Whispers of the Euro: Textual Analysis of ECB Press Conferences and its effects on European Financial Markets

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July 10, 2024

Abstract

This paper analyzes whether the positive or negative views expressed in ECB Press Conferences have an impact on financial markets. We employ Natural Language Processing methods and high frequency data to identify Monetary Policy shocks. Using data from the European Central Bank (ECB) and the Euro-Area Monetary Policy Database (EA-MPD) we construct sentiment scores related to different economic topics which we use in an OLS framework accounting for information effects. Our results show how ECB communication has an impact on financial markets, and how these impacts are highly conditional on known information at the time of the release.

Keywords: Monetary policy, Unconventional policy tools, Forward Guidance, Press conferences, Textual analysis, Sentiment, Market dynamics, Heterogeneity, European Central Bank.

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1 Introduction

In the ever-evolving landscape of monetary policy, the impact of central bank communication on market dynamics remains a subject of great interest and importance. In particular, the euro area (EA) is also challenged by the heterogeneity across financial and economic conditions among member countries. Although there has been convergence over time in financial markets, this process has remarkably slowed down since the financial crisis. Not only has it hampered this convergence, but it has also impacted the effectiveness of conventional monetary policy. Once interest rates hit the zero lower bound and became unavailable, central banks must resort to unconventional policy tools such as forward guidance to manage expectations.

We propose a novel method to capture the intentions of the European Central Bank (ECB) monetary policy stance through their communication with the general public. Our study seeks to uncover the influence of ECB communication on market reactions, how press conferences complement ECB policies, and the rationality of market agents in response to these communications. We demonstrate how a text-based approach can capture the change in dynamics of the market and provide a way to decompose the impact that economic conditions have on their outcomes. Through the lens of textual analysis, we aim to decipher the impact of ECB statements and press conferences, accounting for information effects and employing an interpretable empirical methodology. We proceed to illustrate our method through a comprehensible empirical analysis with different specifications suited for isolating certain effects of interest.

We propose an identification approach that has been heavily used in the context of the Federal Reserve for their Federal Open Market Committee (FOMC) meetings, using high frequency data and natural language processing methods. Our novel addition to the literature consists on the application of such methodologies to the ECB Press Conferences released after each monetary policy decision. We also introduce a novel empirical approach by introducing different information sets to our empirical model in order to account for different economic conditions and heterogeneity within the EA.

On empirical grounds, we assemble economic and financial time series data from 2002 to 2022 for the EA as a block as well as for each of its 4 biggest economies (Germany, France, Italy and Spain). This choice allows us to see different effects in the so-called "core" and "periphery" of the EA, with France and Germany representing the core and Spain and Italy representing the periphery. Overall, we find that when we don't control for current economic conditions, communication is efficient when talking about issues that relate to the ECB mandate. But, when we do consider the economic setting, agents already internalize this information and the surprise effect of communication shrinks. In some cases this can reinforce the goal of their monetary policy as well as counteract it.

The rest of the paper is structured as follows: Section 2 provides a brief literature review and Section 3 describes the data used for the project. Section 4 discusses the methodology, and in Section 5 we present the results and provide interpretations. Section 6 concludes.

2 Literature Review

Our study presented here relates to three strands of the literature about Monetary Policy: study of monetary policy shocks, specifically in currency unions; effects of unconventional monetary policy and the effect of Central Bank communication on policy.

The literature on Monetary Policy shocks has a long history, started by the seminal paper of Romer and Romer (2004) which implemented the idea of measuring outcomes of Monetary Policy decisions in short time frames after their announcement in order to measure outcomes free of endogeneity concerns. Particularly for the Euro zone, the work of Altavilla et al. (2019) is a prominent example of applying this methodology to analyze changes in financial variables. Corsetti et al. (2020) and Ciccarelli et al. (2013) are also relevant examples of estimating how such shocks are heterogeneously transmitted in a currency union. This literature has generally tried to estimate the effect of these shocks treating them as exogenous variation whose effect is caused only by the surprise effect of the Monetary Policy decision. As documented by Nakamura and Steinsson (2018), the effects of such policy shocks do not only depend on the surprise itself, but also on how much it updates the information markets possess about economic fundamentals. Nevertheless, most of the literature is limited to conventional monetary policy time frames, in which the Central Bank is able to use the policy rate as a tool.

Another relevant strand focuses on the effects of Central Bank communication in financial outcomes. A good review of the use of text as data and textual analysis in economics can be found in Gentzkow et al. (2017). Its use as a tool to analyze central bank communications has recently become more accepted, with papers such as Doh et al. (2020), Ehrmann and Fratzscher (2007), Aruoba and Drechsel (2022) and Doh et al. (2021) making use of these tools. This literature attempts to use tools of Computational Linguistics in order to asses the magnitude of the monetary policy shock.

Although there are different approaches to the application of text data to conduct research, with some papers such as Hansen and McMahon (2015) using tools such as LDA algorithms, the most common tool is to use dictionary/lexicon methods to extract sentiment or intention from sentences/statements. The key component of this text classification method is a dictionary of syntactic patterns that denote a specific sentiment (Arratia et al., 2021). This strand has been recently popularized given the appearance of lexicons tailored to economic and financial topics, with Loughran and Mcdonald (2010) and Barbaglia et al. (2022) being the most prominent examples.

Finally, an important strand of the literature related to our study is related to unconventional monetary policy. This refers to the policy tools that a Central Bank can use once the

conventional usage of the policy rate becomes unavailable, usually because it hits the Zero Lower Bound (ZLB). An extensive review of these policies can be found in Bhattarai and Neely (2016). From this branch of unconventional policies, the tool used by central banks that we are more interested in is Forward Guidance. This consists of the Central Bank providing information about its future monetary policy intentions, based on its assessment of the outlook for price stability (ECB, 2017). Forward guidance intends to influence expectations through communication to achieve this goal. Several studies have been devoted to understand the impact and transmission channels of Forward Guidance, such as Hubert and Labondance (2018) and Böck et al. (2021).

Our contribution is to provide a link between the three literature strands. We pose similar questions as the literature on Monetary Policy Shocks and Forward Guidance. Our goal is to use textual analysis to provide a framework from which we can understand what contributes to the strength and effect of a Monetary Policy shock, as well as whether the advent of the Zero Lower Bound really magnified the effects of communication on Monetary Policy effectiveness. Moreover, to the best of our knowledge, most analysis of Central Banks statements did not take into consideration information effects as described by Nakamura and Steinsson (2018). Generally they either used more restrictive lexicon methods, like counting negative words regardless of concept; or Machine-Learning methods which act as a black-box which obscure the interpretation of the economic mechanisms behind the results. We attempt to provide an easy-to-interpret textual analysis and an empirical methodology which can account for information effects in order to improve our understanding of the role that communication plays in regards to monetary policy effectiveness.

3 Data

To study the effect of the ECB communications, we use three types of data. First, we build a measure of sentiment around specific concepts using ECB press conferences obtained from the ECB website. Second, in order to test the effect of this measure we use a set of high frequency financial variables. Lastly, we employ a set of variables that control for different economic conditions. The data-set formed using these variables allows us to study the effect of ECB communications in our sample period from January 2002 to October 2022.

3.1 Dependent Variables

For the dependent variables, we utilize a set of high-frequency financial variables sourced from the Euro Area Monetary Policy Event-Study Database created by Altavilla et al. (2019) to assess the impact of the sentiment measure. These variables encompass a range of asset types. Our safest asset is the Overnight Indexed Swap (OIS), an interest rate derivative, in which the two counterparts exchange a fixed and a floating interest rate. The floating interest rate is the overnight interbank rate (EONIA for the Euro Area), a measure of the de facto monetary policy stance. We include sovereign bond yields, listed from safest to riskiest: German, French, Italian, and Spanish. For bond and OIS analysis, we incorporate multiple maturities. We also consider two stock indices returns, the first being the STOXX 50, which

represents 50 of the largest blue-chip European companies actively operating within the Eurozone. The second is the SX7E, which is the market benchmark designed to measure the price performance of the banking sector in the Eurozone, tracking the total return of the 7 largest bank stocks listed on the Euro Stoxx exchange. Finally, the euro exchange rates against major currencies (USD, GBP, JPY) are included as well.

3.2 Controls

To control for various economic conditions and investigate potential differential effects, we introduce several interaction variables. These variables capture macroeconomic indicators such as core inflation or unemployment, sourced from the ECB Data Warehouse. Additionally, we include indicators reflecting whether the ECB implemented a policy rate change in a given meeting, also obtained from the ECB Data Warehouse. The macroeconomic conditions are represented by both EU-wide and country-level data, offering a comprehensive perspective. In the table below we depict summary statistics for the aforementioned variables:

Table 1: Summary Statistics – Controls

Variable	N	Mean	Std. Dev.	Min	Pctl. 25	Pctl. 75	Max
Interest Rate	213	0.65	1.1	-0.5	-0.2	1	3.2
Interest Rate Changes	213	-0.0047	0.15	-1	0	0	0.75
Core Inflation EA	213	1.4	0.62	0.2	1	1.8	4.8
Unemployment EA	213	9.4	1.5	6.7	8.2	10	12
Germany Unemployment	213	6.4	2.6	2.9	4.1	8.7	11
Germany Core Inflation	213	1.3	0.65	-0.1	0.8	1.5	4.7
France Unemployment	213	9	0.9	7	8.3	9.5	11
France Core Inflation	213	1.3	0.6	0.2	0.8	1.7	4.1
Spain Unemployment	213	16	5.8	7.9	11	21	26
Spain Core Inflation	213	1.6	1.2	-0.7	0.8	2.6	4.9
Italy Unemployment	213	9.2	2	5.9	7.9	11	13
Italy Core Inflation	213	1.6	0.82	-0.5	0.8	2.1	4.4

4 Methodology

In our study, the methodology consists of two separate parts: First, extract a sentiment measure regarding specific topics out of ECB Press Conferences held after each monetary policy decision announcement. Second, construct the empirical model to analyze the effects of this sentiment measure on financial outcomes.

4.1 Constructing Sentiment Scores

In order to extract a measure of ECB sentiment regarding specific topics, we develop an algorithm that consists of three steps. First, we process the texts of each relevant press conference in order to eliminate words and language constructs which are not of interest. Second, we identify frequently discussed economic concepts in the documents. Third, we use dictionary methods in order to construct sentiment scores based on different economic concepts of interest.

In order to begin processing the documents, we input the raw text documents in our statistical software and proceed to get rid of undesired elements. We remove stop words (i.e. "a", "an", "it") which do not convey any useful intention; we remove numbers of dates and page; and finally, we remove words which are not part of the English dictionary, making sure that acronyms and words used in economic discussion are maintained. We then retrieve each word in groupings from the start to the end of the document as *Singles*, *Doubles* and *Triples*. While *Singles* are individual words, *Doubles* and *Triples* are expressions not interrupted by stop words or sentence breaks. For example, "gross domestic product" is a *Triple*, but it can also be constructed as two *Doubles* "gross domestic" and "domestic product", as well as with three *Singles*. We proceed to calculate the frequency at which each *Singles*, *Doubles* and *Triples* occur for each press conference.

By observing the frequencies over all the documents of *Singles*, *Doubles* and *Triples*, we were able to manually discard repeated terms and choose which relevant topics are most often discussed and therefore more fit to form sentiment scores around. This method provides a convenient text-based start in order to select concepts for which to base the analysis around.

Nevertheless, choosing only one concept (as in one *Single*, *Double* or *Triple*) to base the analysis around is fairly restrictive, as the ECB may use different related words to express their opinions regarding a big encompassing area of interest. We therefore decided that it was better to form "Word Clouds" in which to base the analysis. These Word Clouds are groups of different concepts which are related to the same areas of economic discussion. The chosen Word Clouds are the following: *Financial Markets*, *Inflation*, *Employment*, *Public Finances* and *Output*.

To generate these word clouds, we employed an algorithm that followed a specific procedure. Initially, the algorithm divided the documents into individual sentences. Then, it determined the primary concept associated with each word bubble, such as "inflation," and identified the sentences containing the corresponding sentiment. These sentences were then

segmented word by word, creating word vectors for each sentence. We removed common stop words and constructed a frequency table for different word groupings found within the sentences. From these lists, we extracted the words with the highest frequencies, indicating their frequent appearance in sentences related to the main concept of the word cloud. To avoid redundancy, we eliminated duplicate words. For instance, if both "price level" and "price levels" were present, we retained the grouping with the highest frequency. The figure below provides a subset of the word clouds generated by this algorithm, showcasing the resulting visual representations.

Table 2: Word Clouds (Reduced Sample)

Financial Mkts.	**Inflation**	**Real Economy**	**Public**	**Employment**
banks	inflation	GDP	public finances	wage
loans	price stability	investment	spreads	employment
exchange rate	HICP	consumption	public debt	unemployment
credit	commodity prices	economic growth	fiscal consolidation	labor market
bonds	price level	recession	deficit	workforce

Once the word clouds are established, we proceed to construct the sentiment indicator associated with each one[1].

We apply dictionary methods in order to capture the *sentiment* using surrounding words (Hassan et al., 2019). For each appearance in the document of any word in the Word Cloud, we check the ten surrounding words before and after its appearance in order to see if these words have positive or negative connotations. The connotations are classified as positive or negative sentiments according to the *Economic Lexicon* introduced by Barbaglia et al., 2022. This dictionary is the contemporary standard in Economic Literature, along with the one developed by Loughran and Mcdonald, 2010. It is specially designed for economic and financial text, thus making it suitable for evaluating ECB Press Conferences.

Based on this dictionary, each word surrounding a concept appearance will be assigned a score $s \in \{-1, 0, 1\}$, with -1 denoting a negative connotation, 1 a positive connotation and 0 a neutral one. For each word inside a Word Cloud, we provide a sentiment score for each meeting. The final indicator is constructed as an average of the individual sentiment scores for each meeting of all the words inside the Word Cloud. In order to assist interpretation later on, we standardize all the sentiment scores so that they have mean zero and unit variance.

[1]Check Appendix B for a complete disclosure of the Word Clouds and the process to construct sentiment in more detail

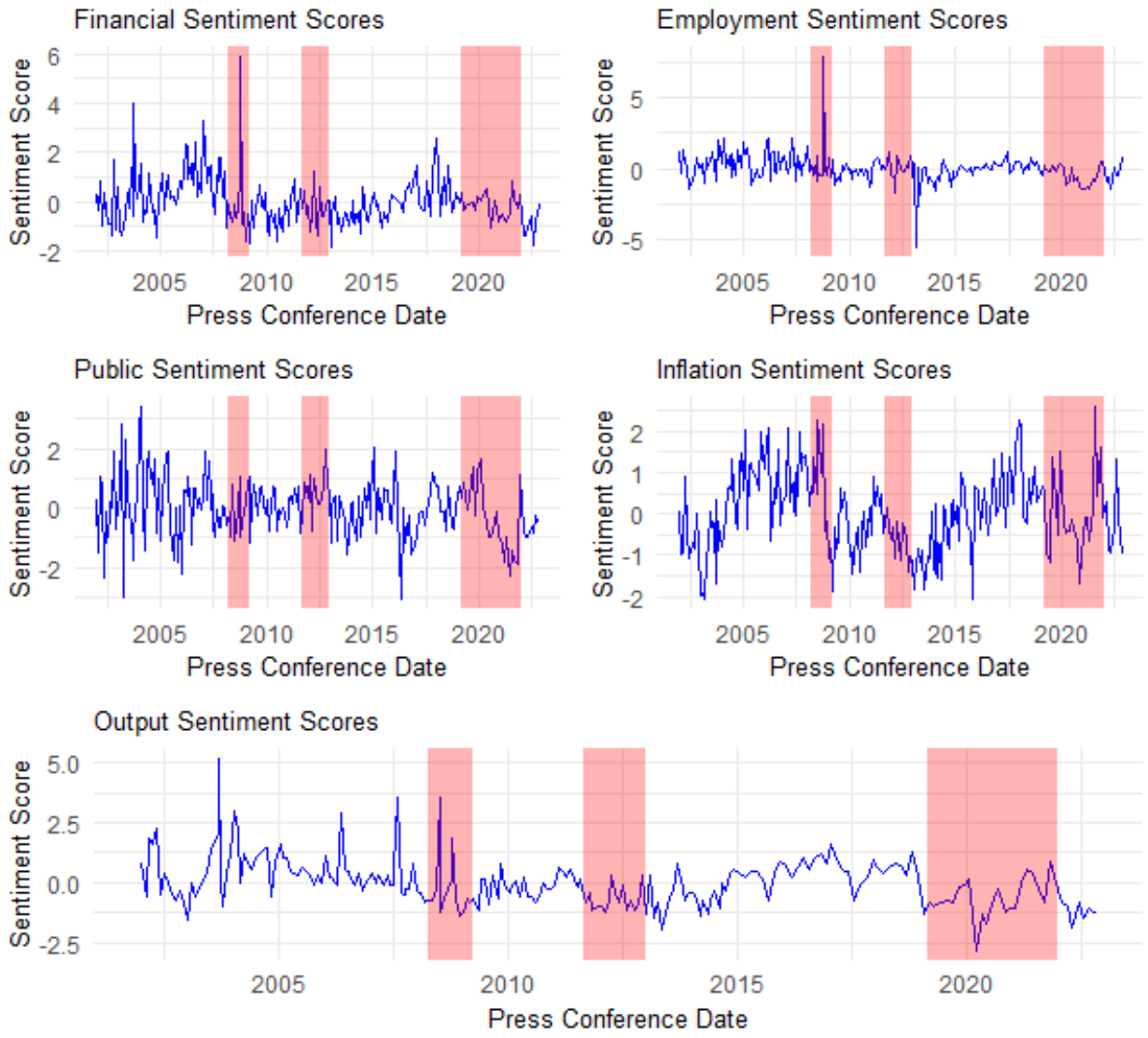

Figure 1: Word Cloud Sentiment Scores (Shaded areas denote recessions and COVID)

4.2 Empirical Model

To examine the impact of wording and sentiment by the ECB on the price of various financial assets, we must first understand the way they organize their communications. The ECB Governing Council convenes on a monthly basis. During these organized meetings, the Council deliberates and formulates its monetary policy decision, specifically pertaining to the establishment of key interest rates for the entire euro area. The ECB policy decision is disclosed in two distinct steps: firstly, at 13:45 CET, a concise Press Release is issued, providing the policy decision without elaboration. Secondly, at 14:30 CET, the Press Conference starts, during which the ECB president presents a prepared statement which elucidates the reasoning behind the decision.

Market participants often perceive this introductory statement as informative of the future

trajectory of monetary policy. The statement lasts around 15 minutes and is followed by a question-and-answer session with journalists that lasts around 45 minutes. These two steps (Press Release and Press Conference) represent two separate events for the market. Consistent with previous studies such as Altavilla et al. (2019) and Gürkaynak et al. (2004), our objective is to define event windows spanning approximately 10 minutes before the release of information and 10 minutes after the conclusion of the event.

4.2.1 Baseline Model

The baseline model, in the spirit of Gürkaynak et al. (2004) which used federal funds futures as a regressor, uses our measure of sentiment as a regressor in the following OLS specification:

$$\Delta y_t = \alpha + \sum_{i=1}^{5} \beta_i \Delta x_{i,t} + \varepsilon_t \tag{1}$$

Where Δy_t represents the change in the price of the financial asset of interest (in basis points) during the press conference time window. $\Delta x_{i,t}$ is the change in the sentiment score of interest between the current press conference and the previous one, serving as a measure of the change in stance of the ECB. The baseline model is designed to capture the effect of changes in the policy stance of the European Central Bank regarding specific economic aspects such as inflation or financial markets.

The use of high-frequency data provides a convenient identification strategy, as the narrow time window in which price movements occur rule out most possible confounding by other variables and endogeneity concerns. It is assumed that any information relevant to pricing of financial assets is known before the meeting, and that no new information other than that released in the press conference is obtained during that time frame.

Useful by its own right, this baseline model presents several limitations which are addressed in the following sections.

4.2.2 Information Effect

Even if our Baseline model is able to identify the effect of changes in policy stance of the ECB on the prices of financial assets, not all the effects are equal across time. The information released in the press conferences does not only update agents' views on the policy stance of the ECB, but also about other economic conditions which were potentially uncertain by the time of the Press Conference.

This updating of information can have relevant economic and financial effects, as documented in Nakamura and Steinsson (2018). Moreover the market response of a change in stance can depend on two main objects. Conditional on the actual change in policy rate accompanying the change in stance, markets might feel the policy rate response as corresponding with the stance change or not. Furthermore, the change of stance will have different effects conditional on the state of the economic setting.

Existing literature such as Bernanke and Kuttner (2003) provides well-documented evidence that the response of asset prices to policy shocks can vary depending on the prevailing economic conditions. To address these concerns, we propose the following augmented Empirical Model of the form:

$$\Delta y_t = \alpha + \beta_0 \Delta x_{0,t} + \sum_{j=1}^{4} \beta_j \Delta x_{j,t} + \sum_{i=1}^{m} \beta_i \Delta x_{0,t} z_{i,t} + \varepsilon_t \tag{2}$$

Where $\Delta x_{0,t}$ is the word cloud of interest (i.e. financial markets), and $\Delta x_{j,t}$ are the other word clouds, to be kept for possible correlation concerns. The variable $z_{i,t}$ denotes current known economic conditions (at Euro Zone level) at the time of the announcement and the actual change in the policy rate.

This specification allows us to capture not only the effect of a change in policy stance of the ECB, but also when those changes in policy stance are relevant for the markets. This enables us to draw conditional and contextual relationships between the sentiment expressed in ECB press conferences and changes in financial assets at high frequencies.

4.2.3 The Zero Lower Bound

In order to enhance the depth of our analysis and gain valuable insights into specific time periods in which monetary policy operated unconventionally, we also focused on a significant time interval: The period characterized by the Zero Lower Bound (ZLB).

The ZLB refers to a time period (From July 2012 to September 2022) in which the policy rate of the ECB stayed at 0 or below. This posed a prominent constraint to conventional monetary policy, which exacerbated the role of otherwise unconventional monetary policy tools such as forward guidance and large-scale asset purchases, among others. Resorting to non-standard tools has given communication a more prominent role as a policy mechanism for the ECB. To study the effect of the ZLB period we modify the specification in the following way:

$$\Delta y_t = \alpha + \beta_0 \Delta x_{0,t} + \sum_{j=1}^{4} \Delta x_{j,t} + \sum_{i=1}^{m} \beta_i \Delta x_{0,t} z_{i,t} + \beta_{ZLB} \gamma_{ZLB} + \beta_q \gamma_{ZLB} \Delta x_{0,t} + \varepsilon_t \tag{3}$$

In which γ_{ZLB} is a binary variable, equal to one if the economy is in the ZLB period and zero otherwise.

5 Results

To discuss the results, we first present the outcomes obtained as a result of applying the empirical model without any interaction effect as a Baseline Specification that will serve as a brief summary statistic of how sentiment scores by themselves can act as predictors of our variables of interest.

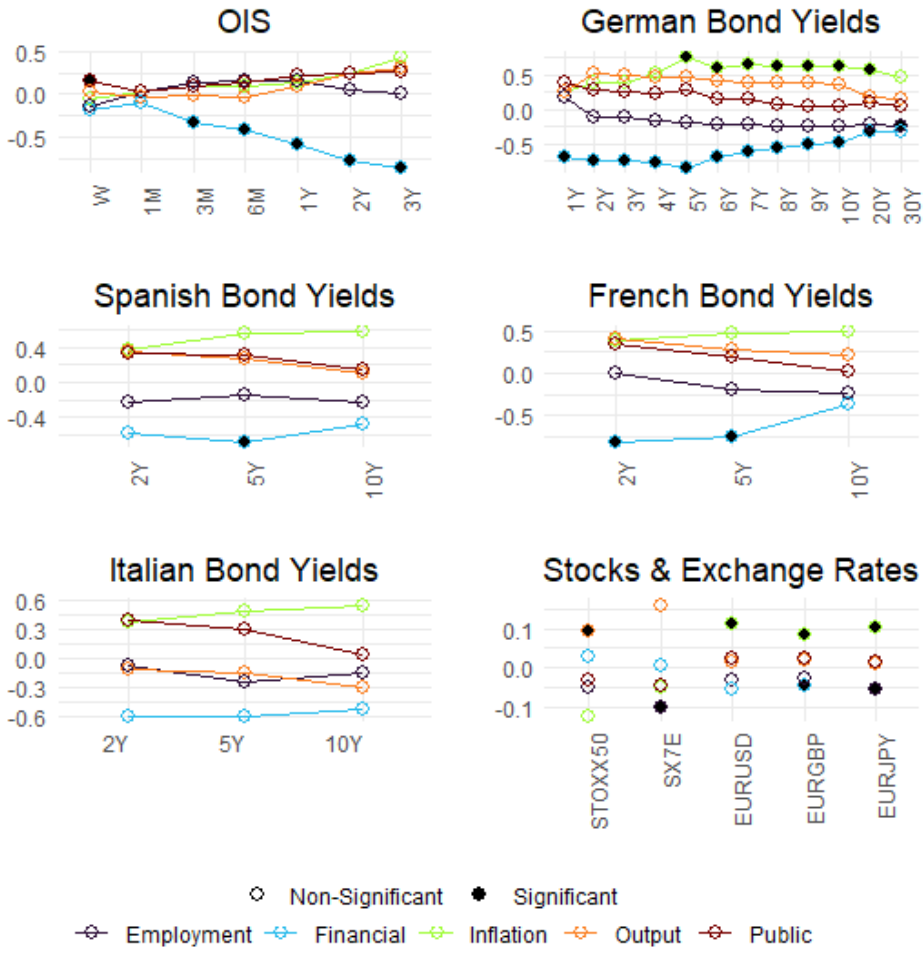

Figure 2: Summary Results - Baseline

The summary of the results highlight the effects of the sentiment expressed in the ECB statements in our baseline regression analysis. Regarding the OIS rate, the very short OIS weekly rate shows a slight positive influence from the sentiment associated with the 'Public' word cloud. However, as the maturity period increases, the significance of 'Public' diminishes. Meanwhile the 'Financial' word cloud becomes more relevant, particularly for maturities exceeding 3 months. The positive sentiment associated with the 'Financial' cloud is linked to a negative impact on the OIS rate, which becomes more pronounced as the maturity length-

ens. The lack of information limits the scope of these coefficients, but we believe that the negative impact of the 'Financial' sentiment is associated with a so-called "spotlight effect". This implies that if the ECB discusses something outside the scope of their mandate, such as Financial Market topics, it is understood that there is a problematic situation occurring, if not, it would not be mentioned. The market understands this and rates decrease.

Shifting our focus to the German bonds, there is a consistent and significant positive impact associated with the 'Financial' cloud on German Bonds. This leads to a reduction in yields, indicating a perception of increased relative safety associated with these bonds, whose safety premium increases if the market perceives a detriment of the financial situation. However, the positive impact gradually decreases as the maturity enters the medium-long term period. This is quite logical considering that what the ECB says today should lose relevance as time passes by. Additionally, the significance of the 'inflation' cloud becomes more prominent in medium and long-term bonds (after 5 years), resulting in a negative impact on German bond yields. This is reflected in an increase in repayment rates and a perception of greater risks.

Examining the riskier bonds of Spain and Italy, the results indicate a weak influence of the sentiments associated with our word clouds on the bonds of these countries. However, there is a noteworthy exception with a significant and positive impact (negative coefficient) of the 'Financial' sentiment on the 5-year Spanish Bond rates.

Stocks and Exchange Rates seems to be influenced by the ECB communications. The SX7E index experiences a negative influence from a positive employment view expressed by the ECB. This is due to the fact that stock prices *usually* decreases on news of rising employment, since the economy is *usually* in an expansion phase (Boyd et al. (2002)). The STOXX50 rises when the ECB expresses a positive sentiment about output, as investors gain confidence and anticipate growth opportunities. Positive economic conditions create a favorable environment, attracting investors and driving up stock prices. Additionally, all the exchange rates have a positive reaction to positive sentiment about 'Inflation'. A positive sentiment about inflation, indeed, suggests a lower level of inflation and, consequently, markets expect central bank to lower or maintain policy rates, resulting in a depreciation of Euro and a decrease in the Exchange Rates.

5.1 The Information Effect

Once we include the interaction with known economic conditions at the moment of the release of new information, we can observe how results are shaped not only by *what* the ECB communicates, but also by what the market *knows* at the time of communication. We incorporate interaction terms with euro-wide inflation and unemployment levels known at the time of announcement. This leads to some interesting outcomes.

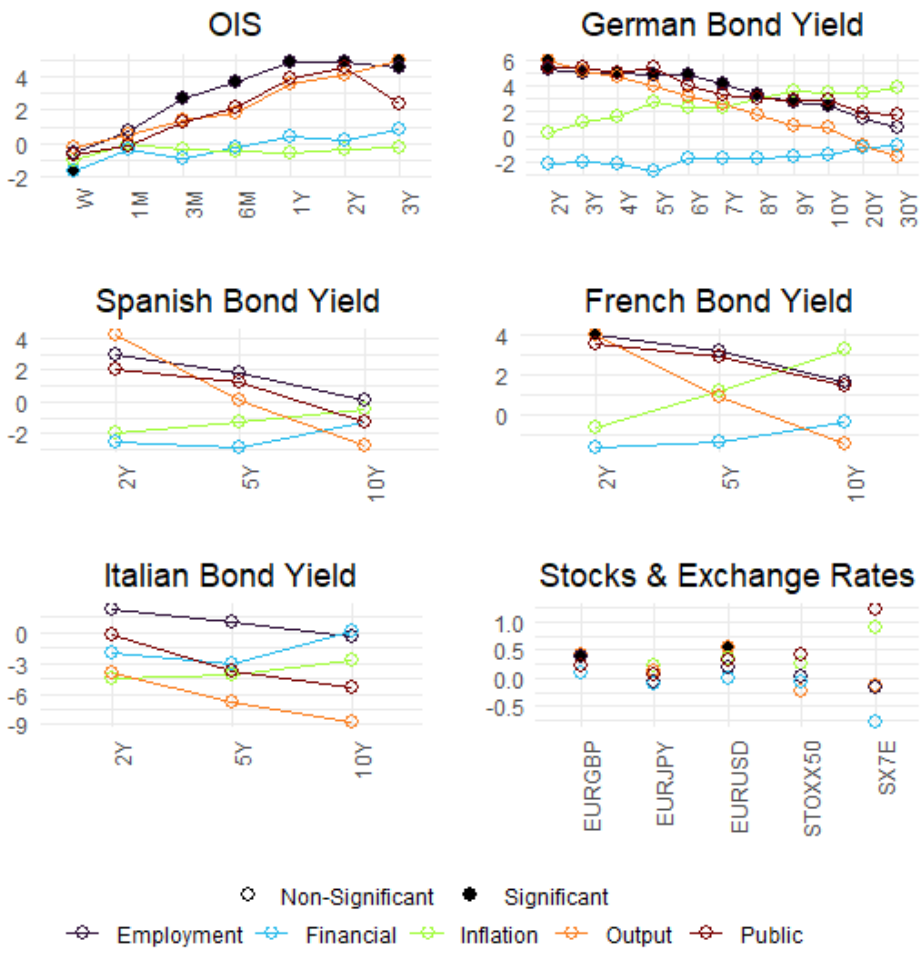

Figure 3: Summary Results - Information Effect

When we add the interaction terms with EA wide economic conditions, we observe that only the coefficients for the sentiment around 'output' and 'employment' are significant for the safe asset yields and the exchange rates. Market participants only react to the assessment the ECB has for the output gap. In the case of their sentiment around 'financial' or the 'public sector', they expect that the ECB will have neutral opinions on these topics since it is not in their mandate. Regarding the coefficient for the 'inflation' sentiment, the ECB has a clear mandate so economic agents already have a clear understanding of what the ECB assessment will be. As a result, the opinion expressed during the press conference is not updating their information.

Regarding the rest of the bond yields, none of the sentiments seems to be significant. The Italian and the Spanish bonds are riskier. As a result, the related yield is not just moved by the policy rate but also by the determinants of their spread with respect to the safe rate which increases the volatility and the standard errors of our estimation. Furthermore, taking as an example the sentiment around 'output', a positive assessment of the ECB regarding the economic situation could lead to higher safe rates, but also lower spreads that lead to po-

tentially uncertain results of ECB communication. Finally, when it comes to stock returns, both the 'employment' and 'output' sentiments are significant for the STOXX50. Investors expect higher demand which should increase firms profitability.

We proceed to use some of the results to try and understand the forces driving them and provide an interpretation of the mechanisms at play:

Table 3: Estimated Effects of Changes in Sentiment on selected Financial Variables

	Dependent variable:		
	EURUSD	DE5Y	OIS_1Y
Word Cloud Sentiment:	Output	Employment	Inflation
Δ Sentiment	0.533^{**}	4.823^{***}	-0.610
	(0.266)	(1.451)	(1.779)
$\Delta Rate * \Delta Sentiment$	-0.146	-0.840	3.753^{**}
	(0.198)	(0.547)	(1.806)
Inflation$*\Delta Sentiment$	-0.002	-1.134^{***}	-0.778^{***}
	(0.053)	(0.245)	(0.282)
Unemployment$*\Delta Sentiment$	-0.057^{**}	-0.315^{***}	0.195
	(0.027)	(0.110)	(0.189)
Controls for other sentiments	✓	✓	✓
Observations	209	209	209
R^2	0.086	0.079	0.053
Note:	Robust standard errors (Newey-West) reported		
	*p<0.1; **p<0.05; ***p<0.01		

In the case of the sentiment for the output cloud, we observe a positive effect of the sentiment in the EURUSD exchange rate. Agents perceive that the positive assessment of the EA output by the ECB should lead to rate increases in the future which would lead to the appreciation of the Euro, thus the market anticipates such rise by appreciating rates in the present. In addition, the interaction with unemployment is also significant with opposite sign, this suggests that the reaction to new information is smaller when the ECB faces a clear picture of the economic situation. In scenarios with high unemployment, investors have a clear understanding of what the ECB will do, thus the surprise effect of the communication shrinks.

This results suggest that agents in the market expect the Central Bank to act conservatively, raising rates when they perceive the situation regarding output as being positive,

which could signal an overheating of the economy and a positive output gap, suggesting an appreciation. The results imply that markets are efficient and quickly implement this new information into market prices.

Regarding employment, the results are relatively similar. A positive sentiment expressed regarding employment appears to be met with an increase in the German Yield, which is usually taken as a proxy for safe interest rates in the EA. Both the interaction term with current inflation and unemployment are significant and negative. This is to be expected and points out how the information effect impacts the results. Scenarios with high levels of inflation or unemployment are scenarios in which the policy course of the ECB is well understood by market agents. These scenarios make the decisions of the ECB more predictable, which reduces the effect that new information disclosed in the conferences have on markets. The results again point to efficient markets, which anticipate conventional monetary policy being conducted and price in the effects beforehand.

Perhaps the most intriguing results come from the inflation word cloud, we observe that by itself, expressing a sentiment about inflation does not appear to have any effect. However, we observe how the interactions with observed inflation and the change in policy rate are highly significant. In particular, each of these interactions is seemingly telling a different story. The interaction with EA inflation is quite intuitive and points towards a reinforcement of the monetary policy decision. A positive outlook on inflation when there is an increase in inflation implies that the communication reassures markets that inflation remains on a track contemplated by the ECB and no rate rises will be needed to bring it down. This decreases the OIS rates, which is a signal that markets perceive the ECB as credible and do not anticipate any contractionary monetary policy.

The interaction with policy rate changes seems counterintiutive at first glance, but we present an example to clarify this result. Lets take for instance a case where the ECB raised rates in the meeting before the conference, but then in the conference it reassures the public that the outlook on inflation is positive. These two actions are contradictory and create mixed signals for the market, which reacts by raising OIS rates. But normally this would occur if inflation was a problem, contracting credit in the economy. Thus, we interpreted this as a loss of credibility of the ECB in case they decide to undertake this seemingly opposite path of action.

In summary, these results seem to point to a market which gives credibility to the views expressed by the ECB and acts accordingly. Interestingly, the non-significance of the coefficient for the change in inflation sentiment without interaction seems to point to the market failing to react to statements about inflation unless there is some policy action or certain unusual economic condition. This is consistent with the fact that the ECB has an inflation mandate and makes their inflation targets very explicit. This implies that markets do not receive any new information about their views on inflation from the press conferences alone, and therefore do not react unless there is a change in the policy rate.

5.2 The Zero Lower Bound

With the addition of the Zero Lower Bound, these are the aggregate results:

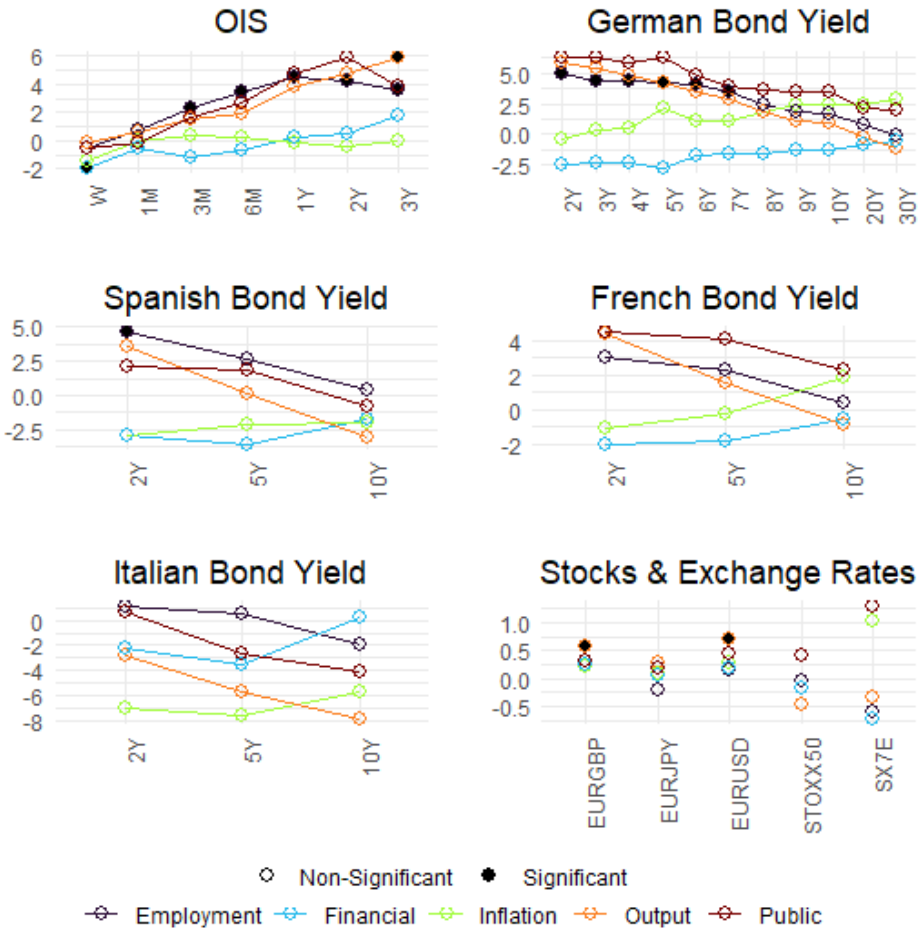

Figure 4: ZLB Summary

The addition of the zero lower bound dummy, allowing for differentiated impacts of communications during the ZLB period, does not change the results. 'Output' and 'employment' sentiments remain significant for the safe and exchange rates, as well as the STOXX50. Meanwhile all the other variables are not significant and show a behavior similar to the one observed in the information section.

To extend the narrative, let's revisit the previously explored results and see how adding the ZLB to the model affected our conclusions:

Table 4: Estimated Effects of Changes in Sentiment, including the ZLB

	Dependent variable:		
	EURUSD	DE5Y	OIS_1Y
Word Cloud Sentiment:	Output	Employment	Inflation
$\Delta Sentiment$	0.709^{***}	4.187^{***}	-0.099
	(0.239)	(1.551)	(2.292)
ZLB	-0.031	0.701^{***}	0.446^{**}
	(0.047)	(0.271)	(0.188)
$\Delta Rate \Delta Sentiment$	-0.240	-0.854^{*}	4.042^{**}
	(0.244)	(0.488)	(1.928)
ZLB$*\Delta Sentiment$	-0.152^{***}	-0.413	-0.308
	(0.056)	(0.303)	(0.587)
Inflation$*\Delta Sentiment$	-0.068	-1.151^{***}	-0.886^{**}
	(0.049)	(0.266)	(0.376)
Unemployment$*\Delta Sentiment$	-0.059^{***}	-0.232^{*}	0.175
	(0.021)	(0.123)	(0.196)
Observations	209	209	209
R^2	0.104	0.087	0.058
Note:			*p<0.1; **p<0.05; ***p<0.01

When comparing the results of our previous specification to the one that includes the ZLB dummy, we can observe some minor changes. For the effect of 'Employment' and 'Inflation' sentiment on the 5 year German bond yield and 1 year OIS rate respectively, the changes are very small, and the dynamics are the same. It appears that being in the ZLB period does not imply greater effect to expressing sentiment around any of these concepts.

Regarding the effect of the 'Output' sentiment on the EURUSD exchange rate, the effect is similar to that observed before. The main difference we see is that the interaction between expressing a change in sentiment and being in the ZLB period is negative, which means that communication is less effective in changing market prices during the period. This can be attributed to the fact that, all other things equal, the inability to change the policy rate hampers the most direct way that the ECB action can affect exchange rates. A remarkably similar dynamic is observed for the exchange rate with the British Pound.

An interesting explanation of this development might be the fact that, during the ZLB period (after 2015) the ECB started releasing the "Monetary policy accounts" every 4 weeks, which are a thorough and detailed review of the state of the economy by the ECB. Given this periodic release of extra and detailed information, we would expect that any effect that could occur by expressing their views on a press conference would be at best equal to, or perhaps smaller than the one we estimated when we were not accounting for the peculiarities of the period. An interesting point to be made about the ZLB period is that, in most of the regressions, the constant term for ZLB is significant, which points to the fact that there is certainly a trend change during the period. Financial assets see their rates/prices change more during the period. We are nevertheless unable to attribute the peculiarities of the period to any communication-related event.

5.2.1 Extension - Heterogeneity

Standard New Keynesian macroeconomics tells us that in a currency union, optimal monetary policy should stabilize a weighted average of the sectoral inflation rates (Benigno, 2004), giving each country a weight according to its economic size. Knowing the true motivation behind the actions of the ECB is a daunting task which we do not undertake in this study, rather, what we are interested in is in observing if markets adhere to that view. That is, do markets consider economic developments in different EU countries as having the same effect on financial assets?. If not, any possible bias that the market might have will indirectly have an effect on how the ECB shapes policy actions.

To do this, we use an augmented form of the empirical model presented in (3). This time, instead of controls for the known economic conditions being about Euro Zone conditions, we use the same set of economic conditions (Inflation and unemployment levels) separately for Germany, France, Italy, and Spain. This specification allows us to observe if the effect of ECB communications differs according to the information that agents have of each of the biggest economies of the currency union. It also looks to analyze if the current known economic situation of one country is taken into account as more relevant by the market than another one.

This model presents a large number of regressors which present a significant degree of correlation between them, which creates a dimensionality problem. Results from this section should be taken as suggestive. Nevertheless, certain interesting patterns can be observed.

Table 5: Model Results when accounting for cross-country conditions

	Dependent variable:		
	OIS_3M	OIS_6M	OIS_1Y
Word Cloud Sentiment:	Employment	Employment	Employment
$\Delta Sentiment$	3.314**	5.060**	6.968**
	(1.297)	(2.120)	(3.316)
$\Delta Sentiment$*DE_Un.	−0.355***	−0.388**	−0.380
	(0.101)	(0.170)	(0.246)
$\Delta Sentiment$*DE_Inf.	−0.680**	−0.609**	−0.848*
	(0.305)	(0.310)	(0.489)
$\Delta Sentiment$*FR_Un.	0.705**	0.705	0.678
	(0.297)	(0.468)	(0.703)
$\Delta Sentiment$*FR_Inf.	−0.546*	−1.057*	−1.262
	(0.318)	(0.555)	(0.824)
$\Delta Sentiment$*ES_Un.	−0.034	−0.065	−0.054
	(0.041)	(0.067)	(0.091)
$\Delta Sentiment$*ES_Inf.	0.178	0.025	−0.169
	(0.170)	(0.265)	(0.407)
$\Delta Sentiment$*IT_Un.	−0.687***	−0.742***	−0.908***
	(0.160)	(0.217)	(0.342)
$\Delta Sentiment$*IT_Inf.	0.552	0.807	1.042
	(0.437)	(0.674)	(1.047)
ZLB	0.354**	0.315	0.517**
	(0.146)	(0.197)	(0.225)
$\Delta Rate * \Delta Sentiment$	−1.970***	−2.083***	−1.924***
	(0.465)	(0.476)	(0.566)
$ZLB * \Delta Sentiment$	0.574	0.656	1.182
	(0.741)	(1.015)	(1.660)
Observations	209	209	209
R^2	0.129	0.102	0.084
Note:			*p<0.1; **p<0.05; ***p<0.01

When we include the interactions with country-specific economic conditions, we observe that the only countries whose economic conditions are relevant for the markets are Italy and Germany. Most of what was said before for results containing Employment as a word cloud hold, although the results are a bit more confusing. One important fact is that it appears that an increase in unemployment in both countries decreases the effect of being positive about employment. Inflation only seems to do so if it is in Germany.

Financial markets seem to give more importance to inflation in Germany than in Italy. We suspect that Germany and Italy results are representative of the "Core" and "Periphery" distinction within Europe, and financial markets seem to give more importance to inflation developments in the core. Given that in general the core is the centerpiece of Europe's economy and it generally maintains a lower level of inflation than the periphery, we can infer than markets appear to be more responsive when that stability is threatened. Developments in the periphery are less relevant to agents, this is because of their history of being prone to periodic inflationary episodes.

6 Conclusions

To conclude, our study shows that ECB communications have a non-negligible impact on financial assets. These impacts are highly conditional on the information available to the public beforehand, which implies a high variety of possible outcomes. In general, results point towards financial markets giving credibility to the ECB.

The findings of this study reveal that market participants adjust their expectations regarding future actions of the European Central Bank (ECB) based on the ECB's assessment of the current economic situation during press conferences. Specifically, they respond to the central bank's evaluation of the output gap in the euro area. However, their reactions to other assessments are limited either due to factors outside their mandate or because the market is already aware of the clear targets set by the ECB.

Based on our results, the ECB is able to impact market prices by shaping expectations about their future actions. Particularly, we have shown in our paper that an effective communication regarding the output and employment situation can be an additional and complementary instrument to conventional tools in order to affect financial markets. This is especially important in a context where the ECB was constrained by the ZLB, given that during this period the central bank could not use the policy rate to stimulate the economy any further. As a result, in this time frame of unconventional monetary policy, the expectations and, consequently, the intentions conveyed by the ECB play a more pivotal role. Although the impact of communication remained the same throughout the zero lower bound period, its importance was magnified due to the inability to use other policy instruments.

Furthermore, we stress the importance of credibility for the ECB. Complementing conventional monetary policy and communication represents a fundamental aspect, and sending mixed signals to market participants could end up being counterproductive to the ECBs

ability to reach its target. Hence, the ECB should assess the economic situation objectively in order to maintain credibility.

Conversely, according to our results, ECB communication during the press conference impacts only safe asset interest rates. The ECB is unable to impact directly the yield of riskier assets with communications alone, which results in a heterogeneous effect across the EA. While the core faces safe asset interest rate changes and is directly impacted by the ECB policy, the periphery whose assets are riskier shows less responsiveness to the ECBs intentions. In the periphery, communication influences both the safe rate and the spread that these countries encounter, resulting in uncertain outcomes and heightened volatility in our estimates.

Having expanded on the interplay between ECB communications and financial market outcomes, we want to stress the potential that this venue offers to the ECB. Tailoring the communication style displayed in the press conferences offers the possibility of achieving the ECBs goals without resorting to conventional monetary policy tools which can result in unintended consequences. This opens the way towards future studies focused on understanding what constitutes "optimal" communication for monetary authorities.

As future steps in our analysis, we would like to mention three potential extensions. Regarding the heterogeneity specification, we introduce many interactions with country level variables that are highly correlated which might lead to over-fitting problems. By summarizing country level variables in regional components using principal component analysis (PCA) we could reduce the number of interactions and their correlation avoiding this potential problem in our estimation. Furthermore, in our dependent variable about periphery countries, we do not observe any impact of the assessments carried out by the monetary authority. It would be interesting to see if although the bond yield of periphery countries is not responsive to communication, it might be the case that an increase in the safe rates, which are more responsive, is compensated by decreases in the spreads with those safe rates. Expanding out the analysis to take into account spreads would be a good way to disentangle the different components of risky assets yields. Last but not least, in our specification we do not take into account the publication of the monetary policy accounts from February 2015 onwards. These publications contain a detailed explanation of the ECB assessment of the economic situation which might reduce the communication effect of ECB press conferences. As a result, our estimation for that period, which contains almost all the ZLB period, might be smaller due to the information disclosed by the ECB through the accounts. A similar study such as the one carried out in this project could be applied as well to the publication of the accounts to better understand how ECB communications affect financial markets and the economic environment.

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Appendix A - Summary Statistics Dependent Variables

Table 6: Summary Statistics

Variable	N	Mean	Std. Dev.	Min	Max
OIS_SW	215	-0.038	1.4	-6.8	5.7
OIS_1M	215	-0.098	0.98	-7.4	3.9
OIS_3M	215	-0.09	1.9	-11	11
OIS_6M	215	-0.098	2.6	-14	16
OIS_1Y	215	-0.15	3.6	-18	21
OIS_2Y	215	-0.21	4.1	-23	19
OIS_3Y	204	-0.25	3.9	-22	13
OIS_4Y	105	0.049	3.1	-14	10
OIS_5Y	104	-0.04	3.2	-13	9.5
OIS_6Y	104	-0.024	3.1	-10	9
OIS_7Y	105	0.044	3	-8.3	8.4
OIS_8Y	104	0.027	2.9	-7	8.5
OIS_9Y	104	0.01	3	-9	8.6
OIS_10Y	105	0.0098	2.9	-8.7	8.7
DE3M	166	0.34	4.2	-9.2	37
DE6M	167	-0.23	2.7	-13	16
DE1Y	196	-0.13	3.4	-14	19
DE2Y	215	-0.17	4.5	-25	23
DE3Y	215	-0.15	4.3	-23	21
DE4Y	215	-0.16	4.2	-21	18
DE5Y	215	-0.092	4.2	-20	16
DE6Y	215	-0.11	3.8	-16	13
DE7Y	215	-0.047	3.4	-12	12
DE8Y	215	-0.067	3.3	-11	12
DE9Y	215	-0.068	3.1	-12	13
DE10Y	215	-0.053	3.1	-13	12
DE20Y	215	0.027	2.7	-7.6	13
DE30Y	215	-0.046	2.9	-18	12
IT2Y	215	0.1	5.6	-24	22
FR2Y	209	-0.16	4.3	-24	21
ES2Y	215	-0.26	4.4	-24	17
IT5Y	215	0.26	5.9	-21	32
ES5Y	215	-0.13	4.6	-19	23
FR5Y	212	-0.18	4.1	-20	16
ES10Y	215	0.16	4.4	-12	31
FR10Y	215	-0.0092	3.2	-14	14
IT10Y	215	0.42	5.4	-14	38
STOXX50	215	-0.11	0.6	-3	2
SX7E	215	-0.21	1.1	-7.1	2.8
EURUSD	215	-0.012	0.43	-1.3	1.7
EURGBP	215	0.0049	0.32	-0.91	1.2
EURJPY	215	-0.01	0.43	-1.3	1.3

Appendix B - Illustration Sentiment Score and Word Clouds

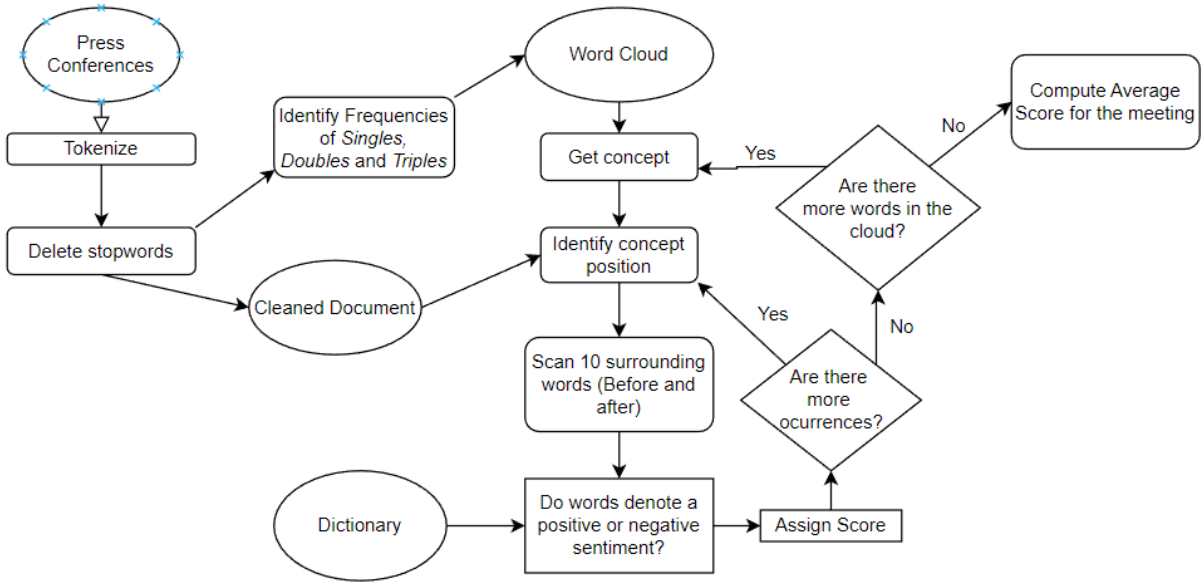

Figure 5: Flow Chart of the Algorithm used to compute sentiment scores

In the following figure, words marked in yellow are targeted concepts, while words marked on red are what the algorithm would identify as providing certain (in this case negative) sentiment to that occurrence.

The latest information has confirmed the existence of strong short-term upward pressure on inflation.
Inflation Ocurrence: Score = -1

Financial Markets ocurrence: Score = -2
Yet the level of uncertainty resulting from the turmoil in financial markets remains high

Figure 6: Example of assigning scores to an occurrence

Table 7: Complete Word Clouds

Financial Markets	**Inflation**	**Output**	**Employment**	**Public Finances**
monetary	inflation	gdp	wage	deficit
bonds	wage	recession	wages	deficits
spreads	hicp	investment	employment	spread
markets	deflation	output	unemployment	spreads
rates	mandate	production	labour	budget
banks	inflationary expectations	consumption	productivity	budgetary
deflation	price stability	depression	structural unemployment	public finances
loan	commodity prices	unemployment	labour market	sovereign debt
loans	inflationary pressures	energy		fiscal consolidation
sovereign	price level	oil		fiscal imbalances
yield	core inflation	employment		public debt
debt	headline inflation	demand		government debt
credit	overall inflation	supply		current account
risk	interest rate	business		
exchange rate	interest rates	profitability		
euro exchange	inflation expectations	economic growth		
interest rate	anchored inflation	economic activity		
interest rates		domestic demand		
loan growth		disposable income		
credit growth		gdp projections		
net purchase				
asset purchase				

Appendix C – Aggregate Results by Word Cloud

Output

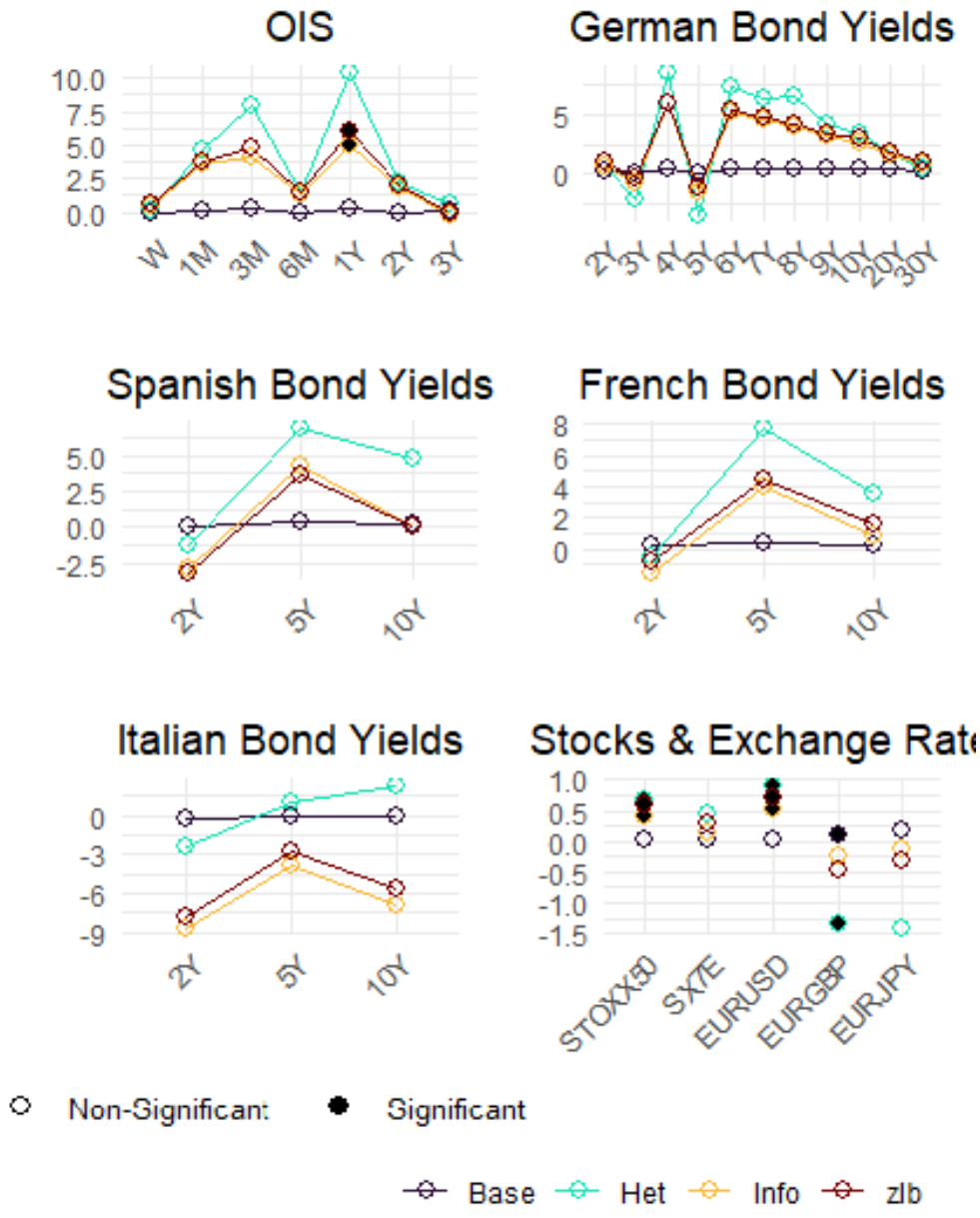

Figure 7: Results for Output Word Clouds for different regressions

Financial Markets

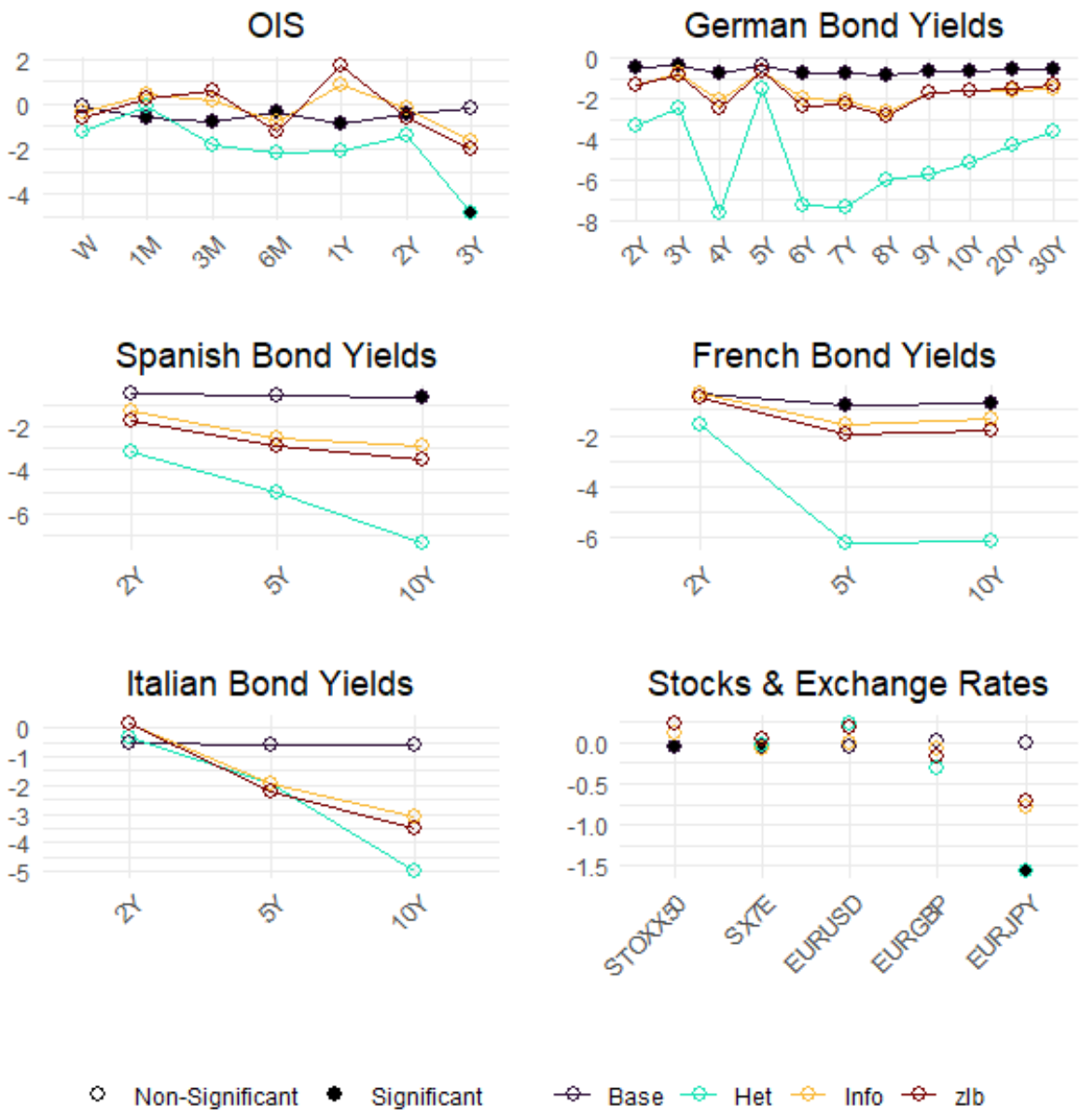

Figure 8: Results for Financial Word Clouds for different regressions

Inflation

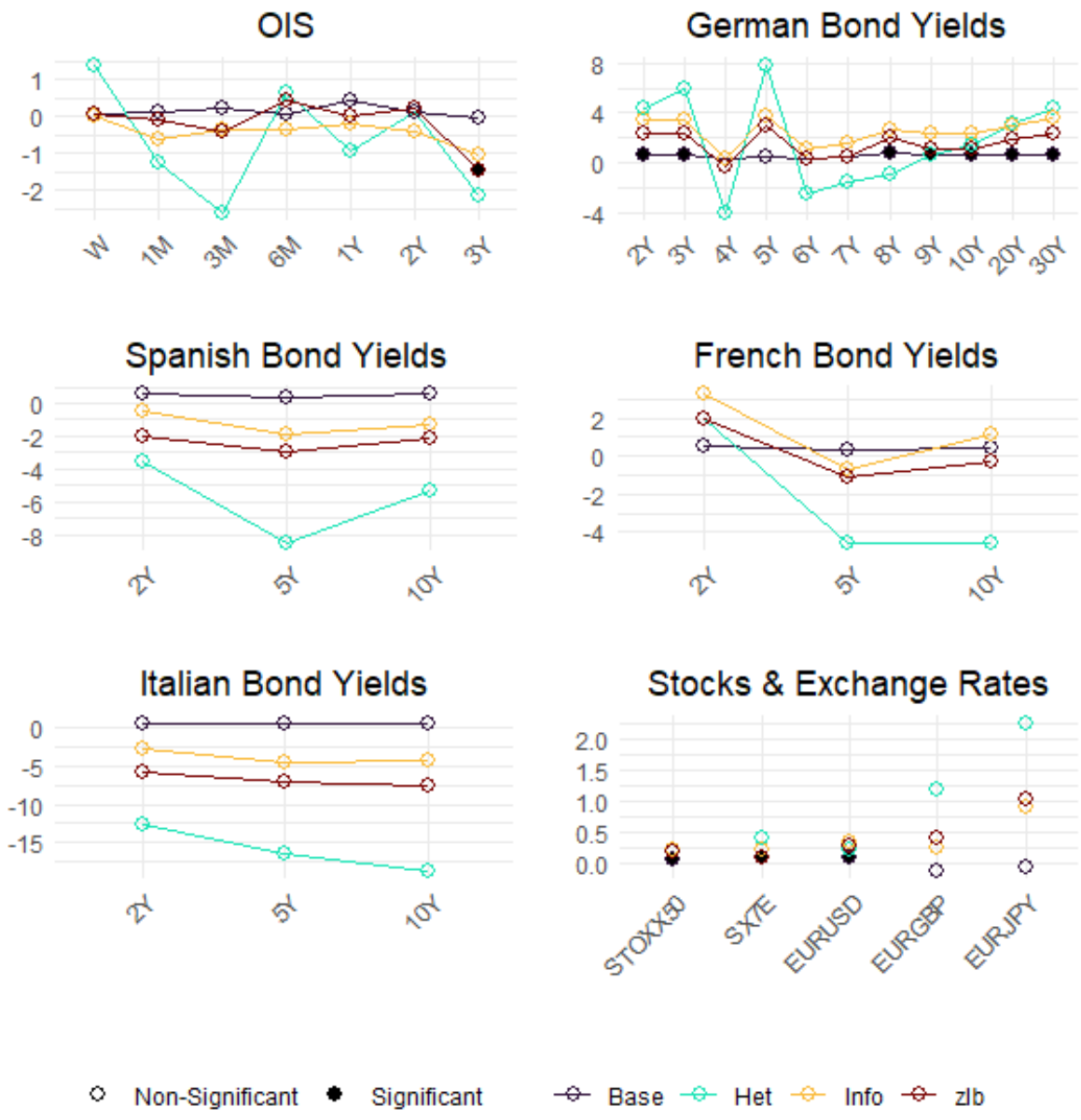

Figure 9: Results for Inflation Word Clouds for different regressions

Employment

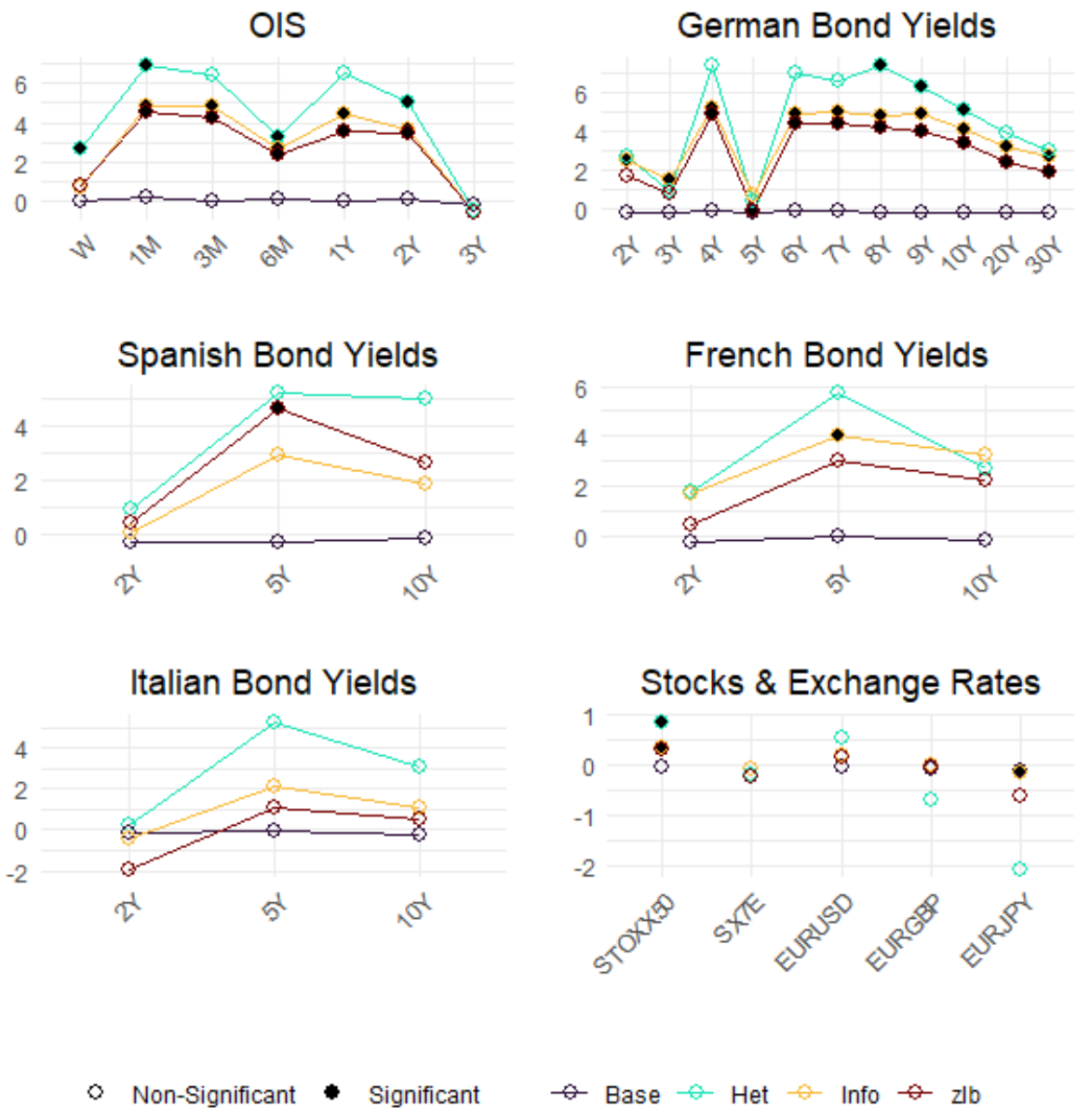

Figure 10: Results for Employment Word Clouds for different regressions

Public Finances

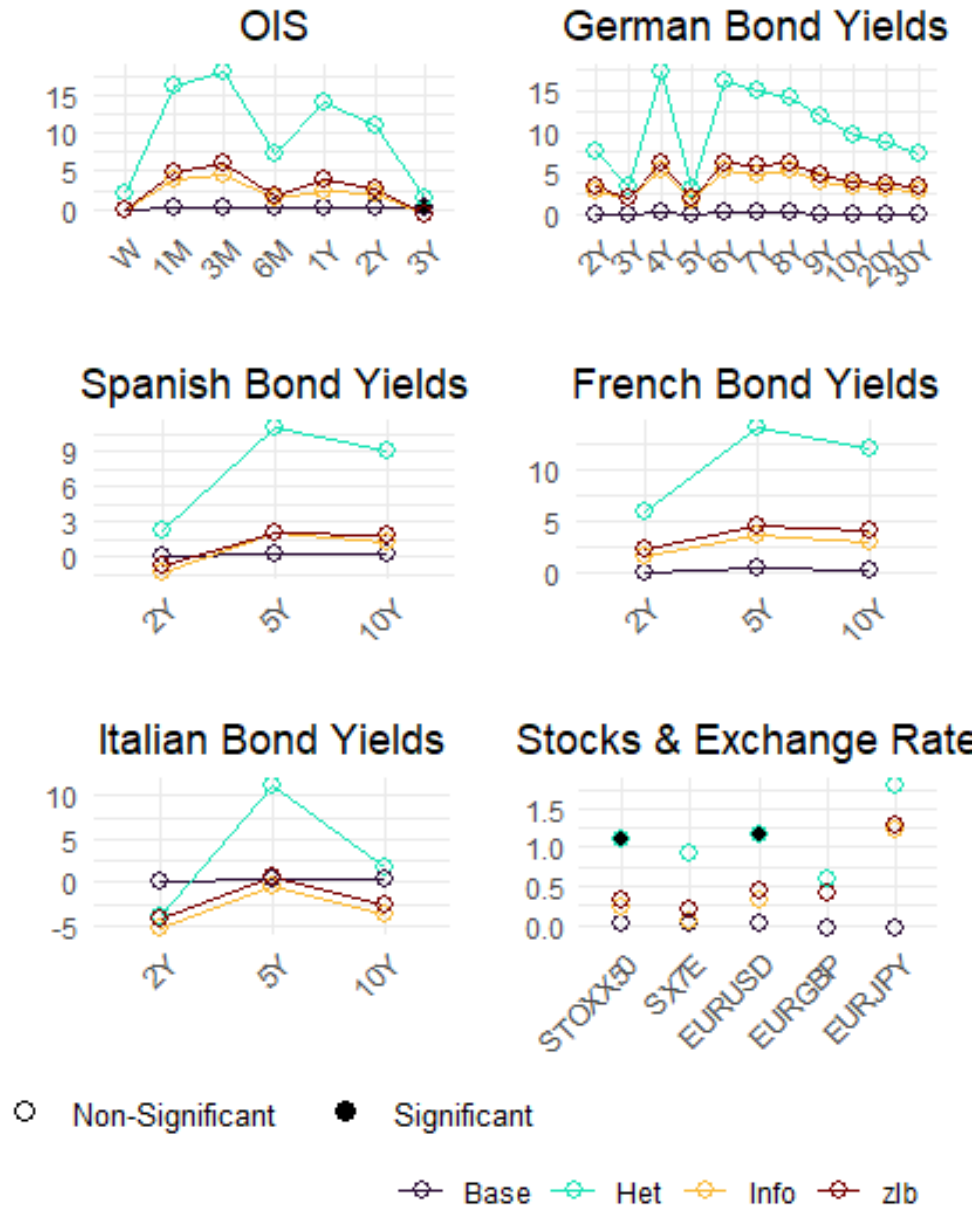

Figure 11: Results for Public Finances Word Clouds for different regressions