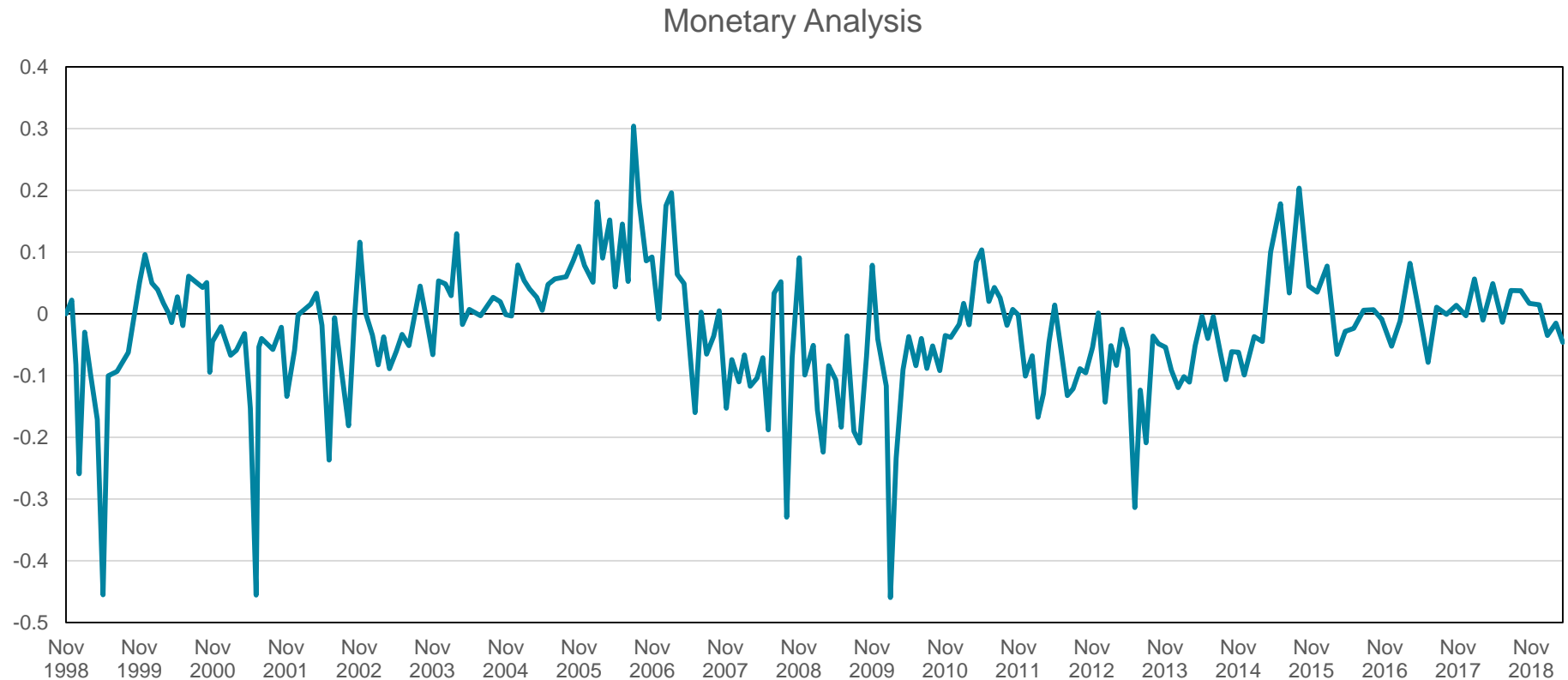


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# Descriptive Results – Tone of Topics



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# Descriptive Results – Topics

Table 11: Descriptive Regression of Hawk-Dove Index on Topic Proportions

|                     | HawkDoveScore        |
|---------------------|----------------------|
| econanalysis        | -116.3***<br>(39.23) |
| structuralreforms   | 64.08<br>(44.27)     |
| monpolinfo          | 19.87<br>(27.18)     |
| monetaryanalysis    | 33.04<br>(44.43)     |
| financialmarkets    | 7.861<br>(38.54)     |
| priceinfo           | -52.67<br>(38.66)    |
| globalmacro         | 19.34<br>(25.50)     |
| pricestability      | 49.05***<br>(18.81)  |
| fiscalconsolidation | -85.80***<br>(27.52) |
| assetpp             | -83.66***<br>(19.67) |
| mpolinfo2           | 14.04<br>(22.22)     |
| Constant            | 19.20<br>(14.41)     |
| Observations        | 211                  |
| R <sup>2</sup>      | 0.355                |

Standard errors in parentheses  
\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



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# Results

## Baseline Regression of Market Variables on AFinn Sentiment Scores

|              | Eurostoxx         | Sx7e              | EURUSD            | EURGBP              | OIS1Y             |
|--------------|-------------------|-------------------|-------------------|---------------------|-------------------|
| adjafinnsent | 3.977<br>(3.878)  | 9.138<br>(6.935)  | -1.977<br>(4.184) | 2.011<br>(2.171)    | -4.096<br>(18.34) |
| Constant     | -0.191<br>(0.154) | -0.416<br>(0.278) | 0.0200<br>(0.136) | -0.0677<br>(0.0828) | 0.233<br>(0.687)  |
| Observations | 211               | 211               | 211               | 211                 | 211               |
| $R^2$        | 0.005             | 0.012             | 0.001             | 0.004               | 0.000             |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## Baseline Regression of Market Variables on Loughran Sentiment

|                 | Eurostoxx           | Sx7e                | EURUSD              | EURGBP              | OIS1Y             |
|-----------------|---------------------|---------------------|---------------------|---------------------|-------------------|
| adjloughransent | 8.268<br>(8.031)    | 19.82*<br>(11.22)   | 0.0488<br>(6.787)   | 1.424<br>(4.434)    | -4.168<br>(47.77) |
| Constant        | -0.0361<br>(0.0384) | -0.0581<br>(0.0516) | -0.0461<br>(0.0438) | 0.00336<br>(0.0241) | 0.0844<br>(0.327) |
| Observations    | 211                 | 211                 | 211                 | 211                 | 211               |
| $R^2$           | 0.005               | 0.011               | 0.000               | 0.000               | 0.000             |

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



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# Robustness – Market Variables

|  | SX7E                   | SX7E                   | SX7E                   | SX7E                   | SX7E                   | SX7E                  |
|--|------------------------|------------------------|------------------------|------------------------|------------------------|-----------------------|
| Hawk-Dove Index                          | 0.00856**<br>(0.00384) | 0.00847**<br>(0.00376) | 0.00847**<br>(0.00377) | 0.00875**<br>(0.00388) | 0.00970**<br>(0.00465) | 0.00854<br>(0.00533)  |
| ChangeDFR                                |                        | 0.0316<br>(0.368)      | 0.0315<br>(0.368)      | 0.0530<br>(0.368)      | 0.140<br>(0.562)       | 0.200<br>(0.617)      |
| ProjectionsReleased                      |                        |                        | 0.00301<br>(0.128)     | -0.00845<br>(0.121)    | 0.0232<br>(0.135)      | -0.0827<br>(0.156)    |
| MedTermInflationRevision                 |                        |                        |                        | -0.126<br>(0.460)      | -0.0859<br>(0.485)     | 0.104<br>(0.492)      |
| MedTermGDPRevision                       |                        |                        |                        | -0.0985<br>(0.297)     | -0.105<br>(0.306)      | -0.140<br>(0.328)     |
| MonetaryPolicyShock                      |                        |                        |                        |                        | 0.0257<br>(0.0702)     | 0.0273<br>(0.0728)    |
| MonetaryPolicyShock<br>× Hawk-Dove Index |                        |                        |                        |                        | -0.00195<br>(0.00325)  | -0.00216<br>(0.00325) |
| Economic Analysis                        |                        |                        |                        |                        |                        | 0.999<br>(2.770)      |
| Structural Reforms                       |                        |                        |                        |                        |                        | 2.865<br>(3.329)      |
| Monetary Policy Information              |                        |                        |                        |                        |                        | 3.428<br>(2.273)      |
| Monetary Analysis                        |                        |                        |                        |                        |                        | 0.0930<br>(2.561)     |
| Financial Markets                        |                        |                        |                        |                        |                        | -0.869<br>(2.459)     |
| Price Information                        |                        |                        |                        |                        |                        | 3.697<br>(2.916)      |
| Global Macro                             |                        |                        |                        |                        |                        | 1.386<br>(1.478)      |
| Price Stability                          |                        |                        |                        |                        |                        | 2.009*<br>(1.175)     |
| Fiscal Consolidation                     |                        |                        |                        |                        |                        | 0.149<br>(1.888)      |
| APP                                      |                        |                        |                        |                        |                        | 1.642<br>(1.948)      |
| Monetary Policy Information 2            |                        |                        |                        |                        |                        | 1.613<br>(1.542)      |
| Constant                                 | -0.190**<br>(0.0898)   | -0.189**<br>(0.0873)   | -0.190*<br>(0.0967)    | -0.192*<br>(0.0980)    | -0.235**<br>(0.115)    | -1.671<br>(1.108)     |
| Observations                             | 211                    | 211                    | 211                    | 211                    | 178                    | 178                   |
| R <sup>2</sup>                           | 0.028                  | 0.028                  | 0.028                  | 0.030                  | 0.038                  | 0.065                 |

■ [Return](#)



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