Reading Between the Lines: Uncovering Inflation Expectations from Multilingual Media Coverage*

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Abstract

This paper examines how households' inflation perceptions and expectations respond to European Central Bank (ECB) communication when filtered through national media in Germany, France, Italy, and Spain. Using 55,490 newspaper articles from 2013 to 2025, I construct measures of the frequency and tone of ECB-related coverage and link them to survey-based inflation perceptions and expectations. The results reveal substantial cross-country differences in both exposure and qualitative framing: German media frequently connect ECB communication to inflation, Italian media emphasize financial markets, France employs a more negative framing and Spanish coverage shows highly volatile tone. Estimates from a Bayesian VAR show stronger prominence of high inflation in media shifts inflation expectations persistently in Germany and France. Model-implied results reveal that households rely mainly on media and personal price observations when forming expectations, shifting even more toward media during inflationary periods, yet the intensity of this shift differs markedly across countries. The findings highlight the limits of centralized monetary communication in a multilingual currency union.

Preliminary Version: Please do not circulate without the author's consent.

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1 Introduction

We are beginning to understand how households are exposed and respond to central bank communication. It took sixteen years, from when Blinder et al. (2008) famously argued that central bank communication should extend beyond Wall Street to Main Street until Blinder et al. (2024) note that central banks have begun to act on this insight, aiming to shape public expectations directly. Even today, our understanding of how households are exposed to central bank communication remains limited. Studies consistently show that households are only partially informed about monetary policy and central bank objectives (Van Der Cruijsen et al., 2015; Carvalho and Nechio, 2014; Binder, 2017). Moreover, few households receive central bank communication directly (Afrouzi et al., 2015). When they do, the information is often filtered through media outlets or shaped by pre-existing beliefs.

In the European context, central bank communication is particularly challenging since a single central bank must convey its messages not only across various media outlets but also languages. The European Central Bank (ECB) faces the unique task of communicating across 20 countries (as of 2024), 15 languages, and multiple media systems. As Draghi (2014) noted, this makes coherent and consistent messaging significantly more complex. Although the ECB has improved transparency and outreach (e.g., ECB explainers "Why are stable prices important?"), most households still encounter central bank information indirectly, often without clear incentives to engage with it. And yet, the implications of monetary policy decisions are far from abstract: they affect the price of their consumption baskets, real wages, and household's mortgage rates.

This paper studies how inflation expectations of households change, when the communication by the ECB is filtered through media coverage separated by countries and languages. While the ECB communicates in a centralized way, national media translate, frame, and distribute its messages unevenly. Using text analysis methods, I show that between Germany, Spain, France and Italy there are quantitative and qualitative differences as to how households are exposed to central bank communication. Identical central bank actions are embedded in informational settings that

vary between the four countries, shaping their expectations. While quantitative exposure mainly drives how inflation is perceived, qualitative exposure affects both, households' inflation perceptions[1] and expectations, but not in all countries.

I collect print and internet media by newspapers from major daily economic newspapers in the four countries. The analysis uses a total of 55,490 articles from 2013 until 2025. I focus on how media outlets filter central bank communication before the message reaches households. These filters are both linguistic and editorial, meaning that translation, tone, and topic can differ depending on the national context. I link this media data to inflation perceptions and expectations from surveys by the European Commission together with other macroeconomic indicators. This linkage allows me to assess how quantitative and qualitative shifts in media affect expectations on a national level but accounting for national macroeconomic environments.

I apply different text analysis methods to the newspaper articles to extract two key measures: frequency and tone. The frequency measures the extent of potential exposure among households, while the tone captures the qualitative framing of the ECB's communication. By separating frequency from tone, I can distinguish the extent of exposure from the content of the message. I show that ECB's communication is often associated with inflation in German and financial market developments in Italy. Although the German media adopts a relatively neutral tone, Spain displays highly volatile swings. Thus, the combination of measures provides a nuanced picture of how households are exposed to central bank communication.

To get the broader macroeocnomic implications, I estimate a Bayesian Vector Autoregression (VAR) model that includes the media based measures alongside inflation perceptions and expectations and other macroeconomic variables. I identify how changes in the frequency and tone of the ECB's communication, filtered through media coverage, affect expectations of households. Using intertial restrictions, the analysis controls for country-specific shocks and isolates the role of national media,

[1]Inflation perceptions reflect how households believe prices have evolved over the past 12 months. In contrast, inflation expectations reflect how households believe prices will evolve over the next 12 months.

holding the ECB's core message constant.

To trace how households update their inflation expectations over time, I develop a model that uses three types of information signals: prior beliefs, media reports, and personal observations of current inflation. The model links each signal to an empirical series by combining households' beliefs about inflation with the media frequency and tone measures introduced earlier. These media indicators are complemented by food price changes, which proxy the inflation households directly observe in their daily purchases. Together, these components allow the model to estimate how strongly households weight each signal and how these weights evolve across countries and over time.

I find that inflation perceptions in Germany and Spain jump, when inflation receives more frequent exposure in the media. The median estimate of inflation expectations in Germany (France) increase by 1% (0.5%) and remain elevated for over two (one) years when a rise in inflation is being mentioned twice rather than once every hundred words in the average month. All results are orthogonal to an increase in inflation and the policy rate, underlining the forward-looking channel of media outlets in some countries but not in others. Differences in frequency and tone across countries appear to explain part of the heterogeneity between the four major economies in the euro area. Model results show that media signals and personal price observations consistently outweigh prior beliefs in all countries. Moreover, the results reveal that during inflationary periods households shift weight from personal price observations toward media when forming inflation expectations, but the magnitude and timing of this shift differ substantially across countries. The findings underline the limitation of a centralized communication in a linguistically fragmented monetary union. Despite the ECB's substantial efforts, including communication departments in each country (Draghi, 2014), significant national differences in responsiveness still persist, underscoring the challenges of conveying its message effectively across diverse media outlets and languages.

Related Literature. The paper relates to three strands of the literature. First, it contributes to the vast line of research on central bank communication and inflation expectations. Second, it adds to the literature of media as a channel for

macroeconomic fluctuations. Third, the paper contributes to the rapidly expanding research on text analysis in the context of monetary policy.

A large literature has documented that modern monetary policy operates increasingly through the management of expectations, making communication a central policy instrument. Blinder et al. (2008) provide an early overview of how central bank communication can meaningfully shape market expectations but note that its effects on the general public remains underexplored. They emphasize that this gap matters for substantial reasons: the general public is the source of central banks' democratic legitimacy and, therefore, of their institutional independence. Since then, several strands of the literature have examined the more direct effects of central bank communication on the expectations of households and firms. Binder (2017) summarizes the evidence on the rationales for, and the effectiveness of, central bank communication with households. The author finds that such communication can clarify policy intentions and reduce uncertainty, although its effects are distributed unevenly.

Another line of research emphasizes the role of intermediaries. Lamla and Lein (2014) provide early evidence that the tone and intensity of inflation-related news influence households' inflation expectations. Gorodnichenko et al. (2024) show that the media are among the most active interactors with the U.S. central bank on social media. Blinder et al. (2024) review the central bank communication literature and note that television and newspapers remain the most effective channels for reaching the general public. They also stress that, although central banks increasingly recognize the value of engaging directly with the public, this effort is still at an early stage and comes with substantial challenges.

Against this background, recent contributions highlight that the effectiveness of communication varies across subgroups and contexts. Coibion et al. (2022) demonstrate that households' expectations differ when they are exposed to direct central bank communication compared with news articles covering the same topic. Coibion and Gorodnichenko (2025) extend this argument by showing that communication strategies must account for heterogeneous information structures if central banks aim to anchor household expectations effectively.

Together, this literature demonstrates that central bank communication influences inflation expectations, but its effectiveness hinges on how messages are filtered through intermediaries and interpreted across heterogeneous audiences. Yet despite these advances, we still know little about how intermediaries shape these heterogeneous interpretations, and how different media environments condition the transmission of central bank communication to households. This paper fills that gap by examining how inflation expectations respond to central bank communication once it is mediated through different media system within a monetary union.

Beyond their role as intermediaries for central bank communication, a parallel strand of research views media as independent sources of information frictions that can drive macroeconomic fluctuations. Theoretical work highlights how the media can generate macroeconomic fluctuations. In their model, Nimark and Pitschner (2019) show that agents' reliance on media reports can propagate shocks and produce comovement beyond what fundamentals imply. Chahrour et al. (2021) further argue that shared media sources can create information traps in which misperceptions become persistent and self-reinforcing. Empirical studies support these mechanisms. Chahrour et al. (2025) show that media's systematic selection of reporting creates asymmetric changes in expectations. In financial markets, Bybee et al. (2024) demonstrate that economic news coverage systematically influences asset prices.

Together, this literature establishes media as a key information channel affecting economic behavior. However, existing work largely treats media as homogeneous, leaving open how cross-country differences in coverage influence the transmission of economic information. This is a key issue addressed in this paper.

The paper also connects to the growing literature employing text analysis methods to analyze monetary policy communication. A foundational contribution in this area, Hansen and McMahon (2016) use Latent Dirichlet Allocation and dictionary methods to extract meaningful signal from Federal Open Market Committee (FOMC) statements that affects asset prices and macroeconomic outcomes. More recently, Handlan (2022) uses a neural network on FOMC and alternative FOMC statements to show effects of central bank communication on macroeconomic vari-

ables. Aruoba and Drechsel (2024) create sentiment measures from staff economist document prepared for FOMC meetings using the dictionary by Loughran and McDonald (2011). Larsen et al. (2025) also employ Latent Dirichlet Allocation in combination with the dictionary by Loughran and McDonald (2011) to extract inflation sentiments from media reporting about the ECB in different European countries.

The current paper is closely related to Larsen et al. (2025) but differs by focusing on broader cross-country differences in reporting on the ECB, not only inflation, employing a neural network to obtain sentiments and controlling for country-specific shocks. Furthermore, it expands the analysis to include a theoretical foundation to quantify welfare implications arising from heterogeneous transmission across countries.

The remainder of this paper is structured as follows. Section 2 describes the data. Section 3 explains the text analysis methodology in use to extract frequency and tone from the data and and identifies country-specific differences in media coverage. Section 4 estimates the macroeconomic consequences of these differences in reporting. 5 presents the theoretical model. Finally, Section 6 concludes.

2 Data

To uncover the impact of central bank communication on inflation expectations of households, I collect print and internet media by newspapers. The analysis focuses on the four largest euro area economies: Germany, Spain, France and Italy. These regions are selected due to their linguistic distinctions, which facilitate a clearer separation of households in the different regions.

2.1 Newspaper Data

The study focuses on major daily economic newspapers from the four largest euro area economies: *Handelsblatt* (Germany), *Expansión* (Spain), *Les Echos* (France), and *Il Sole 24 Ore* (Italy). These outlets are selected because they share similar profiles in content, political orientation, readership, and market position, ensuring

cross-country comparability.[2] All articles mentioning the ECB were retrieved from Factiva in April 2025. The sample begins in January 2013, corresponding to the earliest date for which all four newspapers provide consistent digital archives.

In Germany, the analysis includes 19,419 articles from Handelsblatt and Handelsblatt Online referring to the ECB. Handelsblatt is Germany's leading financial daily, focusing on business, finance, and economic policy. The outlet is generally regarded as center-right and pro-market in orientation. As of 2023, its circulation reached approximately 150,000 copies, most of which were paid subscriptions but the newspaper also holds a strong online presence.

The Spanish dataset comprises 16,152 articles from Expansión that mention the ECB. Expansión is Spain's foremost economic and financial newspaper, with a strong emphasis on business, market, and policy developments. The newspaper holds a center-right and pro-market editorial stance, similar to Handelsblatt. According to Newman et al. (2025), it maintains around 110,000 paid subscriptions.

For France, the study includes 8,441 articles from Les Echos and LesEchos.fr referencing the ECB. The newspaper provides broad coverage of business, finance, and market news targeted at professional and household audiences. It is widely regarded as center-right and pro-business. In 2024, Les Echos reported approximately 140,000 paid subscriptions.

In Italy, the sample consists of 11,478 articles from Il Sole 24 Ore, including both the Digital Replica and Online editions, that mention the ECB. The newspaper specializes in economic, financial, and market reporting and holds a center-right, pro-market editorial position. Il Sole 24 Ore also maintains a strong digital presence, reaching roughly 7% of weekly internet users (Newman et al., 2025). This broad online reach enhances its representativeness among Italian economic media.

Together, these four newspapers provide a consistent and comparable representation of economic media coverage across the largest euro area economies. Their

[2]Research on intermedia agenda-setting shows that such elite media outlets often shape the agendas of other news organizations, including regional and general-interest newspapers (Zhang, 2018). Other work on the interaction between traditional and online media suggests that traditional media continue to play a dominant role in setting the news agenda that is later amplified on digital platforms and social media (Harder et al., 2017; Van Den et al., 2019).

similar editorial focus and political orientation help isolate linguistic and cultural differences in how monetary policy communication is transmitted to the public. The resulting dataset captures both the scope and tone of ECB-related reporting, forming a solid foundation for analyzing how media outlets shape inflation expectations across countries.

2.2 Inflation Perceptions and Expectations

To connect multilingual media coverage with inflation perceptions and expectations, the study uses survey data for Germany, Spain, France, and Italy. Monthly series are used to ensure comparability across countries. The sample spans from January 2013 to March 2025[3], a period covering both conventional and unconventional monetary policy phases. This time frame captures diverse macroeconomic conditions, providing a robust setting for estimating the relationship between media filtering and inflation expectations.

Inflation perceptions and expectation measures come from the European Commission's consumer surveys, which provide harmonized indicators across countries. For inflation perception, survey participants were asked: *How do you think that consumer prices have developed over the last 12 months? They have....* The possible answer choices are given by: *risen a lot (++)* (PP), *risen moderately (+)* (P), *risen slightly (=)* (E), *stayed about the same (-)* (M), *fallen (–)* (MM) and *don't know* (N). These responses are summarized through a balance statistic $B = PP + P/2 - M/2 - MM$, which translates qualitative judgments into a continuous measure of perceived inflation. Inflation expectations are collected in a similar manner, asking survey participants the following: *By comparison with the past 12 months, how do you expect that consumer prices will develop in the next 12 months? They will....* Possible answer choices are similar: *increase more rapidly (++)* (PP), *increase at the same rate (+)* (P), *increase at a slower rate (=)* (E), *stay about the same (-)* (M), *fall (–)* (MM) and *don't know* (N). The same balance formula is applied to this forward-looking question, yielding a consistent indicator

[3]For Spain, the sample is cut in September 2024 as inflation perceptions and expectations are unavailable from then on.

of expected inflation across all countries.

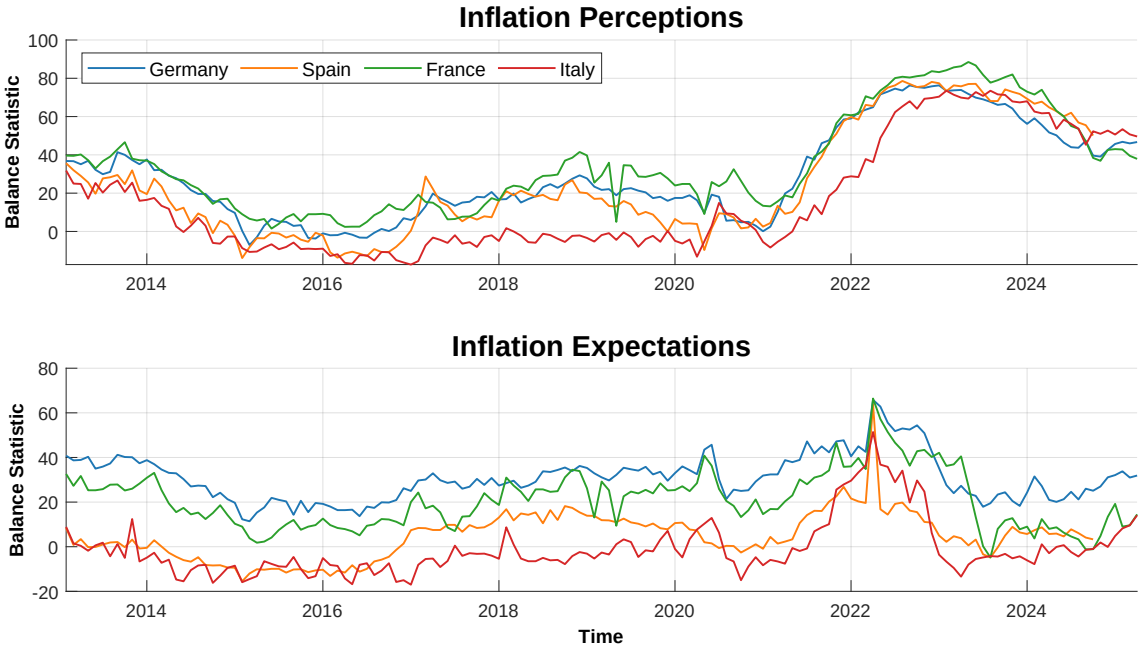
Figure 1 shows the time series of inflation perceptions and expectations for the four countries. In every country, inflation perceptions declined from 2013 to 2016 and rose again after 2021. Inflation perceptions and expectations in Germany and France move closely together, though fluctuations are more pronounced in France. In Spain, inflation perceptions and expectations rose in 2017 and remained elevated until 2021, after which they declined. Spain and Italy exhibit a faster and steeper increase in inflation expectations after 2021, followed by a sharp decline in 2023. Unlike the other countries, Italy shows virtually no change in inflation perceptions between 2017 and 2020 and also displays a delayed response relative to the others after 2021. The subsequent analysis will investigate whether some of these movements can be attributed to changes in media coverage. Although the ECB provides a series beginning in 2020, I rely on the data by the European Commission to capture the longer-run dynamics and to ensure comparability across an extended period in which substantial variations occur.[4]

2.3 Macroeconomic Data

The study uses macroeconomic data that allow for isolating how country-specific reporting channels shape household expectations while accounting for national economic environments. To control for macroeconomic conditions that might influence inflation perceptions and expectations, five additional time series for each country are added. The first is the Harmonized Index of Consumer Prices (HICP) inflation rate from Eurostat, capturing actual price developments faced by households. The second variable is real Gross Domestic Product (GDP), taken from the ECB and interpolated with industrial production following the method of Bernanke et al. (1997), to provide monthly estimates of economic activity. The third control variable is the short-term policy rate, representing the main refinancing operations rate of the ECB. Because this rate was constrained by the zero lower bound during much of the sample, ECB's total assets and liabilities is included as a the fourth variable as a proxy for unconventional monetary policy. Finally, the seasonally ad-

[4]The author will extend the analysis to also include these surveys in the results.

Figure 1: Inflation Perceptions and Expectations per Country



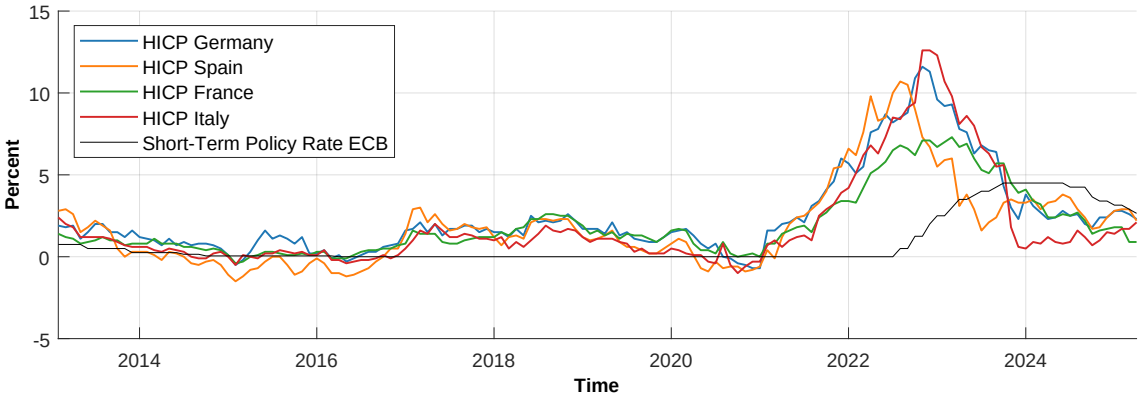
Note: The figure shows how inflation perceptions (top) and expectations (bottom) evolved over time in the countries Germany (blue line), Spain (yellow line), France (green line) and Italy (red line). These survey responses are displayed using the balance statistic provided by the European Commission described in the text. The horizontal axis shows the time horizon.

justed unemployment rate from the ECB is used to capture labor market conditions that can shape households' inflation expectations.

Figure 2 displays inflation rates for the four countries along with the ECB's short-term policy rate. The countries exhibit broadly similar patterns: inflation declined until 2015, increased through 2017, and remained elevated until 2019, after which it began to fall and reached a low point in 2021. Following this trough, inflation rose to varying levels and evolved differently across countries. In Germany, Spain, and Italy, inflation increased rapidly. Spain's inflation began to decline in mid-2022, shortly after the ECB raised the short-term policy rate, with Germany and Italy following a similar pattern soon after. France experienced a more moderate increase, reaching levels below those of the other countries, and subsequently followed Germany and Italy in the later decline. The short-term policy rate continued to rise until late 2023 and began to fall again in mid-2024. Compared with Figure 1, the rise in inflation between 2017 and 2021 did not translate into higher inflation perceptions in Italy,

nor into higher inflation expectations in Germany, France, and Italy. Moreover, inflation perceptions remain elevated in all countries even though actual inflation has fallen back to levels close to those observed in 2017.

Figure 2: Country-Specific Inflation Rates and ECB's Short-Term Policy Rate



Note: The figure shows how the Harmonized Index of Consumer Prices (HICP) inflation rate per month in the countries Germany (blue line), Spain (yellow line), France (green line) and Italy (red line). In addition, the short-term policy rate by the ECB is displayed in black. The horizontal axis shows the time horizon.

3 Quantifying Central Bank Communication Across Media and Languages

To better understand how households are exposed and respond to central bank communication, I observe how national media filter the message by the central bank. To quantify key features of media coverage, I construct two measures—frequency and tone —using natural language processing (NLP) techniques applied to newspaper data. From these two measures, I obtain substantially differences in the countries: media vary both in the frequency with which they report on core economic topics and in the tone they use to frame them. German media outlets report more frequent on the topics inflation and housing, and employ a comparatively neutral tone, whereas Spanish, French, and Italian outlets vary more in their emphasis and often adopt more pronounced tonality.

3.1 ECB Communication and National Media Filtering

ECB communication is mostly issued in English and subsequently translated to official EU languages by the central bank itself. However, the dissemination of interpretation of these messages occurs largely through national media outlets, but also the structure of national media market influences how the communication is transmitted.

Understanding how the ECB's centralized communication is distributed across diverse media outlets is crucial for grasping its impact on public perception, especially since the effectiveness of this distribution hinges on how these messages are subsequently picked up and relayed by national media outlets. The ECB primarily communicates through centralized channels, such as press conferences, official statements, and speeches, which are predominantly issued in English and then translated into the official EU languages by the ECB itself to ensure consistency and accuracy (Draghi, 2014). The translated messages are distributed through various platforms, including the ECB's website and social media. This centralized approach aims to provide a uniform message across all member states, minimizing the risk of misinterpretation at the source and maintaining a coherent monetary policy message.

The role of national media in translating and distributing ECB messages introduces a layer of complexity to the communication process. National media outlets act as intermediaries, deciding whether to cover ECB communications, which aspects to highlight, and how prominently to feature them. This selective process means that households often receive filtered versions of the ECB's messages, shaped by the editorial priorities and biases of national media systems. The extent and manner of coverage can vary significantly between countries, depending on the national context. Consequently, the same ECB message can be framed differently across countries, leading to varied public perceptions and responses.

As an example, in the press release of June 5, 2014 the *ECB introduces a negative deposit facility interest rate. [...] When deciding to lower the key ECB interest rates at its meeting today, the Governing Council of the ECB took the decision to cut the interest rate on the deposit facility to -0.10%* (European Central Bank, 2014). Les Echos in France released to following news coverage: *The ECB pulls out all*

the stops to revive the eurozone. Unique measures to avoid deflation. European leaders and financial markets welcome Mario Draghi's actions. The Handelsblatt in Germany states *The minus revolution. Banks will be penalised for hoarding money in future, the base rate is heading towards zero – ECB President Draghi is fighting deflation with every means at his disposal.* The Expansión in Spain wrote *Banks and construction companies, sectors favored by Draghi.[...] immediate positive effect on virtually all Ibex stocks, but especially on banking stocks.*[5] Although the core message of the ECB was transmitted, the way the information is embedded differs across the three journals.[6]

The structure of national media markets determines how widely and consistently ECB communication is distributed. According to the Centre for Media Pluralism and Media Freedom (2022), the risk of news media concentration is medium in Germany and high in France, Italy and Spain. In more concentrated media systems, a few dominant outlets may set the framing tone[7] and amplify central bank messaging. In contrast, fragmented or polarized media landscapes can lead to uneven or conflicting interpretations of the same message. Differences in public broadcasting roles, journalistic standards, and economic reporting cultures also affect how ECB content is selected and presented. These institutional features can significantly mediate the public's exposure to and understanding of monetary policy. In Appendix A, other national factors are discussed that might influence how households are exposed and respond to central bank communication.

3.2 Measuring Quantitative Exposure via Frequency

To measure the extent of potential exposure of households to central bank communication, I extract a quantitative feature from newspaper data using text processing. The key idea is that greater quantitative exposure to ECB news framed around specific topics—such as inflation—increases the likelihood that households associate

[5] Text translated by the Data Science Lab at the University of Bern.

[6] These excerpts are illustrative and do not capture the full context of the original articles. They should therefore be interpreted with caution.

[7] Beckers et al. (2019) show that higher concentration of media ownership leads less diverse reporting over time.

central bank actions with inflationary outcomes. This measure thus captures the informational environment through which economic expectations may form differently across countries.

The dictionary forms the foundation of the exposure measure by identifying the linguistic markers of five major economic topics. It is developed along the lines of Gardner et al. (2022) and consists of the most frequent keywords appearing in articles related to inflation, housing, labor markets, financial markets, and the overall economy. For instance, the inflation topic includes keywords such as cost, deflation, devaluation, inflation, prices, and purchasing power. The full dictionary is reported in Appendix B, which provides the complete list of keywords for each topic. Because media outlets publish in different languages, each newspaper article is analyzed in its original language—German, Spanish, French, or Italian—to preserve its linguistic and contextual nuances.

Using a predefined dictionary is suitable in this context as the media texts analyzed are general-interest articles rather than streamlined or deliberately structured communications. Unlike speeches or press releases issued directly by the ECB, these articles do not follow a fixed narrative structure, making topic inference methods such as unsupervised topic models (see, e.g., Hansen and McMahon (2016); Hansen et al. (2018)) or n-grams (see, e.g., Aruoba and Drechsel (2024)) less reliable for identifying consistent themes across countries. A dictionary approach provides a stable first filter that captures core economic concepts even when journalists use broader or more varied language. Moreover, relying on the same set of predefined topics facilitates cross-country comparability, which is central to studying how different media outlets report on a common underlying signal. This approach therefore allows the analysis to focus directly on meaningful variation in how national media emphasize economic topics rather than on variation generated by the topic-identification method itself.

The computation of exposure standardizes keyword occurrences to ensure that topic frequencies are comparable across articles and languages. Each article is searched for dictionary keywords, and each mention of a keyword increases the count of its associated topic. These counts are then aggregated at the article level and

divided by the total number of words in the article, thereby controlling for length differences. This normalization ensures that longer articles do not automatically receive higher topic counts simply because they contain more words. As a result, a short article that mentions inflation once contributes proportionally more to the inflation topic frequency than a long article mentioning it once.

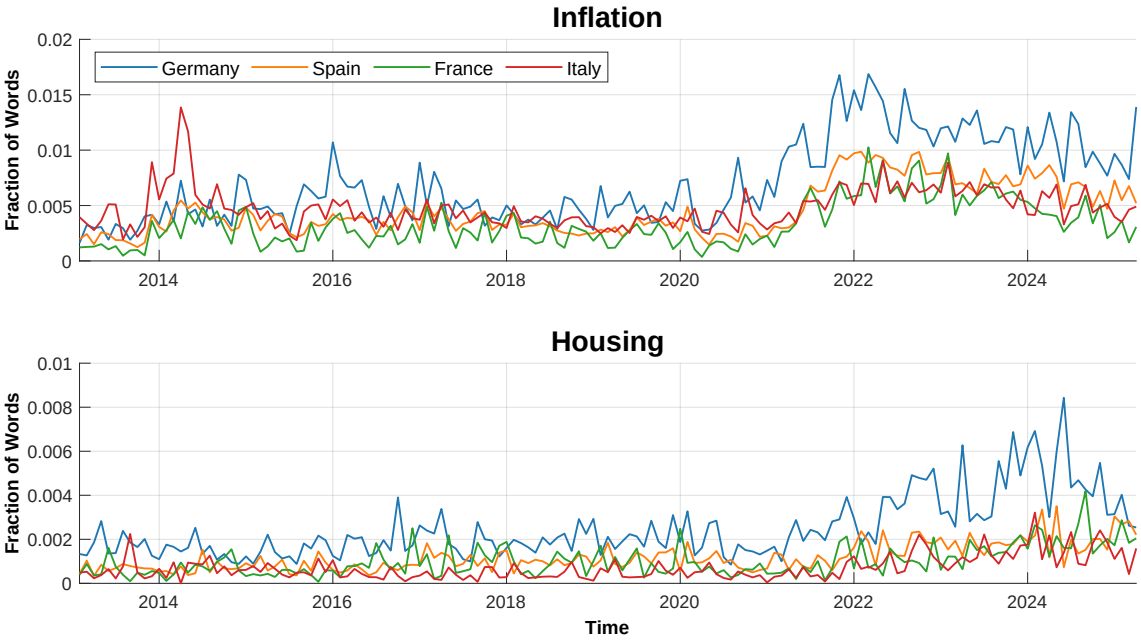
This normalized topic frequency provides a consistent quantitative measure of media exposure across countries. By aggregating these measures over time, I capture the variation in how central bank communication is filtered through the media in different national contexts. The measure thus reflects both the intensity and thematic framing of economic coverage, allowing for a systematic comparison of exposure to central bank narratives across multilingual media environments.

Figure 3 shows the frequencies of the topics inflation and housing covered in the media outlets across the four countries over the sample period. In all countries, reporting about inflation increased during the recent inflation surge, but magnitude differs across the countries. Italian media outlets covered the topic inflation more frequent around 2014 but reporting decreased afterwards. Germany features more attention to inflation and housing, especially after 2020, suggesting a stronger focus on these two topics in this country. Spanish and French media outlets devote comparatively less attention to inflation and housing over the whole timeseries.

Table 1 displays how strongly the frequencies of economic topics in media coverage differ in the four countries. In all countries, media outlets report more frequently on the topic financial than the other topics. German media outlets devote comparatively more attention to inflation, housing and financial developments, indicating a media environment, where price stability and financial conditions receive heightened emphasis. Spain and France feature lower shares for most topics, suggesting that households in these countries encounter less frequent economic framing in routine reporting. Italy shows a distinct pattern, with relatively strong coverage of financial issues but very limited discussion of housing and inflation.

These cross-country patterns indicate that central bank communication reaches households through media environments that differ markedly in the salience of core macroeconomic themes. Because reporting on inflation, housing, and financial de-

Figure 3: Monthly Mean Frequencies of Topics Inflation and Housing in Media Coverage per Country



Note: The figure shows how frequently the topic inflation (top) and housing (bottom) is mentioned on average per month in the countries Germany (blue line), Spain (yellow line), France (green line) and Italy (red line). Both topics are normalized by the number of words per article that they are mentioned in. The horizontal axis shows the time horizon.

Table 1: Mean Frequencies of Economic Topics in Media Coverage per Country

Topic	**Germany**	**Spain**	**France**	**Italy**
Inflation	0.0070 (0.0111)	0.0046 (0.0068)	0.0034 (0.0067)	0.0045 (0.0055)
Labor	0.0025 (0.0036)	0.0026 (0.0059)	0.0020 (0.0048)	0.0029 (0.0052)
Housing	0.0024 (0.0067)	0.0012 (0.0039)	0.0010 (0.0032)	0.0007 (0.0028)
Financial	0.0243 (0.0173)	0.0154 (0.0129)	0.0126 (0.0110)	0.0287 (0.0125)
Economy	0.0102 (0.0085)	0.0058 (0.0057)	0.0059 (0.0055)	0.0089 (0.0069)

Note: Mean values with standard deviations (in parentheses) of how frequent the topics inflation, labor, housing, financial and economy are covered in the media per country as a fraction of total words per article.

velopments varies both across countries and over time, the informational context surrounding central bank actions is not uniform. As a result, households interpret monetary policy signals within national media landscapes that emphasize some topics more than others, shaping how they process central bank communication. These differences in media emphasis ultimately contribute to heterogeneity in how

households form and adjust their inflation expectations.

3.3 Measuring Qualitative Exposure via Tone

Understanding how media frames central bank communication requires a systematic measure of tone. To capture this framing, I develop a qualitative indicator that assesses whether news coverage conveys a negative, neutral, or positive sentiment for each topic. The underlying assumption is that the tone associated with specific topics shapes how households form and adjust their expectations. For instance, phrases such as *inflation has increased slightly* and *inflation surged* may convey similar information but differ strongly in tone. To construct this measure, I train a multilingual NLP model to interpret media coverage in a four-step procedure: selecting a pre-trained language model, creating a multilingual fine-tuning dataset, training the model, and applying it to obtain the tone.

A multilingual NLP sentiment model is particularly useful here because it allows the articles to be analyzed in their original language, preserving the wording and tone that households actually encounter. While dictionary-based approaches are valuable, most widely used sentiment dictionaries, such as Loughran and McDonald (2011), are developed from English financial texts and therefore do not naturally reflect the broader vocabulary found in general-interest media outlets. Moreover, translating such dictionaries may miss linguistic nuances or country-specific expressions that shape how similar economic developments are described across languages. In contrast, a multilingual NLP model can learn sentiment directly from the phrasing and context used in German, Spanish, French, and Italian media. This approach ensures that tone is captured as it appears in everyday language, rather than through a financial-specific or translation-adjusted lens.

3.3.1 Select Pre-Trained Neural Network for Text Processing

A multilingual language model is essential for capturing the semantics of central bank communication as it appears across languages and contexts. For this reason, I use Multilingual RoBERTa, a natural language understanding model developed by

Conneau et al. (2020).[8] The model was trained on 100 languages and is capable of detecting the input language without the need for separate language embeddings. Its training objective, masked language modeling, requires predicting randomly hidden words within a sentence, allowing the model to learn both word meanings and sentence structures simultaneously. This approach enables Multilingual RoBERTa to represent linguistic meaning in a bidirectional way, making it particularly suitable for multilingual text analysis.

Because Multilingual RoBERTa already encodes general linguistic knowledge across 100 languages, it provides an ideal foundation for sentiment classification in multilingual data. The model can be fine-tuned to map text onto discrete categories such as negative, neutral, and positive tone. In this study, I use the base version's pre-trained word representations as a starting point, building upon its broad understanding of language to specialize it for economic contexts.[9] Such pre-trained architectures are widely used because training them from scratch would require extensive computational resources and massive datasets. This transfer learning approach allows the model to adapt efficiently to the task of identifying tone in media articles reporting about the ECB.

3.3.2 Create a Dataset for Fine-Tuning

Developing an accurate tone measure requires a dataset that reflects how media report on central bank communication in multiple languages. The model must learn to classify phrases containing specific keywords as negative, neutral, or positive, but no such financial or multilingual dataset currently exists. Although Multilingual RoBERTa understands many languages, it must be fine-tuned on text that reflects the stylistic and contextual features of media coverage about monetary policy. To address this gap, I construct a novel dataset designed specifically for this purpose.

The dataset generation process aims to approximate real newspaper language while avoiding direct overlap with the model's prediction data. I use articles from the

[8]The base model consists of 12 layers, a hidden size of 768, 12 attention heads, resulting in approximately 270 million parameters.

[9]The model was pretrained on approximately 2.5 trillion tokens across 100 languages, derived from Common Crawl data.

Swiss Broadcasting Corporation, which publishes economic news in German, French, Italian, and Spanish through its multilingual platform *SWI swissinfo.ch*. Using these texts as templates, I generate additional examples with two large language models: GPT-4.5 by OpenAI and mistral-large-2411 by MistralAI. One example of setting up such a prompt is written in Appendix C. For each topic and language, I obtain 25 examples per sentiment category (negative, neutral and positive), resulting in 3,000 training phrases in total. The generated labels were verified by two human annotators who reviewed and resolved any disagreements, ensuring a reliable ground truth for fine-tuning the sentiment model.

3.3.3 Fine-Tune the Neural Network

Fine-tuning adapts the general multilingual model to the specific task of classifying tone in central bank–related news. Each phrase in the training dataset is first converted into tokens consistent with Multilingual RoBERTa's vocabulary, which represents words in an N-dimensional space where semantically similar terms lie close together. This tokenization process enables the model by Conneau et al. (2020) to interpret linguistic nuances such as contextual differences between words like *slight increase* and *surge*. The fine-tuning stage then trains the model to associate these tokenized representations with sentiment categories.

Moreover, we want our model to learn the mapping from the provided phrases to negative, neutral and positive categories. The objective is for the model to predict category based on an unknown phrase containing one of the keywords. The model provided by Conneau et al. (2020) can not yet execute this task. Thus, in this project, I train it further with the created database without changing its original structure. Appendix D explains the training algorithm in further detail.

To train the model, I apply five-fold cross-validation, splitting the dataset into five parts so that each subset serves once as a validation set while the remaining four are used for training. Notably, I always have a training set that the model adapts its internal parameters on and a test set that it runs the model on but does not adapt its internal parameters to. Such train and test splits are important in machine learning because the models are prone to overfitting, i.e., to learn too much

from the training data, thereby being unable to predict data it has not yet seen. This procedure also implies that for the same hyperparameter described in Appendix D, I have five different parameter values, depending on the data the model was trained on.

To find the optimal hyperparameters for the model, I experiment with different combinations of the number of epochs[10] and the learning rate.[11] During these experiments, I monitor its learning ability on the training data by observing the loss to be able to correctly predict the labels of the test data (accuracy). The average loss on the training data including the accuracy on the test data over the epochs with a fixed learning rate of 1e-06 is displayed in Table 2. Based on these results, the number of epochs for the training was set to 7, as the training loss keeps decreasing but test accuracy plateaus. The model has learned most of what it can learn without overfitting

3.3.4 Obtain Tone

After fine-tuning, the model is ready to predict the tone of media content related to central bank communication. Each article is scanned for the presence of keywords, and for every instance, the surrounding phrase is extracted and passed through the fine-tuned model, which classifies it as negative, neutral, or positive. The resulting tone categories are then converted into numeric values (-1 for negative, 0 for neutral and 1 for positive) and aggregated at the article level, with normalization again by total word count to account for length differences across texts. This procedure ensures that the tone measure is comparable both across languages and across time.

The resulting tone index provides a consistent qualitative indicator of how central bank communication is represented in different country-specific media environments. By aggregating this measure across time and languages, I capture the evolution of media framing that households are exposed to in their respective national contexts. This allows for systematic cross-country comparisons of qualitative exposure

[10]The number of epochs defines how often the model sees the same data set to adapt its parameters.

[11]The learning rate defines by how much the neural network adapts its internal parameters after each iteration.

Table 2: Training Loss and Test Accuracy Across Epochs

Epoch	**Average Training Loss**	**Test Accuracy**
0	0.5400	0.8177
1	0.3340	0.8469
2	0.2147	0.9003
3	0.1154	0.8983
4	0.0707	0.9134
5	0.0654	0.9154
6	0.0269	0.9144
7	0.0373	0.9265
8	0.0179	0.9134
9	0.0079	0.9204
10	0.0153	0.9144

Note: Average training loss reflects how well the model fits the training data during each epoch, while test accuracy measures how well it generalizes to unseen data. Monitoring both indicators helps determine when further training no longer improves performance: training loss may continue to fall even when test accuracy plateaus or declines, signaling overfitting.

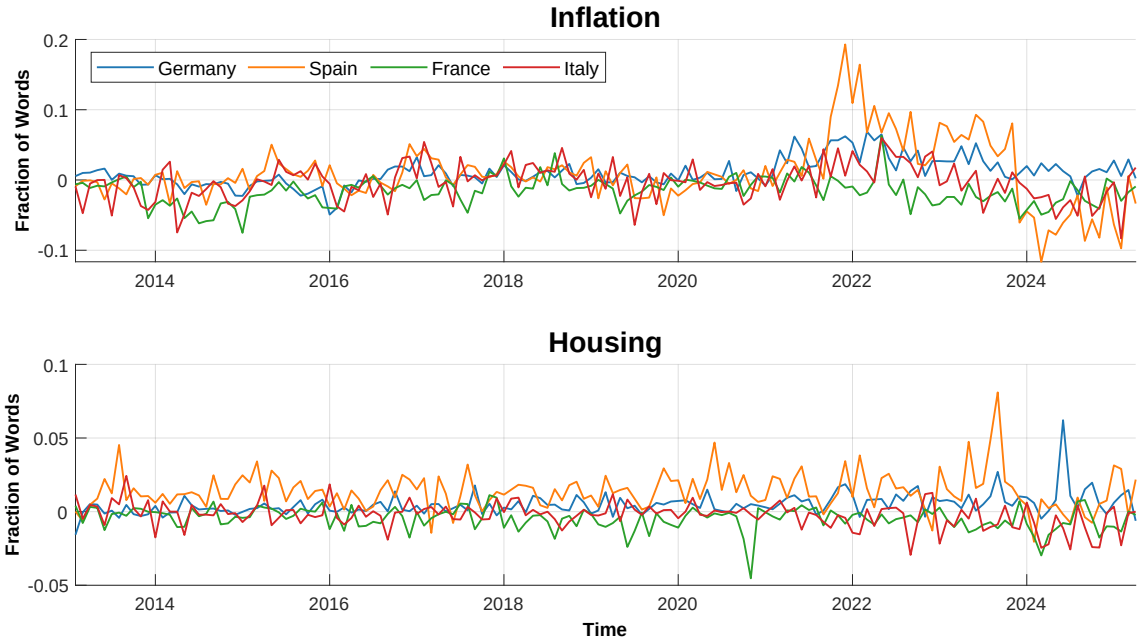
to central bank narratives, shedding light on how the tone of communication shapes expectations across countries.

Figure 4 shows the tone index for inflation and housing for the four countries over time. Overall, the tone used by media to talk about inflation became more intense[12] during the inflation surge. Media in Germany seem to use moderate tone when talking about inflation and housing, showing less fluctuations over the whole period. Spanish media coverage seem to use more opposite tones, showing big variations for both topics. In France media outlets generally use a more negative tone when reporting about inflation and housing. Italian coverage shows moderate variations for both topics and turns more negative starting in 2023.

Table 3 highlights substantial cross-country differences in the tone with which

[12]The model sees higher inflation as negative, to match it to the data I flip the sign for easier interpretation of the results. This becomes more important in the next section, when talking about the macroeconomic consequences.

Figure 4: Monthly Mean Tone of Topics Inflation and Housing in Media Coverage per Country



Note: The figure shows the tone used by media to report on the topic inflation (top) and housing (bottom) on average per month in the countries Germany (blue line), Spain (yellow line), France (green line) and Italy (red line). Both topics are normalized by the number of words per article that they are mentioned in. The horizontal axis shows the time horizon.

key economic topics are discussed in the media. German coverage is generally more neutral to mildly positive across topics, suggesting a relatively balanced interpretation of central bank–related developments. Spain displays the most positive tone overall but also exhibits the largest variability, indicating a more volatile and event-driven pattern of media reactions. In contrast, French media tend to adopt slightly negative tones for most topics, particularly financial and inflation reporting, implying a more cautious or skeptical framing of economic conditions. Italy shows a mixed pattern with moderately positive labor and economy tones but comparatively negative financial and inflation tones, reflecting a fragmented information environment.

These results show that the tone used to report on inflation, housing, and broader economic developments differs markedly across countries. While German media adopt a relatively stable and neutral tone, Spain displays highly volatile swings and France consistently employs a more negative framing, with Italy falling in be-

Table 3: Mean Tone of Economic Topics in Media Coverage per Country

Topic	**Germany**	**Spain**	**France**	**Italy**
Inflation	0.0079 (0.0885)	0.0098 (0.2017)	-0.0168 (0.0960)	-0.0057 (0.1492)
Labour	0.0152 (0.0496)	0.0175 (0.2132)	0.0054 (0.0916)	0.0246 (0.1503)
Housing	0.0048 (0.0445)	0.0137 (0.1199)	-0.0047 (0.0442)	-0.0015 (0.0620)
Financial	0.0107 (0.1526)	0.0296 (0.3623)	-0.0545 (0.1658)	-0.0537 (0.4516)
Economy	0.0220 (0.0932)	0.0561 (0.2255)	-0.0053 (0.0958)	0.0211 (0.2119)

Note: Mean values with standard deviations (in parentheses) of tone used by the media to report on the topics inflation, labor, housing, financial and economy per country as a fraction of total words per article.

tween. The tonal differences imply that households are repeatedly exposed to national narratives that vary in both direction and intensity, especially during periods of macroeconomic stress. As a result, the perceived stance of the central bank are filtered through framings that diverge substantially across country-specific media environments.

Taken together, the frequency and tone results indicate that households encounter central bank communication within media landscapes that differ along two dimensions: how much attention is devoted to key macroeconomic topics and if these topics are framed negative, neutral, or positive. Countries not only emphasize quantitatively different economic themes, such as Germany's stronger focus on inflation and Italy's heightened attention to financial developments, but also attach distinct qualitative patterns to their reporting. These combined differences mean that identical central bank actions are embedded in informational environments that vary in both salience and sentiment. Consequently, households interpret and update their inflation expectations within national media contexts that shape not only what economic issues they notice but also how they feel about them.

4 Macroeconomics Implications

Understanding how the media's frequency and tone of central bank communication influence macroeconomic outcomes is crucial for linking the media filter to households' behavior. To examine these effects, I estimate a Bayesian VAR model

that includes both NLP-based measures—tone and frequency—alongside inflation perceptions, inflation expectations, and other key macroeconomic variables. Using inertial restriction, I find that inflation perceptions in Germany and Spain rise when media coverage on inflation becomes more frequent. Moreover, the tone of inflation-related news positively affects inflation perceptions and expectations among German and French households, indicating that qualitative aspects of communication play a distinct macroeconomic role.

4.1 Bayesian VAR Methodology

The Bayesian VAR framework provides a structured way to estimate how media tone and frequency affect inflation perceptions, inflation expectations, and broader macroeconomic dynamics. Following Giannone et al. (2015) and Lenza and Primiceri (2022), this approach incorporates prior information into the estimation and accommodates uncertainty in both parameters and hyperparameters.[13] As this framework forms the empirical foundation of the analysis, I summarize its key components below. Consider the following Bayesian VAR:

$$\begin{aligned} Y_t &= B_0 + B_1 Y_{t-1} + \cdots + B_p Y_{t-p} + u_t \\ u_t &\sim N(0, \Sigma), \end{aligned} \tag{1}$$

where Y_t is an $n \times 1$ vector of macroeconomic variables as described in Section 2, u_t is an $n \times 1$ vector of the reduced-form innovations, and $B_0, B_1, \ldots, B_p$ and Σ are matrices of suitable dimensions containing the model's unknown parameters. N denotes a normal density. Consistent with most papers in the literature, I set the lag order, p, to 6. I assume that the reduced-form innovations, u_t, are a linear combination of n orthogonal structural disturbances, ε_t, which I write as $u_t = A_0 \varepsilon_t$. Here, A_0 is the impact matrix of the structural disturbances at $t = 0$.

I estimate the Bayesian VAR as described in Lenza and Primiceri (2022). As suggested by the authors, I define $\beta \equiv vec([B_0, B_1, \ldots, B_p]')$ and $X_t \equiv I_n \otimes x_t' \equiv I_n \otimes [1, Y_{t-1}', \ldots, Y_{t-p}']$, where I_n denotes an $n \times n$ identity matrix. Substituting these

[13] The key difference between the two papers is that Lenza and Primiceri (2022) account for the increased volatility following the COVID-19 pandemic.

definitions, Equation 1 becomes:

$$Y_t = X_t\beta + u_t \tag{2}$$

This representation enables efficient sampling from the posterior distribution of β and Σ, given suitable priors.

The hierarchical Bayesian structure allows the data to inform the strength and tightness of prior beliefs. Following Giannone et al. (2015), I treat the hyperparameters as additional parameters to be estimated, with the prior distribution of the coefficients belonging to the Normal–Inverse-Wishart family:

$$\Sigma \sim IW(\Psi; d) \tag{3}$$

$$\beta|\Sigma \sim N(b, \Sigma \otimes \Omega), \tag{4}$$

where IW denotes the Inverse-Wishart density and the elements Ψ, d, b and Ω are functions of a lower dimensional vector of hyperparameters. Through this hierarchical approach, the prior hyperparameters are assigned hyperpriors, and the marginal likelihood is used to explore the full posterior hyperparameter space.

Setting the hyperparameters ensures both statistical coherence and empirical plausibility. I set the degrees of freedom of the Inverse-Wishart distribution to $d = n + 2$, the minimum value that guarantees the existence of the prior mean of Σ, equal to $\Psi/(d - n - 1)$. The matrix Ψ is diagonal, with hyperparameters ψ on the main diagonal. For β, I use a Gaussian prior conditional on Σ. A version of the Minnesota prior introduced by Litterman (1979). This prior assumes that each variable follows a random walk process, possibly with drift, and defines the first and second moments as follows:

$$E\left[(B_s)_{ij}|\Sigma\right] = \begin{cases} \mu & \text{if } i = j \text{ and } s = 1 \\ 0 & \text{otherwise,} \end{cases}$$

$$Cov\left[(B_s)_{ij}(B_r)_{hm}|\Sigma\right] = \begin{cases} \lambda^2 \frac{1}{s^2} \frac{\Sigma_{ih}}{\psi_j/(d-n-1)} & \text{if } m = j \text{ and } r = s \\ 0 & \text{otherwise,} \end{cases}$$

The hyperparameters μ and λ govern persistence and tightness, respectively. I set μ to 0.5 for real GDP growth and inflation, reflecting their relatively low serial

correlation during the sample period, and μ to 0.9 for other variables such as interest and unemployment rates, inflation perceptions and expectations, consistent with their high persistence. The hyperpriors for λ and ψ follow the data-driven approach proposed by Giannone et al. (2015). This specification ensures a balance between flexibility and empirical realism in capturing the effects of media communication.

I implement the estimation using the routines from Lenza and Primiceri (2022), available on Giorgio Primiceri's website. My implementation diverges from the source code in one respect: I impose stationarity on the VAR throughout the Markov Chain Monte Carlo sampling. Specifically, I accept a draw for the VAR parameters only if it satisfies the stationarity condition; otherwise, I redraw. This ensures that the posterior inference reflects economically meaningful dynamics.

4.2 Identification

Identifying structural disturbances within the Bayesian VAR is essential for linking media-driven shocks to macroeconomic outcomes. I adopt an agnostic identification strategy based on inertial restrictions, which imposes minimal structure on the data and avoids strong priors about the sign or timing of shocks.[14] These restrictions are implemented through a Cholesky decomposition of the covariance matrix of reduced-form innovations from Equation 1.

This decomposition enables the extraction of mutually orthogonal shocks that can be interpreted as structural disturbances. By ordering the variables appropriately, I can isolate the effects of the media measures—frequency and tone—after accounting for standard macroeconomic innovations. To control for country-specific characteristics, I first identify shocks to inflation, real GDP, and monetary policy before introducing the media variables. This step ensures that the residual variation attributed to tone and frequency captures information dissemination rather

[14]The identification strategy is agnostic in the sense that it imposes only minimal structure on the data. It precludes the concerns raised by Baumeister and Hamilton (2015) about identification via sign restrictions. The authors argue that when using sign restrictions, the posterior distribution of the shocks' IRFs potentially reflects—or is even dominated by—priors about the IRFs that are implicit in the sign restrictions imposed by the researcher.

than structural country effects. The resulting identification framework allows me to trace the macroeconomic consequences of media coverage filtered through national contexts.

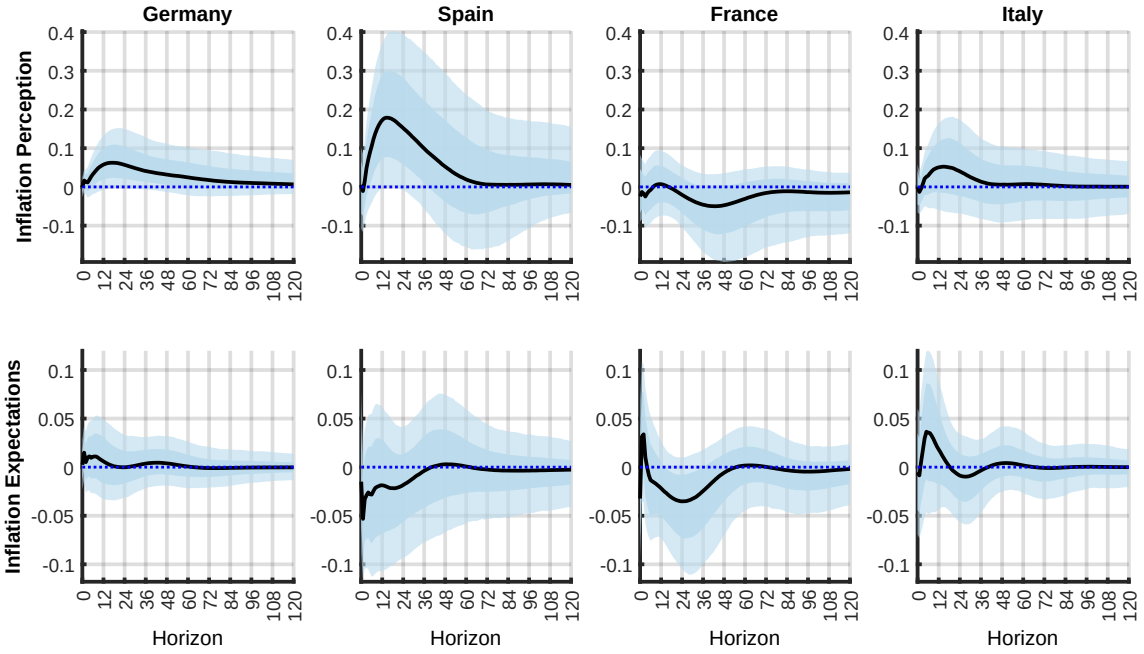
4.3 Media Coverage, Inflation Perceptions and Expectations

The Bayesian VAR with inertial identification allows me to quantify how media-based measures of frequency and tone shape households' inflation perceptions and expectations across the four countries.[15] These innovations are normalized to reflect a 100-basis-point increase in each measure per article per month, which ensures a meaningful comparison across countries and across media. The setup isolates the effect of media communication by constructing shocks that are orthogonal to contemporaneous changes in inflation, real GDP and monetary policy. As a result, the impulse responses reflect changes attributable solely to media-filtered central-bank communication and abstract from country-specific shocks.

The responses to the frequency shock show how households react when the topic of inflation receives more quantitative exposure in the media. Under the normalization, this corresponds to the topic inflation being mentioned twice rather than once every hundred words in the average month. In this setting, as shown in Figure 5, inflation perception rise in Germany and Spain, with effects persisting for almost two years in Germany and roughly one year in Spain. Because this innovation is orthogonal to actual inflation and the policy rate on impact, these responses indicate that households react to increased media attention rather than to economic conditions or monetary policy shifts. The pattern suggests that more frequent reporting on inflation raises the prominence of price developments for households in these two countries. In contrast, inflation perceptions in France and Italy, as well as inflation expectations in all four countries, remain largely unresponsive to higher media frequency.

[15]The reaction of inflation perceptions and expectation to the media-based innovations are of similar magnitude than the innovation to inflation and the monetary policy. Complete results of all macroeconomic variables are displayed in Appendix E.

Figure 5: Impulse Response Functions from the Innovation to Media Frequency

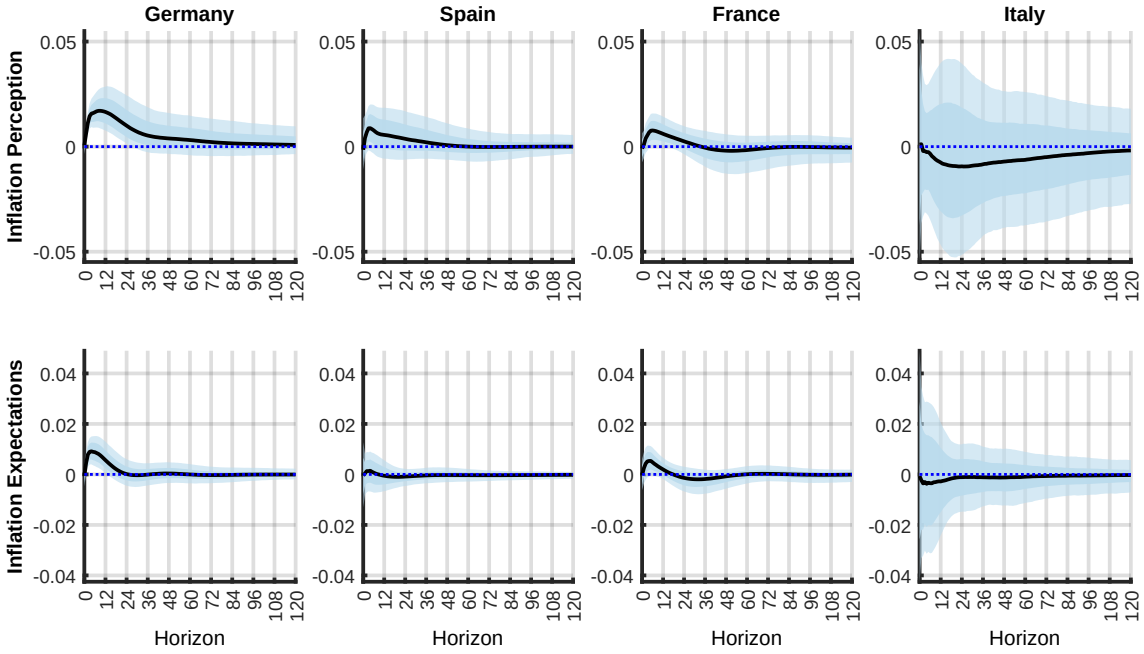


Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified with the innovation to media frequency about inflation. The impulse responses are normalized to a 100-basis-point increase in the average number of mentions of the topic inflation per article per month. The figures display the responses of inflation perceptions and inflation expectations in the four countries: Germany, Spain, France, and Italy. The horizontal axis shows the time horizon in months.

The responses to the tone shock reveal how households react when inflation is discussed in a more positive qualitative context. The normalization implies that as favorable mentions of inflation increase by 1% per article relative to the baseline frequency of coverage in the average month. As shown in Figure 6, in Germany and France, both inflation perceptions and expectations rise significantly and persistently following a tone innovation. Because this shock is again orthogonal to inflation and policy rates on impact, the results are consistent with the idea that qualitative communication in the media acts as a form of forward guidance for households. This forward-looking channel appears to influence how households interpret future price developments, especially where media tone is more strongly linked to perceptions of central-bank communication. Meanwhile, Spain and Italy show no comparable response, suggesting substantial cross-country heterogeneity in how tone-based communication is internalized.

Taken together, the results show that media frequency and media tone influence

Figure 6: Impulse Response Functions from the Innovation to Media Tone



Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified with the innovation to media tone about inflation. The impulse responses are normalized to a 100-basis-point increase in the average tone surrounding the topic inflation per article per month. The figures display the responses of inflation perceptions and inflation expectations in the four countries: Germany, Spain, France, and Italy. The horizontal axis shows the time horizon in months.

households' inflation beliefs through distinct channels. Quantitative exposure primarily affects inflation perceptions in countries where inflation becomes more salient through repeated reporting, while qualitative exposure shapes both perceptions and expectations where households appear attuned to media-mediated forward guidance. These findings highlight that country-specific media environments condition how central-bank communication is interpreted by the public. Overall, the evidence underscores the importance of understanding media structures when evaluating the transmission of monetary policy communication to household inflation expectations. The full set of macroeconomic reactions are displayed in Appendix E.

5 Information Signals and Inflation Expectations

To uncover why households inflation expectations react differently in the countries and over time, I develop a model that accounts for some of the changes. Similar to

Lamla and Lein (2014), I assume a representative consumer who forms expectations about future inflation π_{t+1} based on (i) a prior belief and (ii) media reports. In addition, she has (iii) her own observation of current inflation. The representative consumer holds normally distributed prior beliefs,

$$\Pi_t \sim \mathcal{N}(\pi_t, \sigma_\pi),$$

about future inflation π_{t+1}. The consumer also receives V independent normally distributed media reports

$$\psi_{v,t} \sim \mathcal{N}(\pi_{t+1},\, \sigma_\psi), \qquad v = 1, \ldots, V,$$

and M independent normally distributed private observations of inflation

$$\theta_{m,t} \sim \mathcal{N}(\pi_{t+1},\, \sigma_\theta), \qquad m = 1, \ldots, M.$$

These private observations can be seen as personal shopping experience or utility bills that need to be payed.

Let $\bar{\psi}_t = \frac{1}{V}\sum_{v=1}^{V} \psi_{v,t}$ and $\bar{\theta}_t = \frac{1}{M}\sum_{m=1}^{M} \theta_{m,t}$ denote the average signals from the media and own observations, respectively. Given conditional independence of all signals, the posterior distribution of π_{t+1} is normal with mean

$$E_t(\pi_{t+1} \mid \bar{\psi}_t, \bar{\theta}_t) = \rho_{\pi,t}\pi_t + \rho_{\psi,t}\bar{\psi}_t + \rho_{\theta,t}\bar{\theta}_t, \tag{5}$$

and variance

$$\sigma^2_{\text{post},t} = \left(\frac{1}{\sigma_\pi} + \frac{V}{\sigma_\psi} + \frac{M}{\sigma_\theta}\right)^{-1}. \tag{6}$$

The weights on the prior, media signals, and private observations are given by

$$\rho_{\pi,t} = \frac{1/\sigma_\pi}{\Lambda_t}, \qquad \rho_{\psi,t} = \frac{V/\sigma_\psi}{\Lambda_t}, \qquad \rho_{\theta,t} = \frac{M/\sigma_\theta}{\Lambda_t},$$

where

$$\Lambda_t \equiv \frac{1}{\sigma_\pi} + \frac{V}{\sigma_\psi} + \frac{M}{\sigma_\theta}, \qquad \rho_{\pi,t} + \rho_{\psi,t} + \rho_{\theta,t} = 1.$$

Thus, the consumer's inflation expectations is a weighted average of her prior belief, the average media report, and her private observation of inflation. An increase

in the number or precision of media reports (higher V or lower σ_ψ) raises the precision of the average media signal $\bar{\psi}_t$ and therefore increases the weight $\rho_{\psi,t}$, shifting weight away from the prior and from private information. Likewise, an increase in the number or precision of private observations (higher M or lower σ_θ^2) raises the precision of $\bar{\theta}_t$ and increases $\rho_{\theta,t}$.

To estimate the model parameter in Equation 6, I link each component of household information to suitable empirical series. The prior belief is anchored in households' inflation perceptions, which the literature consistently identifies as a central determination of inflation expectations (see, e.g., Jonung (1981) and Weber et al. (2025)). The average media reports that the households observe are captured through the tone measure developed earlier and paired with the frequency measure that quantifies the volume of coverage. These two indicators jointly reflect the information set that reaches households through news outlets and therefore serve as the basis for the media signal in the model. The household's personal observation of inflation is represented by the Eurostat monthly food price monitor, which closely tracks the price changes individuals encounter in everyday consumption. Together, these series allow the representative consumer in the model to update her beliefs about future inflation using one media signal and one private signal per period.

The estimated parameters in Table 4 indicate how strongly households respond to each of the three information components. The results show that the estimated variance of underlying inflation is high across all countries, implying that households place relatively limited weight on their prior beliefs when updating expectations. Media signals appear most precise in Spain, followed by Germany, Italy, and France, suggesting cross-country differences in the informativeness of media coverage. Private observations are less precise than media in Germany and Spain, roughly equally precise in Italy, and more precise in France, indicating that the salience of private observation varies across contexts. These comparisons reveal how the model allocates belief updating between media and personal observation, with notable heterogeneity across countries.

The model-implied inflation expectations displayed in Figure 7 reproduce the broad dynamics of survey expectations but exhibit several systematic deviations.

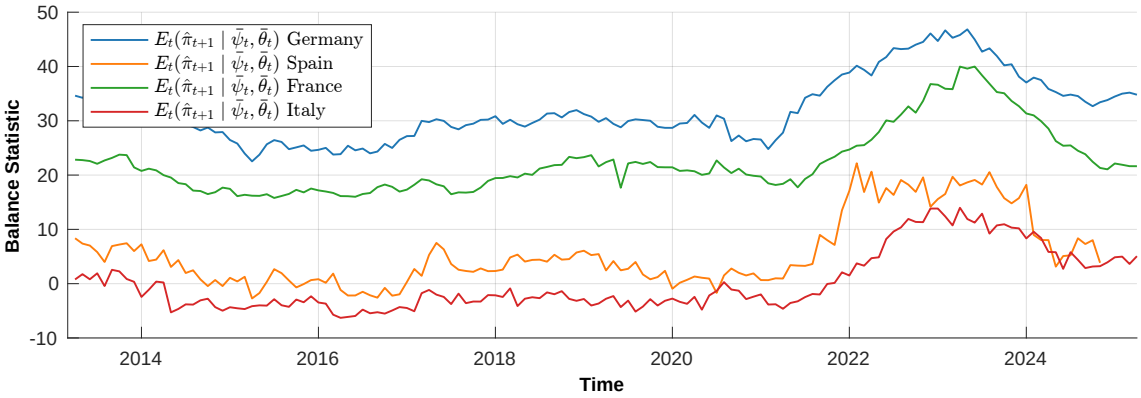
Table 4: Estimated Parameter Values by Country

Parameter	DEU	ESP	FRA	ITA
σ_π	0.0475 (0.0000)	0.0573 (0.0000)	0.0940 (0.0038)	0.0955 (0.0016)
σ_ψ	0.0156 (0.0006)	0.0079 (0.0001)	0.0506 (0.0294)	0.0201 (0.0558)
σ_θ	0.0207 (0.0005)	0.0299 (0.0136)	0.0191 (0.0000)	0.0231 (0.0021)

Note: The table shows the model estimates for the parameter values of σ_π, σ_ψ and σ_θ for the four countires including p-values in parenthesis.

The estimated series track the rise in expectations from 2017 to 2021 in Germany, Spain, and France, mirroring patterns in the survey data for these countries. From 2021 onward, the estimated expectations continue to rise, peaking earlier in the model than in the data for Germany and France but matching the timing more closely in Spain and Italy. The decline from these peaks sets in around mid-2024 in the model, which occurs earlier in the survey benchmarks for all countries. Overall, the estimated expectations capture the main direction of movements but smooth or shift certain features observed in the actual data.

Figure 7: Estimated Inflation Expectations

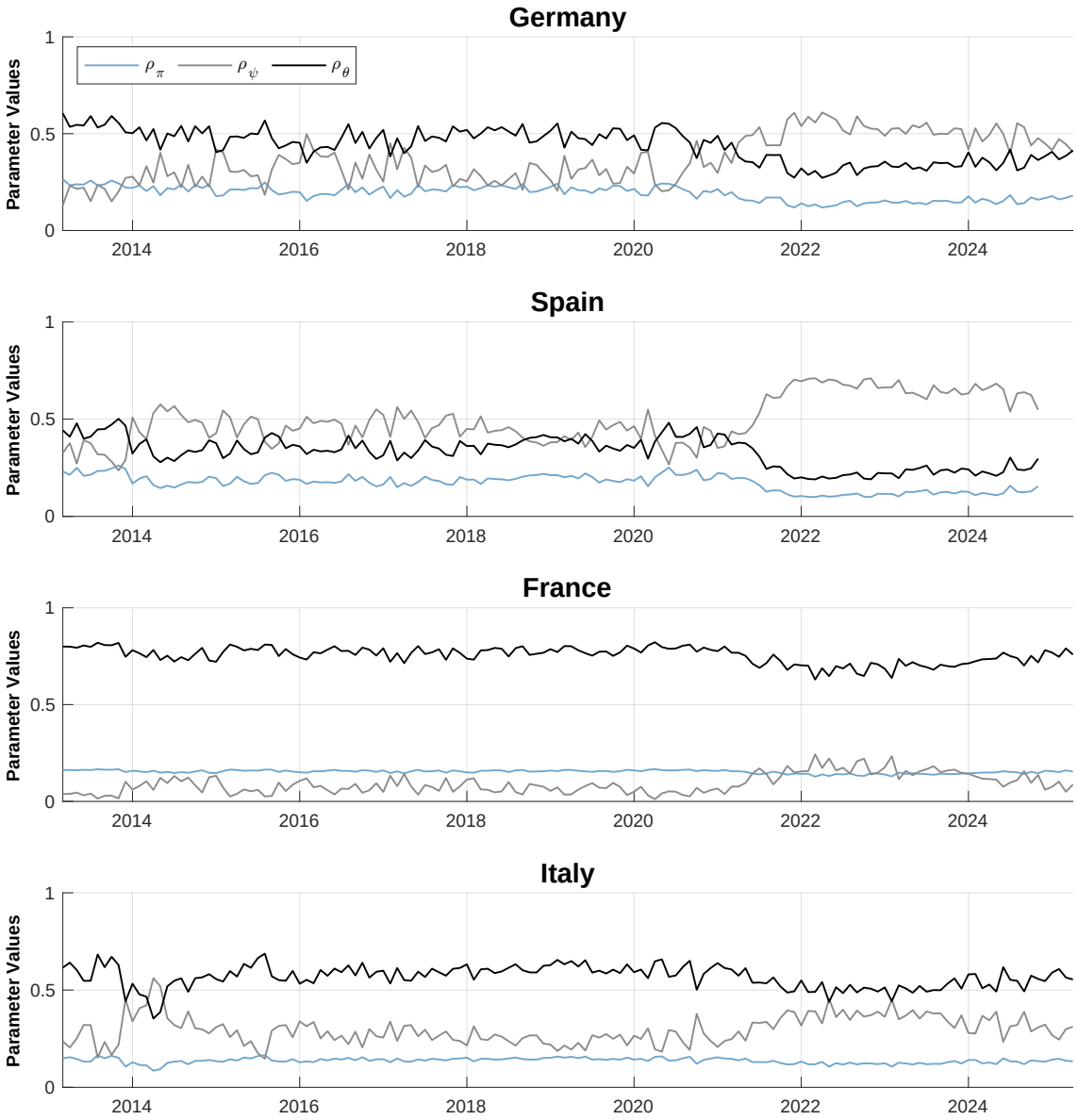


Note: The figure shows the model estimates of inflation expectations, $E_t(\hat{\pi}_{t+1} \mid \bar{\psi}_t, \bar{\theta}_t)$, per month in the countries Germany (blue line), Spain (yellow line), France (green line) and Italy (red line).

The evolution of the model-implied weights in Figure 8 shows how households shift attention across prior beliefs, media reports, and private observations over time. The estimated weights on prior beliefs remain consistently low for all countries, reinforcing the earlier evidence that perceptions contribute little to updating once new information becomes available. The onset of the inflation surge in 2021 is associ-

ated with a pronounced rise in the weight on media reports, which simultaneously reduces the weight placed on private observations. In Germany and Spain, media and private observations contribute similarly before 2021, after which media clearly dominate the updating process. In France and Italy, private observations initially play the larger role, yet these countries also exhibit a post-2021 shift toward media, with Italy nearly converging to an equal reliance on both sources.

Figure 8: Estimated Parameter Weights for Consumer's Inflation Expectations



Note: The figure shows the model estimates for the parameter weights for the consumer's inflation expectations of the prior belief (ρ_π; blue line), the media report (ρ_ψ; grey line) and her private observation of inflation (ρ_θ; black line) over time.

Taken together, the results show that households update their inflation expectations primarily through media and personal observations rather than through persistent prior beliefs. Media become particularly influential during periods of rising inflation, especially after 2021, when the volume and tone of coverage intensify. Although the model tracks broad movements in survey expectations, it differs in timing and magnitude, highlighting the complexity of expectation formation. Overall, the evidence suggests that country-specific media environments meaningfully shape how households interpret inflation developments.

6 Conclusion

The analysis demonstrates that the way households are exposed and respond to central bank communication depends critically on the media environments through which they receive it. Even when the ECB delivers a centralized and consistent message, national media filter this information in ways that introduce substantial variation across countries. By separating frequency from tone, the analysis reveals that quantitative exposure primarily affects inflation perceptions, while qualitative exposure can shape both inflation perceptions and expectations in certain countries. These differences are not driven by underlying macroeconomic developments but by the way national media outlets frame and prioritize economic topics. As a result, despite the ECB's substantial efforts to strengthen its outreach, the paper shows that significant national differences in households' responsiveness still persist, underscoring the challenges of conveying a centralized message effectively across diverse media outlets, languages, and editorial environments.

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A Understanding National Context

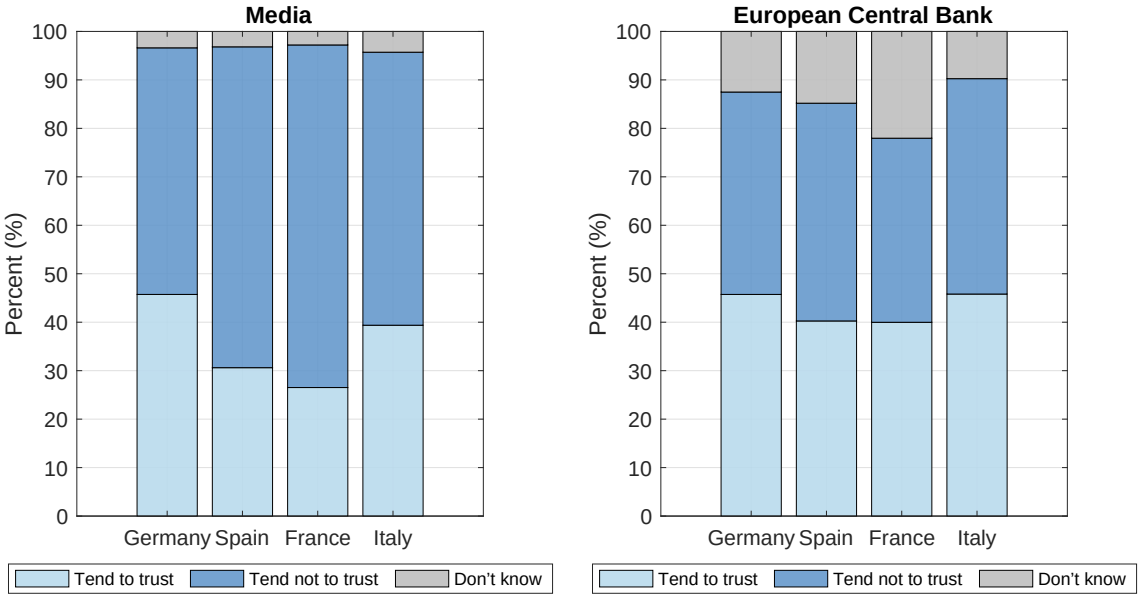
The difference observed between countries may reflect not just linguistic filtering but broader structural, cultural and institutional factors. Such factors can shape how households and firms receive, understand and respond to central banks' communication. Understanding these national contexts is crucial for interpreting the effects of ECB communication.

Trust in media is central to whether households engage with information about monetary policy presented by media outlets. When audiences distrust traditional media outlets, they are less likely to absorb or act upon coverage of central bank decisions, even when exposure is high. Walder et al. (2024) show that trust in political institutions is strongly tied to traditional media use, underlining the media's role in shaping public understanding. In countries where media outlets are perceived as reliable, messages from the ECB are more likely to influence inflation expectations effectively. Conversely, where trust is low, the link between central bank communication and household behavior weakens. As shown in Figure 9, trust in media varies notably across countries, with Germany (46%) and Italy (39%) reporting higher

levels than Spain (31%) and France (27%), illustrating an uneven foundation for communication effectiveness.

Trust in the central bank itself shapes how households interpret and react to monetary policy messages. Christelis et al. (2020) show that trust in the ECB reduces inflation expectations on average and significantly reduces uncertainty about future inflation. This indicates that even clear and consistent communication cannot succeed if the public doubts the institution's credibility. Similarly, Brouwer and de Haan (2022) show that those who trust the ECB align their expectations more closely with its inflation target, reinforcing the role of confidence in policy transmission. Data from European Commission (2021) reveal that general trust in the ECB differs only slightly across countries. However, 22% of the participants in France didn't know whether they should trust the ECB compared to 14% in Spain, 12% in Germany and 10% in Italy. In the same study, participants were also asked if they have heard of the ECB. In Germany 94% had heart of the ECB, compared to 90% in Spain, 84% in France and 80% in Italy.

Figure 9: Trust in the Institutions



Note: Distribution of trust from European Commission (2021). For the left graph, participants where asked *How much trust do you have in certain institutions? For each of the following institutions, do you tend to trust it or tend not to trust it? The media.* Possible answer choices were *Tend to trust* (light blue), *Tend not to trust* (darker blue) or *Don't know* (grey). For the right graph, participants where asked *And do you tend to trust or tend not to trust these European institutions? The European Central Bank.* Answer choices were the same.

Financial literacy provides the foundation for understanding and acting on monetary policy communication. According to Klapper and Lusardi (2020) financial literacy rates [16] differ widely across Europe, with Germany (66%) ahead of France (52%), Spain (49%), and Italy (37%), reflecting unequal capacity to interpret economic messages. These variations suggest that communication may resonate more effectively in countries where basic economic concepts are more familiar. Moreover, Binder (2017) argues that when information is too complex or abstract, individuals often disengage entirely, leaving the message unprocessed. Low financial literacy therefore weakens the transmission of central bank communication by limiting comprehension of key terms such as inflation or interest rates. This variation in understanding constrains how well households can adjust expectations in response to policy signals.

Together, the national context shapes how households interpret and internalize monetary policy communication. Even when information is available and well-formulated, its impact depends on whether audiences find the source credible and the content comprehensible. Differences across countries in these factors help explain why central bank messages may shift inflation expectations unevenly. Understanding and addressing these soft foundations is thus essential for effective policy communication in a multilingual and diverse information environment.

B Frequency Dictionary for Topics

The table below presents the set of keywords employed for the text-based analysis explained in Section 3.2. For each topic category, the table lists word stems or frequent linguistic variants in English (ENG), German (DEU), Spanish (ESP), French (FRA), and Italian (ITA). During text processing, these stems are used to detect topic-related terms in the media corpus, allowing for consistent classification across languages.

[16] Klapper and Lusardi (2020) calculate the share of respondents who answer at least three out of the five questions on financial literacy correctly. The questions assess basic knowledge of four fundamental concepts in financial decision making: knowledge of interest rates, interest compounding, inflation, and risk diversification

Table 5: Keywords by language and topic.

ENG	DEU	FRA	ITA	ESP	Topic
Cost	kost	cost	coût	cost	Inflation
Deflation	deflation	deflac	déflat	deflaz	Inflation
Devaluation	entwert	devalu	dévalu	svalut	Inflation
Inflation	inflat	inflac	inflat	inflaz	Inflation
Inflation	teuerung				Inflation
Price	preis	preci	prix	prezz	Inflation
Purchasing power	kaufkraft	poder adquisit	pouvoir d'achat	potere d'acquisto	Inflation
Employers	arbeitgeb	empleador	employeur	datori	Labor
Employment	beschäftig	empleo	emploi	occupaz	Labor
Income	einkomm	ingreso	revenu	reddit	Labor
Job gains	beschäftig	empleo	emploi	occupaz	Labor
Job gains	stelle	contrat	embauch	assunz	Labor
Job losses	verlust	pérdida	perte	perd	Labor
Jobs	arbeitsplatz	empleo	emploi	lavoro	Labor
Labor market	arbeitsmarkt	mercado laboral	marché de travail	mercato del lavoro	Labor
Layoffs	entlass	licenci	licenci	licenz	Labor
Remuneration	vergüt	remuner	rémunér	retribuz	Labor
Unemployment	arbeitslos	desemple	chôm	disoccup	Labor
Wages	lohn	salari	salair	salar	Labor
Workers	arbeitnehm	trabajad	travaill	lavorat	Labor
Construction	bau	constru	construct	costruzion	Housing
Housing	wohn	viviend	logement	allogg / abit	Housing
Mortgages	hypothek	hipotec	hypoth	mutu	Housing
Real estate	immobil	inmobil	immobil	immobil	Housing
Rent	miet	alquil	loyer	affitt	Housing
Bonds	anlei	bon	oblig	obblig	Financial
Capital	kapital	capital	capital	capital	Financial
Credit	kredit	crédit	crédit	credit	Financial
Credit		credit			Financial
Defaults	ausfall	incumpl	défaut	insolv	Financial
Debt	schuld	deud	dett	debit	Financial
Exchange rate	wechsel	cambi	change	cambi	Financial
Financial	finanz	financi	financi	finanz	Financial
Interest rates	zins	tipo	taux	tasso	Financial
Saving	spar	rispar	éparg	ahorro	Financial
Securities	wertpapier	valor	titre	titol	Financial
Stock	akti	accion	action	azion	Financial
Swaps	swap	swap	swap	swap	Financial
Swaps				scamb	Financial
Yields	rendit	rendim	rendem	rendiment	Financial
Crisis	kris	cris	cris	crisi	Economy

Continued on next page

ENG	DEU	ESP	FRA	ITA	Topic
Confidence	vertrau	confianz	confianc	fiduc	Economy
Consumption	konsum	consum	consomm	consum	Economy
Economy	wirtsch	económ	économ	econom	Economy
Economy	konjunkt		eonom		Economy
Export	export	export	export	esport	Economy
GDP	bip	pib	pib	pib	Economy
Import	import	import	import	import	Economy
Indicators	indikator	indic	indicateur / indic	indic	Economy
Investment	invest	invest	invest	invest	Economy
Investment		invert			Economy
Production	produkt	produc	product	produz	Economy
Recession	rezess	reces	récess	recess	Economy
Uncertainty	unsicher	incertid	incertitud	incertezz	Economy

Note: Keywords used per topic in English (ENG), German (DEU), Spanish (ESP), Frech (FRA) and Italian (ITA). The keywords expand the dictionary developed by Gardner et al. (2022) to fit the newspaper data.

C Example Prompt to Generate Dataset for Fine-Tuning

Figure 10 displays an example prompt used to generate phrases that can be used for fine-tuning the language model on predicting the correct sentiment.

D Overview of the Training Algorithm

1. **Label encoding:** The categorical labels *negative*, *neutral*, and *positive* are converted into numerical values 0, 1, and 2, respectively. This transformation allows the model to process the categories as discrete classes during training.
2. **Definition of hyperparameters:** The main hyperparameters, which determine the learning behaviour of the model, are defined as follows:
   (a) **Learning rate:** Specifies how much the model's internal parameters are adjusted after each iteration. A relatively small learning rate is chosen to ensure gradual and stable learning.
   (b) **Number of epochs:** Indicates how many times the model iterates over the entire training dataset to refine its parameters.

Figure 10: French prompt used to generate dataset for fine-tuning

```
J'entraine un modele linguistique avec des actualites financieres.
Pourrais-tu me fournir 25 phrases [label] sur le theme [topic] en
francais ? Inspire-toi de phrases d'exemples ci-dessous et
concentre-toi sur les actualites concernant la banque centrale.
Merci de fournir 25 phrases exemplaires differentes.

Example 0: [FRA_topic_example0]
Example 1: [FRA_topic_example1]
Example 2: [FRA_topic_example2]
Example 3: [FRA_topic_example3]
Example 4: [FRA_topic_example4]
Example 5: [FRA_topic_example5]
Example 6: [FRA_topic_example6]
Example 7: [FRA_topic_example7]
Example 8: [FRA_topic_example8]
Example 9: [FRA_topic_example9]
```

Note: French prompt used to generate 25 negative, neutral and positive phrases per topic. Words in squared brackets are dynamic, i.e., [label] was replaced by negative, neutral and positive; the [topic] adjusted to the five topics used in this study as well as the examples given to the model.

(c) **Loss function:** The loss function measures the difference between the model's predictions and the true labels. For this classification task, a cross-entropy loss function is used, as it is particularly suited for categorical outcomes. In this setting, the model predicts the probability of each class, and cross-entropy quantifies how close these predicted probabilities are to the correct class.

(d) **Batch size:** Determines how many input samples are processed together before updating the model parameters.

3. **Cross-validation:** The dataset is divided into five equally sized subsets (five-fold cross-validation). In each iteration, one subset serves as the validation set, and the remaining four are used for training. This procedure ensures that every observation is used once for validation and provides a more reliable estimate of the model's ability to generalize.

4. **Training phase:** The model is set to training mode, allowing it to adjust its internal

parameters. During training, the model iteratively minimizes the loss function using an optimization algorithm (e.g., stochastic gradient descent). The process of adjusting the parameters based on the loss gradient is known as backpropagation.

5. **Validation phase:** After each training iteration (epoch), the model's performance is evaluated on the validation subset. This allows monitoring of potential overfitting, which occurs when the model learns the training data too precisely and performs poorly on unseen data.

6. **Early stopping:** If the validation performance no longer improves or begins to deteriorate while training performance continues to improve, the training process is stopped early to prevent overfitting.

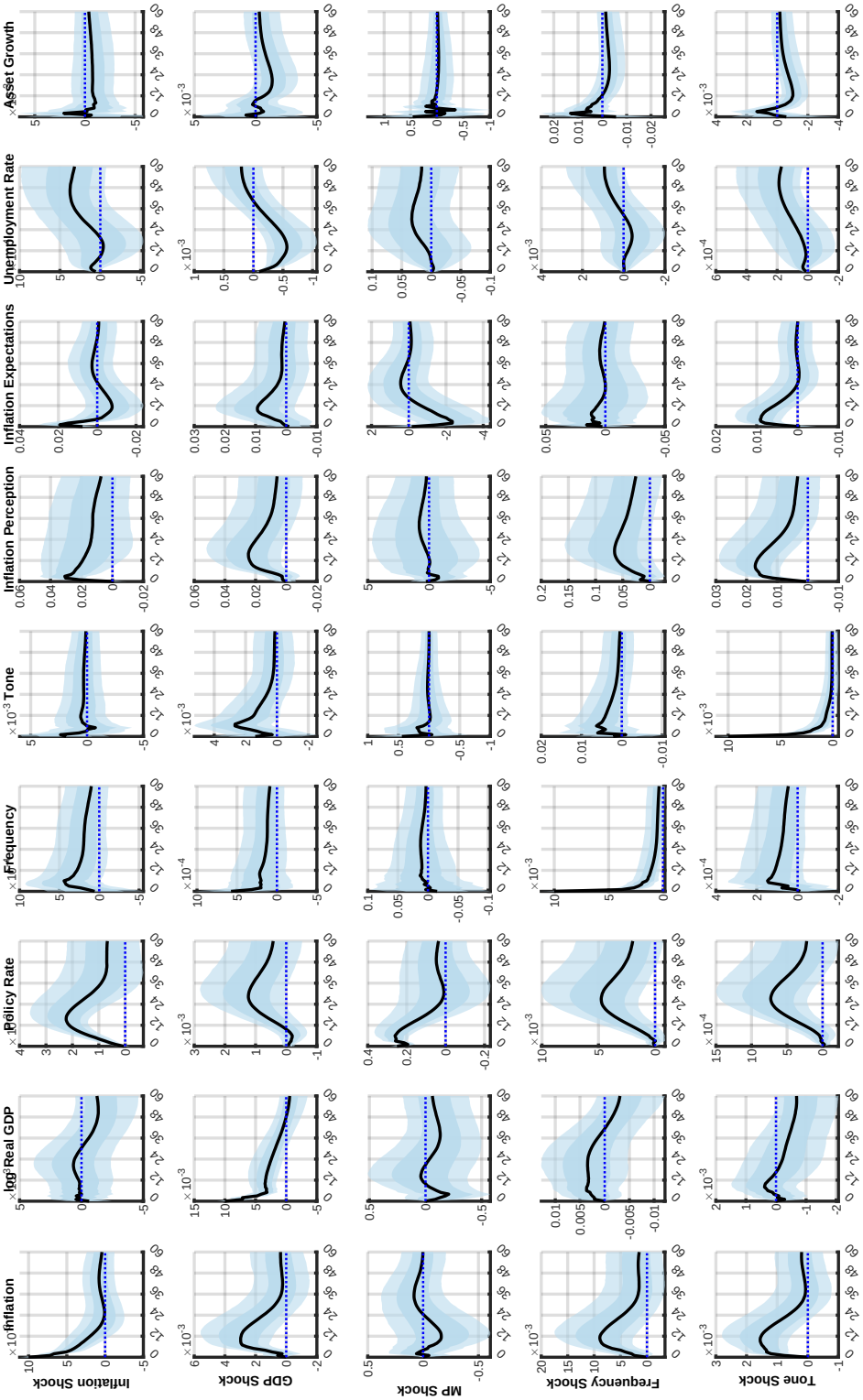
7. **Repetition cross folds:** Steps 4 to 6 are repeated until all five folds have been used for validation. The overall performance of the model is then computed as the average across all folds.

8. **Label Decoding:** Finally, the numerical predictions (0, 1, 2) are converted back into their corresponding categorical labels: negative, neutral, and positive.

E Full Set of Macroeconomic Reactions

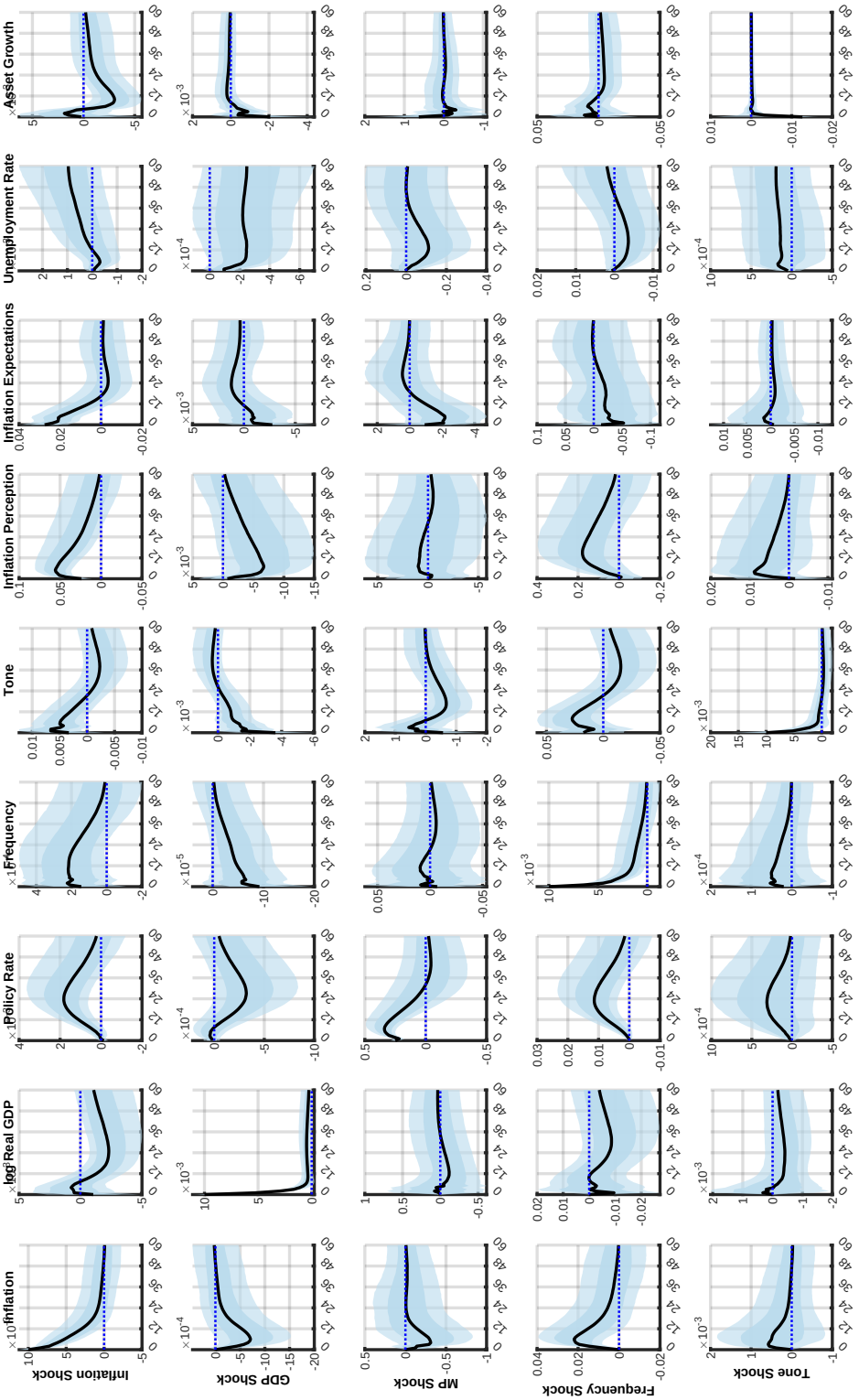
Figures 11 to 14 display the impulse response functions to the five shocks identified through inertial restrictions for Germany, Spain, France and Italy, respectively. The five shocks are a shock to inflation, real GDP, monetary policy, media frequency and tone. The reactions from all macroeconomic variables are displayed: inflation, log real GDP, the policy rate, media frequency and tone, inflation perception and expectations, unemployment rate as well as asset growth. With exception of the monetary policy shock, which is normalized with 250-basis-point, all other shocks are normalized to an 100-basis-point increase of the target series on impact.

Figure 11: Impulse Responses to all Shocks in Germany



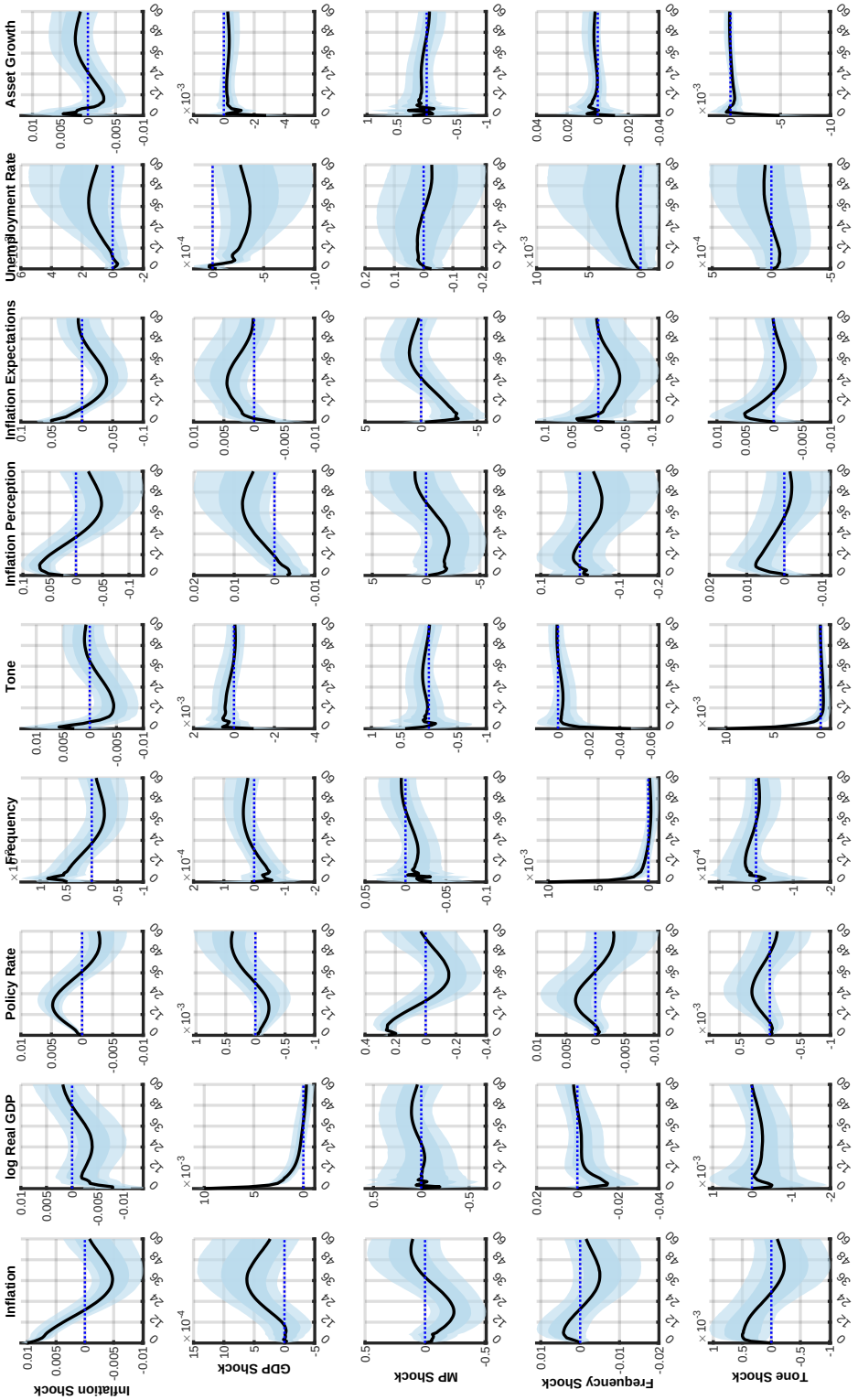
Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified using inertial restictions. The impulse responses are normalized to a 250-basis-point increase of the policy rate for the monetary policy shock and to a 100-basis-point increase to the respective series for the remaining shocks. The horizontal axis shows the time horizon in months.

Figure 12: Impulse Responses to all Shocks in Spain



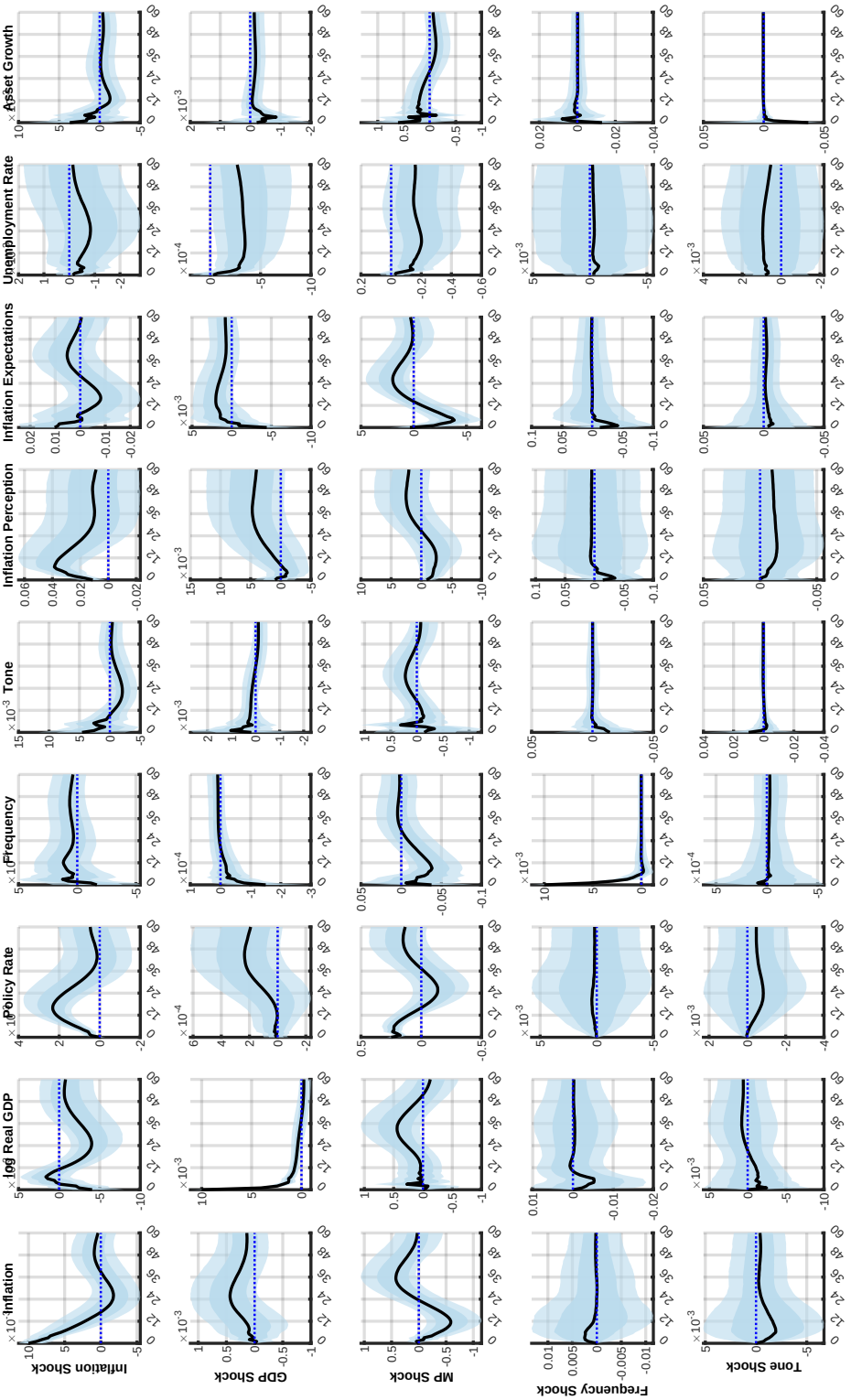
Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified using inertial restictions. The impulse responses are normalized to a 250-basis-point increase of the policy rate for the monetary policy shock and to a 100-basis-point increase to the respective series for the remaining shocks. The horizontal axis shows the time horizon in months.

Figure 13: Impulse Responses to all Shocks in France



Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified using inertial restictions. The impulse responses are normalized to a 250-basis-point increase of the policy rate for the monetary policy shock and to a 100-basis-point increase to the respective series for the remaining shocks. The horizontal axis shows the time horizon in months.

Figure 14: Impulse Responses to all Shocks in Italy



Note: The blue shaded areas represent the 5–95 percentiles of the impulse responses identified using inertial restictions. The impulse responses are normalized to a 250-basis-point increase of the policy rate for the monetary policy shock and to a 100-basis-point increase to the respective series for the remaining shocks. The horizontal axis shows the time horizon in months.