Measuring the ECB's monetary policy: a text-based approach

Nataliia Ostapenko[*] [†]

Draft Version January 28, 2025

Abstract

The paper uses a natural language processing technique to transform European central banks' policy statements and question-and-answer sessions into topic proportions of different monetary policy measures. The dates on which these policy measures were active are then used in the rotation of market surprise factors to ECB press conference announcements, thus proposing an alternative to the standard rotation scheme. The paper then reassesses the impact of unconventional monetary policy shocks on euro area output and inflation.

Keywords:

JEL Classification:

Acknowledgements

The views and results presented in this paper are those of the authors and do not necessarily present the official opinion of the National Bank of Slovakia. Any errors that remain are my own.

[*]Economics and Monetary Policy Department, National Bank of Slovakia, Imricha Karvasa 1, 813 25 Bratislava, Slovak Republic

[†]Corresponding author. E-mail address: nataliia.ostapenko@gmail.com

1 Introduction

How does unconventional monetary policy affect the economy? Studies typically examine the impact of monetary policy on the economy using proxy SVARs, sign restrictions, identification by heteroskedasticity and high-frequency identification. The last two require specific dates of shocks. However, identification by heteroskedasticity assumes that the variances of other shocks remain constant at the dates of specific shocks. This assumption does not hold if there is more than one non-standard monetary policy shock on a given date. At the same time, high-frequency identification imposes a specific structure on the rotation of the principal components of the market reaction in a monetary event window.

This paper presents original empirical evidence on the identification of the dates of various ECB monetary policy measures, which allows us to identify the pure dates of specific non-standard monetary policy shocks. To identify these dates, I use a natural language processing approach, specifically Latent Dirichlet allocation, to identify when the ECB implements various non-standard monetary policy measures. I use the identified dates of forward guidance and non-standard monetary policy measures to test the standard rotation of the principal components (Gürkaynak, Sack, and Swanson (2005), Swanson (2021), Altavilla et al. (2019)) of the market reaction in a window of ECB press conferences.

The main results are as follows. In a monetary event window, market surprises are driven by updates in the inflation outlook of central bank's projections and sentiment, which may indicate that markets react mainly to a variable that is included in the ECB's reaction function. In the press conference window, financial market reactions are also predictable from GDP forecasts and its forecast revisions, which may indicate that markets are trying to anticipate the future macroeconomic development of the euro area.

The texts of the ECB's press releases and Q&A sessions provide useful information on the timing of various monetary policy measures, in particular by allowing the dates of forward guidance (FG), non-standard monetary policy measures, quantitative easing (QE) and the pandemic emergency purchase programme (PEPP) to be disentangled. The timing of these measures can then be used in the rotation scheme of the principal components of monetary policy surprises, as an alternative to Altavilla et al. (2019) by minimising factor variances outside these dates. The results show that the rotation scheme of the principal components of Altavilla et al. (2019) can lead to a mixing of forward guidance with quantitative easing factors, as both have relatively low variance before 2008.

Using the identified topic proportions from the ECB statemenst and Q&A sessions, I am able to relax the assumptions of no loadings of forward guidance and quantitative easing factors on the short-term interest rate and the assumption of orthogonality between these factors. Relating the first two assumptions while using specific dates to minimise the variance of the FG and QE factors outside these dates, together with the assumption that the first factor does not load on the long-term interest rate, shows quantitatively similar results to the rotations proposed in Gürkaynak, Sack, and Swanson (2005), Swanson (2021), Altavilla et al. (2019). On the other hand, relaxing the orthogonality assumption between the FG and QE factors leads to different rotation results. The resulting factors show more contractionary effects on euro area inflation compared to the factors using the rotation scheme as in Gürkaynak, Sack, and Swanson (2005), Swanson (2021) and Altavilla et al. (2019).

The paper contributes to several strands of literature. First, in terms of identifying monetary shocks, the study complements the work of Gürkaynak, Sack, and Swanson (2005) Altavilla et al.

(2019) and Swanson (2021) in using the ECB statements and Q&A sessions to identify the dates of various unconventional monetary policy measures, and proposes an alternative rotation scheme for the factors of market surprises in a conference window of ECB announcements.

Second, this paper contributes to the literature by examining the macroeconomic effects of unconventional monetary policy shocks. Hachula, Piffer, and Rieth (2020) divided the ECB's unconventional policy into two phases, with the first phase affecting the periphery countries and the second the core euro area countries, and used the estimated reactions of the sovereign yields of the affected countries to the monetary policy announcements in these phases as instruments in a vector autoregression model.

Third, this study also finds that surprises in a press release window are predicted by a central bank's inflation projections and sentiment. Similar to this study, Jainand and Sutherland (2020) examined the effect of different types of information released by central banks in their macroeconomic projections on private forecasts and found that inflation projections reduce forecast dispersion while unemployment projections increase it.

Many studies investigated market reactions to ECB statements using textual analysis. For instance, Möller and Reichmann (2021) studied tone, uncertainty and forward-lookinness of the ECB press conferences and how those affect euro area stock returns. Hansen, McMahon, and Tong (2019) used the Bank of England's Inflation Report and found that a central bank's communication can send signals of uncertainty about macroeconomic conditions and thus affect the yield curve through the risk premium channel. Ahrens et al. (2024) has developed a new supervised model that maps FED speeches into inflation and output projections, and examined how changes in FED Chairs' forecasts affect stock market volatility.

Similar to the methods used in this paper, Pavelkova (2022) used structural topic modelling for ECB press conferences. However, the author analysed the similarity of language between ECB statements and Q&A sessions. Similarly, Angino and Robitu (2023) used structural topic modelling for the Q&A sessions of ECB press conferences and the media coverage of them. Klejdysz (2023) also used LDA as a textual analysis tool for ECB press conferences and found that market volatility increases when the ECB changes its language. Klejdysz and Lumsdaine (2023) used LDA for ECB press conferences and investigated the effect of topics, content and uncertainty on market volatility. Diaf (2022) used a semi-supervised topic model to disentangle the inflation/unemployment trade-offs of FED governors.

The rest of the paper is structured as follows. Section 2 describes the facts about market surprises in a monetary event window and discusses the data and methodology. Section 3 presents the main results on the impact of unconventional monetary policy shocks in the euro area using different identification schemes. Section 4 concludes.

2 Facts about euro area monetary surprises

2.1 Market surprices and new information

To check the market reaction in the monetary event window to new information provided by the ECB, I use the medium-term projections and economic and monetary developments from the National Bank of Slovakia (2024) (NBS) website. The European market cannot react to the relevance of the information from the inflation and GDP forecast in Slovakia, as it is confidential and is sent to the ECB before the monetary policy decision. Nevertheless, this forecast and its revisions could indicate new information that central banks take into account during the forecasting rounds. Thus, this information should capture updated economic prospects to which the ECB reacts in its monetary policy event window. Therefore, in order to disentangle the market reaction to the updated outlook (referred to as the central bank information effect, as in Bauer and Swanson (2023) and Jarociński and Karadi (2020)) from the market reaction to ECB decisions and statements, I used the NBS forecast, the forecast revisions and the sentiment accompanying these forecasts. The sample starts from 2009Q4, as Slovakia joined the monetary union in 2009 and the National Bank started to publish medium-term forecasts in English.

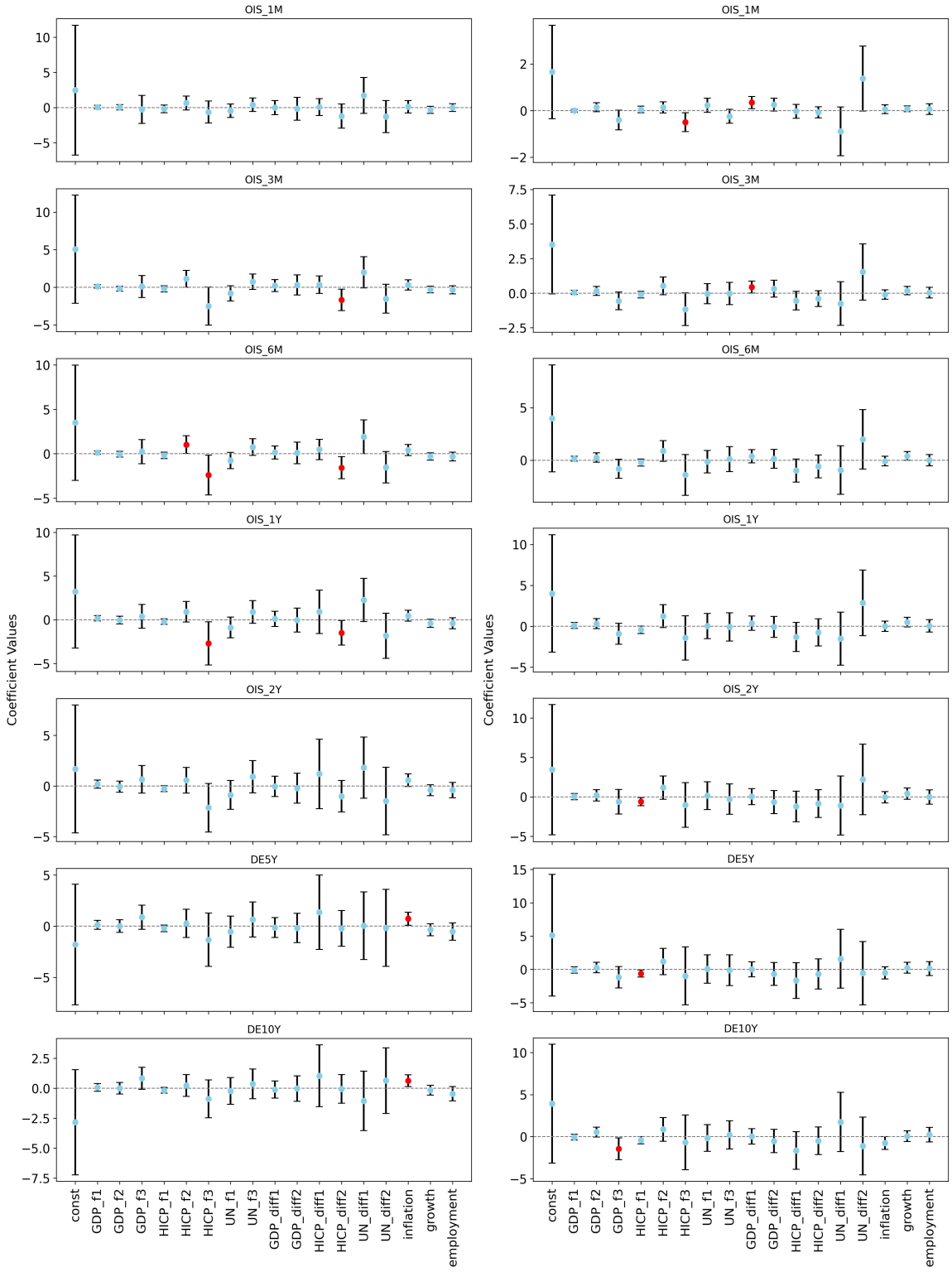
The main variables of interest are the NBS forecasts for GDP, inflation and unemployment, both estimates and revisions (differences between different rounds of forecasts for the current year, next year and two years ahead). As not all information may be captured in the forecast, I have also used the introductory parts of the reports, as these may contain important information on central banks' expectations for future macroeconomic developments.

First, from the introductory parts of the central bank forecasts, I keep only those lines that contain economy-related words from Hashimzade, Myles, and Black (2017). Second, I extracted seven preceding and seven following words for each term to estimate their sentiment. Third, to assign sentiment to each category (growth, inflation and employment), I created lists of words[3] connected with each of these terms. To assign sentiment, I use a dictionary approach, namely, calculate the number of positive and negative words connected to each term in a fourteen-word window.[4] These positive and negative words are taken from the dictionaries of Loughran and Mcdonald (2011)[5] and Henry (2008). The sentiment associated with each term is calculated as the number of positive words in a window of fourteen words minus the number of negative words divided by the total number of words in the window. The total number of words in the window is not necessarily fourteen, as a term may be at the beginning or end of a sentence.

[3]The words for inflation consist of a combination of 'inflationary', 'inflation', 'price', 'market', 'global', 'growth', 'food', 'comodity', 'input', 'gas', 'energy', 'property', 'housing', 'producer', 'manufacturing', 'oil', 'heat' and 'rate', 'pressure', 'rates', 'pressures', 'level', 'levels', 'price', 'prices', 'headline', 'core'. Employment words consist of a combination between 'growth', 'market', 'markets', 'force', 'costs', 'rate' and 'labour', 'employment', 'job', 'jobless', 'wage'. The growth words are from a combination between 'growth', 'gap', 'gdp', 'gnp','output', 'productivity', 'production', 'economy', 'income' and 'economic', 'industrial', 'potential', 'national', 'real', 'nominal', 'gdp', 'gnp', 'wage'.

[4]Additionally, I use a negation rule, meaning that if preceeding three words contain the word aint, arent, cannot, cant, couldnt, darent, didnt, doesnt, ain't, aren't, can't, couldn't, daren't, didn't, doesn't, dont, hadnt, hasnt, havent, isnt, mightnt, mustnt, neither, don't, hadn't, hasn't, haven't, isn't, mightn't, mustn't, neednt, needn't, never, none, nope, nor, not, nothing, nowhere, oughtnt, shant, shouldnt, wasnt, werent, oughtn't, shan't, shouldn't, wasn't, weren't, without, wont, wouldnt, won't, wouldn't, rarely, seldom, despite, no, nobody.

[5]The full list of words for each sentiment category is available at https://sraf.nd.edu/textual-analysis/resources/ .



(a) Press release window **(b)** Press conference window

Figure 1: Predictive regressions for market surprises
red dots - statistically significant at the 10% level; bars show 90% heteroskedasticity robust CIs

Figure 1 shows the results for the predictability of market surprises via OLS regressions in the

monetary policy event and press conference windows (data on these surprises were taken from Altavilla et al. (2019)) of new macroeconomic assessments captured by the NBS projections. Each graph represents a separate regression with a different dependent variable, with bars showing estimates and 90% confidence intervals. Independent variables are shown on the horizontal axes. f1 stands for a forecast one period ahead, f2 for two periods ahead and so on, while diff stands for forecast revisions relative to the previous forecast round. Inflation, growth and unemployment are the NBS views on these categories from the introductory sections of the medium-term forecasts.

Interestingly, in a monetary policy event window, changes in the 3-month, 6-month and 1-year OIS are predicted by HICP forecast revisions two periods ahead, while the 6-month OIS is also predicted by HICP forecasts two to three periods ahead and the 1-year OIS is also predicted by HICP forecasts three periods ahead. In addition, 5-year and 10-year German government bonds are predicted by the central bank's sentiments regarding inflation. Interestingly, in a monetary event window, market surprises only react to updates in the inflation outlook, which may indicate that markets react mainly to a variable that is included in the ECB's reaction function.

In a press conference window, market reactions of short-term interest rates are predicted by the GDP forecast revision one period ahead and the 1-month OIS is also predicted by the HICP forecast three periods ahead. In contrast, longer-term bonds are predicted by the HICP forecast one period ahead (2-year OIS and 5-year German bond) and by the GDP forecast three periods ahead (10-year German bond). In contrast to the results from the monetary event window, in the press conference window financial market reactions are also predictable from GDP forecasts and forecast revisions, which may indicate that markets are trying to anticipate the future macroeconomic development of the euro area.

2.2 Market surprises and the information content of the ECB

In order to identify the dates of various monetary policy measures from the ECB's statements, I downloaded the ECB's policy statements and Q&A sessions for the period 09.06.1998–12.12.2024 from the European Central Bank (2025) (ECB) website. The ECB statements and Q&A sessions were pre-processed using the following steps: (1) stop words such as conjunctions and pronouns were removed from the texts; (2) only nouns, adjectives, verbs and adverbs were retained through lemmatisation; (3) word endings were removed through porterisation; (4) frequently occurring words were grouped into a phrase, known as a trigram. I used the Latent Dirichlet Allocation (LDA) Blei, Ng, and Jordan (2003) for ECB policy statements, which is a clustering model for text data. The output of the LDA is the topic proportions for each sentence.

Figure 2 shows the results of decomposing ECB statements into forty-five topics and presents word clouds of the twenty most frequent words for each topic. Larger word sizes in these word clouds mean that a particular word is more frequent in that topic cluster. For example, in topic 3 the most frequent word is policy, followed by the word monetary, then the words import and fiscal, but these words are much less frequent than the first two words.

For instance, the thirtieth topic includes the words forward, guidance, expectations, interest rate, medium term, and change. This topic might indicate when the ECB talks about forward guidance or provides guidance regarding its medium-term interest rate. In this case, indicating the dates when the proportion of this topic is higher in ECB statements might help to identify the dates when ECB announces or implements forward guidance.

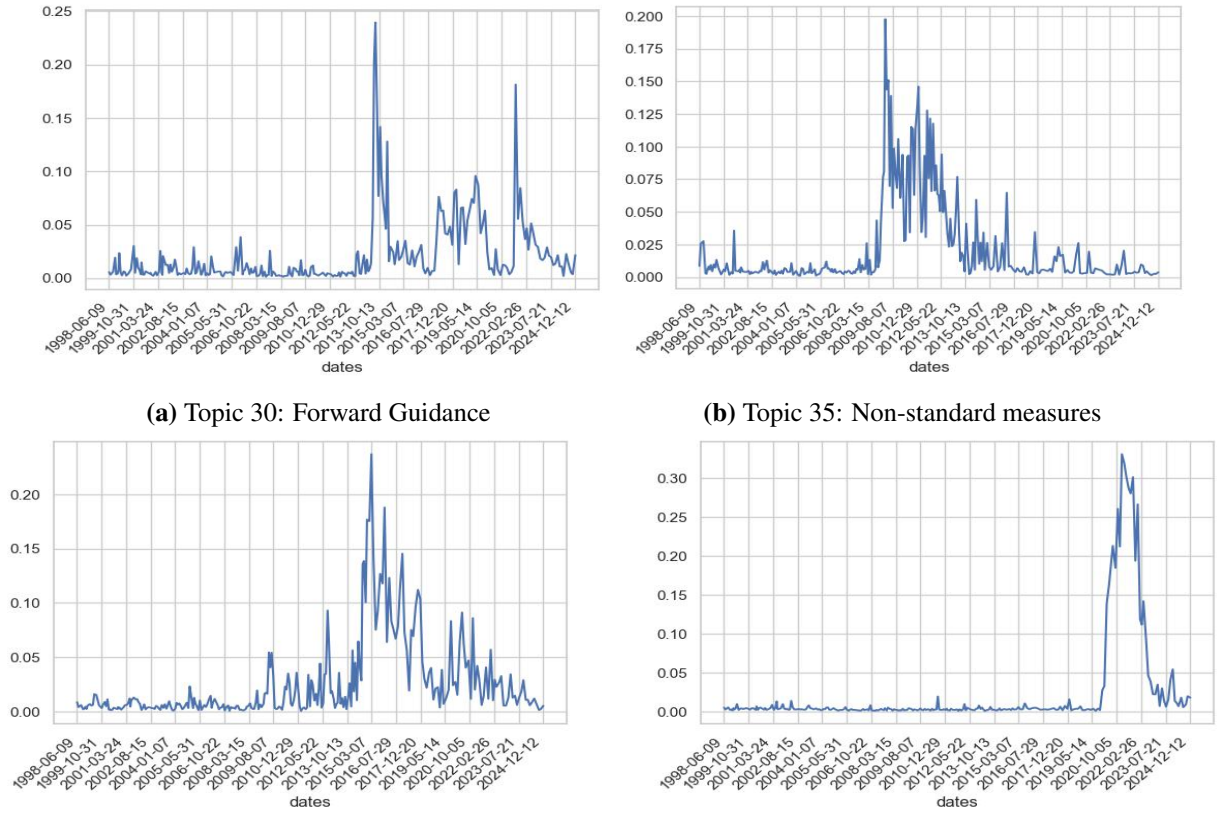


Figure 2: LDA topics from ECB policy statements

The eighteenth topic concerns a pandemic, purchase, recovery, and support. This topic might be regarding the pandemic emergency support program (PEPP) implemented in March 2020 in response to COVID-19. At the same time, the thirty-fifth and forty-second topics indicate that the

ECB is discussing non-standard measures and asset purchase programmes, as the most frequent words in these topics are measure, non-standard and programme, asset, purchace respectively.

Figure 3 presents time series data for topics related to different ECB monetary policy measures, corresponding to the clusters from Figure 2. The time series for topic 30, related to forward guidance, shows increased volatility after 2012 with some small peaks before 2008. This time series may effectively capture the implementation of the ECB's forward guidance policy. Topic 18 discusses support measures implemented during the COVID-19 pandemic. The time series for this topic was particularly high in 2020, with a gradual decline thereafter. It appears that this time series reflects the implementation of pandemic contingency measures by the ECB. Topic 35 relates to the non-standard monetary policy measures implemented by the ECB in response to the 2007-2008 financial crisis and the European sovereign debt crisis. Topic 42 covers the ECB's asset purchase programmes, which started in 2014. The time series for this topic show the highest peaks between 2015 and 2019.



(a) Topic 30: Forward Guidance

(b) Topic 35: Non-standard measures

(c) Topic 42: APP

(d) Topic 18: PEPP

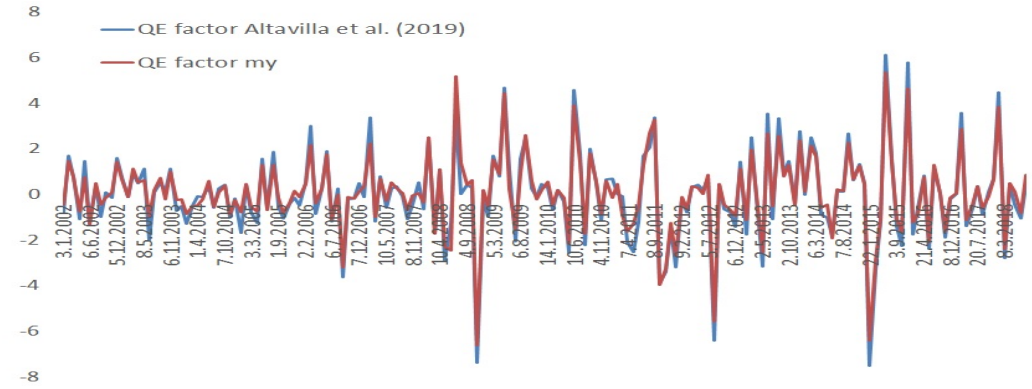
Figure 3: Topics time-series

Having identified the proportions of topics related to forward guidance, they can be used as dates on which the ECB sends forward guidance signals. On these dates, the volatilities of forward guidance shocks should be higher than on announcement dates when the ECB did not implement forward guidance. However, on some of these dates the ECB also implemented other non-standard monetary policy measures. Altavilla et al. (2019) identified the QE factor that has a minimum variance before 2008 and is also orthogonal to the FG factor, but as can be seen from Figure 3 (1) the variance of the FG factor is also not high before 2008 and furthermore (2) both factors

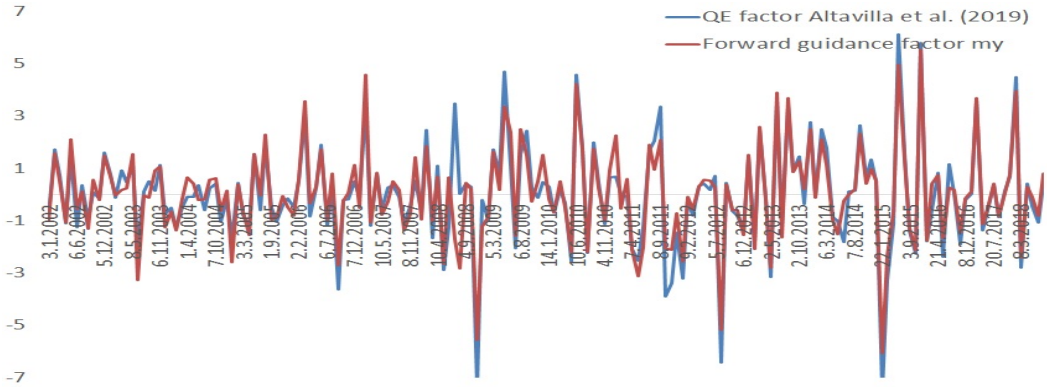
might be correlated since the ECB started to implement these non-standard monetary policy tools simultaneously.

To explore the possibility of mixing FG and QE factors, Figure 4 (a) compares the structural QE factor from a press conference window from Altavilla et al. (2019), exploring the constraints from the factor rotations proposed in Gürkaynak, Sack, and Swanson (2005), Swanson (2021) and Altavilla et al. (2019), and my rotation using the topic frequency of all non-standard monetary policy. I identify the dates of non-standard monetary policy as the sum of the topic shares of topics 35 and 42 and check whether the resulting share is below its 95% quantile (corresponding to the 0.1553 threshold). I then minimise the variance of this factor on these dates. Figure 4 (a) shows that the results are almost identical and the correlation coefficient between two differently rotated principal components is 0.98.

However, Figure 4 (b) shows the comparison between the QE factor from Altavilla et al. (2019) and the FG factor I identified using topic 30 for the rotation. I minimise the variance of this factor where the data is below the threshold of 0.0813 (95% quantile). It can be seen that the correlation coefficient is quite high (0.93) and that two factors are almost identical. Therefore, using the original rotation scheme of Gürkaynak, Sack, and Swanson (2005), Swanson (2021) and Altavilla et al. (2019), it is possible to mix two components by using the minimum variance assumption before 2008 for identification.



(a) QE factor Altavilla and my QE using topics 35 and 42, correlation is 0.98

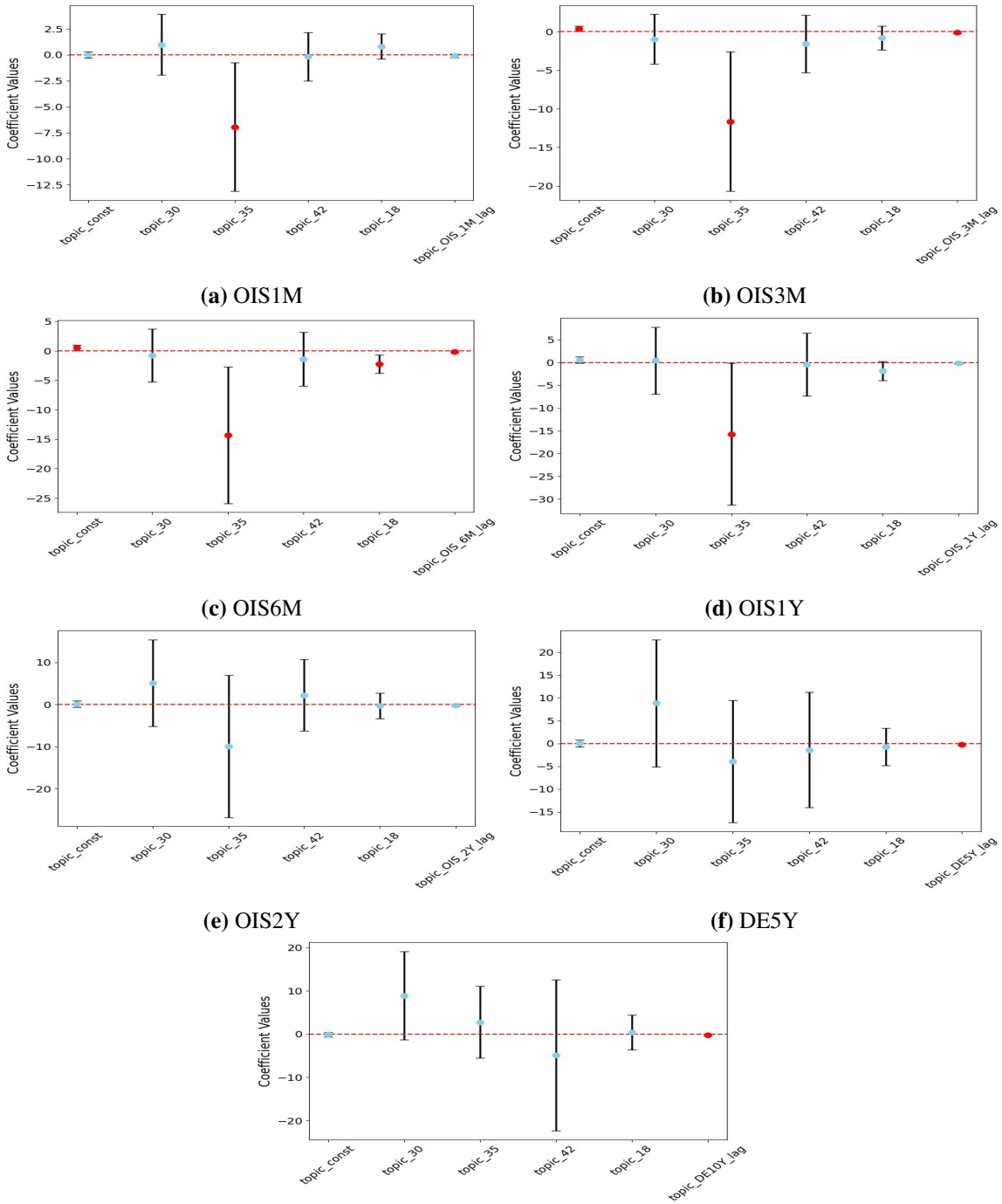


(b) QE factor Altavilla and my FG using topic 30, correlation is 0.93

Figure 4: Resulting structural factors from rotation schemes using topic frequencies

2.3 What information from the ECB does the markets react to?

It is also interesting to examine whether market surprises in a conference window around the ECB's monetary policy announcement are sensitive to specific topics discussed by the ECB in that window.



(a) OIS1M **(b)** OIS3M

(c) OIS6M **(d)** OIS1Y

(e) OIS2Y **(f)** DE5Y

(g) DE10Y

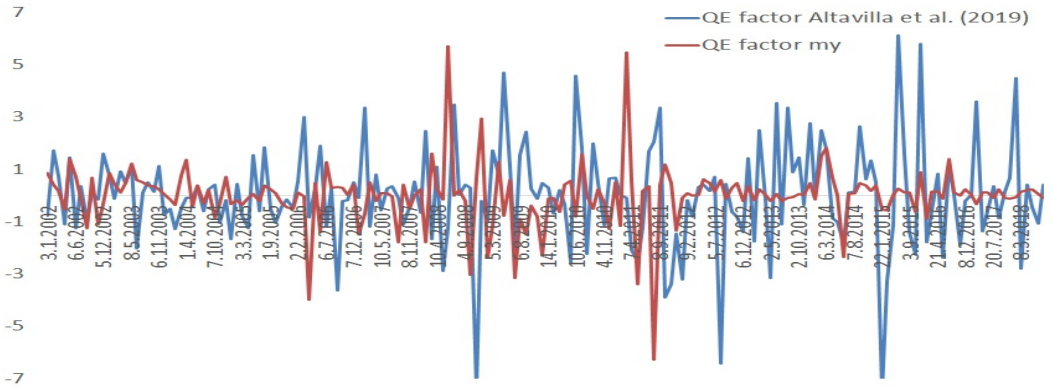
Figure 5: Predictive regressions for market surprises in a press conference window
red dots - statistically significant at the 10% level; bars show 90% heteroskedasticity robust CIs

Figure 5 shows the predictive regression results for press conference window and topic frequen-

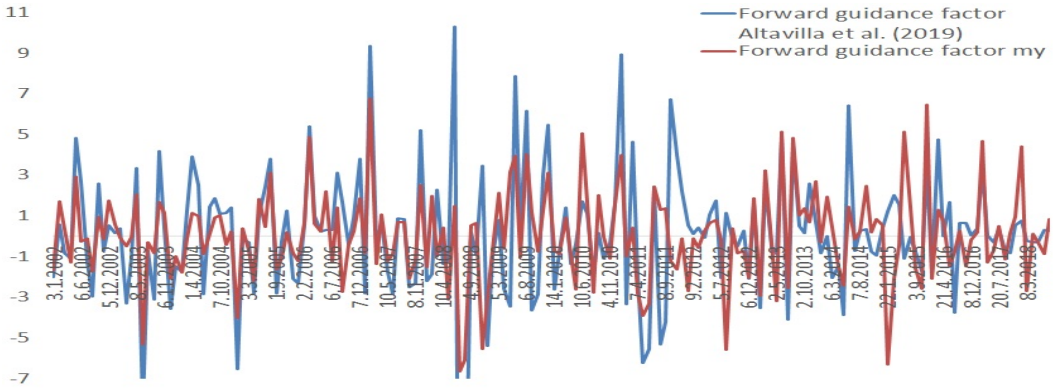
cies from Figure 3, namely when the ECB talks more about non-standard monetary policy measures (topic 35), asset purchase programmes (topic 42), the PEPP (topic 18) and forward guidance (topic 30). I have also included a lag of a dependent variable in each regression. As can be seen, for 1-month, 3-month, 6-month and 1-year OIS, the topics related to non-standard monetary policy measures have predictive power. However, it is only for the 6-month OIS that the topic of the PEPP programme is also predictive.

2.4 Alternative to Altavilla et al. (2019) factor rotations

Therefore, based on the results of Figure 5, it may be questionable that the second and third factors of market surprises are not correlated with the short-term interest rate (the assumption used to rotate the market surprise factors in Gürkaynak, Sack, and Swanson (2005), Swanson (2021) and Altavilla et al. (2019)). At the same time, it is possible to rotate factors of market surprises in a press conference window using topic frequencies from Figure 3.



(a) QE factors Altavilla and my QE using topics 35 and 42, correlation is -0.01



(b) FG factors Altavilla and my using topic 30, correlation is 0.61

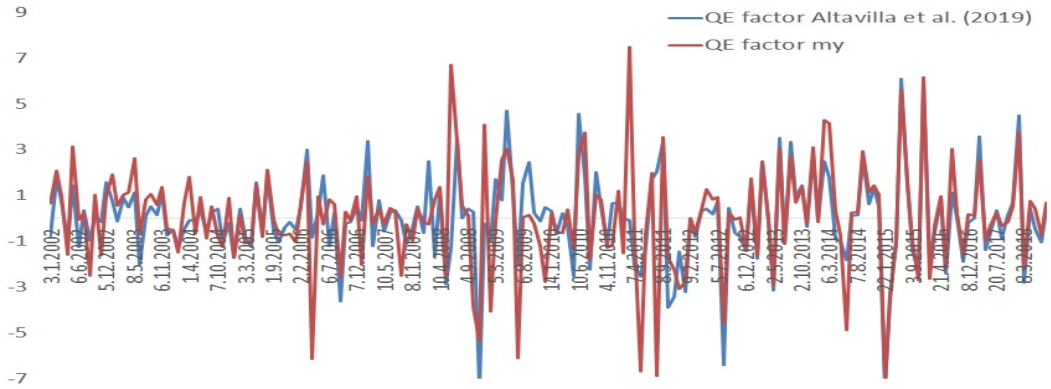
Figure 6: Resulting structural factors from rotation schemes using topic frequencies

I can relax one restriction of Altavilla et al. (2019) by minimising the variances of both FG and QE factors using the topic frequencies from Figure 3. First, I relax the assumption that the correlation between the FG and QE factors and the short-term rate is zero (two restrictions in total) and add an additional restriction that the first factor does not load on the 10-year rate. Figure 6 and Figure 7 discuss the results, where in Figure 6 I use the sum of topics 35 (non-standard measures) and 42 (APP) to identify the QE factor, while Figure 7 shows the results where I use the sum of

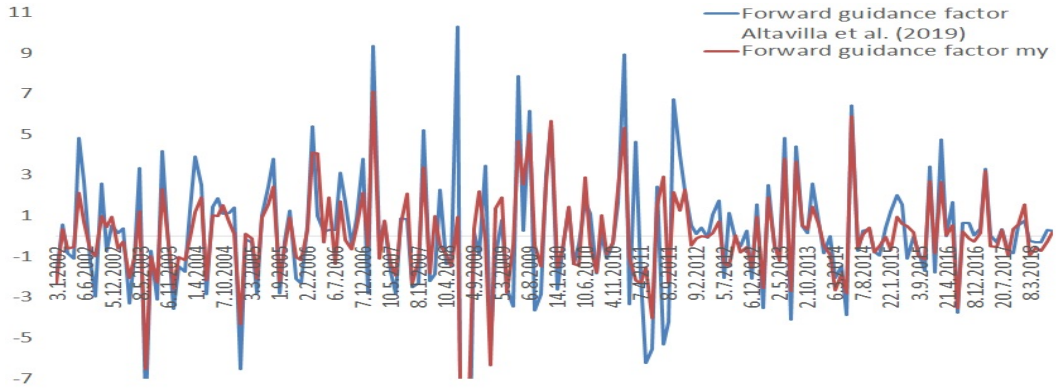
topics 35 (non-standard measures), 42 (APP) and 18 (PEPP). In both cases I use the frequency from topic 30 to minimise the variance of the FG factor.

Figure 6 shows the results of rotations where I use the sum of topics 35 and 42 to idenfity dates to minimise the variance of the QE factor. It can be seen that in this case the correlation between the QE factor from Altavilla et al. (2019) and the resulting QE factor from my alternative rotation scheme is -0.01, mainly because my factor has quite low variance after 2012. In this case, all the variance after 2012 could be captured by the identified FG factor, which correlates quite highly with the FG factor from Altavilla et al. (2019) (the correlation coefficient is 0.61).

Figure 7 shows the results of alternative rotations where I use the sum of topics 35, 42 and 18 to identify dates to minimise the variance of the QE factor. Now the correlations between the resulting factors and those identified in Altavilla et al. (2019) are higher: 0.71 for the QE factor and 0.87 for the FG factor. These high correlations confirm the topic frequencies identified from ECB statements and Q&A sessions are usefull for factor rotations. In the case of the QE factors, the resulting factors differ mainly in 2006-2007, 2008 and 2009-2010. For the FG factors, the results differ the most in 2008–2009.



(a) QE factors Altavilla and my QE using topics 35, 42 and 18, correlation is 0.71



(b) FG factors Altavilla and my using topic 30, correlation is 0.87

Figure 7: Resulting structural factors from rotation schemes using topic frequencies

3 The effects of unconventional monetary policy in the euro area

To examine the impact of unconventional monetary policy on the euro area economy, I use a monthly vector autoregression with Cholesky identification, where the first three factors of market surprises in a window of ECB press conferences are ordered by their identification numbers. These factors have been aggregated at a monthly frequency using simple averaging by months. In months where there was no monetary policy event, I included zeros for the values of the factors. I then order three interest rates: Euribor 3 months, Euribor 1 year and the 10-year euro area benchmark government bond yield (changing composition) from the European Central Bank (2025). After those I include industrial production for the euro area in the fixed composition of 19 countries as for 2015, where 2015=100%, and the HICP for the euro area in the changing composition, where 2015=100%. Both variables are seasonally adjusted and transformed to 100 multiplied by their natural logarithms (European Central Bank (2025)). The VAR is estimated using Normal Inverse Wishart prior with standard hyperparameters, 12 lags, 10,000 replications and 5,000 burn-ins. The estimations were performed using the BEAR Matlab toolbox Alistairand and Björn (2016).

3.1 Relaxing zero restrictions on the short-term rate

Figure 8 compares the impulse responses to the factors identified in Altavilla et al. (2019) with the factors using ECB topic frequencies as in Figure 7[6]. As these factors are highly correlated with each other, the results of the VAR are quantitatively very similar: a one standard deviation shock to the FG factor has an expansionary effect on the HICP and a muted effect on industrial production in the euro area, which may correspond to the Delphic forward guidance effect. However, 68% of the credible sets of the effect of the FG factor identified using topic frequencies contain zero. The effect of the QE factor seems to move euro area industrial production and inflation in opposite directions: a one standard deviation QE shock raises industrial production on impact and the effect is positive for the next fifteen months, while it gradually lowers inflation with the peak effect in about two to three months.

[6]Alternative results with different aggregation of surprises at a monthly frequency are presented in Appendix A.

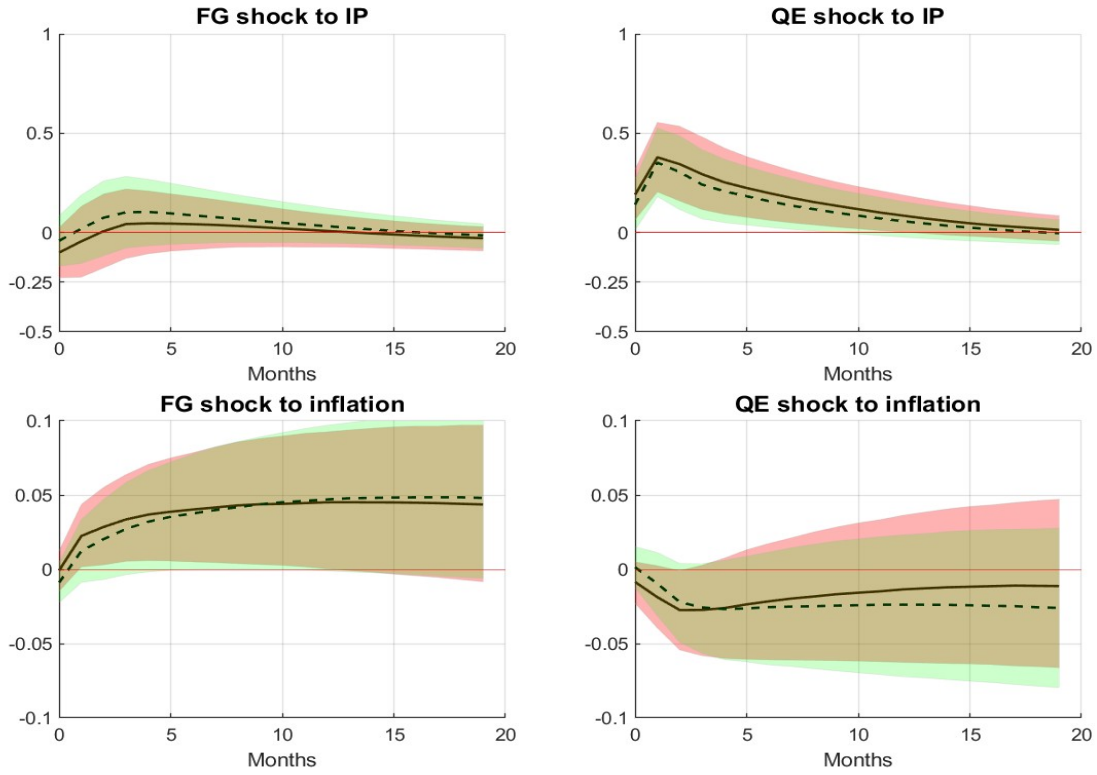


Figure 8: Impulse responses of IP and inflation to rotated PC from an ECB press conference window solid line with pink area - mean IRFs with 68% credible sets for original PC from Altavilla et al. (2019) rotation dotted line with green area - mean IRFs with 68% credible sets for PC from rotation where zero restrictions on short-term rate are relaxed

3.2 Relaxing orthogonality between FG and QE factors

Figure 9 discusses the results of the effects of the factors identified in Altavilla et al. (2019) with the factors using ECB topic frequencies and relaxing the orthogonality restriction between the identified factors. The differences between the effects of the differently rotated factors of market surprises in an ECB press conference window are more visible in this case. The effect of the FG factor on inflation is more contractionary than the effect of the same factor using the Altavilla et al. (2019) rotation scheme: the posterior mean of the impulse response of inflation is negative on impact and remains negative for about five months after the shock. However, the effect on industrial production is now positive, implying that this shock has an expansionary effect on the real economy.

Comparing the effects of the QE factors, we see that the factor identified using topic frequencies has a more negative and persistent effect on inflation: the effect is about twice as low as using the original QE factor at about five months after the shock and remains negative for more than twenty months after the shock. Moreover, 68% of the credible sets are non-zero for about two to ten months after the shock. In addition, the expansionary effect on industrial production is now about twice as large as the effect of the original rotated QE factor.

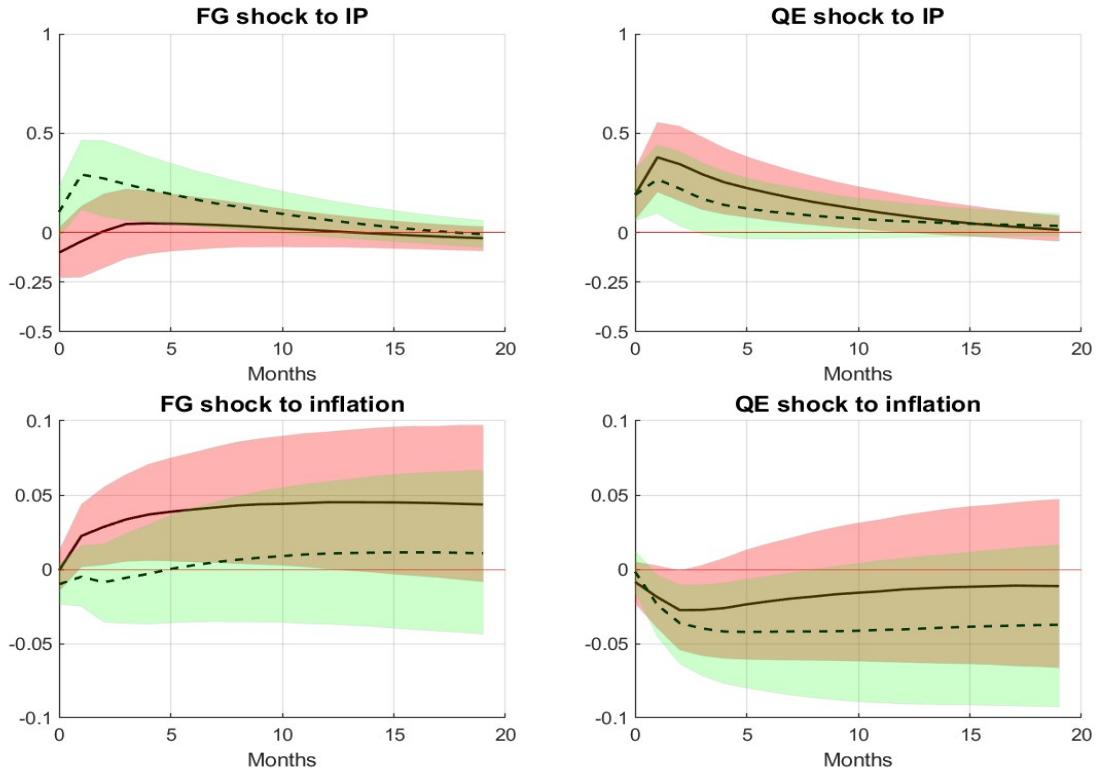


Figure 9: Impulse responses of IP and inflation to rotated PC from an ECB press conference window solid line with pink area - mean IRFs with 68% credible sets for original PC from Altavilla et al. (2019) rotation dotted line with green area - mean IRFs with 68% credible sets for PC from rotation where zero restrictions on short-term rate are relaxed

4 Conclusions

The study presents a novel method that uses textual analysis of ECB press releases and Q&A sessions to identify the dates of forward guidance and non-standard monetary policy measures for the rotation of market surprises in a press conference window. The study decomposes ECB communications into forty-five topics, of which one corresponds to forward guidance, while three other, namely non-standard monetary policy measures, the asset purchase programme and the pandemic emergency purchase programme, correspond to other unconventional monetary policy measures.

Market surprises in short-term interest rates during an ECB press conference window are predicted by the topic frequency of non-standard monetary policy measures, implying that these measures can potentially influence short-term market reactions.

The frequency of use of words relating to non-standard monetary measures by the ECB during its press conferences makes it possible to use them in navigating the rotation of factors of market reactions in a press conference window and to relax some of the standard identifying assumptions for rotation of these factors in order to obtain a structural interpretation. The results show that when the restriction of zero loading of FG and QE factors on the short-term interest rate is relaxed, the results are quite similar while maintaining the restriction of orthogonality between the resulting factors. In contrast, the results are different when the orthogonality constraint between the FG and

QE factors is relaxed. The resulting factors have a more contractionary effect on euro area inflation when Cholesky identification is used in a VAR setting.

References

Ahrens, Maximilian, et al. "Mind your language: Market responses to central bank speeches". *Journal of Econometrics* (2024).

Alistairand, D., and R. van Björn. *BEAR toolbox*. https://www.ecb.europa.eu/pub/research/working-papers/html/bear-toolbox.en.html. European Central Bank, 2016.

Altavilla, Carlo, et al. "Measuring Euro Area Monetary Policy". *Journal of Monetary Economics* 108 (2019): 162–179.

Angino, Siria, and Robert Robitu. *One question at a time! A text mining analysis of the ECB Q&A session*. Tech. rep., ECB Working Paper Series 2852. 2023.

Bauer, Michael D., and Eric T. Swanson. "An Alternative Explanation for the "Fed Information Effect"". *The American Economic Review* 113, no. 3 (2023): 664–700.

Blei, David M., Andrew Y. Ng, and Michael I. Jordan. "Latent Dirichlet Allocation". *Journal of Machine Learning Research* 3 (2003): 993–1022.

Diaf, Sami. *Policy preference at central banks: Quantifying monetary policy signals using keyword topic models*. Tech. rep., WiSo-HH Working Paper Series 69. University of Hamburg, Faculty of Business, Economics and Social Sciences, WISO Research Laboratory, 2022.

European Central Bank. Accessed on: January 2025, 2025. https://www.ecb.europa.eu/.

Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson. "Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements". *International Journal of Central Banking* 1, no. 1 (2005): 55–93.

Hachula, Michael, Michele Piffer, and Malte Rieth. "Unconventional Monetary Policy, Fiscal Side Effects, and Euro Area (Im)balances". *Journal of the European Economic Association* 18, no. 1 (2020): 202–231.

Hansen, Stephen, Michael McMahon, and Matthew Tong. "The long-run information effect of central bank communication". *Journal of Monetary Economics* 108 (2019): 185–202.

Hashimzade, Nigar, Gareth Myles, and John Black. "A Dictionary of Economics (5 ed.)" Accessed on: November 2022, 2017. https://www.oxfordreference.com/.

Henry, Elaine. "Are Investors Influenced By How Earnings Press Releases Are Written". *The Journal of Business Communication* 45, no. 4 (2008): 363–407.

Jainand, M., and C. S. Sutherland. "How Do Central Bank Projections and Forward Guidance Influence Private-Sector Forecasts?" *International Journal of Central Banking* 64, no. 5 (2020).

Jarociński, Marek, and Peter Karadi. "Deconstructing monetary policy surprises: the role of information shocks". *American Economic Journal: Macroeconomics* 12, no. 2 (2020): 1–43.

Klejdysz, Justyna. "Narratives in ECB Press Conferences: A Textual Analysis". *EconPol Forum* 24, no. 1 (2023): 42–45.

Klejdysz, Justyna, and Robin L. Lumsdaine. "Shifts in ECB Communication: A Textual Analysis of the Press Conference". *International Journal of Central Banking* 19, no. 2 (June 2023): 473–542.

Loughran, Tim, and Bill Mcdonald. "When Is a Liability Not a Liability? Textual Analysis, Dictionaries, and 10-Ks". *The Journal of Finance* 66, no. 1 (2011): 35–65.

Möller, Rouven, and Doron Reichmann. "ECB language and stock returns – A textual analysis of ECB press conferences". *The Quarterly Review of Economics and Finance* 80 (2021): 590–604.

National Bank of Slovakia. Accessed on: November 2024, 2024. https://www.nbs.sk/.

Pavelkova, Andrea. *The ECB press conference: a textual analysis*. Tech. rep., ECB Working Paper Series 2742. 2022.

Swanson, Eric T. "Measuring the Effects of Federal Reserve Forward Guidance and Asset Purchases on Financial Markets". *Journal of Monetary Economics* 118 (2021): 32–53.

A Additional results

Alternative aggregation of rotated principal components for a monthly frequency are as follows:

$$S_t = \sum_{m=1}^{T} \frac{M}{M-t} S_m$$

where M is a number of days in a months and t is a day of a surprise.

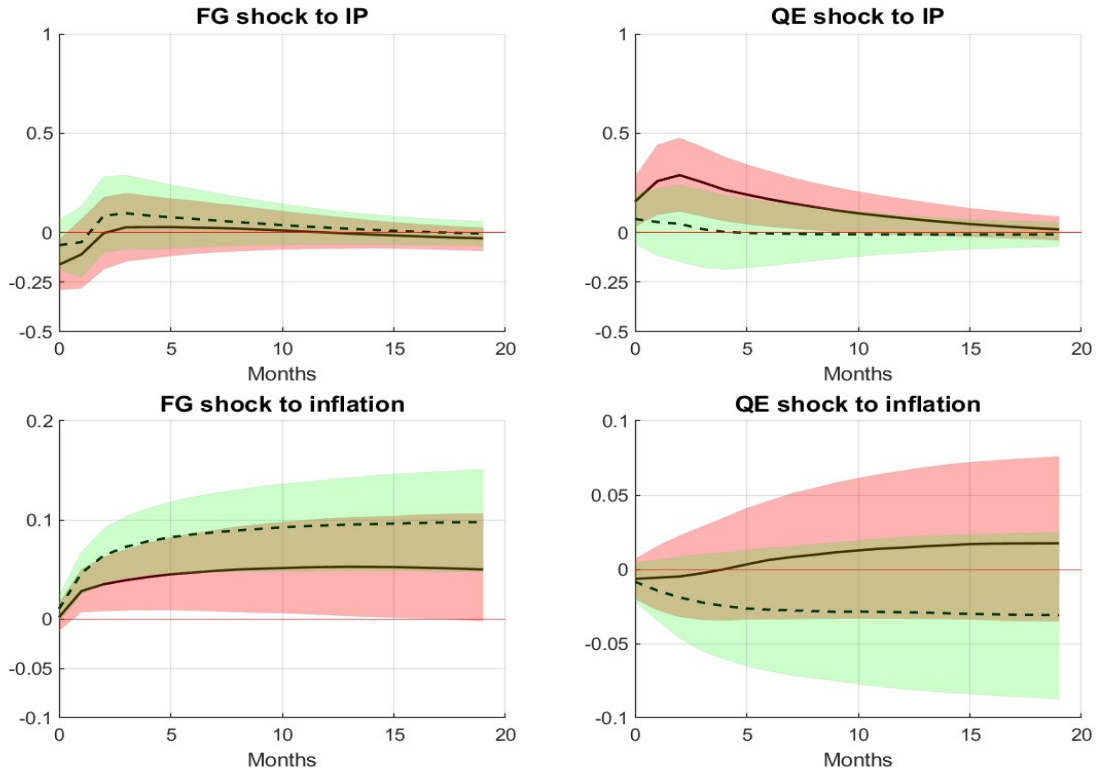


Figure A.1: Impulse responses of IP and inflation to rotated PC from an ECB press conference window solid line with pink area - mean IRFs with 68% credible sets for original PC from Altavilla et al. (2019) rotation dotted line with green area - mean IRFs with 68% credible sets for PC from rotation where zero restrictions on short-term rate are relaxed