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Inflation Perception and the Formation of Inflation Expectations

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Inflation Perception and the Formation of Inflation Expectations

Abstract

In this paper, we present a new indicator to measure the media coverage of inflation. Our Inflation Perception Indicator (IPI) for Germany is based on a corpus of three million articles published by broadsheet newspapers between January 2001 and November 2022. It is designed to detect thematic trends, thereby providing new insights into the dynamics of inflation perception over time. Methodically, the IPI makes use of RollingLDA, a dynamic topic modeling approach refining the rather static original LDA to allow for changes in the model's structure over time. We then use time series for the overall inflation perception indicator as well as for specific topics to analyze time-varying correlations with time series for inflation expectations of firms and households. Our results reveal that the link between reporting about inflation and changes in inflation expectations is time-dependent. During periods of intensive newspaper coverage of inflation developments, a correlation with inflation expectations emerges that does not exist at other times. Such correlations are evident after the introduction of the euro, during the financial crisis and during the recent energy price shock.

JEL-Codes: C22, C82, D84, E31

Keywords: Inflation; perception; expectations; media; attention cycle

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1. Introduction

In many situations households and firms build expectations about future development of inflation. For investment decisions and the purchase of durable goods the development of inflation is a crucial variable. For this reason, monetary policy monitors the development of inflation expectations closely. In addition, monetary policy tries to guide inflation expectations towards the target of the central bank. It is therefore an important question how inflation expectations by economic agents are build and how they can be guided by economic policy. In particular, for monetary policy the communication of its strategy is an important tool. While financial market experts follow the speeches and press statements directly, firms and private households are informed about monetary policy and other macroeconomic issues to a greater extent via the media. However, the magnitude to which the media influence the inflation expectations of firms and private households is the subject of intensive research. The results of many studies reveal that in particular private households use mainly information from their environment to build inflation expectations.[2] Similar results are obtained for the formation of inflation expectations in firms (Born et al., 2022). Firms are well informed about changes in demand from their customers as well as their suppliers. In contrast, information about the macroeconomic environment do not have an important impact in the formation of inflation expectations. Such behavior of economic agents is plausible in normal times. Recent studies about the formation of inflation expectations that include the role of media coverage find that, in general, the link between media coverage and the formation of inflation expectations is rather weak. Media, such as newspapers, cannot serve the purpose of regularly providing households and firms with the information they need to form expectations and make decisions. On the other hand, in many situations, information on general price developments is too general to be useful for individual expectation formation.

In this paper, we argue that while media do not have a permanent influence on the formation of inflation expectations, they can certainly have an important temporary effect. Nimark and Pitschner (2019) build a model that rationalizes that media are able to reduce information costs but they focus on outstanding events. These findings are in line with the event-driven nature of news: the public sphere tends to be dominated by a limited number of issues, that follow distinct attention cycles (Downs, 1972; Lörcher & Neverla, 2015; Waldherr, 2014). In modern-day media environments these patterns can amount to rather extreme outbursts of public attention encompassing not only traditional media, but also social media and other parts of the public sphere, a phenomenon Waisbord and Russell (2020) refer to as “news flashpoints”. The media stress what’s new and problematic, but attention wanes as newness fades, no matter if the underlying problem passes or persists.

This type of media mechanism should have consequences for expectation formation. In the first phases of an attention cycle, rational inattention is overcome by the sheer volume of reporting, prompting economic agents to watch events closely and adjust their expectations accordingly. As media attention peters out, economic agents revert to inattention. Expectations remain unaltered, even if economic conditions change. In our case, inflation expectations would stay at elevated levels somewhat irrespective of actual price developments, bar the emergence of another attention-arousing news shock. Hence, it would

[2] The review articles by D’Acunto et al. (2022) and Weber et al. (2022) provide a good overview of recent work on the determinants of economic expectations.

be media mechanisms that contributed to the well-known stickiness of inflation expectations (e.g., Carroll 2003). The resulting recognition lags of households and firms may complicate the central bank's job to rein in inflation (Müller et al., 2023). Accordingly, some empirical studies show that in periods of intensive reporting about inflation developments media play a role in the formation of inflation expectations (Larsen et al., 2021). Moreover, it is also shown that different information about inflation developments have different effects on inflation expectations (Dräger & Nghiem, 2021). Another important result is that the perception of news about inflation developments is an important prerequisite for an adjustment of inflation expectations.

We therefore examine two related questions. First, we analyze the reporting about inflation developments in more detail. The question is whether the intensity of reporting varies over time. We argue that an increasing intensity of reporting is an important condition for households to perceive the news about inflation. In addition, we extract different topics from newspapers that are related to inflation developments. It is also interesting to see whether the topics vary over time. Second, we analyze the relationship between the overall intensity of reporting about inflation as well as the related topics and different measures of inflation expectations to get some indication about the link between these two sets of variables. We use a time-varying parameter approach. It is possible to identify periods of significant correlation.

For this reason, in this paper we make use of a measure we call Inflation Perception Indicator (Müller et al., 2022). It is based on large corpora of newspaper articles and calculated by applying a dynamic topic modelling method, RollingLDA (Rieger et al., 2021), that enables us to build consistent time-series from the otherwise unstable Latent Dirichlet Allocation (LDA) algorithm (Blei et al., 2003). The IPI is designed to capture inflation narratives floating in the public sphere, thereby complementing established measures of inflation expectations derived from surveys and financial market data. The concept of the narrative has the potential to shed extra light on inflation dynamics, since it adds context to figures: what prompts people to believe price levels to rise at a certain speed? Which causes do they have in mind? Who do they blame? Since the price momentum is largely driven by inflation expectations, identifying narrative factors that drive these projections strikes us as a worthwhile endeavor. Based on the RollingLDA method, nine inflation-related topics are identified. These include the coverage of central banks, fiscal and re-distributional policies, raw material prices and others. The time series for these topics show that the intensity of reporting varies over time.

Moreover, we analyze the correlation between these inflation perception indicators and measures of inflation expectation. We use data from the European Commission survey on consumer climate to measure inflation expectations and data from the ifo business survey to measure inflation expectations of firms. We examine the inflation expectations of four different groups: households, firms as a whole, automobile manufacturers, and the producers of nondurable goods. We analyze the time-varying correlation between the respective measure of inflation expectation and the Inflation Perception Indicator. Our results show that in specific periods news about macroeconomic price developments are linked to the inflation expectations of firms and private households. Moreover, we find similarities but also some important differences in the link between news reporting and inflation expectations. For example, during the recent surge of inflation there is a significant link between the central bank topic and the expectations of firms, but not with the expectations of households.

This paper is organized as follows: section 2 provides an overview of the relevant literature, particularly studies that point to a time-varying importance of media for inflation expectations. Section 3 provides a description of the RollingLDA method, the data base and our processing steps. Section 4 presents the resulting timeseries for the Inflation Perception Indicator and specific topics. in section 5 we present the econometric approach for the analysis of the time-varying relationship between inflation perception and inflation expectations. The results are presented in section 6 and section 7 concludes.

2. Time varying role of media for inflation expectations: A review of the literature

There is a growing body of literature that documents the time varying nature of the relationship between news about inflation developments and the formation of inflation expectations. Starting point of these analyses is hypothesis of rational inattention of entrepreneurs and private households (Reis, 2006; Sims, 2003). Due to the cost of information collection people only form and adjust economic expectations from time to time. In the meantime, expectations remain unaltered. In this context information rigidity is an indicator for the frequency of the adjustment of expectations. The longer the time period between expectation adjustment is the higher is the information rigidity. Coibion and Gorodnichenko (2015) found empirical evidence for the US that this information rigidity varies over time. For example, they found that during recessions the information rigidity declines.

Bracha and Tang (2022) have taken the idea of time-varying carelessness and reviewed it for the formation of inflation expectations. To do so, they constructed a measure of inattention from the Michigan Consumer Survey surveys. In the survey, respondents are asked about their inflation expectations in two stages. Here, respondents who answered in the first stage that they expected no change in the inflation rate are asked to indicate the current inflation rate. They have the option of answering that they do not know the current inflation rate. The authors use the ratio of the number of responses not knowing the rates to the number of responses not expecting a change as a measure of inattention. Using this measure, the authors show that the extent of inattention is state dependent. In periods of low inflation rates, the ratio is higher than in periods of high inflation.

This does not, however, imply that the relationship between media coverage and the adjustment of inflation expectations is time-varying. It could well be the case that companies and households get their information on inflation developments from the media, i.e., that the relationship between reporting and expectation formation is constant. It is just that there are not constantly stronger changes in the inflation outlook reported by the media, causing firms and households to adjust their expectations. In this sense, studies that find a persistent relationship between media coverage and changes in inflation expectations should be interpreted. Like Carroll (2003), Doms and Morin (2004) base their analysis on counts of newspaper articles about inflation over time and compare the results with economic outcomes. Lamla and Lein (2014) conclude that people's personal forecasts are strongly influenced by information provided by the media. In particular, they find that intensive reporting improves the accuracy of consumers' inflation expectations. The media, in turn, tend to report more on economic news when negative developments arise, e.g., when inflation is higher or on the rise. If there is also a negativity bias in "news tone", however, they find a diminished influence on the accuracy of expectations.

However, studies that compare the importance of different sources of information on the formation of inflation expectations typically find that the media channel only play a minor role. The results are summarized in two recent review articles by D'Acunto et al. (2023) and Weber et al. (2022). Recent studies on the determinants of the formation of inflation expectations by households and corporate decision makers have differed in their assessment of the importance of media coverage. Weber et al. (2022) and D'Acunto et al. (2023), among others, provide an overview of studies on media effects with a focus on central bank communication. They summarize the results as showing that the reporting of central bank actions in particular are too complex for most households, so that they do not align their inflation expectations. Rather, both households and corporate decision makers seem to rely on price signals from their environment in forming their expectations. However, there is also evidence that, for example, households with higher incomes or households who are confronted with persistently higher inflation rates are better informed about inflation developments.

Conrad et al. (2022) find media influences on the level of perceived past and expected future inflation. Users of traditional media, as opposed to social media, have a lower and more accurate inflation perception for the past year, as well as lower inflation expectations for the coming year. But consumers also obtain price information from personal experience, and the authors find that these direct observations have a larger effect on the "expected future change in inflation." This finding is in line with other recent studies indicating that media play a subordinate role in the formation of expectations about inflation developments. Rather, companies and households primarily use information from their private environment.

In a recent study Dräger and Nghiem (2021) analyse among other things the role of news on inflation perceptions and inflation expectations based on survey data. The authors show that households, who are able to recall news about monetary policy issues that includes inflation developments, have more accurate inflation expectations than households who cannot recall them. In addition, the authors find that the type of information has different effects. Their results suggest that information about monetary policy issues has an effect on inflation expectations. Information about financial market topics is more likely to influence expectations about nominal interest rates.

The studies mentioned so far have examined how news affects the inflation expectations of firms and households. However, they have largely abstracted from the role of media companies. In this context, the media play an important role in conveying information. Nimark and Pitschner (2019) argue that businesses and households delegate information gathering and viewing to media companies. Media companies gather information and monitor inflation developments, for example, and decide on a case-by-case basis whether to report on current developments. In this regard the reporting of media is state dependent. By reporting on current developments, they give readers a signal that a new development potentially important to them has begun. The authors use a LDA approach to analyse the reporting behavior of media around two outstanding events: the 9/11 terrorist attacks in 2001 and the collapse of Lehman Brothers in 2008. Their main findings are that different newspapers specialize on different topics. More important for our analysis, topics related to the two events under analysis received a large fraction of the overall reporting after the events. And last but not least the reporting became more homogenous after the events.

If the media play a significant role in forming inflation expectations, then exaggerated reporting may also cause perceived inflation developments to diverge from actual ones. In an empirical study, Lamla and Lein (2015) argue that such a situation occurred after the introduction of the euro in Germany. Among other things, they evaluate how often the word "Teuro" is used in newspaper articles after the introduction of the euro. This composition of the words “euro” and “expensive” (“teuer”) clearly indicates price hikes due to the introduction of the euro. They show empirically that negative media coverage led to households' perception of inflation after the introduction of the euro being significantly higher than the actual inflation trend. However, before the launch of the common currency inflation perception and actual inflation development were highly correlated. This suggests also that the link between the media reporting about inflation and the inflation perception or expectations are state dependent.

Larsen et al. (2021) take up the idea that households get information about future price trends through the media. The authors use an LDA approach to generate 80 topics based on newspaper articles from the Dow Jones Newswires Archive. They then empirically test whether these topics are related to inflation expectations of private households. Using a LASSO approach, they find six topics that are significantly related to private households' inflation expectations. Topics that show a significant relationship to inflation expectations are education, Transactions, Health, Internet and Trading. The interpretation of the authors is that all of these topics are related to some sort of household expenditures. The authors then examine whether information rigidity is time-varying and whether media coverage can explain the variation over time. The results suggest that media can help households adjust their expectations and thereby reduce expectation errors. Thus, through intensive coverage, media can help households adjust their inflation expectations.

In recent decades, monetary policy makers have greatly intensified their public relations efforts, and the media have become an important transmission channel (Berger et al., 2011). As traditional monetary policy instruments such as short-term interest rates and asset purchases have been all but exhausted, forward guidance has emerged as a policy instrument in its own right, i.e., communication has become part of the standard monetary policy toolbox. Informing the public about its views concerning the workings of the economy (the model) and its current state (the data), as well as stating an explicit medium- to long-term policy goal (2 per cent annual CPI inflation), central banks intend to influence long-term yields and thereby forward-looking decisions concerning the real economy (investment). Hansen et al. (2019) find that there is indeed such a long-term effect on asset-prices, particularly by shaping perceptions of long-run uncertainty. Ter Ellen et al. (2022) consider “narrative monetary policy surprises” and come to conclude that such information shocks lead to real macroeconomic effects. The authors stress the role of the media as information intermediaries. Seen this way, complexity-reducing media coverage can be seen as an efficient way to transmit monetary policy narratives, which, as Ter Ellen et al. (2020) point out, are “key ingredients in any interest rate decision and important for households”. Thus, central banks’ communicative efforts prompt media coverage and, thereby, influence expectations. Households do not need to know anything about macroeconomics and the transmission channels of monetary policy, let alone the specifics of a “true model”, as long as media coverage informs them of what to expect (and as long as central banks are credible and the media is trusted).

3. Construction of inflation perception indicators

To measure inflation perceptions, we construct an indicator based on newspaper text using a dynamic version of LDA (Müller et al., 2022). LDA produces what can be called mean macro-content analysis. We are not looking for extreme occurrences on the edges of a polarized media sphere, or differences between different media, but at some kind of average thematic media coverage on inflationary developments in mainstream media. The IPI is based on a corpus of three leading nation-wide German newspapers: Süddeutsche Zeitung (center left), Die Welt (center right) and Handelsblatt (business). The data was obtained from LexisNexis and from the publishing houses. Articles published between 1 January 2001 and 30 November February 2022 were considered. In a first step, the corpus (n = 2, 866, 214) is cleaned. For example, all words are converted to lower case and umlauts are resolved. Afterwards, we delete an extended selection of stop words that do not contribute to the generation of topics or that might even involve noise. Following these preprocessing steps, an issue-specific analysis corpus (n = 50,495) was produced as a sub-set of the entire newspaper corpus.

In its original form (Blei et al., 2003), LDA is well-suited for the identification of media frames (DiMaggio et al., 2013). Frame being an inherently static concept and LDA being a static method, they fit together well over limited time-horizons and for thematically limited text corpora. Over longer time-horizons, however, the correspondence between research object and method is less obvious. After all, what we are interested in is detecting the *evolution* of thematic trends. Rieger et al. (2021) construct a dynamic version of LDA, *RollingLDA*, that allows topic-structures to change over time by modeling the fading of collective memory, as newer versions of narratives overwrite older ones. New data are fitted to a topic model that is calculated based on a rolling window of past observations.

This approach has two major advantages: it resolves the problem of arbitrariness that plagues the original LDA method which produces fundamentally different models with each run due to the random initialization of the Gibbs sampler (Griffiths & Steyvers, 2004), even if exactly identical data and parameter settings are applied, running counter to the scientific requirement of reproducibility. Furthermore, RollingLDA allows us to build a consistent, updatable time-series of the Inflation Perception Indicator.

More specifically, we use the selection method *LDAPrototype* (Rieger et al., 2020). At several stages of the process, a prototypical LDA is being chosen from a set of LDA models. The method solves the above-mentioned problem of arbitrary selection and thus improves the reliability of findings (Rieger et al., 2020). Prototyping is achieved following a typical statistical approach: for a given combination of parameters a number of models is calculated (usually about 100), from which the particular model is determined that is most similar to all the other models in the set. For this purpose, pairwise model similarities are calculated using the S-CLOP measure (Similarity of Multiple Sets by Clustering with Local Pruning). These similarities are determined measuring the deviation from strictly matched topics in the resulting local clusters, which are created based on a hierarchical clustering result of topics using pairwise topic similarities of two LDA results considered. These deviations are computed for all possible pairs of LDA models. The LDA that has the highest average similarity to all others is selected as the prototypical LDA. The methodology is implemented in the corresponding R package ldaPrototype (Rieger, 2020).

In addition to the LDAPrototype method for initial estimates of the model, we employ an implementation of LDA that uses preceding LDA results as an initialization for subsequent quarters. We modify an existing implementation of LDA (Chang, 2015) by iterating the collapsed Gibbs sampler over the new data only: the topic assignments of all the previously modeled articles remain constant and we obtain assignments to the existing topics solely for all new articles. The process of fitting new data to a predefined topic model is known as "seeding".

Here, we refine the initialization approach by implementing it on a rolling basis. The first modeling step is limited to all the articles published between 1 January 2001 and 31 December 2005. Using a rather low threshold, we determine the vocabulary for this initial modeling: all the words that occur more than five times in this time interval are considered. This procedure removes the long tail of very infrequently occurring words that provide very little information. The result is a sub-corpus of 13,895 texts with an average of 239 tokens from a 42,834 words-vocabulary for the first modeling period. These texts from the first five-year-period are modeled using the LDAPrototype procedure as described. After a thorough content analysis (described in more detail below) we chose the model's parameter K = 10 topics and accordingly as Dirichlet parameters $\alpha = \eta = 1/K$, while the Gibbs sampler iterates 200 times over the dataset.

In a second modeling step we consider the articles from the subsequent first month of 2006, i.e. the 193 articles published between 1 and 31 January 2006. By applying the seeding procedure described above, we model the topic assignments to these 193 articles. However, we only use the last three months as memory, i.e. we initialize the model with the 863 articles from October to December 2005. The vocabulary is extended by words that occur more than five times in the new 193 articles and that were not included in the vocabulary before. Employing this procedure, we add 11 words in the first month of 2006. The topic assignments of the new articles are initialized randomly and the Gibbs sampler iterates over each of the new articles another 200 times, while the topic assignments of all articles acting as initializing memory remain constant.

We apply the model updating procedure described for the first month of 2006 on a rolling basis for all subsequent months, so that we finally obtain assignments to the 10 topics for the entire analysis corpus with an average of 280 tokens over a vocabulary of 48,487 different words. Modeling of newly occurring articles, for example from the first month of 2022, can then be performed analogously.

The initial modeling by the LDAPrototype approach ensures the reliability of the method, while the restriction to three months as memory opens the possibility for the appearance of new topics or the mutation of existing ones. This parameter can be varied. However, three months are intuitive from the point of view that the memory spans one quarter. A larger number of months, i.e. a longer memory, could lead to very inflexible models, a reduction to fewer months to more flexible, but also to rapidly changing topics.

To check the memory parameter, we recommend looking at the self-similarity of the topics over time. Since we allow topic structures to change, we have to make sure that topics remain stable over time to a degree that comparability is ensured, i.e. that they actually deal with similar content. Certain actors may change, new terms may be coined, some words may fade

from vocabulary while others become fashionable; nonetheless, a topic should contain articles about similar issues over the entire time horizon. Here, we use cosine similarity to calculate the similarity of the word frequency vector of each topic from the current quarter to the previous one. The quarter-to-quarter similarity in our K=10 model is rather high and stable for all the topics (see appendix).

To ensure the validity of the IPI, we first exclude all articles that do not provide any information on inflation reporting – which applies to the majority of the texts in our corpus. Our goal is to consider all articles that actually mention inflation while also including articles that address this topic without using the term "inflation". Furthermore, we aim at calibrating our indicator so that it responds early to changes in reporting. To achieve this, we tested various search terms to filter the dataset for relevant content. In a first step, we applied a rough search pattern that filters out all articles that do not cover the economy or prices at all. Based on these articles, we drew a random sample of 300 texts and coded each text as relevant (1) or not relevant (0). Afterwards, we applied all of our potential search terms to our sample. Based on these results we calculated their "recall" and "precision" values, respectively, as proposed by Stryker et al. (2006), who find a trade-off between the two conflicting goals of getting all the relevant articles and getting as little irrelevant ones as possible. Following this concept, a search term should provide the best compromise between a high recall and a high precision value. However, since our aim is to provide a rather sensitive indicator, we prefer a high recall over a high precision value.

The final search term in our analysis is of the form *inflation* OR teuerung OR geldentwertung* OR preissteigerung** (inflation, devaluation of money, rising prices). It comes with a recall value of 0.808 and a precision value of 0.576. The selection of its individual components is based on both intuition and statistics. The inclusion of the word "inflation" is (intuitively argued) self-evident. The synonyms used, in turn, go back to their respective cosine similarities to the word "inflation".[3]

The resulting corpus comprises 50,495 articles, 21,318 of which are from Handelsblatt, 14,670 from Süddeutsche Zeitung and 14,507 from Die Welt. LDA requires the choice of parameter K, that is, the number of topics the algorithm is set to produce. This is a critical part of the analysis. An inadequate value of K results in topics that are thematically indistinguishable and therefore not applicable to the research questions. Instead, K should be set at a value where topics are formed that are coherent in the sense that they are separately interpretable by human researchers according to their research questions. Setting K arbitrarily, or according to some mathematical optimization approach, runs the risk of producing irrelevant result (Chang et al., 2009; Hoyle et al., 2021). We produced four LDA models on the corpus, with *K* set to 6, 8, 10, and 12 respectively, and resorted to an "eyeballing" procedure: three coders labelled

[3] To calculate the cosine similarities of the words in our corpus, we followed a procedure proposed by Moody (2017). First, we draw a random sub-corpus of size 50,000 from our corpus, which we tokenized and cleaned from stop-words. Based on this sub-corpus, we computed the normalized skipgram probabilities of each possible word tuple. That is, for each word in the sub-corpus, we compute the probability with which it appears near every other word. Knowing the probability of a word appearing at all, we can thus determine which words appear next to each other more often than would be expected. In our case, "nearby" means "within a word window of size 4".

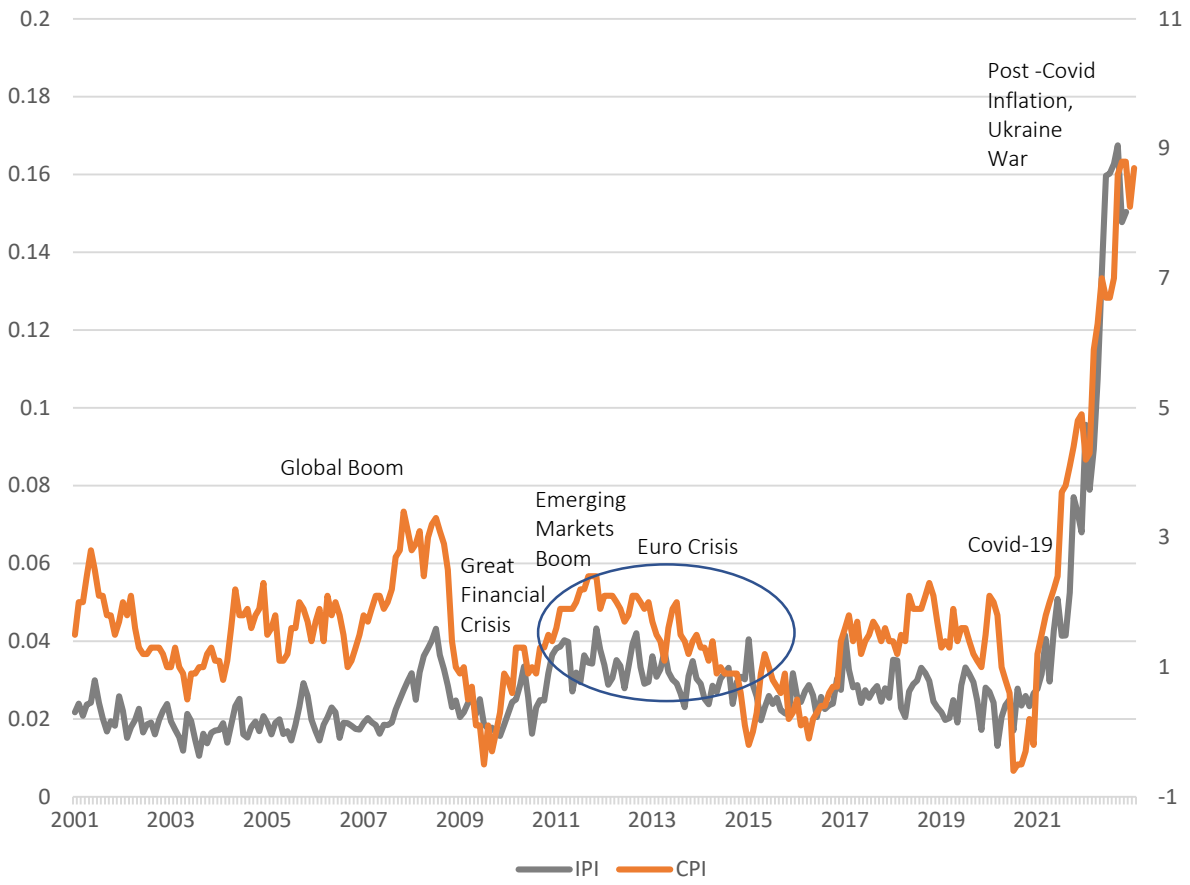
Based on word vectors, we determine the cosine similarity of individual words and detect those words that are most similar to our target word "inflation". This approach has the advantage that we take the peculiarities of journalistic writing and the actual word distributions within our articles into account. This makes our embeddings much more accurate than embeddings that were computed and trained on (e.g.) a Wikipedia dataset.

the topics of each model independently, making use of the most characteristic word ("top words") and articles ("top articles") as well as each topic's frequency distributions over time. A value of $K = 10$ was found to be the most appropriate in terms of our research interest.

4. Changes in inflation perception

Figure 1 displays the overall results for the entire sub-corpus (without LDA-guided thematic decomposition) and monthly CPI inflation data (y-o-y) for Germany. In the 2000s, an initial period of relative calm is visible where inflation oscillates around 2 per cent and inflation is only a minor issue of interest. This changes in 2008 when the boom preceding the Great Financial Crisis (GFC) drives up inflation rates above three per cent annually. Inflation coverage reaches a local peak in July, in parallel with actual price developments. After that, inflationary pressures recede in an environment of plummeting financial markets, turning media attention away from inflation. In 2011, somewhat similar developments occur: inflation and its coverage are both on the rise, until the sovereign debt crisis rattles the Eurozone to an extent that leads to a gradual and prolonged decline of inflation rates. This time, however, inflation coverage does not revert to low pre-GFC levels, but stays at somewhat elevated levels even as CPI inflation falls towards zero (highlighted area in Figure 1), a period where price dynamics and their coverage seem somewhat out of sync. The Covid-19 pandemic from 2020 prompts an unprecedented slump in economic activity and a subsequent elimination of inflationary pressures; media attention duly declines. The post-pandemic recovery causes inflation readings to shoot up unexpectedly which is causing considerable media coverage broadly in line with actual developments.

Figure 1
Inflation (CPI for Germany, y-o-y percentage change) and overall IPI (rhs)*



**Share of analysis corpus relative to entire corpus*
Source: authors' calculations, Deutsche Bundesbank

Turning to our research questions the IPI curve progression indeed resembles the predictions of communication theory laid out in the introduction: media attention is largely driven by actual developments, with distinct waves of coverage being kicked-off by key-events (inflation spikes), subsiding afterwards as public attentiveness is re-directed to other issues. However, there is an exception: between 2012 and 2015 inflation coverage remains at elevated levels, even though inflation rates decline considerably. This effect can be likened to phase 5 in Downs' (1972) taxonomy, where issue attention stays above pre-cycle levels after a wave of coverage, a phenomenon that can be attributed to collective memory and the news value of consonance (e.g., Müller, 2023, chapter 3), i.e., new information is incorporated into dominant existing media narratives.

Decomposing the IPI sub-corpus as described in the previous section yields ten clearly distinguishable topics, nine of which, almost 90 per cent of the analysis corpus, are interpretable in terms of our research interest. What's more, the value of LDA parameter *K* appears to be well-chosen, for many aspects that were touched upon in our research questions play a prominent role in different topics. Several topics have a clear geographical focus, namely 3 and 10 deal with international issues, 4 with the Eurozone, and 9 with Germany. Others fit into our thematic framework of potential causes (1, 4, 10) and consequences (2, 3, 5, 9) of inflation. Protagonists can also be detected, ranging from those

potentially responsible (central bankers, governments, unions) to those adversely affected (savers, workers) – hence, there's villains and victims. Table 1 provides an overview of the model's topics.

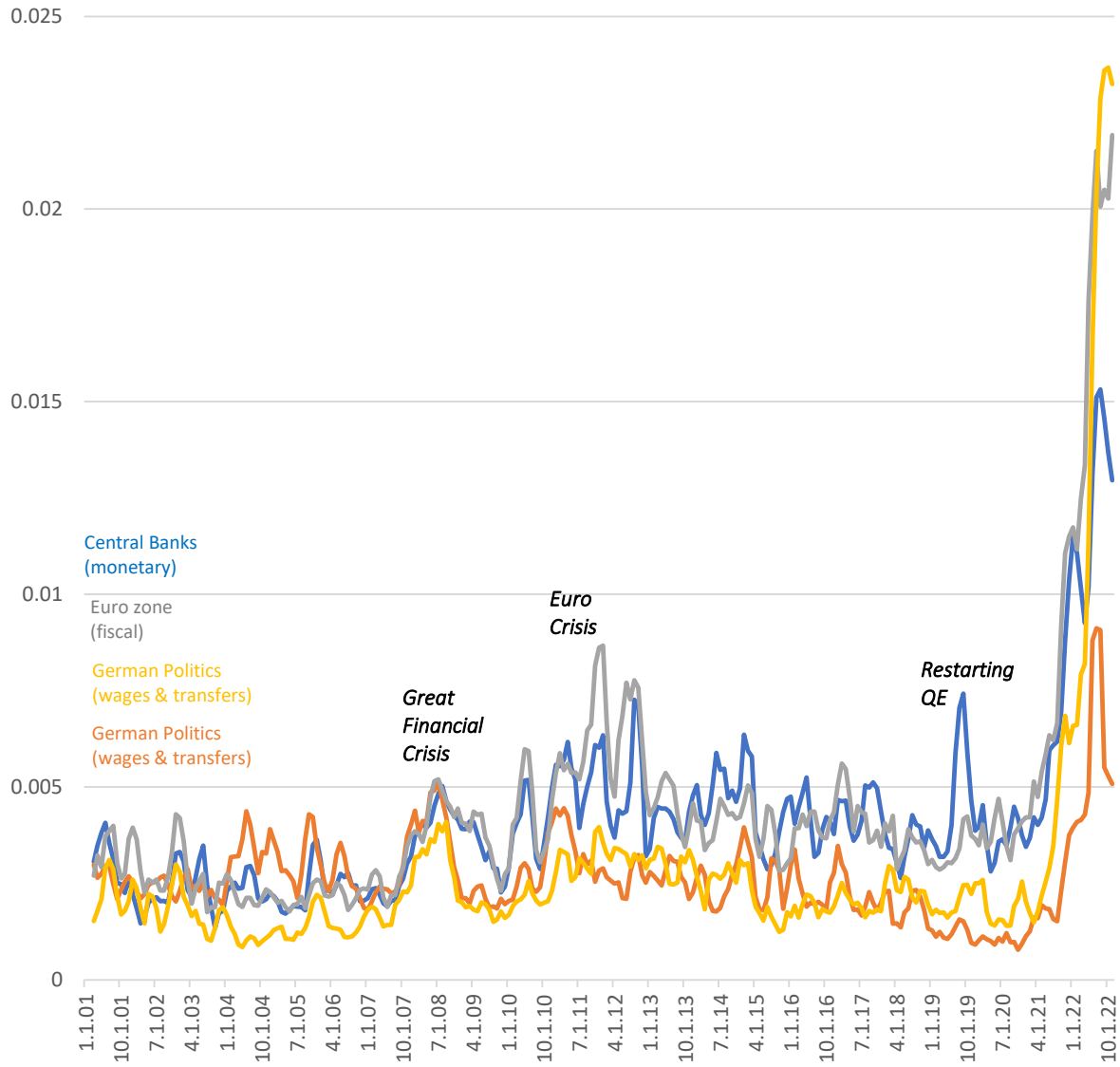
Table 1
Overview of the LDA model's topics, Jan 2001 – November 2022)

Topic No.	Label	Share of analysis corpus (per cent)	Topic Content	Top words (Nov. 2022)	Key Events
1	Central Banks	14.1	Speculation about policy measures of advanced economies' central banks (rate changes, asset purchases/sales etc.)	ecb, fed, interest rate, central bank, inflation, interest rate hikes, monetary policy, central banks	7-08 (rate hike), 11-11 (rate drop), 1-15 (before QE), 7-19 (disc. of QE restart), 21/22 (inflation surprise)
2	News	12.5	News briefs covering data releases (CPI, market rates, oil price etc.)	percent, prices, gas, consumer, company, october, germany, year	inflation spikes (7-08, 2-11, 12-21), QE (1-15)
3	International	6.5	Inflationary developments in Argentina, Turkey, Venezuela, Iran…	trump, biden, democrats, republican, party, president, russia, joe, sunak	EM booms (7-08, 1-11), Iran uprising (1-18), inflation spike (12-21)
4	Eurozone	12.4	Policy discussions and developments in other Eurozone countries and at EU level (fiscal stance, Stability and Growth Pact etc.)	china, germany, europe, must, eu, our, yes, usa, company, gas	Sov. Debt crisis (11-11), Greek stand-off (1-15), post- covid inflation surprise (10-21)
5	Private Investment	10.8	How to cope with low real yields, "private saver" perspective, focus on inflation hedges (Gold, Real Estate…)	banks, clients, tenants, interest, insurer, landlord, euro, says, bank, private	Boom (7-08), EZ uncertainty (sev. peaks 3-11 – 11-13), post-cov-19 inflation surprise (12-21)
6	Miscellaneous	11.4	Diverse		
7	Financial Markets	12.5	Financial Market developments and reactions to inflation risks	shares, investor, percent, dollar, dax, share prices, investors, interest, share, bonds	Nat. election (10-05), EM Booms (7-08, 3-11), Inaug. Trump (1-17), trade war (2-18), post-covid rally (3-21)
8	Companies	4.8	Developments in certain companies and sectors in Germany, focus on shareholder meetings and earnings calls, many calendar previews	million, corporation, company, turnover, euro, auris, airlines, customers, henkel, startups	Post-covid 19 inflation surprise (12-21)
9	German Politics	6.7	Collective bargaining, social, tax, fiscal policies – reactions to inflation	euro, scholz, spd, lindner, federal government, fdp, buergergeld, federal level, merz, gas price break	Inflation surprises in 7-08, 11-11 and 11-21)
10	Raw Materials	8.9	Inflationary developments in EMs with particular focus on raw material demand and prices (gold, oil, copper, wheat…)	Ftx, yoon, dollar, Fisker, kim, oujoon, Thielemann, Bitcoin, mbc, tbs	Price hikes doe to trade tensions (most pronounced spike: 8-18), also inflation surprise 11-21

A large share of reporting on inflation – topics in sum comprising about two thirds of the analysis corpus – is international or European in scope. Only topics 5, 8 and 9 have a predominantely national focus. Given the international integration of product and financial markets and the European integration of monetary (and to some degree fiscal) policy, the breadth of coverage seems adaquate.

As far as potential causes of inflation are concerned, topics 1 and 4 capture monetary and fiscal policies, topics 9 and 10 wage negotiations and raw material prices respectively. Figure 2 shows that the four topics are moving largely in parallel. The situation in 2021/22 is unique in so far as topics 1, 4, and 9 shoot up to unprecedented levels.

Figure 2
"Causal" IPI topics*



three-month moving averages; authors' calculations

The topics' frequencies reveal that the heightened awareness of inflation in German media after the GFC is driven in particular by an enduring preoccupation with the ECB. In addition, fiscal policy and business-cycle developments across the Eurozone get a lot more attention than during the days of the "great moderation" before the 2008 crash. (The rising trends in both topics' shares can also be interpreted as the German media paying more attention to European developments and institutions, which could indicate the emergence of a European public sphere, and thus a positive development.) Raw material prices are only temporarily a source of concern, most notably in 2008, in 2018/19 following the deterioration of trade relations under the Trump administration, and in 2021 due to post-Covid global supply-chain issues. Wages and social policies in Germany barely contribute to inflation concerns.

To get a glimpse of the framing of the topics, one way is a qualitative analysis of the top articles (i.e., LDA-assigned texts characteristic of a topic's content):

> *Topic 1: Central banks*. The top articles deal mostly with changes of the monetary policy stance. The ECB and its chiefs are the main protagonists; the Fed and other advanced-country central banks play minor roles. While the articles are mostly worded matter-of-factly, a certain bias towards a toughening of monetary policy can be detected, particularly when the ECB is concerned. Examples of headlines read: "*ECB: Rates to be raised if inflationary pressures ensue."*[4] "*Weber: ECB must react to inflation risk."* "*German inflation above ECB target."* "*Dangerous debate about higher inflation."* "*Tentative shift away from bond purchases."* "*ECB council member warns of inflation."*
>
> *Topic 4: Eurozone.* Fiscal policies of Eurozone countries, the recurring efforts to reform its framework (the stability and growth pact), and the enlargement of the Eurozone are major themes of the top articles. The connect to inflation is rather indirect via potentially detrimental effects of high accumulated debt levels on the conduct of monetary policy. Before the current bout of inflation two events drove this topic's dynamics: the financial crisis of 2008 and the Eurozone sovereign debt crisis peaking in 2011. Characteristic headlines read: "*Financial Crisis: Greek bankruptcy affects Germany, too."*[5] "*New Ideas for the Eurozone."* "*Our Currency's stability is severely threatened."*
>
> *Topic 9: German Politics.* The focus here is on collective bargaining and social transfers. These developments can be attributed to second round effects, that have the immediate implication of alleviating the consequences of inflation for wage earners and recipients of government transfers, but may prompt companies to embark on further rounds of price hikes. In times of higher inflation, such as 2008, substantial wage demands made the headlines, such as: "*Eight per cent wage increase."*[6] Since strikes are rare events in Germany and the unions have a reputation of taking macroeconomic side-effects into account when formulating their demands, the topic

[4] „EZB: Zinsen werden bei Inflationsdruck erhöht", Handelsblatt, 23 Sep 2005; „Weber: EZB muß auf Inflationsgefahr reagieren", Welt, 11 May 2006; „Deutsche Inflation übersteigt EZB-Ziel", Handelsblatt, 2 May 2017; „Gefährliche Debatte um höhere Inflation", Welt, 19 June 2018; „Behutsame Abkehr von Anleihekäufen", Süddeutsche Zeitung, 21 Sep. 2021; „EZB-Ratsmitglied warnt vor Inflation", Handelsblatt, 7 Dec 2021

[5] Finanzkrise: Der Bankrott der Griechen streift auch Deutschland, Welt, 10.12. 2009; Neue Ideen für die Eurozone, Süddeutsche Zeitung, 4.6. 2004; Stabilität unserer Währung ist schwer gefährdet, Welt 9.7.2005

[6] Acht Prozent mehr Lohn, Handelsblatt, 9.9. 2008

has not ranked high in the past. This may change, though. If inflationary pressures remain on the agenda, topic 9 deserves closer monitoring.

Topic 10: Raw Materials. Top articles deal with price developments, but also with implications for exporting countries, such as Iran, Venezuela and Turkey. Hence, this topic partly overlaps with topic 3. Characteristic headlines read: "*Boom in Asia clears oil markets."*[7] "*Crop shortfalls ignite speculation." "Oil pushes up Gold."*

Summing up the causes of inflation addressed in German coverage during the period considered in our analysis, we find that the blame is mainly put on the central bank. Fiscal policy plays its part, too, but to a lesser extent. Over the past two decades second-round effects in the form of rising wages and social benefits were not much of an issue in inflation reporting, though that has changed since higher CPI inflation induced higher wage demands. Turning to the perceived consequences of inflation, we resort to topics 5, 7 and 8 in particular, topic 2 can also be attributed to this question. Figure 3 shows three peaks associated with higher-than-usual CPI inflation in Germany, in 2008, 2011 and 2021. Additionally, financial market coverage is also driven by inflation concerns in 2017 and 2018, when the phasing-out of the ECB's asset purchase program was conditional on inflation developments, so analysts and investors watched the associated developments closely.

The topics' content can be summarized as follows:

Topic 5: Private Investment. The consequences of inflation for middle-income savers and consumers are addressed. Low inflation is seen as good (for consumers), very low (real) rates as bad (for savers). Articles address the need to take some risk in order to get positive returns on investments as well as the need to save, even though returns are sparse. Typical headlines read: *„Bundesbank: saving pays off despite mini rates."*[8] *"Savers' fears." "Zero per cent on savings."*

Topic 7: Financial Markets. The articles share an unambiguously negative framing of inflation, the common thread being that rising inflation (readings and prospects) fuel fears of monetary tightening, thereby depressing asset prices. Characteristic headlines read: *"Inflation fears depress sentiment."*[9] *"Global bourses: cheap oil provides push." "Gold becomes more popular with investors."*

Topic 8: Companies. This small topic consists mainly of short article that announce the publication of company results in the coming days. The impact of inflation on companies is seen as rather neutral.

Topic 2: News. As the neutral label indicates, this topic contains new information about price developments at different levels of the economy (consumers, producers etc.) and in different countries. Declining as well as rising price levels are reported. The top

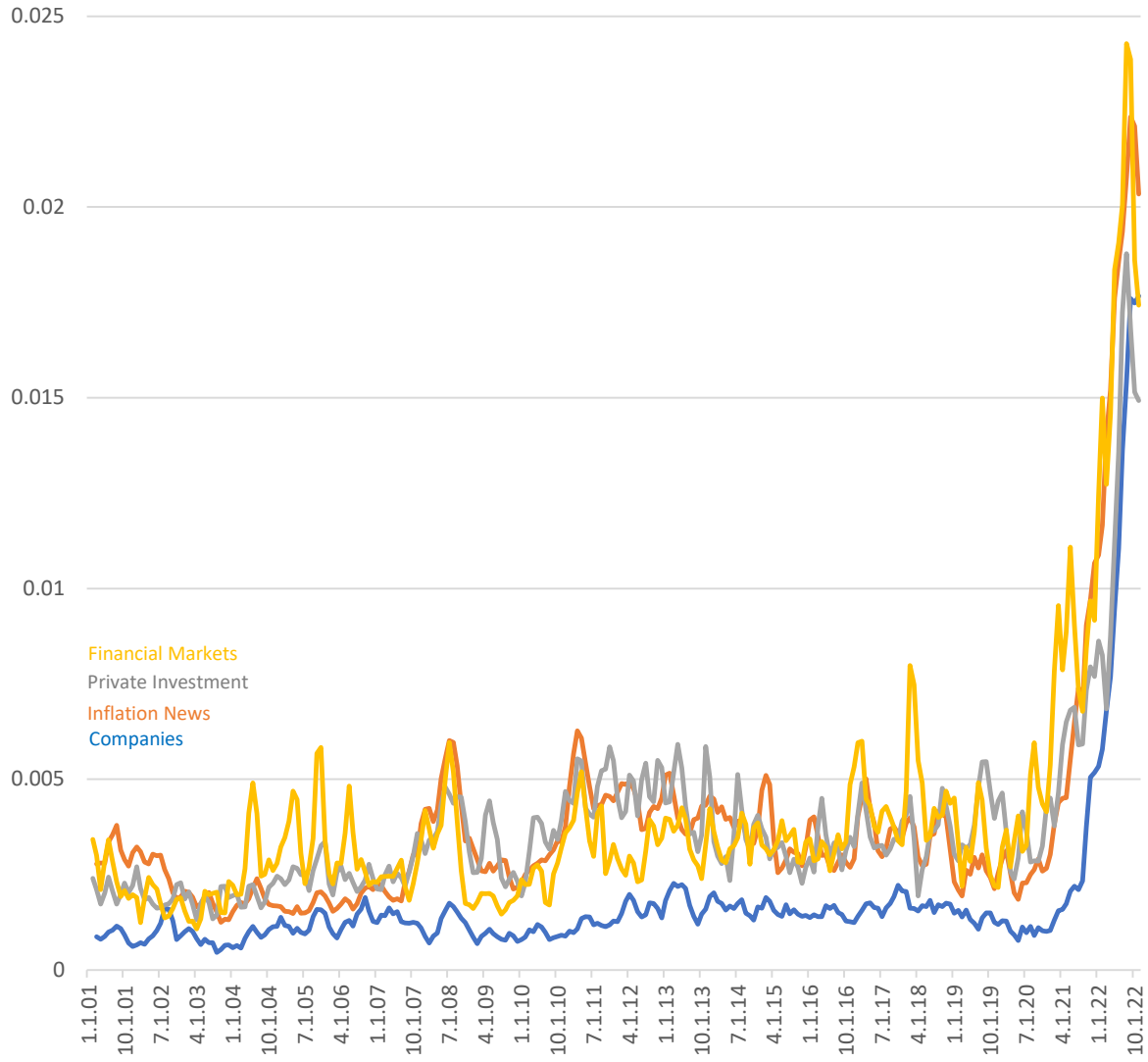
[7] Asienboom fegt den Ölmarkt leer, Handelsblatt, 29.9.2004; Ernteausfälle heizen Spekulation an, Handelsblatt, 7.3.2006; Öl treibt Gold, Handelsblatt, 30.11.2005

[8] Bundesbank: Sparen lohnt sich trotz Mini-Zinsen, Welt 25.10.2015; Die Angst der Sparer. 14.10.2011, Handelsblatt; Null Prozent auf das Ersparte, Süddeutsche Zeitung, 12.8.2014

[9] Inflationsängste drücken Stimmung, Süddeutsche Zeitung, 22.2.2001; Weltboersen: Billigeres Oel gibt Auftrieb, Süddeutsche Zeitung, 22.3.2008; Gold bei Anlegern immer beliebter, Handelsblatt, 4.7. 2016

articles suggest matter-of-factly, balanced reporting. Typical headlines read: *"Producer prices rise more slowly." "Italy: Inflation rate drops slightly." "Wholesale goods only slightly more expensive."*[10]

Figure 3
"Consequences" IPI topics*



three-month moving averages; authors' calculations

5. Analysis of the relationship between inflation perception and expectations

To analyze the relationship between news and inflation expectations of private households and firms we use our newly constructed inflation perception indices and survey data for expectations. The data for inflation expectations of households are taken from the consumer

[10] Produzentenpreise steigen langsamer, Süddeutsche Zeitung, 10.1.2001, Italien: Inflationsrate geht leicht zurück, Handelsblatt 22.12.2003; Großhandelswaren nur etwas teurer, Süddeutsche Zeitung 11.11.2003

survey of the European Commission. This survey is conducted monthly. In this survey 2000 people are asked about their assessment about the current situation and expectations about future economic developments. With regard to future price developments people are asked about their assessment of the development of consumer prices over the next twelve months compared to the last twelve months. Possible answers are “rise more sharply than before”, “rise to somewhat the same extent as before”, “rise to a lesser extent than before”, “remain more or less the same”, “decrease” and “do not know”.

In addition, we use data from the ifo institute that measures inflation expectations of firms. In this survey 9000 firms are asked about the assessment of the current situation and future outlook. In contrast to the consumer survey the question about future prices captures a three-month horizon. Firms are asked to indicate whether they expect their own prices to rise, stay somewhat the same, or fall. Indices for inflation expectations are constructed for different sectors and groups of sectors. In the empirical analysis we use indices for all goods and services. We also consider expectations of price changes for non-durable goods and motor vehicles.

All time-series are standardized to make sure that they have the same mean and variance. In this case we can compare the coefficients of the regression equation directly.

In our empirical specification inflation expectations are linked to the IPI lagged by one period. We analyze the relationship between news about inflation developments and inflation expectations using a model with time varying parameters. The state space model contains the following measurement equation to explain the development of inflation expectations:

$$p_t^e = a + b_t ipi_{t-1} + e_t$$

Here p_t^e is the measure of price expectations and ipi_t is the index of inflation perception that captures the information about media reporting about inflation developments. To consider that households may react differently to different topics related to the inflation development (Dräger and Nghiem, 2021) we use news indicators for different topics. The variable for lagged inflation expectations is the component for adaptive expectations. The coefficients can be interpreted as weights for the two components that are included in the forming process of inflation expectations. These weights are allowed to vary over time. The state equation for the time varying coefficient b_t is modeled as a random walk

$$b_{t+1} = b_t + f_{1,t}$$

To estimate the variance-covariance matrix we assume that the covariances between the errors are zero.

$$var\begin{bmatrix} e_t \\ f_t \end{bmatrix} = \begin{bmatrix} \sigma_e & 0 \\ 0 & \sigma_f \end{bmatrix}$$

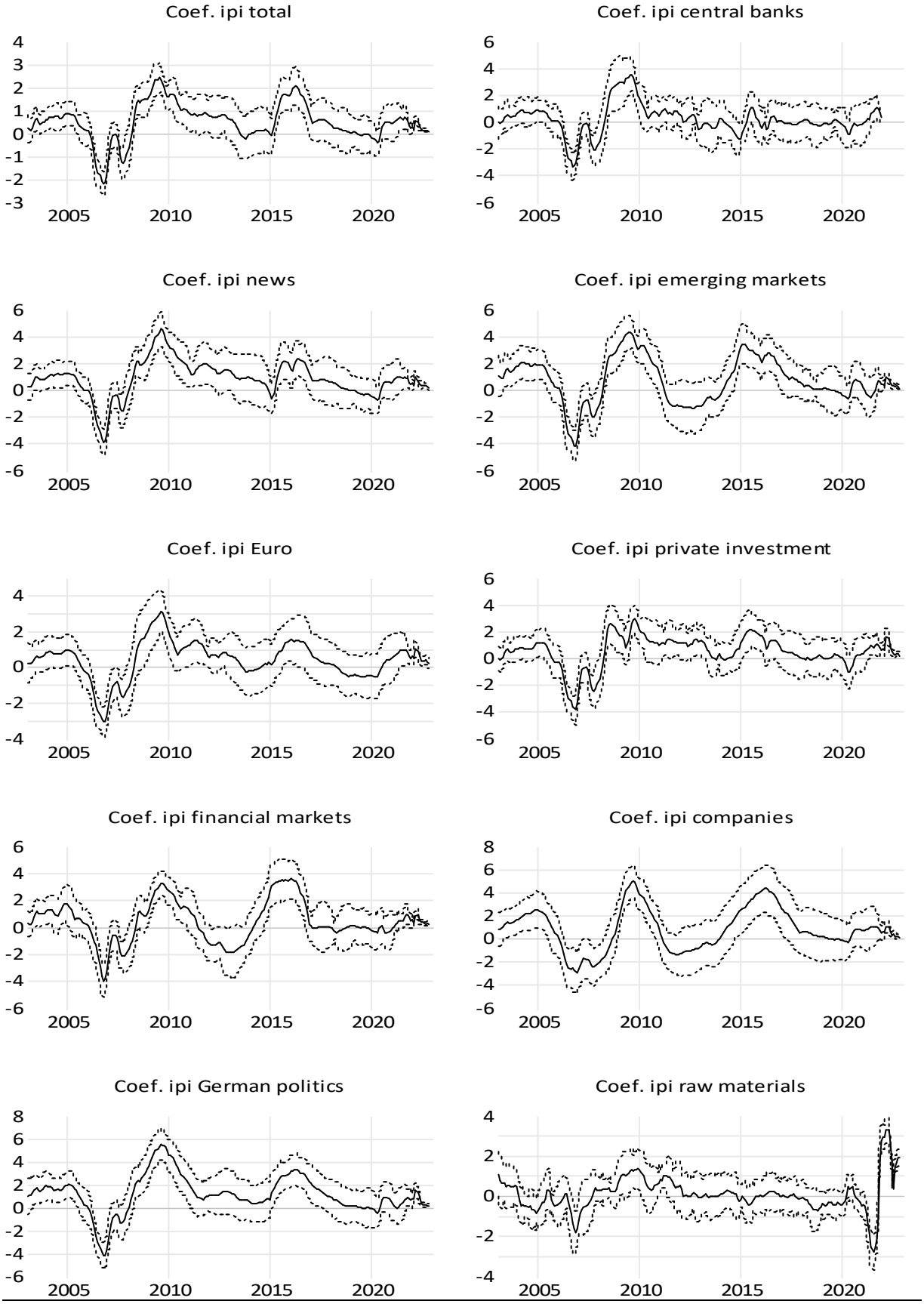
The model is estimated using the Kalman filter. We estimate the constant, the variances for the measurement equation as well as the state equations using the BFGS algorithm. We

assume for all models that the variances for the state equations are the same. As starting values we use in all estimations zero for the constant and ones for the variances. We estimate the model from January 2002 to November 2022.

6. Changes in the relationship between inflation perception and expectations

The flexibility of the time-varying parameter model allows us to carve out the relationship between news indicators and an adaptive expectation component at different time periods. The standardized variables allow us to compare the magnitude of the coefficients. We estimate this model with an indicator for private household inflation expectations as well as indicators of firm expectations of price changes for different branches of firms. We combine these indicators of inflation expectation with different indicators for news topics. In Figures 4 to we present for each combination of one inflation expectation indicator and different indicators of news topics the time-varying coefficient for the news variable. We use two standard deviations to indicate the statistical significance of the coefficient. To indicate the economic importance of these two variables we use standardized variables. In this case the magnitude of the coefficient indicates the importance of the relationship of that variable with the endogenous variable of inflation expectation.

Figure 4
Relationship between IPI topics and household inflation expectation



We present the time varying coefficients plus/minus two standard deviations.

Figure 5
Relationship between ipi indicators and business (total) inflation expectations

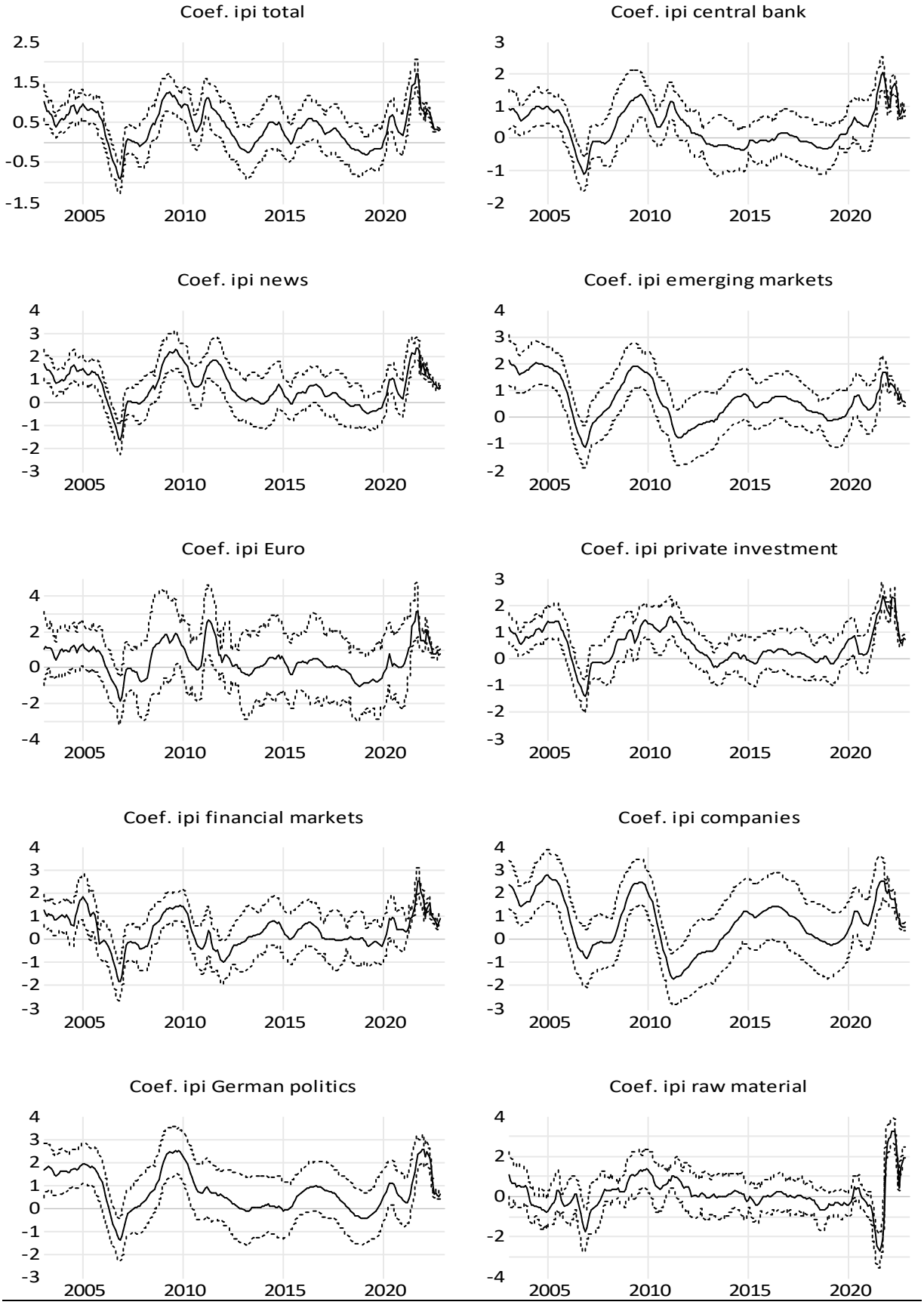


Figure 6
Relationship between IPI topics and business (Motor Vehicles) inflation expectations

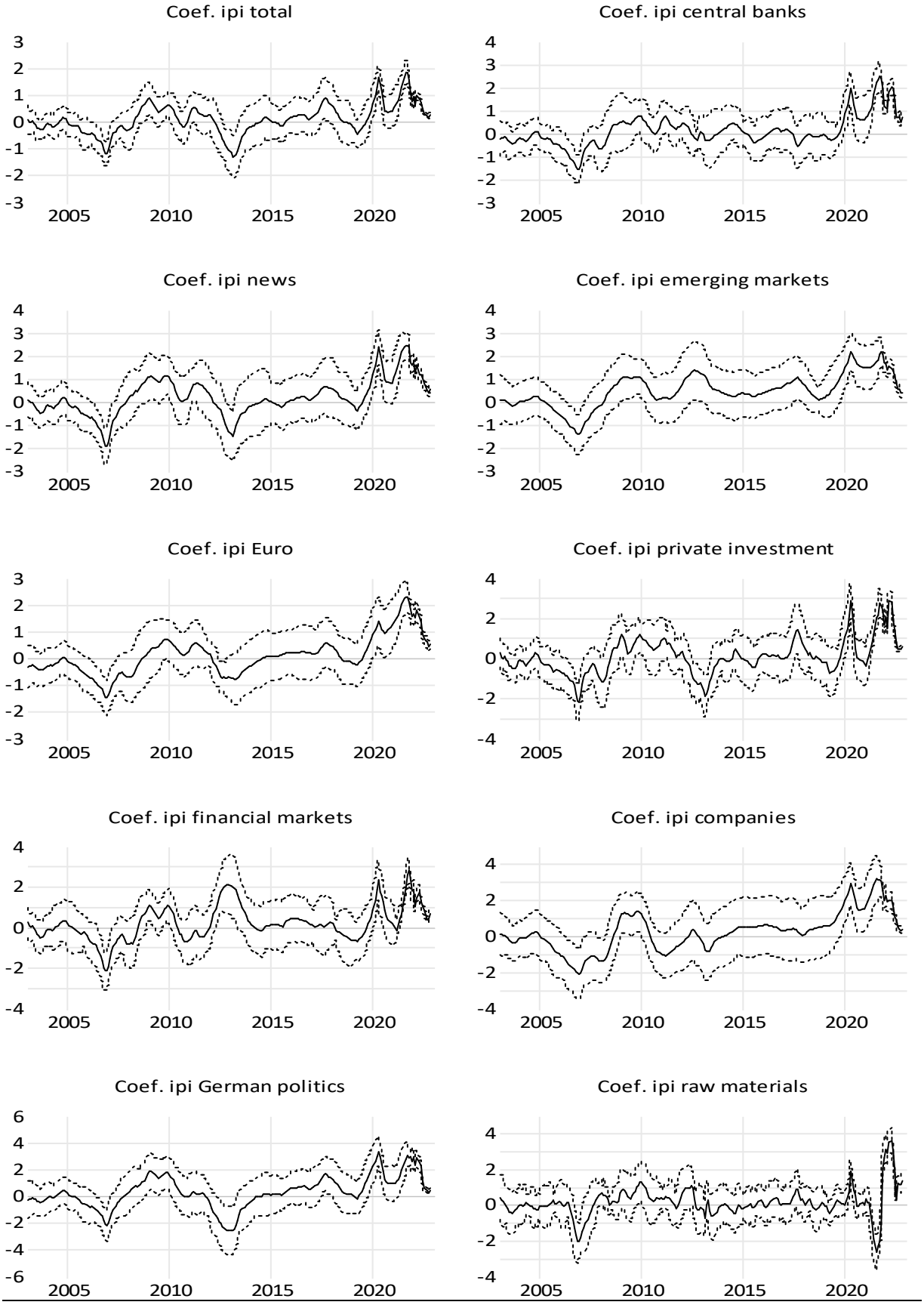
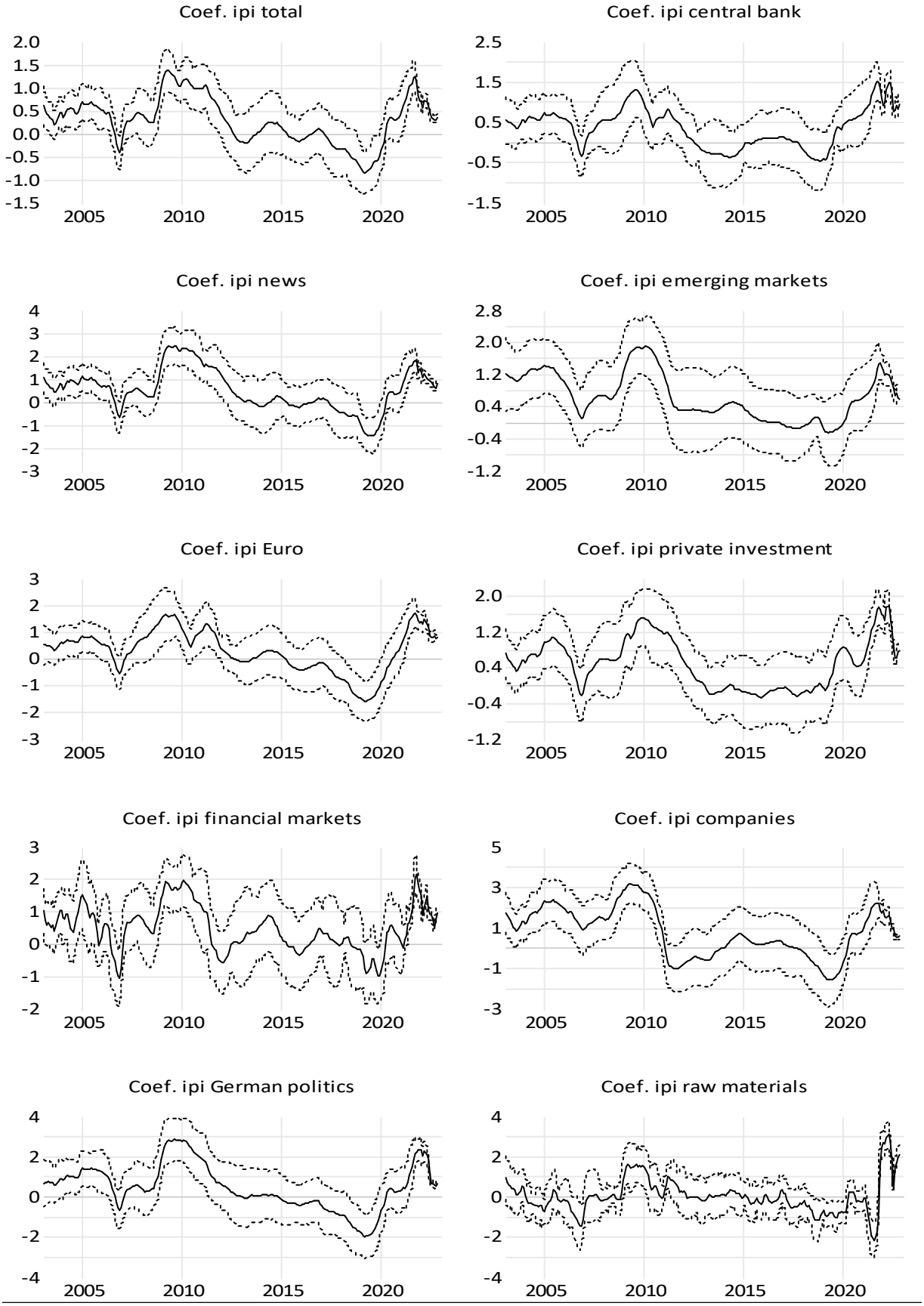


Figure 7
Relationship between IPI topics and business (non-durable goods) inflation expectations



The overall picture for the relationship between inflation reporting and household inflation expectations is that the phases in which a relationship exists are very similar for the overall index and the topics (Figure 4). It turns out that the correlations are significant only in certain phases. For both the overall indicator and most topics, the correlation with household inflation expectations during the financial crisis is negative. A positive correlation then emerges in the subsequent recovery. This is also found in 2015 and 2016. In the current phase starting with the Corona pandemic, there is only a slightly significant correlation between media coverage and inflation expectations. A notable exception to this is the commodities topic, which shows a clearly significant positive correlation with inflation expectations from 2021 onwards. The topic "central banks" is significant only in the period around the financial crisis. This is in line with the literature that finds only a limited impact of central bank communication on inflation expectations (Conrad et al., 2022).

The results for the business sector show some similarities but also some interesting differences (Figure 5). For example, at the beginning of the period under investigation after the introduction of the euro there is a significant link between news reporting and inflation expectations of firms. This is in contrast to the inflation expectations of households. Other differences include the highly significant link between news and business expectation in the years 2021 and 2022 and the insignificant relationship in the years 2015 and 2016.

As very different firms and industries are grouped together in the corporate sector, we compare the link between news reporting and inflation expectations for different firms. In this context, the literature emphasizes the distinction between groups of goods, e.g., producers of durable and non-durable goods (Coibion et al., 2019). As an example for durable goods producers, we select to the motor vehicles sector (Figure 6). With regard to car producers, we find only short periods of a significant relationship between news and inflation expectations. An exemption is the period after the corona crisis. In addition, we find some significant links for the topic financial markets and companies after the financial crisis.

Comparing these results with the results for non-durable goods producers (Figure 7), we again find substantial differences. The overall news index as well as most of the topic series show much longer periods of significant links between news and inflation expectations. We find three periods where the link between the media coverage and expectation formation is particularly closely related: in early years after the launch of the Euro, after the financial crisis, and in the context of the corona crisis. Again, there are no significant links around 2015.

The stark differences in expectation formation between durable and non-durable goods producers are likely to stem from different market structures, in particular different behavior of consumers in both types of industries. As shown by Coibion et al. (2019), when inflation expectations rise, private households limit their demand for durable goods as they compensate for the loss of real income. In contrast, the authors' empirical results tend to suggest that households expand their demand for consumer goods when inflation expectations rise. This leads to different price-setting margins in the two market segments.

7. Conclusions

In this paper we use a newspaper-based measure of inflation reporting and relate it to inflation expectations of consumers and companies derived surveys. As our measure, the Inflation Perception Indicator (IPI), is calculated by employing a dynamic topic modeling technique, RollingLDA, we are able to differentiate between distinct thematic patterns of inflation coverage and their respective influences on expectation formation.

For private households we find only weak links between overall inflation reporting and expectations over time. However, the topic containing news pieces about raw material prices shows a clearly significant positive correlation with inflation expectations from 2021 onwards. The topic "central banks" shows a significant relation to inflation expectations only around the financial crisis.

With regard to the corporate sector, the links are at the same time more direct and more nuanced. In times of price uncertainty firms pay close attention to overall inflation reporting. This was the case in the early years of European monetary union at the beginning of our observation period as well as during surge of inflation starting in 2021. Companies from different industries behave quite differently. While producers of durable goods mostly pay little attention to inflation news, the link between coverage (the overall indicator as well as most individual topics) and expectations is a lot closer for producers of non-durable goods. In periods of more intensive inflation coverage the correlation is becoming stronger and more significant. For all economic agents considered in our analysis, periods of low inflation coverage are characterized by non-significance with regard to inflation expectations.

Our overall findings are in line with the idea that the link between news and inflation expectations of private households as well as firms are state-dependent. If the intensity of the reporting increases the information provided by the media are used to adjust inflation expectations. In addition, it is obvious that different topics are related to the formation of expectations of economic actors.

As the media have the tendency to lower reporting intensity once an issue loses its newness, the resulting inattention is set to induce firms and households to adapt their expectations in a delayed manner, even if actual inflation rates fall successively. This type of interaction between the media and economic agents is likely to contribute to the stickiness of inflation expectations, complicating the job of policy makers. The gap between inflation perception and actual price developments may be aggravated, if a convincing "inflation narrative" emerges that puts the blame on domestic institutions assigned to keep inflation under control. In fact, the results of the IPI model can be interpreted as manifestations of a German inflation narrative that attributes the role of villains to central banks, finance ministries, and raw materials-exporting countries (Müller et al., 2022).

However, our findings come with a crucial caveat. Most of the observation period was characterized by an extensive phase of more or less stable price levels. As inflation remained at low levels for many years, it comes as little surprise that we find low levels of attention – and insignificant links to expectation formation – for much of the period and actors involved. All this may change, though, were the world economy to enter a high inflation regime (Borio et al., 2023). In such radically altered circumstances, the behavior of individuals, company

executives and, not least, the media is likely to change profoundly. If and how these changes come about will be an issue worthwhile to be studied in future research.

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