Central Bank Communication: Information and Policy shocks

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Abstract

The study proposes a novel way to identify the effects of monetary policy shocks taking into account time-varying signals of the central bank. I augment the standard monetary policy Bayesian Vector Autoregression (BVAR) with additional information variables from Fed statements, which allows us to study the information-free effects of monetary policy shocks and to take into account forward-looking information released by the central bank. The results show that, compared to surprises in 3-month federal funds futures, the policy shock identified in this study has a more negative effect on GDP, a more prolonged negative effect on inflation and a greater impact effect on the excess bond premium. In the short-run it causes S&P500 to decline and the Fed to raise its interest rate. Furthermore, the results of large-scale Bayesian VAR confirm the standard transmission channels of monetary policy.

Keywords: monetary policy, shock, transmission, statements, Latent Dirichlet Allocation, information

JEL Classification: E52, E31, E00

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1 Introduction

How does monetary policy affect the economy? To answer this question it is necessary to find an effective means of analysing the effects of monetary policy shocks due to the fact that the Fed reacts to macroeconomic indicators and shocks should be orthogonal to this reaction. The principal empirical strategies lie in purging a monetary policy instrument from the reaction function (Romer & Romer (2004)) or employing high-frequency identification (Gertler & Karadi (2015)). Nevertheless, recent studies have pointed out that the effect of the information in central bank communications might invalidate even high-frequency identification (Steinsson (2019), Jarocinski & Karadi (2020), Hansen & McMahon (2016) among others).

The main concern with high-frequency identification lies in the fact that the Federal Open Market Committee (FOMC) might possess insider information (Romer & Romer (2000)), as a consequence of which FOMC statements might release this private information or time-varying preferences of the central bank to the public. The reaction in a narrow window around Fed announcement could well contain a response to this additional information rather than a response to unexpected monetary policy action by the Fed. Therefore, the response in 3-month federal funds futures would not be a causal consequence of a monetary policy action itself. In line with that, Miranda-Agrippino & Ricco (2014) found that shocks identified by purging can be predicted from macroeconomic indicators (from *Federal Reserve Economic Data* (2019)), while shocks identified by high-frequency strategy can be predicted from *Greenbook Historical and Forecast Data* (2019) projections.

Moreover, literature still lacks a good measure of monetary policy shock. Popular approaches rely on purging suitable proxies with respect to Fed private forecasts (Romer & Romer (2004), Miranda-Agrippino & Ricco (2014)) or on augmenting VAR with forward-looking information emanating from Federal Reserve forecasts (Bu et al. (2020)). Nevertheless, these approaches are also problematic because Fed forecasts are not available to the public in real-time (as was pointed out by Ramey (2016)) and, therefore, the "correct" reactions of macroeconomic variables to a "monetary policy shock" in this case are puzzling because there is still unresolved signal-extraction problem by the public. Using information released in policy statements instead of Fed private forecasts helps to overcome above-mentioned problems and at the same time to purge monetary policy surprises.

This paper provides original empirical evidence regarding the information contained in FOMC statements. Identifying the type of information inherent in "policy surprises" enables these surprises to be decomposed into information and information-free policy effects. I use FOMC statements as the main data source for 1994–2016 because the Fed started to release statements from 1994. I employ Latent Dirichlet Allocation (LDA) pre-trained on the business sections of main U.S. newspapers for content extraction from the FOMC statements, which transforms Fed statements into topics distributions over time. Following that, I adopt a lexical-based approach to assign the tone to each sentence from the FOMC statements, which counts the frequency of positive/negative and uncertain words in each sentence. These topic time series are employed to identify the types of information that are important for surprise changes in the 3-month federal funds futures on FOMC statement release dates. I use Bayesian Lasso regression for this purpose.

Furthermore, the study decomposes federal funds future surprises on FOMC dates into information and information-free shocks by augmenting the standard VAR with information variables, which enable us to separate the Fed information effects from a pure policy shock. For this purpose, I use the data from Jarocinski & Karadi (2020) on 3-month federal funds futures and S&P500 surprises in a narrow window around the FOMC announcement, as well as the main macroeconomic indicators employed in Vector Autoregressions (VAR) by Jarocinski & Karadi (2020) to make the findings comparable.

The main results are as follows. The most important news released by the central bank concern the macroeconomy. The positivity of these signals lead to an increase in short-term nominal daily yields, while signals concerning macroeconomic uncertainty increase long-term daily nominal and real yields, as well as expected inflation. These fiddlings are also in line with those of Hansen et al. (2019). The result confirms that central bank communication is a multi-dimensional object and affects the economy in different directions.

The conventional way of identifying monetary policy shocks in the literature is to rotate principal components around monetary policy announcements to capture target and path factors of monetary policy, as was first introduced by the excellent work of Gürkaynak et al. (2005). Derived path factor should capture communication channel of monetary policy that influence long-term rates mainly through the term premium. My findings show that this path factor might capture central bank uncertain signals concerning future economic development. These signals are important for the long tails of nominal and real yield curves.

The paper introduces a novel way to identify the effects of monetary policy shocks conditional on information released by the central bank in its statements. The popular approach is to purge suitable surprise components with respect to Fed private forecasts (Romer & Romer (2004), Miranda-Agrippino & Ricco (2014)). But this approach has two major issues. Firstly, why to do conditioning on Fed private forecasts that are unavailable to the public in real-time? In this case, there is still a signal extraction problem by the public and the "standard" reactions of output and inflation are questionable[1]. Secondly and more importantly, recent literature questions the information advantages of the Fed[2]. An alternative explanation is that the Fed releases its time-varying reaction function to the public and from its statements the public learns it and updates expectations accordingly. In this case, it is reasonable to conditioning on central bank signals[3] instead of internal forecasts. Moreover, Gürkaynak et al. (2020) shows that based on the comments in the financial press, latent factors that explain most of the variation of the yield curve are indeed days of well-known "statement surprises".

After augmenting VAR with these news series the results show that a policy shock has a more negative effect on GDP and more prolonged negative effect on inflation compared to the baseline results. In the short-run it causes S&P500 to decline and the Fed to raise its interest rate. What is more, it rises the cost of credit on impact.

The results contribute to the literature on the transmission channel of monetary policy. The results of large-scale Bayesian VAR show that a monetary policy shock is transmitted according to the theory: it reduces real economic activity, inflation, credit spreads, while increases interest rates, the cost of credit and macroeconomic uncertainty. The results also confirm the importance of interest rate, credit, exchange rate, asset prices and expectations channels of monetary policy propagation. However, contrary to previous findings, I could not confirm the importance of the term premium channel for monetary policy shocks propagation.

The findings add to the results of Jarocinski & Karadi (2020), who employed sign restrictions to identify the monetary policy and information effects of the central bank. The effect of policy surprise shocks are in line with the main findings of Jarocinski & Karadi (2020): the effect is less persistent on interest rates but more persistent on inflation

[1] As was pointed out by Ramey (2016)

[2] See, for instance, Michael D. Bauer and Eric T. Swanson (2020)

[3] Delphic forward guidance by Campbell et al. (2012)

and the cost of credit. Therefore, I relaxed sign restrictions and obtained quantitatively similar results.

Moreover, the study extends the findings of Romer & Romer (2000) on asymmetric information between the Federal Reserve and the public. My findings show that FOMC statements provide additional information which goes beyond the monetary policy actions themselves, but this information also should be well anticipated by markets. Therefore, the central bank might release time-varying policy preferences to the public in its communications instead of new information about economic development.

The information shock, identified in this study, has an expansionary effect on the economy as in Steinsson (2019), who showed that a contractionary monetary policy shock from high-frequency identification has an expansionary effect on output growth expectations. Hubert (2019) found that contractionary monetary policy has negative effects on inflation expectations and stock prices only if and when associated with positive economic news. This study could not confirm this finding. Moreover, Iglesias et al. (2017) found that neither positive nor negative communication had particularly significant effects on inflation nor real economic activity, whereas Hubert & Labondance (2017) found that sentiment affects private interest rate expectations, inflation and industrial production beyond monetary shocks. On the contrary, this study finds that communication mainly reduces the cost of credit.

The study expands the literature on the importance of FOMC statements. For instance, Gürkaynak et al. (2020) show that when a sample includes statements the heteroskedasticity-based estimator yields a reaction coefficient that is two to 400 times larger than the OLS estimator without statements.

Last but not least, this study complements the recent literature in its way of decomposing FOMC statements into topic time series with sentiments. To the author's best knowledge this is the first study to employ a pre-trained LDA model for decomposing the sentences from FOMC statements into economic topic time series. Hansen et al. (2019) used Bank of England Inflation reports and treated each paragraph as a document in LDA. Similarly, Hansen & McMahon (2016) trained the LDA model on sentences from FOMC statements. Subsequently, the previously-cited authors assigned the tone to each topic. My approach differs from the above-mentioned in that the LDA model was trained on the business section of a selection of U.S. newspapers, which enables us to obtain more distinguishable topics. What is more, my methodology captures changes in the topic composition of FOMC statements without the need to rely on the dynamic topic model.

The remainder of the paper proceeds as follows. Section 2 describes the data and methodology. Section 3 discusses the information content of Fed communication. Section 4 discusses the mechanism of central bank communication effects. Section 5 presents the main results on the transmission mechanism of the information-free effect of monetary policy. Section 6 concludes.

2 Methodology

The Federal Open Market Committee (FOMC) holds eight regularly scheduled meetings during the year and additional meetings as needed. In these meetings the Federal Open Market Committee decides on the interest rate changes necessary for adjusting inflation. Beginning with the 1994 meetings, the FOMC Secretariat started to release FOMC statements to the public (*Federal Open Market Committee: Transcripts and other historical materials* (2019)). Federal Open Market Committee statements for 1994–2020 used in this study were downloaded from the Fed webpage.

The standard high-frequency identification strategy employs a narrow window (30 minutes) in order to detect surprise changes in 3-month federal funds futures around FOMC announcements. The main concern with this identification strategy lies in the fact that the FOMC might possess insider information (Romer & Romer (2000)), and FOMC announcements might contain additional information for the public or it might reveal its time-varying preferences. The reaction in a narrow window might contain a response to this additional information rather than a response to unexpected monetary policy action. This might invalidate the interpretation of the results based on high-frequency identification since it is not possible to distinguish the effect of monetary policy shocks from information shocks.

Following the previous logic, Miranda-Agrippino & Ricco (2014) found that the surprises highlighted in Gertler & Karadi (2015) can be predicted from from *Greenbook Historical and Forecast Data* (2019) projections and *Federal Reserve Economic Data* (2019) factors. The authors purged the shock series with respect to their own lags and Greenbook information[4]. Nevertheless, these surprises may, in fact, be attributed to revelation of time-varying preference of the central bank. In this case, purging shock series with respect to Greenbook

[4]As in Romer & Romer (2004)

information might not capture this additional information. Therefore, I purge shock series with respect to topics from FOMC statements. These topics and the tone of the Fed should serve to capture the Fed information effect and allows to separate pure monetary policy shocks from information shocks.

I use the data from Jarocinski & Karadi (2020), who decomposed surprise and information shocks from surprises in 3-month federal funds futures and stock prices around FOMC announcement using sign restrictions. However, in order to obtain more accurate results when purging surprises in federal funds futures from the information effect, I add additional informational proxies to the standard SVAR, which allows us to separate these surprises from the effects of information.

To train a model for the topic extraction, details of which are presented below, I use the Nexis Uni database from where I extracted daily business news from The New York Times (1980–2019), The Washington Post (1981–2019), The Los Angeles Times (1985–2019) and The Chicago Tribune (1985–2019). The New York Times is the second-largest in circulation and the largest circulating metropolitan newspaper with a weekly circulation of 2.1 million. It is also ranked 18th in terms of world circulation. The Los Angeles Times is the fourth-largest US newspaper by circulation, The Chicago Tribune is the sixth- and The Washington Post is the seventh-largest by circulation. The total timespan is 1980:M6–2019:M7.

Following Shapiro et al. (2017) I filtered out the news that does not contain one of the following words: said, says, told, stated, wrote, reported. After imposing these criteria, the data pull yielded approximately 416,000 articles.

Following Larsen & Thorsrud (2019), I employ Latent Dirichlet Allocation (LDA) (introduced by Blei et al. (2003)) for topic extraction. The LDA is a probabilistic graphical model that is based on the bag-of-words assumption, that is the word order does not matter. If one mixes words in an article and employs the LDA it leads to the same results as without mixing. For extracting news topics with Latent Dirichlet Allocation standard text processing steps are employed:

- Words from a stoplist are excluded. This list contains common words that contribute little meaning to the documents, such as prepositions, conjunctions, and pronouns.
- Words are reduced to their word root form. Example: economy, economic, economical, economics, economise are reduced to the root form econom.
- Rare and frequent words are removed

- Vocabulary consists of 57,990 unique words.

LDA is a mixed-membership directed probabilistic graphical model for a text corpus. The generative process for a document collection D under the LDA model is as follows (Darling (2011)):

1. For each topic $k = 1, ..., K$ (K is the total number of latent topics):
   - A discrete probability distribution over a fixed vocabulary that represents the k^{th} topic distribution, $\varphi_k \sim Dirichlet(\beta)$[5]
2. For each document $d \in D$ (D is the total number of documents):
   - A document-specific distribution over the available topics (per-document topic proportion), $\theta_d \sim Dirichlet(\alpha)$[6]
   - For each word $w_n \in d$ (N is the total number of words):
     (a) Per-word topic assignment (shows which topic generated the word instance $w_{d,n}$), $z_{d,n} \sim Mult(\theta_d)$[7]
     (b) An observed word, $w_{d,n} \sim Mult(\varphi_k)$

The joint probability for LDA takes the form (2):

$$p(w_{d,n}, z_{d,n}, \theta_d, \varphi_k|\alpha, \beta) = (\prod_{n=1}^{N} p(z_{d,n}|\theta_d)p(w_{d,n}|z_{d,n}, \varphi_{n,k}))(\prod_{k=1}^{K} p(\varphi_k|\beta))(\prod_{d=1}^{D} p(\theta_d|\alpha))$$

$$= (\prod_{n=1}^{N} Mult(z_{d,n}|\theta_d)Mult(w_{d,n}|z_{d,n}, \varphi_{d,k}))(\prod_{k=1}^{K} Dirichlet(\varphi_k|\beta))(\prod_{d=1}^{D} Dirichlet(\theta_d|\alpha)) \quad (1)$$

where, $p(w_{d,n}, z_{d,n}, \theta_d, \varphi_k|\alpha, \beta)$ is the posterior from the LDA model.

Latent variables $z_{d,n}$, θ_d, φ_k are unobserved. Inference is done via Collapsed Gibbs Sampling (Griffiths & Steyvers (2004)) with $\alpha = 50$ and $\beta = 0.01$. Since for the inference of both θ_d and φ_k it is sufficient to know just $z_{d,n}$, Collapsed Gibbs Sampling is based on integrating out the multinomial parameters and simply sampling $z_{d,n}$ (see Griffiths & Steyvers (2004) for the detailed treatment). The outcomes of the algorithm are topic distributions θ_d and word distributions per topic φ_k.

[5] $Dirichlet(.)$ is the Dirichlet distribution (a conjugate prior for the Multinomial distribution), β is a hyper-parameter

[6] α is a hyper-parameter.

[7] $Mult(.)$ is the Multinomial distribution.

The optimal number of topics for LDA was chosen based on coherence values. The topics are considered to be coherent if all or most of the words, for example, the topic's top N words, are related. Coherence values for different numbers of topics are presented in Figure A.1. According to the coherence values, the optimal number of topics is 40. All topics from the LDA model are interpretable and are shown in Figure 1, whereas Table A.1 shows word distributions for each topic.

Larsen & Thorsrud (2019) in their study implemented sign adjustment (positive versus negative news) to news topics. However, as was pointed out by Sims (2003), the tone of economic reporting affects sentiment beyond the economic information contained in reporting itself (which was explored in the study of Shapiro et al. (2017)). Therefore, I take into account both the statement's topic and its sentiments.

To assign a sentiment for each FOMC statement I employ a dictionary of Loughran & Mcdonald (2016) with a negation rule (details are discussed in Appendix B). This approach relates to Shapiro et al. (2017), where the authors found that a combination of different dictionaries with a negation rule is closer to human judgements with regard to labelling sentiment.

The positive sentiment of a sentence is calculated as following (2):

$$Pos_i = \frac{\#positivewords_i - \#negativewords_i}{\#totalwords_i} \tag{2}$$

The total monthly positive sentiment for a specific economic topic is calculated as the sum of sentence positive sentiments minus negative sentiments multiplied by topic proportions within the sentence and sum over the sentences (3):

$$Pos_{topic} = \sum_{i \in topic} Pos_i \times topic\_proportions_i \tag{3}$$

where $topic\_proportions_i$ is the proportions of the topics in a sentence that is above a threshold (details can be found in Appendix B).

Similarly, I calculated uncertainty sentiments by employing (2) and (3) for uncertain words from Loughran & Mcdonald (2016)[8].

In order to purge monetary policy shock series with respect to central bank signals I augment the standard VAR with information variables.

The standard Structural VAR representation in companion form is:

$$Ay_t = Bx_{t-1} + \varepsilon_t \tag{4}$$

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

, where $x_t^{'} = [1, y_{t-1}^{'}, y_{t-2}^{'}, ..., y_{t-k}^{'}]$ and $\varepsilon_t \sim i.i.d.N(0, D)$, D is diagonal, y_t is $k \times 1$ vector of endogenous variables, ε_t is $k \times 1$ vector of exogenous random shocks. A and B are $k \times k$ coefficient matrices.

The reduced form representation is:

$$y_t = A^{-1}Bx_{t-1} + A^{-1}\varepsilon_t$$

$$y_t = Cx_{t-1} + \epsilon_t \tag{5}$$

where $C = A^{-1}B$ and ϵ are $k \times 1$ vector of reduced form shocks, which don't have any economic interpretation.

Infinite MA representation of (5) is:

$$y_t = \sum_{j=0}^{\infty} \Theta_j \varepsilon_{t-j} \tag{6}$$

The identification problem to (6) comes from two sources. First one is the regular identification problem: recovering structural shocks from (6) by imposing restrictions on A matrix and variance-covariance matrix of residuals. These helps to overcome the observation equivalent problem of:

$$y_t = \sum_{j=0}^{\infty} (\Theta_j U^{-1})(U\varepsilon_{t-j})$$

$$y_t = \sum_{j=0}^{\infty} \Theta_j^* \varepsilon_{t-j}^* \tag{7}$$

When decision's maker information set is different from econometrician information set the second problem of non-uniqueness arises:

$$H^*(z)E\varepsilon^*\varepsilon^{*'}H^*(z^{-1})^{'} = H(z)E\varepsilon\varepsilon^{'}H(z^{-1})^{'} \tag{8}$$

where $H(z)$ is the z-transform. The (8) shows two observatory equivalent results, one of which is invertible representations and other is non-invertible. If A^{-1} is equal to $H^*(z)$ then standard identification by imposing restrictions in A matrix recovers ε^* structural shock:

$$y_t = A^{-1}Bx_{t-1} + A^{-1}\varepsilon_t^*$$

Identifying A^{-1} recovers the shocks ε_t^*, but not the structural shocks ε_t, that agents observe since the econometrician conditions on a smaller information set than do agents (Leeper et al. (2013)). Moreover, there should not be foresight effects in VAR. Therefore, augmenting VAR with additional information variables that are forward-looking should help to overcome the invertibility problem of VAR. What is more, these information variables are available to the public in real-time and it is more reasonable to take this information into account instead of conditioning on the Fed information set that is not available to the public.

Noh (2018) suggested to use proxy variables as additional regressors in the VAR instead of using proxy variables as IV for a shock identification assuming the invertibility condition, because the Proxy-SVAR, which is the most efficient approach under the invertibility and linearity, is valid if and only if the pre-whitened proxy variable has no direct forecasting ability if it is added in the VAR. It is well-known that surprises in 3-m federal funds futures on FOMC announcements dates contain forward guidance effects and, therefore, have forecasting power for future interest rate changes. That is why instead of using surprises in 3-m federal funds futures as a proxy variable and assume invertibility of VAR, I use it as an additional regressor in the conventional monetary VAR. This is "internal instrument" approach, also pointed out by Plagborg-Mollerand & Wolf (2019), who highlighted that structural estimation with an instrument (proxy) can be carried out by ordering the instrument first in a recursive VAR, even under non-invertibility[9].

There are some implicit assumptions while using surprises around FOMC announcements to measure the effect of monetary policy shocks, namely (1) there is only one event in a selected window; (2) markets know exactly data-generating process and information of the central bank, (3) markets know exactly the central bank reaction function; (4) efficient market hypothesis; (5) a risk premium does not change in a window. Moreover, foresight should be already taken into account by markets. In this case, asset price changes in a window around an announcement can be represented as:

$$p_t^h - p_{t-30min}^h = [\mathbb{E}_t(i_{t+h}) - \mathbb{E}_{t-30min}(i_{t+h})] + [\zeta_t - \zeta_{t-30min}]$$

$$p_t^h - p_{t-30min}^h = [\mathbb{E}_t(i_{t+h}) - \mathbb{E}_{t-30min}(i_{t+h})] = e_p + error$$

where the first part in brackets is a revision of expectations and the second is a revision of a term premium.

A shock is an innovation orthogonal to the state of the economy and a surprise is an innovation orthogonal to the public information set. In case the Fed has an information

[9]For instance, Durante et al. (2020) used poor man's proxy of surprises as a policy shock measure in the framework of Jorda local projections.

advantage over markets, agents' update of forecasts during an announcement can confound e_p with the reaction function of the central bank, which gives a reason to purge surprises with respect to the central bank information set. However, in case the Fed does not have an information advantage over markets, but signalling its time-varying preferences then purging surprises with respect to the central bank information set would not clean them form information effects.

3 Information content of Fed communication

The pre-trained LDA model can be used to classify new documents. It decomposes any new document into forty topics by assigning topic proportions that sum up to one. Therefore, any document can be represented as forty topic proportions. These proportions should capture the meaning of a document. Appendix C presents the results for labelling topics for FOMC statements separated into paragraphs and sentences. Topic distributions for the most part correctly capture the meanings of each sentence and paragraph. Moreover, aggregated topic distributions over all the documents are approximately the same as if I were to assign a topic based on the threshold 0.3 for each sentence and 0.25 for each paragraph (see Figure C.29, Figure C.30 and Figure C.31).

Figure 1 shows aggregated topic distributions over all the documents with topics assigned for each sentence. Based on the results, the Fed provides the greatest amount of information on its monetary policy (topic: Fed), economic conditions (topics: Economic, Economics), federal committee regulations (topic: Rules), interest rates setting (topic: Rates), reporting (topic: Reports), job market conditions (topic: Jobs), asset market (topics: Investing, Securities), budget (topics: Income, Taxes, Budget, Spendings), and oil/gas (topics: Gas, Energy, Oil prices, etc.).

These topics are in line with types of information the Fed usually releases in its statements. Infrequent and non-intuitive topics might reflect changes in information that the Fed releases. For instance, the Health topic time series is important when the Fed talks about the effect of Coronavirus in its statements; the Food topic time series highlights periods when the Fed talks about food prices; the Computers topic time series might pin down words about monitor or monitoring in the Fed statements; the Housing topic time series might indicate periods when the Fed talks about house prices, etc.

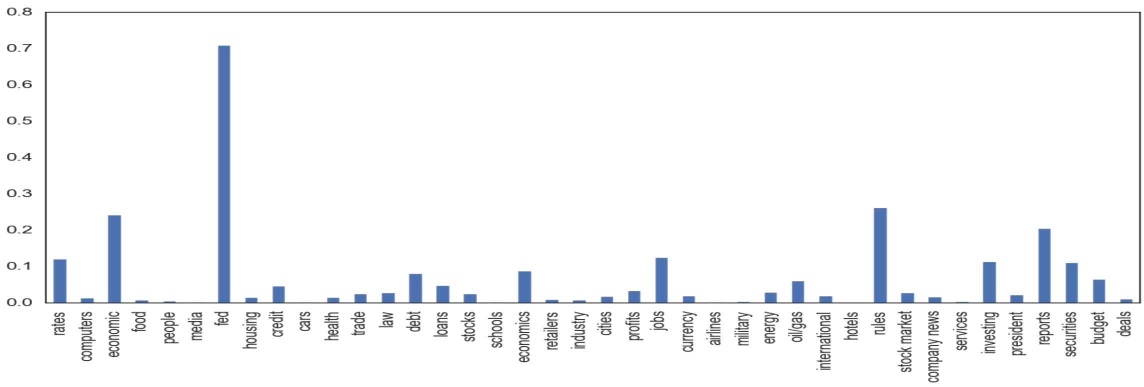
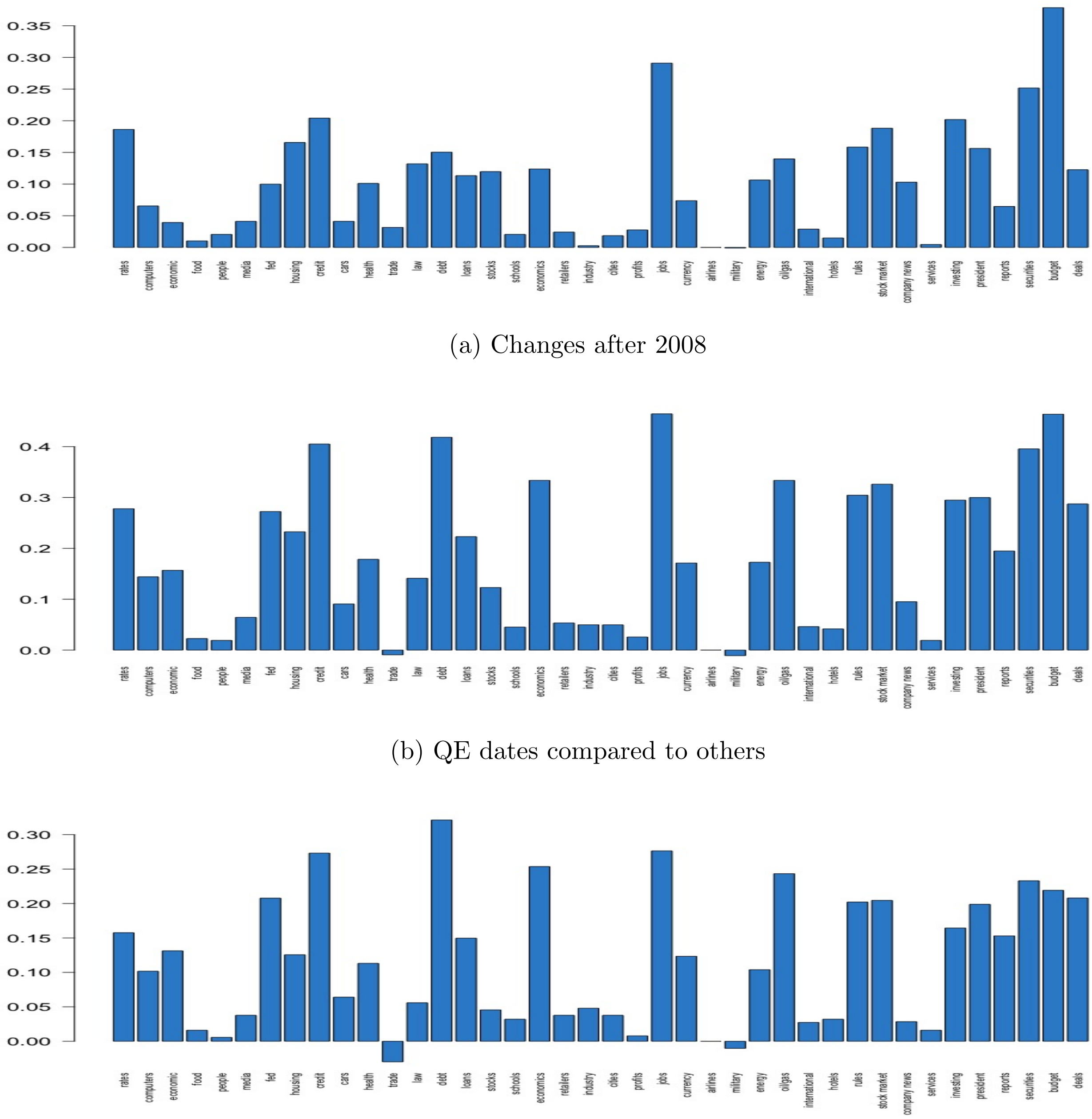


Figure 1: Topic proportions of statements by each sentence

The topic decompositions for FOMC statements over time show that from 2008 the FOMC started to rely more on communications (Figure D.7). That is fully in line with the fact that the federal funds rate hit the zero lower bound and the FOMC started to use unconventional monetary policy tools. The Fed started to communicate more frequently about its monetary policy, but also about economic conditions, its interest rate settings, jobs, rules, reports, securities and investment.

The distribution of topics, however, is not constant over time. The FOMC releases more information concerning debt and loans from 2008, and about stocks and jobs from 2010. Additionally, the Fed communicates more frequently on its interest rates policy from 2012 (Figure D.7). Moreover, the tone of the Fed during economic recessions is generally more negative (Appendix D).

Figure D.8 and Figure D.9 present tone adjusted separate topic time series. Figure 2 reports on changes in topic proportions in Fed statements over time. For instance, the Fed started to signal more regarding jobs, budget, securities, shock market, investing, housing, credit and rates after the funds rate hit the zero lower bound. The rates topic reflects that the Fed started to explain more its interest rate setting decisions, topics concerning budget, securities, shock market, investing, housing, credit might reflect the use unconventional monetary policy tools, while the topic concerning jobs should provide information for the public about future labor market conditions. Therefore, topic time series provide evidence that the Fed started to rely more on communications strategies during unconventional times.



(a) Changes after 2008

(b) QE dates compared to others

(c) QE dates compared to after 2008

Figure 2: Topic proportions over time

The methodology allows to identify topics connected with quantitative easing announcements of the central bank. Figure 2 shows that on dates of these announcements the Fed signaled more on debt, stock market, securities, credit, budget, housing.

I use the information contained in the FOMC statements to decompose monetary policy surprises into information and policy shocks. Surprises are changes in the federal funds futures on the dates of announcements in a narrow time window around these announcement[10]. To decompose surprises into information and non-information components I need to select the topics that are important for these surprises. Each FOMC statement is decomposed into 40 topics but not all information is relevant for the public. I use a Bayesian Lasso regression (Park & Casella (2008)) for topic selections. For this purpose all non-stationary topic time series were transformed into a stationary form by taking first differences. All series were standardised for Lasso regression.

Figure 3 presents the Bayesian Lasso for 40 topics time series from FOMC statements. It shows the proportions of samples when each topic was selected. The total number of MCMC samples is 10,000. It is necessary to set a threshold for selecting the most important topics. In this instance, I use the threshold 0.65, selecting the topics that were included in at least 6,500 MCMC samples.

The topics that are found to be important for predicting Fed "surprises" are fully in line with what one would expect. These surprises are predicted from economic, credit, economics, international, company news, investing and deals topics. The result is robust also with regard to important topic time series for the first principal component of the surprises in fed funds futures and eurodollar futures with one year or less to expiration. Importance of topics on economic issues might contain the Fed information effect. For instance Jarocinski & Karadi (2020) found that a difference between the staff and private forecasts for one-quarter-ahead real GDP growth influences the central bank information shocks significantly.

Employing sign adjustment for topics from FOMC statements instead of tone adjustment leads to similar results, namely the topics Economic, Economics, Cities, Deals are important for surprises in federal funds futures on the FOMC statements release dates (Figure E.1).

[10]Usually it is a 30-minutes window around the announcement time.

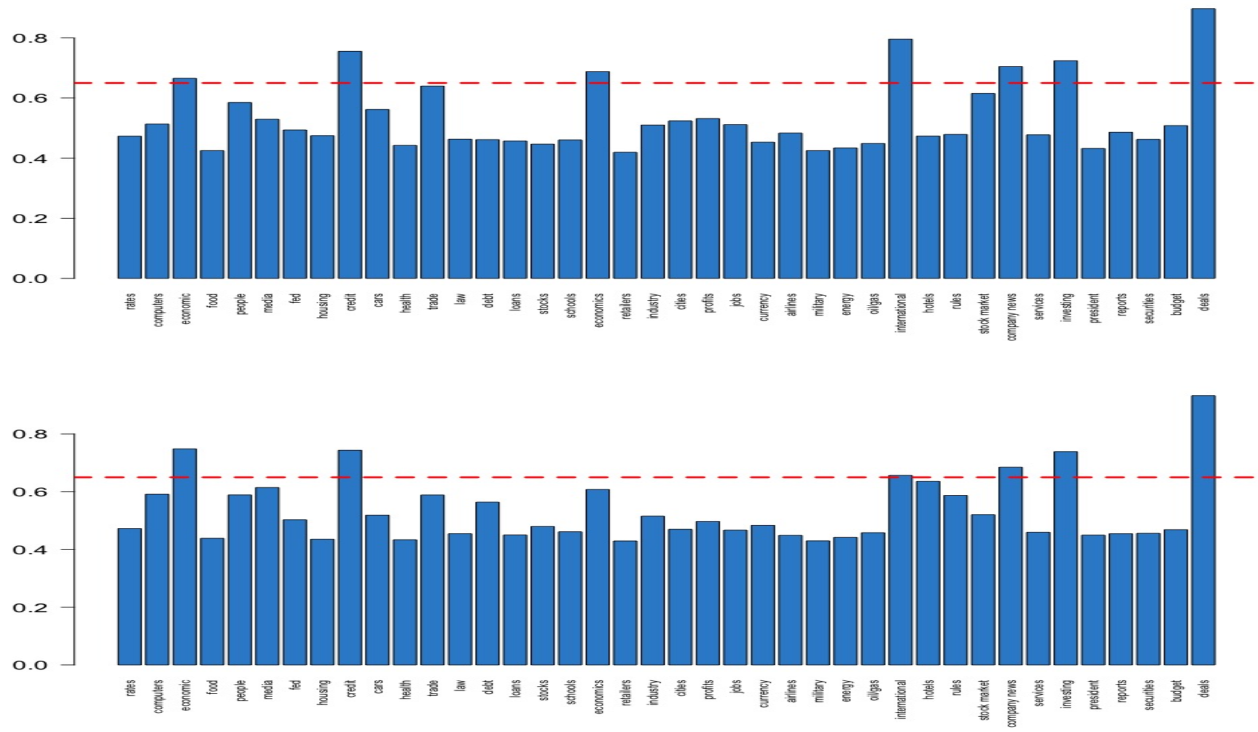


Figure 3: Bayesian Lasso for surprises in 3m federal funds futures (top) and the first principal component of the surprises in fed funds futures and eurodollar futures with one year or less to expiration (bottom)

The Fed does not talk about cities in its statements, rather Cities is purely a label to serve as a topic for the distribution of words. The topic Cities represents sentences that contain a particular combination of words, such as: citi, build, develop, offic, area, project, project, real, properti, million, estat, space, plan, squar, washington, district, construct, park, street, local, leas, counti, feet, downtown, rent, land, region, commun, includ, commerci. It does not necessarily need to contain information about cities per se, but there might be information concerning development, projects, etc. This topic is quite infrequent in FOMC statements (Figure 2). Similarly, the topic Cars is not limited exclusively to cars, but also covers car, sale, auto, vehicle, ford, year, motor, chrysler, truck, model, gm, gener, compani, dealer, market, product, automak, plant, industri, sold, sell, toyota, maker, unit, detroit, driver, incent, american, part, engin. This topic is also infrequent in FOMC statements.

The topics relating to trade and industry which contain uncertainty sentiments are also found to be important for surprises in Federal funds futures (Figure E.1). Furthermore, the topics Computers, Economic, Health, Trade, Industry, Cities, Services, Investing and Deals are found to be important for Gertler & Karadi (2015) proxy for surprises in federal funds futures (Figure E.1).

Figure 4 sheds a light on asymmetric effects of Fed information on surprises in federal funds futures and S&P500 in a narrow window around announcements. Surprises in federal funds futures are more susceptible to negative Fed signals on economy, credit, economics and investing, while surprises in S&P500 are influenced by positive signals concerning the Fed, health, stocks and securities, and by negative signals on credit, trade and currency. In line with logic, surprises in S&P react more on signals about stock markets, whereas surprises in federal funds futures on signals about the economy.

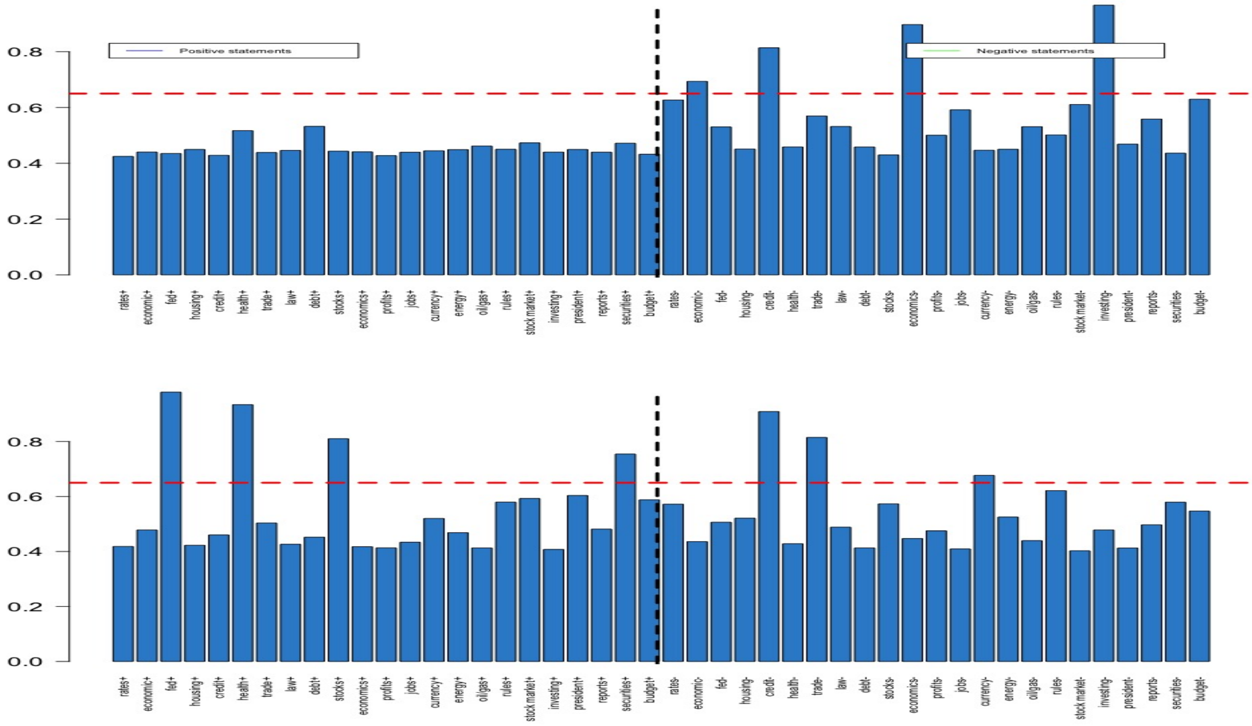


Figure 4: Bayesian Lasso for surprises in 3m federal funds futures (top) and S&P500 (bottom). Asymmetric effects of information

Figure E.2, Figure E.3, Figure E.4, Figure E.5 discuss further asymmetric effects of central bank statements.

4 Mechanism of Central Bank Communication effects

The previous section stated that information released by the central bank in its statements is important for expectations revisions by the public. But what is the channel of propagation of central bank communication on the economy? Central bank communication aims to shape agents expectations of future interest rates and economic conditions, and, therefore, communication should affect through expectation revisions. However, Hansen et al. (2019) showed that news on economic uncertainty can have increasingly large effects along the yield curve. The authors argued that these central bank's signals that drive long-run interest rates do not affect short-run rates and operate primarily through the term premium and have an effect through shaping perceptions of long-run uncertainty.

Firstly, I argue that the central bank sends signals about current macroeconomic conditions and, therefore, it is plausible to take them into account in the standard VAR instead of conditioning on central bank information set, which is unavailable to the public in real-time. I show that central bank communication can be predicted from forward-looking financial market variables. As forward-looking variables, I use changes between FOMC meetings in nominal effective exchange rate (Δ NEER) for USA and Euro, TED Spread (Δ TEDRATE), which is calculated as the spread between 3-Month LIBOR based on U.S. dollars, and Moody's Seasoned Aaa and Baa Corporate Bond Yield Relative to Yield on 10-Year Treasury Constant Maturity (Δ AAA10Y and BAA10Y). Series were downloaded from *Federal Reserve Economic Data* (2019).

Table E.1, Table E.2, Table E.3, Table E.4 report results of predictive regressions for all forty topic time series from FOMC statements. I concentrate on topic time series from FOMC statements that are (1) connected to news about the economy, (2) important for surprises in the federal funds futures in a narrow window around announcements, and that are not important for surprises in S&P500 during announcements. The topics are Economic, Economics and Investing. Table E.1 and shows that the Economic topic from statements is predicted from changes in the spread between 3-Month LIBOR based on U.S. dollars and Moody's Seasoned Baa Corporate Bond Yield Relative to Yield on 10-Year Treasury Constant Maturity. Both variables serve as indicators of credit risks. The Economics topic from Fed statements can be predicted from changes in S&P500 (Table E.2), which is a stock market index that tracks 500 large companies. According to Table E.4 the Investing topic from FOMC is also predicted from changes in the spread between 3-Month LIBOR based on U.S. dollars. These results are in line with the recent findings of Beckers (2020), who claimed that credit risk conditions enter the central bank reaction function.

Table 1 shows the connection between aggregated signals about the economy[11] in FOMC statements and surprises in 3-month federal fund futures around Fed announcements. Interestingly, R^2 from these regressions are similar to R^2 in the first stage regressions of Miranda-Agrippino & Ricco (2014), who regressed surprises around FOMC announcements on Fed private forecasts.

Table 1: Surprises in ffr futures

	Dependent variable:	
	ffr_hf	ffr_hf_PCA
	(1)	(2)
Economic aggregated	1.696**	2.174**
	(0.831)	(0.940)
Constant	−0.002	0.009***
	(0.002)	(0.003)
Observations	274	274
R^2	0.098	0.086
Adjusted R^2	0.095	0.083
Note:	Newey-West HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01	

Furthermore, it is important to investigate whether Fed signals are important for interest rate changes. For this, I aggregate the topics Economy, Economic and Investing into one and see if it has predictive power for interest rate changes around Fed announcements days[12]. Table 2 reports on the importance of economic news signals sent by the Fed during announcement days on daily changes in short-term rates. As a baseline, I use two-days difference in short-term rates, i.e. one day after an announcement minus one day before an announcement. That is because, as noted in the literature, markets might need time to adjust for the information beyond the Fed action itself.

[11] I aggregate the topics Economy, Economic and Investing into one

[12] Daily yields are taken from Gürkaynak et al. (2007)

Central bank's signals about the economy in its statements are positively correlated with changes in short-term yields. This might indicate the expectations channel of central bank communication. Positive signals of central bank concerning the economy lead to a revision of expectations by market participants. If central bank information set was the same as market participants information these signals would not be important for markets. Moreover, these signals can be predicted by forward-looking financial variables and according to the efficient market hypothesis should already be taken into account by markets by release date.

Table 2: Δ Yields, 2 days difference

	Dependent variable:				
	1 year rate Δ 1 day	1 year rate	breakeven 5 years	breakeven forward 2 years	breakeven 10 years
	(1)	(2)	(3)	(4)	(5)
Economic aggregated	1.294*	1.733**	−1.563	−2.260*	−1.046
	(0.757)	(0.782)	(1.134)	(1.311)	(0.684)
Constant	0.0004	−0.008	0.005	0.012*	0.001
	(0.004)	(0.005)	(0.005)	(0.007)	(0.004)
Observations	186	186	132	132	132
R^2	0.039	0.048	0.036	0.054	0.029
Adjusted R^2	0.034	0.042	0.028	0.046	0.022

Note: Newey-West HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Reverse causality is not valid in this case, because the Fed should not react to previous day yields in its statements. Moreover, the assumption of no omitted variable bias is not too restrictive because usually there are no other events during the days of statements releases. One concern is that markets react to unexpected actions of the central bank and these actions are correlated with signals concerning the economy. But the more plausible explanation, in this case, is that markets react to signals and to actions at the same time. The latter claim was confirmed by Gürkaynak et al. (2005) for instance.

Moreover, as was notices by Hansen et al. (2019), central bank signals are highly-dimensional objects, which can affect the term premium as well. The authors pointed out the importance of central bank signals concerning macroeconomic uncertainty. To study this channel I use topic time series that were labelled with uncertainty sentiments instead of positivity/negativity. Moreover, I concentrate on topics concerning the economy, because these topics should reflect central bank views about future macroeconomic conditions and, therefore, these should be a source of important information for markets.

Appendix F reports on the predictive power of central bank uncertain signals concerning the economy for the yield curve, Treasury Inflation-Protected Securities (TIPS) and breakeven inflation rates[13]. Economic aggregated is the sum over uncertainties from the Economic, Economics and Investing topics. I also control for uncertainties from the Fed topic that should capture Odyssean forward guidance, where the Federal Reserve release uncertainty concerning information about future monetary policy. Fed topic on FG dates controls for this topic on days of forward guidance.

The results show that uncertainty concerning the economy released by the Fed in its statements affects the long tail of the yield curve. That is in line with the finding of Gürkaynak et al. (2020), who showed that a statement is more informative for longer maturities. Uncertainty concerning the economy is positively connected with daily changes in ten, fifteen, twenty, twenty-five and thirty years yields. The result is robust also for two days changes in yields and also while controlling for surprises in federal funds futures. The results are completely in line with those of Hansen et al. (2019), who found that long-run interest rates respond to central bank communication, namely central bank uncertainty signals on economic development. The authors used the publication of the Bank of England's Inflation Report. The uncertainty signals that drive long-run interest rates do not affect short-run rates and operate primarily through the term premium.

Central bank uncertain signals concerning the economy are also positively connected with two five and ten years forward rates and with one-year forward rate four years ahead. The result is also robust to controlling for a measure of surprises in federal funds futures and to different ways of differencing dependent variables. Moreover, central bank uncertain signals concerning the economy are positively connected to all curve of Treasury Inflation-Protected Securities, while surprises in federal funds futures on announcement days are not. Therefore, uncertain signals concerning the economy released by the Fed in its statements might affect the yield curve of real interest rates.

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[13]Daily yields, TIPS and breakeven inflation rates are taken from Gürkaynak et al. (2007) and Gürkaynak et al. (2010). Inflation compensation incorporate inflation risk premiums and the effects of the differential liquidity of TIPS and nominal securities.

Appendix F.2 presents the robustness check results where I include also a measure of surprises in a narrow window around announcements[14]. All results concerning the importance central bank uncertain signals hold. Surprisingly enough, the measure of surprises about future interest rates is neither connected with changes in yields of Treasury Inflation-Protected Securities, nor with daily changes in Inflation Compensation.

Appendix F.3 discusses bad controls and measurement errors issues. Measurement error is a potential issue with the results because the coefficient of surprises in federal funds futures is higher when I add my proxies for central bank uncertainty signals compared to coefficients from univariate regressions. In this case, there might be a slight upward bias. Bad controls situation occurs when potential outcome variables are used as controls in a regression. I show that surprises in federal funds futures around announcements cannot be outcome variables in a regression.

Hanson & Stein (2015) argue that news about short-term policy expectations is propagated to longer-maturity bonds by the trading activity of yield-oriented investors. According to their model, decreases in short rates induce these investors to switch to longer-maturity bonds, driving the yields on such bonds down through changes in the term premium. Hansen et al. (2019) found that central bank communication affects long-run interest rates by providing news on risk and uncertainty around economic conditions, and thereby generating a change in the long-run term premium. This channel operates not by changing long-run expectations of economic conditions, but by changing the perceived variance of those conditions. Furthermore, the effect of uncertainty signals comes via the long-run term premium, which can move independently of short-run expectations. My results confirm those of Hansen et al. (2019), central bank communication indeed affects market beliefs about long-run uncertainty.

[14]Here I use the first principal component of surprises in the current month and 3-month fed funds futures and 2-, 3-, and 4- quarters ahead 3-month eurodollar futures because it should capture more of forward guidance.

5 Monetary policy vs. Information shocks

5.1 Baseline results

Following Jarocinski & Karadi (2020), I use Cholesky identification[15] for monetary policy shocks with Jarocinski & Karadi (2020) original variables in the following order: surprises in 3-month federal funds futures, the one-year government bond yield, real GDP, GDP deflator and the excess bond premium. To separate a pure monetary policy shock from an information shock, I add additional information variables before surprises in 3-month federal funds futures. The studied period is 1994:M3–2016:M12. Because the data are at monthly frequency I use twelve lags in SVAR. Appendix G presents the SVAR estimation details.

As information variables I select those that should capture the effects of information about the economy, that are topics concerning economy, economics and investing. These topics time series were selected based on following criteria: (1) they have high predictive power for surprises in federal funds futures; (2) they are connected to news about the economy as opposed to monetary policy decisions per se; (3) they are not connected to quantitative easing announcements, which are mainly concerning debt, housing, stock market and securities. Moreover, these topic time series affect the yield curve during the announcement dates.

Figure 5 discusses the baseline results, focusing on three distinct types of shock. In Panel (a) the surprises in 3-month Federal funds futures are ordered first; in Panel (b) the information variables are ordered before the surprises in 3-month Federal funds futures; while Panel (c) presents the difference between the two, which should capture information effects.

The baseline results (Panel (a)) are fully in line with the results of Jarocinski & Karadi (2020) and Gertler & Karadi (2015). Some difference in magnitudes might be explained by their use of a different period of study as Jarocinski & Karadi (2020) used the period from 1984 and employed Kalman filter and smoother for substituting the missing values in surprises in 3-month Federal funds futures. Also, prior tightness parameters are a bit different since I use tighter prior for lags further than the first one.

[15]The authors use Cholesky identification as alternative specifications to sign restrictions.

The result of a small decline in S&P500 in a tight window can be explained in line with Steinsson (2019), who stated that a pure tightening of monetary policy leads stock prices to fall for two reasons: higher discount rates and lower output. The authors found that if monetary policy conveys information about both future monetary policy and future exogenous economic fundamentals, stock prices fall by lesser amount in response to the FOMC announcement than to the shock without information about future exogenous fundamentals.

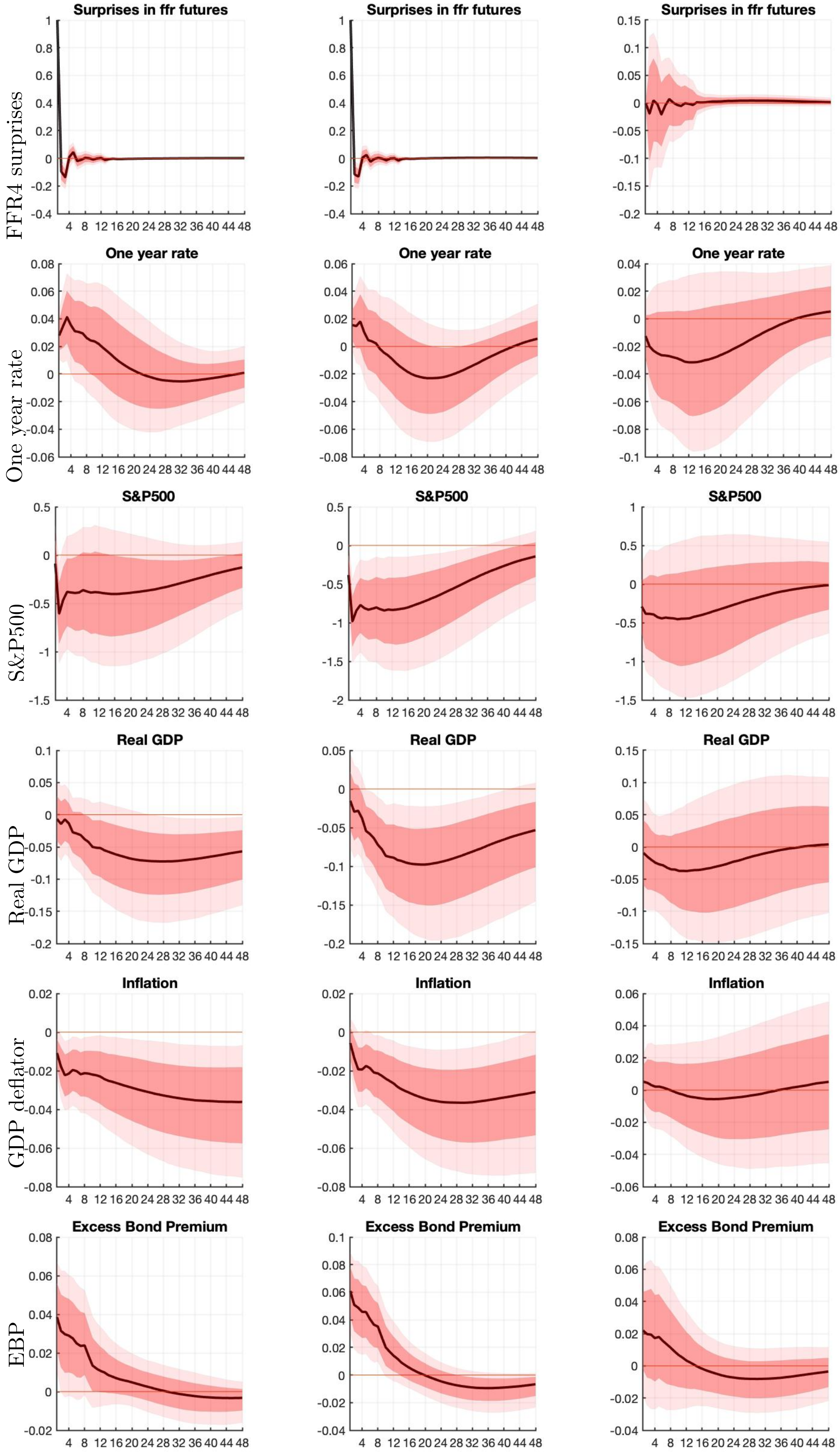
Panel (b) presents the results for purged shocks, which should not contain the Fed information effect. The results are similar to Jarocinski & Karadi (2020). The response of the one year rate is more transitory than in Panel (a). The response of S&P500 is negative for the first few months. The response of real GDP has greater magnitude and it is more prolonged. Finally, the response of GDP deflator is more prolonged compared to the results in Panel (a) with the consequence that the identified effect looks like a contractionary monetary policy shock. For all these variables there is a higher posterior probability for a contractionary response because even 90% posterior credible sets are below zero for a long period. The response of the Excess Bond premium is also in line with the results Jarocinski & Karadi (2020) - a contractionary monetary policy shock without an information effect has a greater effect on the cost of credit with narrower credible sets, which lasts for almost twelve months.

Panel (c) discusses the results for differences between two previous effects, which should capture pure negative information shocks. The results are in line with those of Jarocinski & Karadi (2020) and Steinsson (2019): the Fed information shock has a more prolonged but muted effect on the one year rate, on S&P500 and real GDP. An interesting result is that it has a large short-run effect on the EBP. So positive news contained in announcements can reduce the costs of credit in the short-run.

Therefore, I studied the effect of information free policy shock without relying on sign restrictions. Some differences in impulse responses from Jarocinski & Karadi (2020) ones might be explained by (1) differences in the periods studied[16], (2) and the identification strategies for monetary policy and information shocks[17].

[16] Jarocinski & Karadi (2020) dealt with missing values for the shocks series via Kalman filter and smoother.

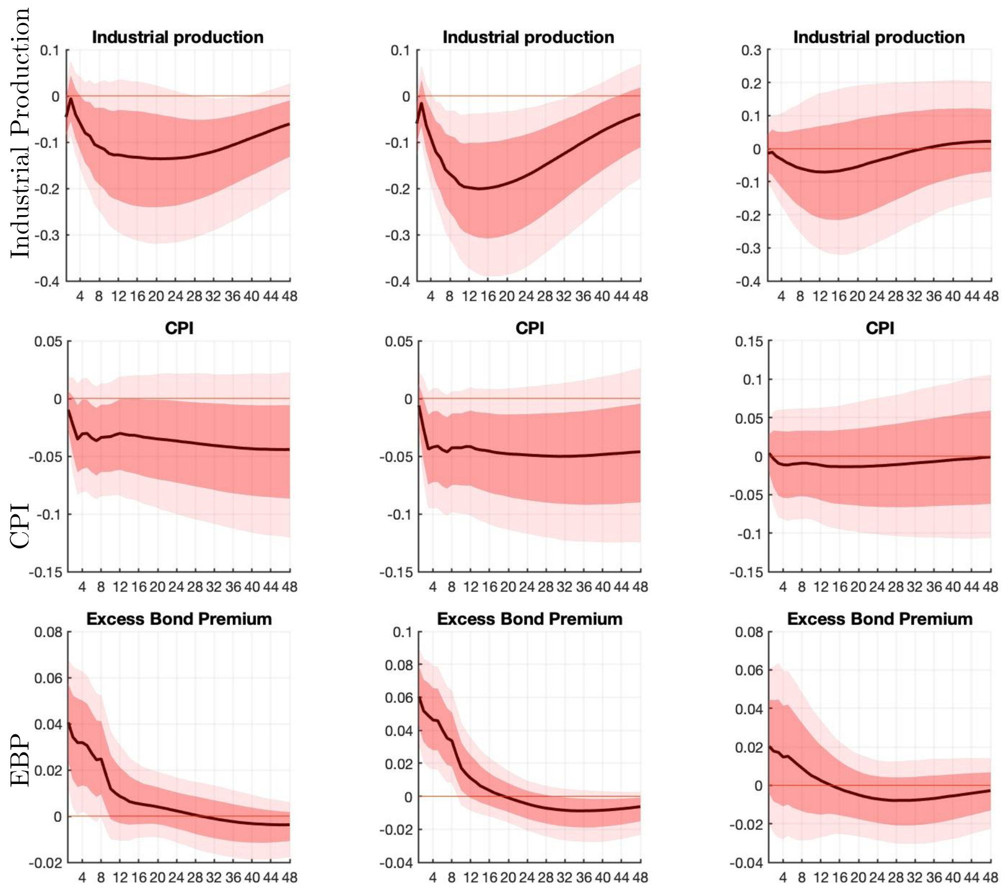
[17] Jarocinski & Karadi (2020) employed sign restriction which is set identification while Cholesky is point identification.



(a) Baseline (b) Policy shock (c) Difference

Figure 5: Comparison between monetary policy and information shocks. 3m federal funds futures shaded 5%,16%, 84% and 95% percentiles

Figure 6 presents the robustness exercise with the log U.S. consumer price index and industrial production as proxies for inflation and economic activity. The results are completely in line with the baseline results in Figure 5, namely industrial production and inflation decline in response to a policy shock with higher posterior probability in case of controlling for informational effects. The difference between information free policy shock and a policy shock is visible the most in the Excess Bond premium, but differences in responses of real economic activity are also distinguishable.

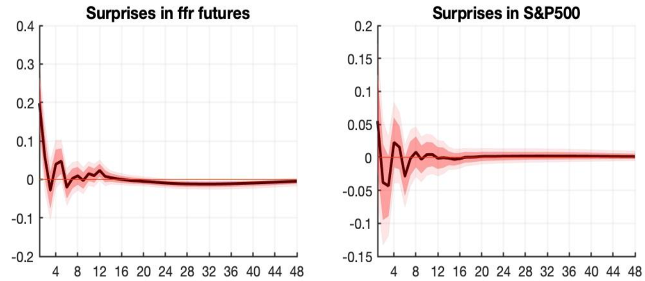


(a) Baseline (b) Policy shock (c) Difference

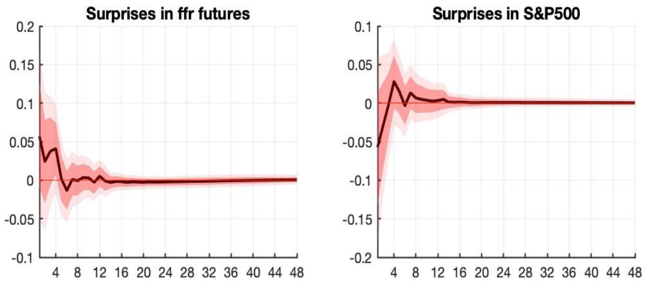
Figure 6: Comparison between monetary policy and information shocks. 3m federal funds futures
shaded 5%,16%, 84% and 95% percentiles

Appendix H discusses the results of Forecast error variance decompositions to both shocks and their difference. A pure monetary policy shock explains higher proportion of the forecast error variance of the Excess Bond Premium during the whole period, higher proportion of S&P500 just after the shock and higher proportion of GDP and industrial production in the long-run. It also explains a lower share of the one-year rate on impact.

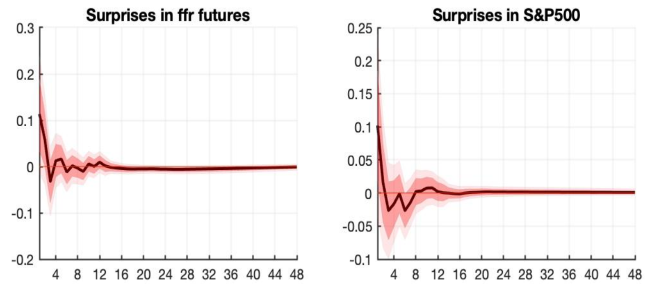
Figure 7 shows the responses in surprises in 3-m federal funds futures and S&P500 to information shocks. According to the theory, they should respond to information shocks in the same direction. It is seen that mainly high-frequency surprises respond to a positive economic information shock as the theory predicts. This economic information might capture the effects of Delphic forward guidance.



(a) Information shock 1



(b) Information shock 2

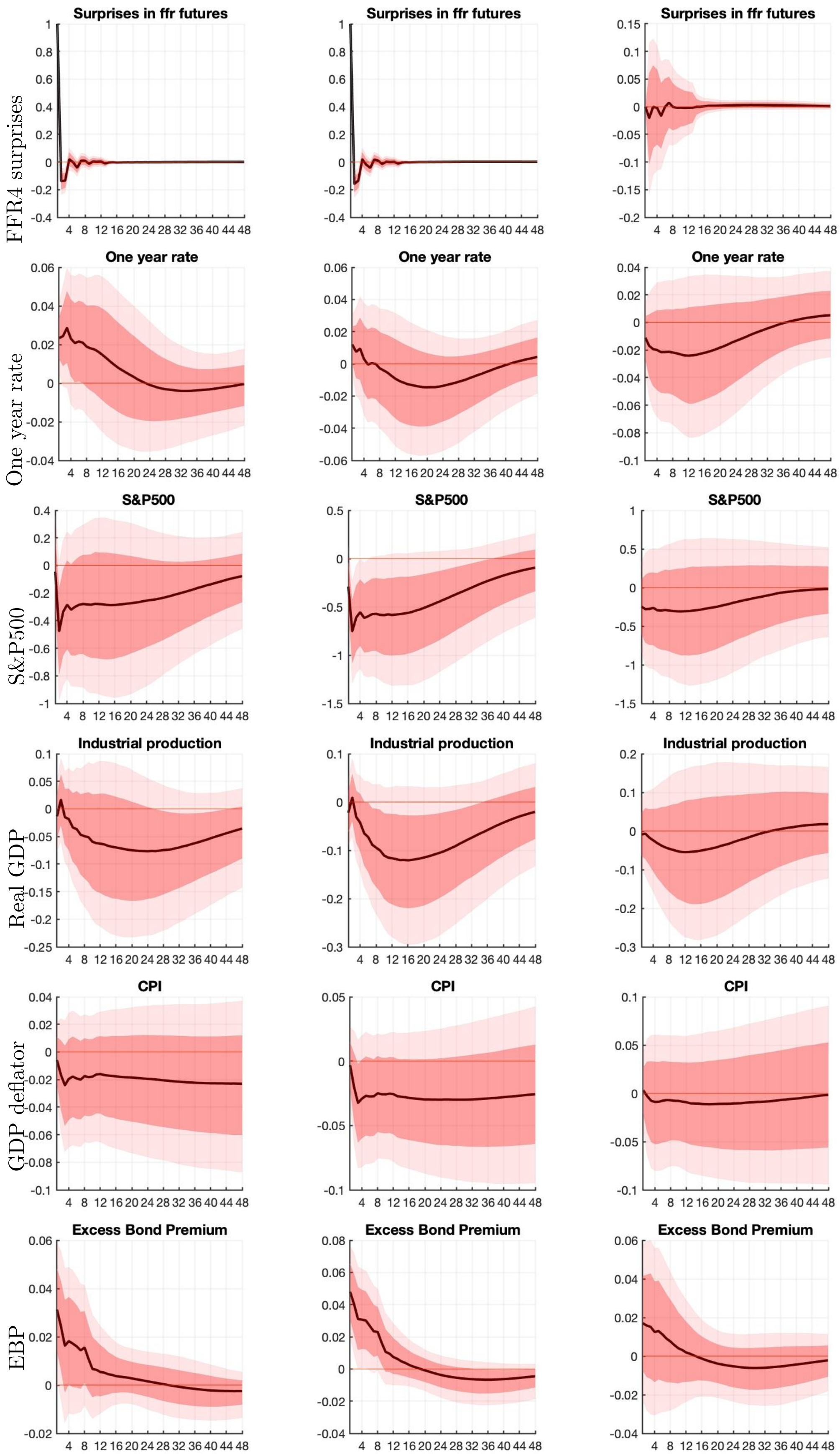


(c) Information shock 3

Figure 7: Information effects

5.2 Robustness analysis

For the robustness check I use the first principal component of surprises in the current month and 3-month fed funds futures and 2-, 3-, and 4- quarters ahead 3-month eurodollar futures (Jarocinski & Karadi (2020)).



(a) Baseline (b) Policy shock (c) Information shock

Figure 8: Comparison between monetary policy and information shocks. The first principal component of the surprises in fed funds futures and eurodollar futures with one year or less to expiration

shaded 16% and 84% percentiles

I purge this series in a similar way to the previous one but use topics with tone adjustment that were found to be important for this principal component (Figure 3 bottom panel). I also use a measure of the stock price surprises from Jarocinski & Karadi (2020), which is the first principal component of the surprises in the S&P500, Nasdaq Composite and Wilshire 5000. Figure 8 presents the results.

There are differences between these results and the baseline results from Figure 5. For responses of industrial production and CPI there is a posterior probability mass that lies within a region of positive values while looking at 68% credible sets. For a response of the excess bond premium, there is a region of 90% posterior probability mass that takes negative values. Adding information variables to VAR reduces these probabilities of incorrect impulse responses and sharpens identification.

The results concerning the effect of information-free shock are similar to the results from Figure 5, with the exception of a more muted response in inflation. The effects of a policy shock on real GDP and one year rate are completely in line with the previous findings.

Another difference with previous findings lies in the information shock having a larger effect on the one year rate. The magnitude of the effect of information shock is also larger for S&P500 and real GDP compared to the findings using surprises in 3-month federal funds futures.

5.3 Transmission of monetary policy shocks

To study the transmission of monetary policy shocks I use large-scale Bayesian VAR following the work of Banbura et al. (2010), who introduced dummy variables prior similar to Minnesota to work with a large number of variables in VAR. The model assumes natural conjugate Normal-Inverse-Wishart prior for autoregression coefficients and variances. As hyper-parameters I use λ 0.1[18], that controls overall prior tightness, and as the prior means of coefficients I use ones for trending variables and zeros for stationary variables, prior mean for a constant is 100[19].

Figure 9 presents the results for a medium-scale VAR, that includes information variables, monetary policy shock variable, various interest rates and expectations from Consen-

[18] I tuned this hyper-parameter to match impulse responses of small scale VAR with Independent Normal-Inverse-Wishart prior with Minnesota hyper-parameters, as shown in Appendix G

[19] These are the conventional settlings in literature

sus Economics. Surprisingly, even without short-run restrictions slow-moving variables do not respond much on impact, while fast-moving variables respond more sharply on impact. The shock increases the costs of credit for about four months after the shock and reduces S&P500 for about eight months after the shock. It leads to a steady decline in inflation and a decline with reversion in real economic activity. The shock also leads to more negative expectations of GDP and inflation. As a result, longer-term interest rates are not rising to reflect these expectations. Moreover, it does not seem that a contractionary shock transmits through term premium.

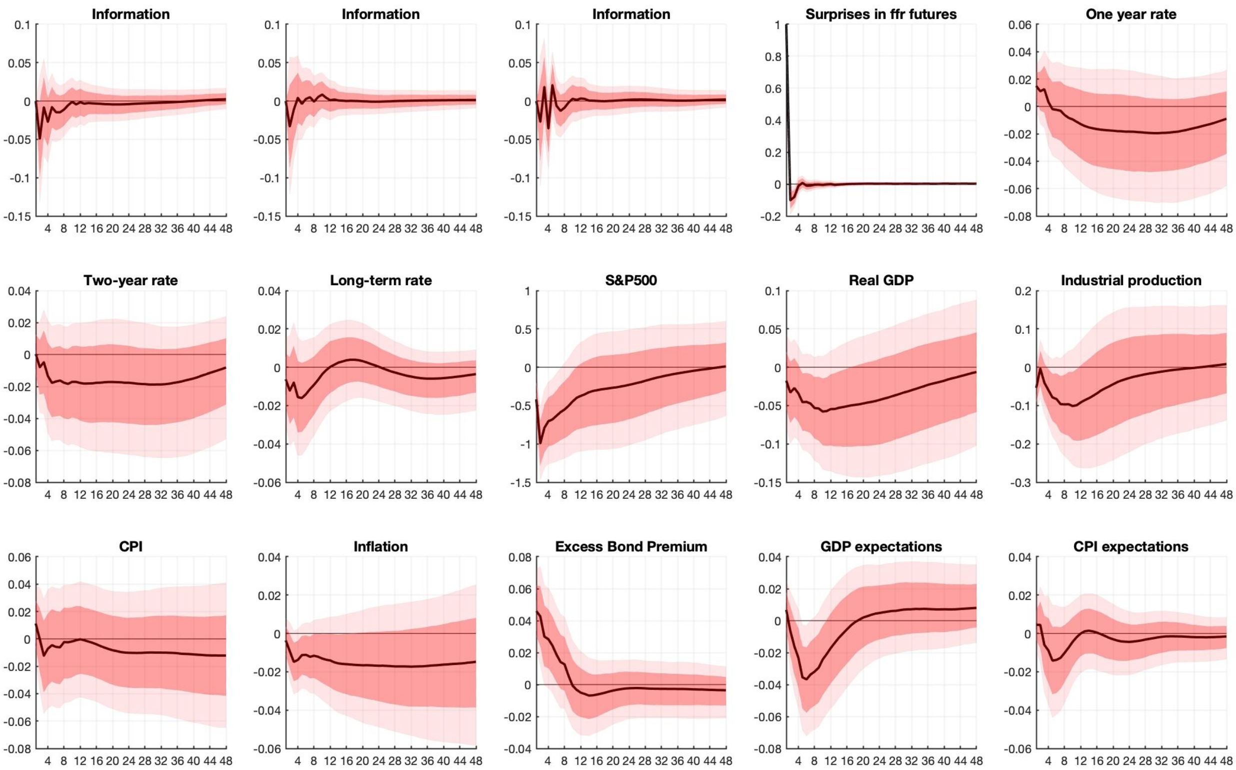


Figure 9: Monetary policy shock in medium-scale VAR

I use the big database of McCracken & Ng (2015), that contains 128 monthly variables. This database includes variables that should capture variables from the central bank's reaction function. Moreover, there are forward-looking financial variables, which should capture central banks' and agents' foresight. All variables were transformed into stationary form, following the recommendations of McCracken & Ng (2015), and afterwards impulse responses were cumulated in levels.[20] Figure 10, Figure 11 and Figure 12 report the results.

All slow-moving variables do not respond much on impact without any zero contemporaneous restrictions, while fast-moving variables do respond on impact. The shock leads to an increase in all short-term interest rates up to one year rate.

The findings confirm the interest rate channel of monetary policy transmission: industrial production of durable consumer goods, business equipment and durable materials fall more compared to other components of industrial production. Moreover, employment in the durable sector falls at a higher rate than corresponding employment in the non-durable sector. New orders for durable goods rise on impact after the shock, while at the same time unfulfilled orders for durable goods increase for a few months after the shock. Inflation in the durable sector does not decline in response to a shock, while the growth rate of personal consumption expenditures on durables declines on impact.

In line with the results of Gertler & Karadi (2015), the credit channel[21] is found to be an important channel of monetary policy propagation. The shock rises on impact the Excess Bond Premium, the three-month commercial paper spread, and leads to an increase in the long-run spread between Moody's BAA and the effective federal funds rate. The Excess Bond Premium reflects long-run borrowing costs in the non-farm business sector, the three-month commercial paper spread is relevant to the cost of short-term business credit and the cost of financing consumer durables, and BAA spread measures credit risk. The shock leads to a decrease in commercial loans on impact.

The balance sheet channel cannot be estimated directly. Nevertheless, the shock leads with high probability to a reduction in house prices, since the largest share of posterior probability mass lies in the negative region. That might be explained by the fact that higher interest rates increase the costs of owning a house, which implies a lower asset value. Therefore, a lower value of collateral leads to rising the borrowing cost, making it harder for smaller or younger firms to get access to credit through asymmetric information among economic agents.

As for the expectation channel of monetary policy, a contractionary monetary policy shock also leads to a decline in consumer confidence in the long-run, measured by the

[20] With the exception of variables that were double differenced. Impulse responses for these variables are in growth rates.

[21] Bernanke & Gertler (1995)

consumer sentiment index. The shock also increases macroeconomic uncertainty, but the effect is not persistent and disappears in about twelve months after the shock.

The asset price channel is also visible from impulse responses: S&P500 declined in the long-run in response to a contractionary monetary policy shock, as well as S&P industrial. Lower asset prices together with lower in house prices, lead to a decline in consumption and investment via wealth effect and the effect on the value of collateral. A decline in manufacturing capacity utilisation could lead to subdued business investment in the future. Moreover, there is a negative growth rate of personal consumption expenditures on nondurable goods in about four months after the shock.

U.S. dollar appreciates on impact based on the response of trade-weighted U.S. dollar index, that is compared to weighed shares of Euro, Japanese yen, Canadian dollar, British pound, Swedish krona, and Swiss franc. That confirms the importance of the exchange rate channel of monetary policy.

According to the results, all components of industrial production steadily decline in response to a contractionary shock. Capacity utilisation in manufacturing also steadily falls meaning that actual output in manufacturing slowly falls with respect to its potential level.

Unemployment starts to increase in about eight months after the shock together with average unemployment duration. The impact on unemployment is not distinguishable over the short-term, possibly due to nominal rigidities in the economy. This effect mainly leads to a larger share of long-term unemployed people. Average weekly hours worked also start to decline in about eight months after the shock but the effect is less persistent here. Initial claims increase in about four months after the shock and the effect is persistent for about four years. These claims are filed by an unemployed individual after a separation from an employer for eligibility for the Unemployment Insurance program.

A monetary contraction causes all components of growth rates of inflation to decline in the short-run with exception of apparel, medical care and durables. These components are less sensitive to a monetary policy shock.

Total business inventories start to decline steadily a few months after the shock, but sales decline at a higher rate and therefore total business inventory to sales ratio increases from the fourth to the twelfth months after the shock.

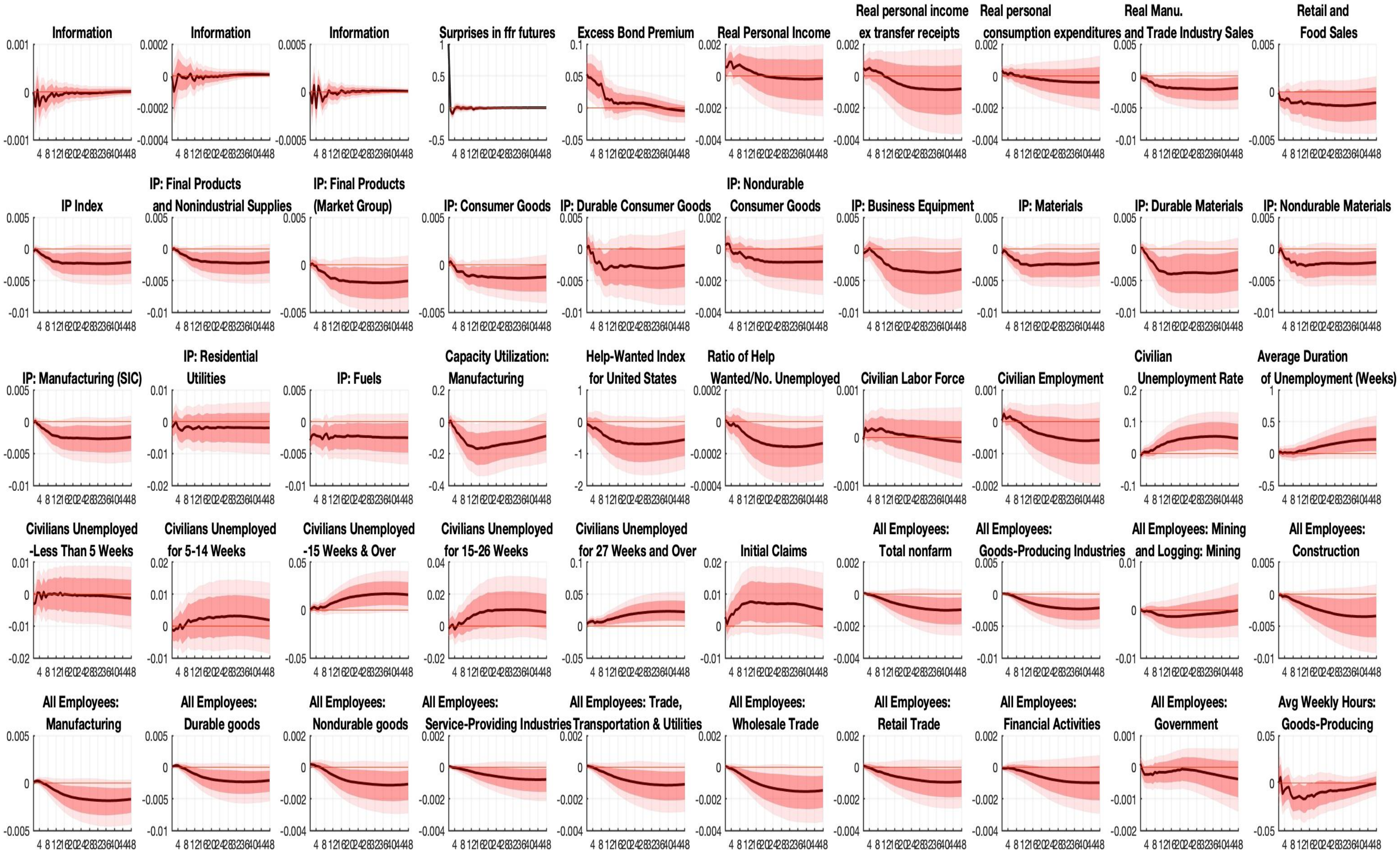


Figure 10: Monetary policy shock in large-scale VAR

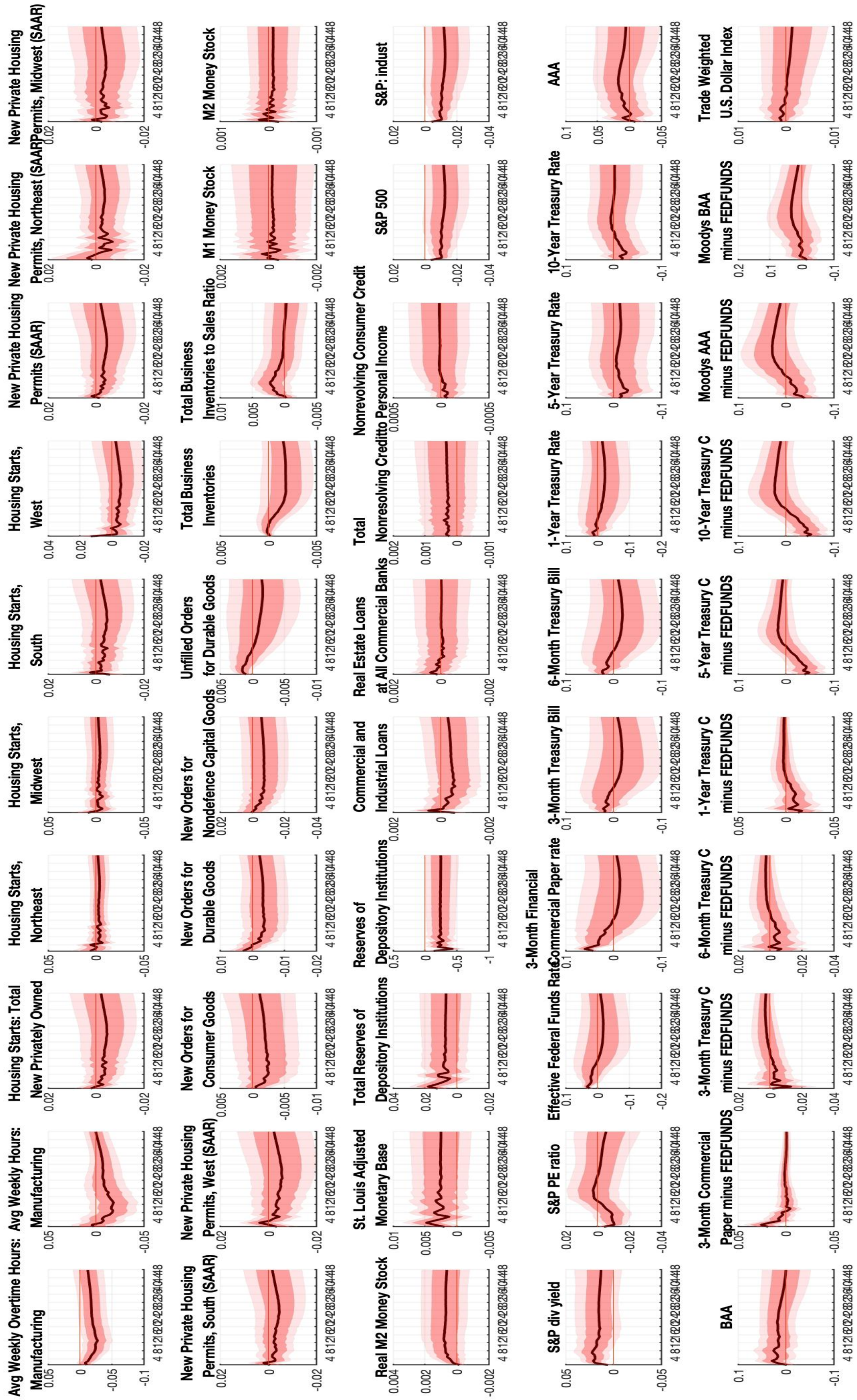


Figure 11: Monetary policy shock in large-scale VAR

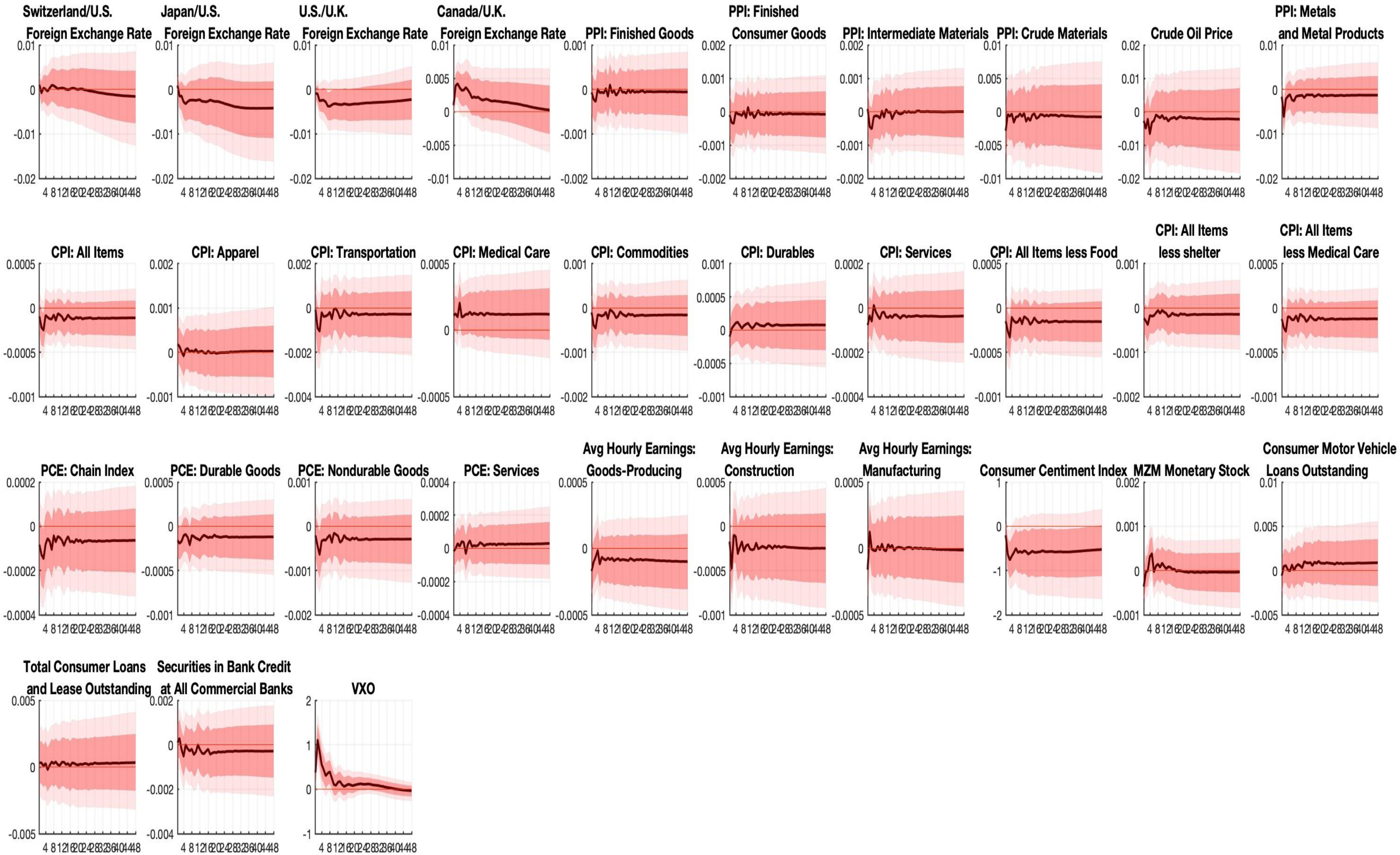


Figure 12: Monetary policy shock in large-scale VAR

6 Conclusions

The paper elaborates on the recent contribution of Jarocinski & Karadi (2020) in decomposing information from policy shocks, as well as on invertibility problem when econometrician's information set differs from decision maker's. This study uses information from FOMC statements and augments the standard VAR with important information. This allows to condition on information that is directly available to the public in real-time.

The study combines topic time series from FOMC statements with the tone of these statements. I extract information from FOMC statements by using Latent Dirichlet Allocation that was pre-trained on the business section from major U.S. newspapers. The tone was assigned using a lexicon-based approach that counts positive and negative words in each sentence. After topics time series were adjusted for the tone, these series were investigated by their predictive power for surprises in 3-month federal funds futures on the FOMC meeting dates. The topics, that were found to be important for these surprises, are about the economy, credit, investment, company news and deals.

I use information released by the Fed in its' statements as additional variables in VAR that might affect policy surprises contemporaneously. The results show that a policy shock has a more negative effect on GDP, a more prolonged negative effect on inflation and greater effect on the excess bond premium compared to the baseline surprises measure. In the short-run it causes S&P500 to decline and the Fed to raise its interest rate. The transmission channels of monetary policy identified in this paper are in line with the theory: monetary policy operates through the interest rate, credit, asset prices, exchange rate and expectations channels. What is more, I did not find evidence of the importance of the term premium channel for monetary policy transmission.

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Appendix A. Latent Dirichlet Allocation

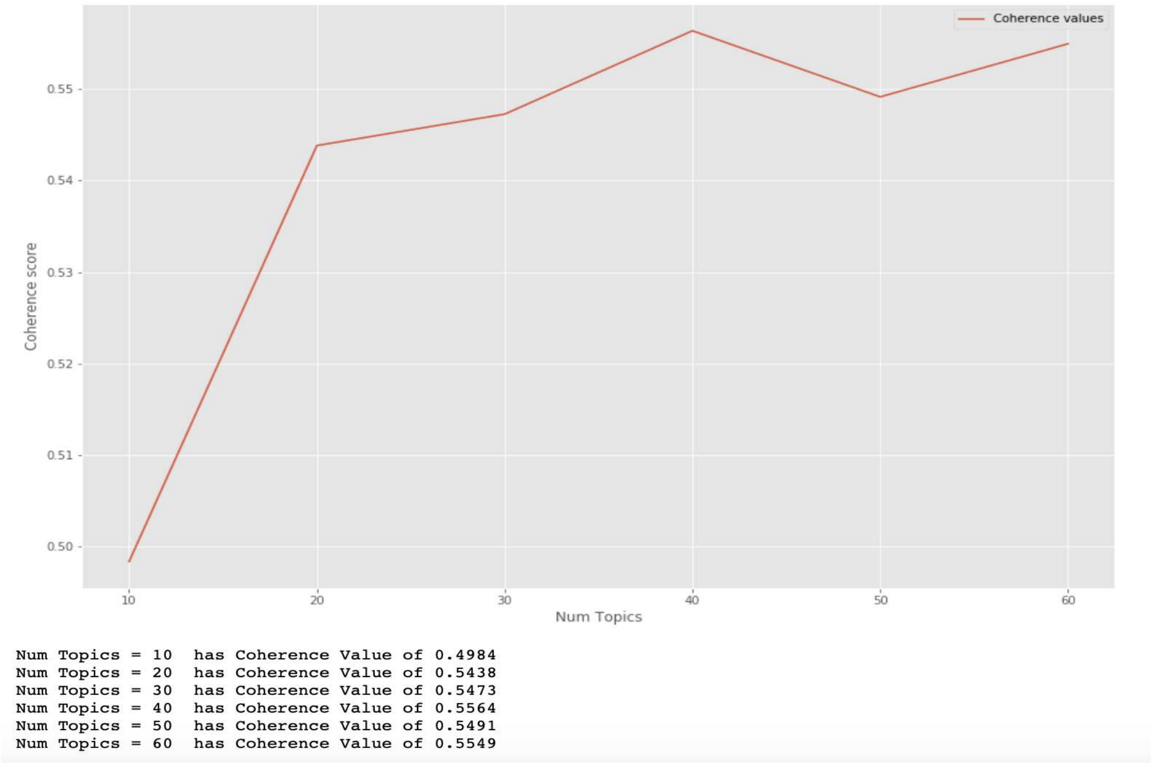


Figure A.1: Coherence values for the number of topics

Table A.1: Topic labelling for the LDA model

Topic	Words
rates	percent, year, increas, rate, averag, price, declin, rise, month, drop
computers	comput, technolog, compani, system, softwar, product, appl, microsoft, electron, market
economic	year, economi, growth, market, recess, expect, econom, mani, continu, industri
food	food, year, product, price, farm, market, farmer, restaur, agricultur, produc
people	peopl, time, make, thing, day, good, lot, work, back, tri
media	advertis, onlin, ad, site, internet, web, time, media, googl, publish
fed	rate, fed, interest, inflat, feder, reserv, economi, econom, polici, economist
housing	home, hous, california, lo, angel, year, price, counti, sale, san
credit	credit, consum, card, pay, custom, fee, account, servic, charg, check
cars	car, sale, auto, vehicl, ford, year, motor, chrysler, truck, model
health	insur, health, drug, care, compani, cost, medic, hospit, plan, year
trade	trade, state, unit, american, countri, foreign, import, world, mexico, export
law	case, court, investig, file, law, feder, charg, lawyer, attorney, judg
debt	debt, financi, billion, govern, bankruptci, crisi, plan, financ, money, problem
loans	bank, loan, mortgag, financi, feder, save, institut, borrow, lender, lend
stocks	stock, market, index, point, dow, rose, fell, gain, close, share
schools	chicago, school, photo, student, illinoi, famili, univers, colleg, program, tribun
economics	studi, econom, research, chang, univers, professor, differ, mani, exampl, problem
retailers	store, retail, sale, shop, year, chain, custom, buy, consum, holiday
industry	compani, industri, product, manufactur, steel, million, busi, produc, equip, oper
cities	citi, build, develop, offic, area, project, project, real, properti, million
profits	million, quarter, share, billion, earn, year, profit, compani, cent, sale
jobs	job, worker, work, employ, labor, employe, union, wage, unemploy, peopl
currency	dollar, york, cent, price, gold, trade, late, exchang, futur, currenc
airlines	airlin, travel, unit, air, fare, american, flight, carrier, boe, airport
military	war, govern, nation, countri, offici, attack, militari, soviet, world, defens
energy	power, energi, electr, state, util, plant, ga, water, cost, project
oil/gas	price, oil, energi, barrel, ga, product, gasolin, crude, day, produc
international	global, european, world, unit, europ, china, countri, british, intern, bank
hotels	hotel, photo, room, year, park, show, game, open, peopl, time
rules	propos, rule, regul, agenc, offici, feder, requir, law, member, committe
stock market	trade, market, stock, exchang, firm, secur, street, wall, futur, option
company news	compani, busi, execut, chief, firm, manag, presid, corpor, offic, year
services	servic, compani, commun, phone, network, custom, provid, busi, cabl, telephon
investing	fund, invest, stock, investor, market, manag, money, return, year, valu
president	presid, hous, republican, democrat, obama, trump, senat, white, polit, administr
reports	report, month, consum, economist, depart, increas, rose, declin, good, show
securities	bond, rate, treasuri, market, yield, price, issu, interest, note, secur
budget	tax, incom, year, budget, cut, plan, spend, save, pay, benefit
deals	compani, share, deal, million, offer, stock, billion, sharehold, merger, bid

Appendix B. Tone adjustment for topic time series

For assigning a sentiment for each sentence from FOMC statements I use a negation rule. If the following words precede a collocation in the three-word window, then they are labelled as an opposite sentiment. Negation dictionary consists of the following words: aint, arent, cannot, cant, couldnt, darent, didnt, doesnt, ain't, aren't, can't, couldn't, daren't, didn't, doesn't, dont, hadnt, hasnt, havent, isnt, mightnt, mustnt, neither, don't, hadn't, hasn't, haven't, isn't, mightn't, mustn't, neednt, needn't, never, none, nope, nor, not, nothing, nowhere, oughtnt, shant, shouldnt, wasnt, werent, oughtn't, shan't, shouldn't, wasn't, weren't, without, wont, wouldnt, won't, wouldn't, rarely, seldom, despite, no, nobody.

I assign tone for each sentence based on three different strategies:

1. Positivity is calculated for each sentence and it scales its topic frequencies which are higher than the threshold (0.3).
2. Sign (positive/negative) is calculated for each sentence and it scales its topic frequencies which are higher than the threshold (0.3).
3. Uncertainty is calculated for each sentence and it scales its topic frequencies which are higher than the threshold (0.3).

Appendix C. LDA and Fed Statements

C.1 Performance of LDA by paragraphs

1. The federal reserve board today approved an increase in the discount rate from 4 3/4 percent to 5 1/4 percent, effective immediately. 1995-02-01

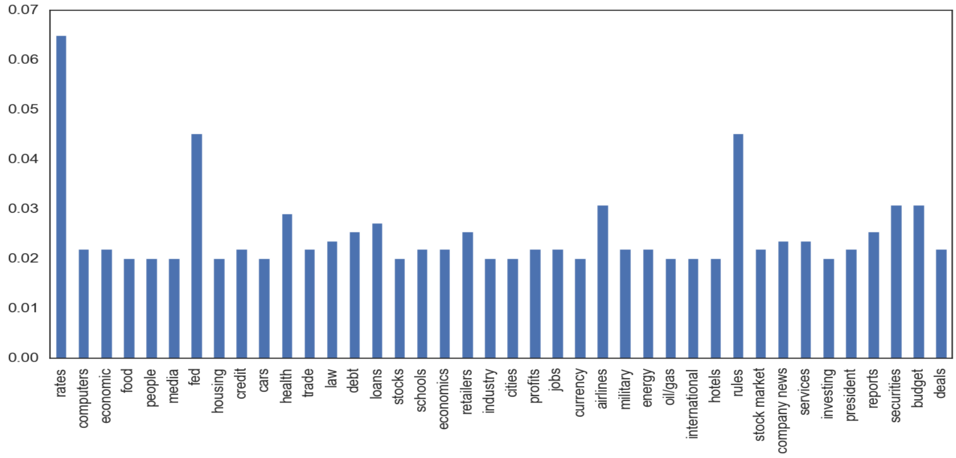


Figure C.1: Topic proportions for the paragraph 1

2. The committee perceives the upside and downside risks to the attainment of sustainable growth for the next few quarters are roughly equal. the probability of an unwelcome fall in inflation has diminished in recent months and now appears almost equal to that of a rise in inflation. with inflation quite low and resource use slack, the committee believes that it can be patient in removing its policy accommodation. 2004-03-16

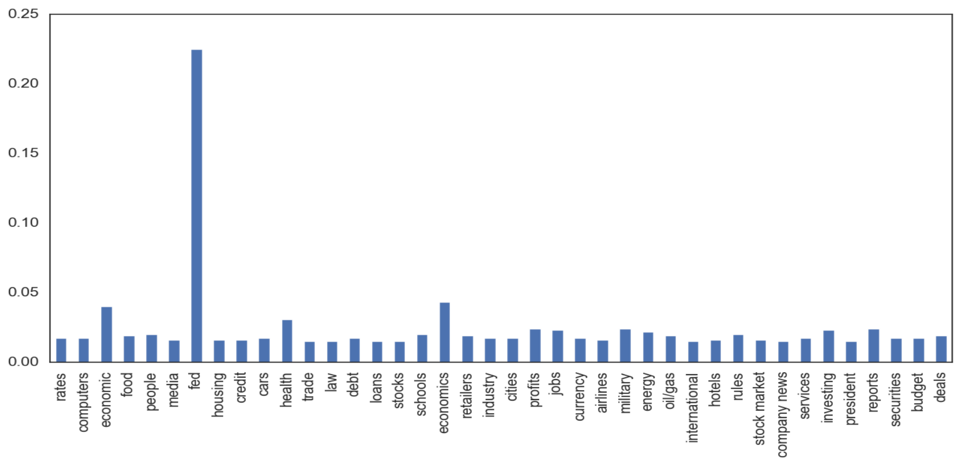


Figure C.2: Topic proportions for the paragraph 2

3. Developments in financial markets since the committee's last regular meeting have increased the uncertainty surrounding the economic outlook. the committee will continue to assess the effects of these and other developments on economic prospects and will act as needed to foster price stability and sustainable economic growth. 2007-09-18

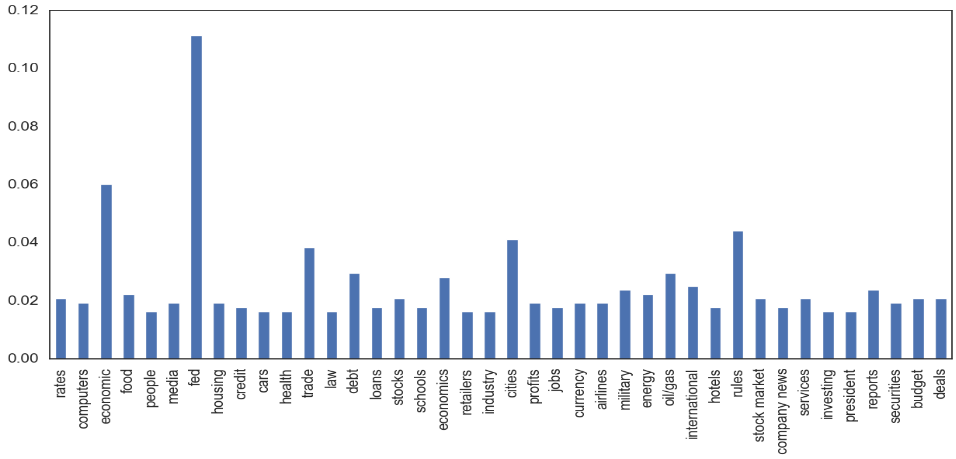


Figure C.3: Topic proportions for the paragraph 3

4. Strains in financial markets have increased significantly and labor markets have weakened further. economic growth appears to have slowed recently, partly reflecting a softening of household spending. tight credit conditions, the ongoing housing contraction, and some slowing in export growth are likely to weigh on economic growth over the next few quarters. over time, the substantial easing of monetary policy, combined with ongoing measures to foster market liquidity, should help to promote moderate economic growth. 2008-09-16

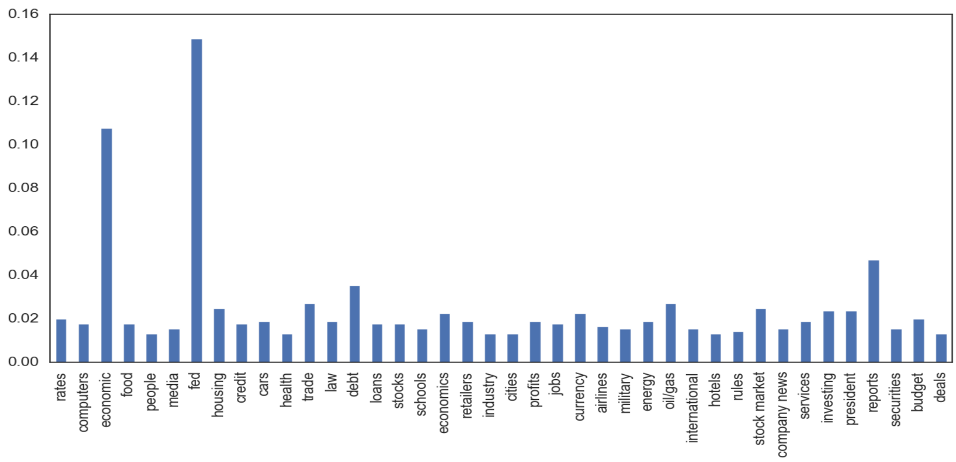


Figure C.4: Topic proportions for the paragraph 4

5. Inflation has been high, spurred by the earlier increases in the prices of energy and some other commodities. the committee expects inflation to moderate later this year and next year, but the inflation outlook remains highly uncertain. 2008-09-16

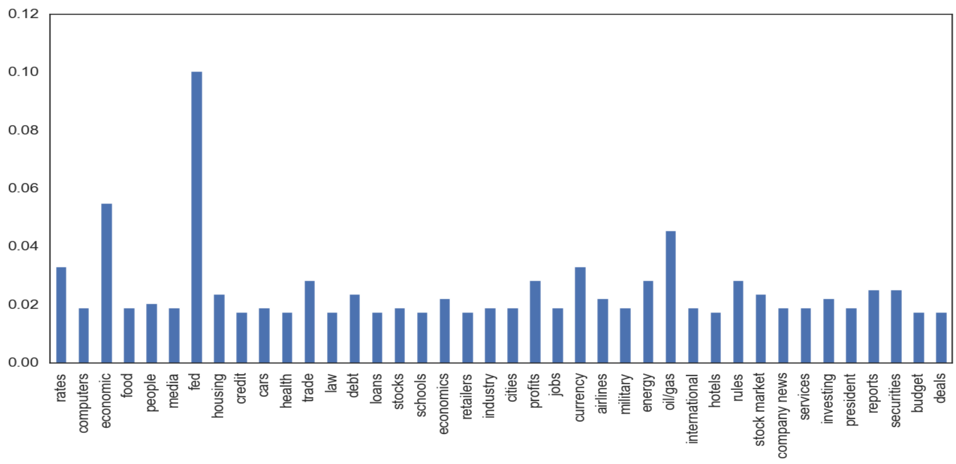


Figure C.5: Topic proportions for the paragraph 5

6. The downside risks to growth and the upside risks to inflation are both of significant concern to the committee. the committee will monitor economic and financial developments carefully and will act as needed to promote sustainable economic growth and price stability. 2008-09-16

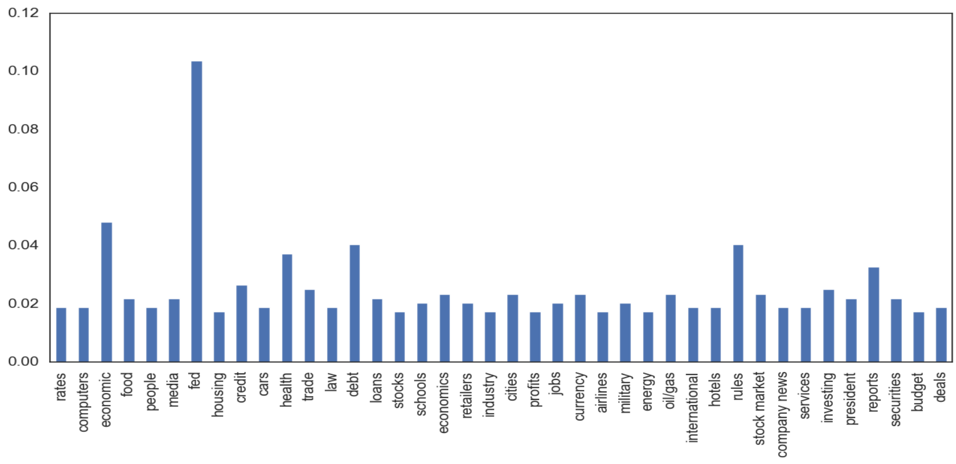


Figure C.6: Topic proportions for the paragraph 6

7. Throughout the current financial crisis, central banks have engaged in continuous close consultation and have cooperated in unprecedented joint actions such as the provision of liquidity to reduce strains in financial markets. 2008-10-08

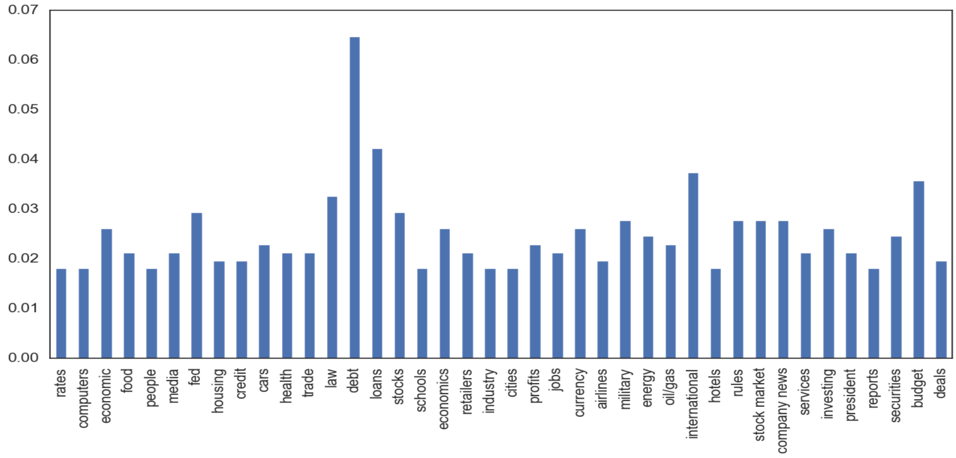


Figure C.7: Topic proportions for the paragraph 7

8. Information received since the federal open market committee met in june indicates that the labor market strengthened and that economic activity has been expanding at a moderate rate. job gains were strong in june following weak growth in may. on balance, payrolls and other labor market indicators point to some increase in labor utilization in recent months. household spending has been growing strongly but business fixed investment has been soft. inflation has continued to run below the committee's 2 percent longer-run objective, partly reflecting earlier declines in energy prices and in prices of non-energy imports. market-based measures of inflation compensation remain low; most survey-based measures of longer-term inflation expectations are little changed, on balance, in recent months. 2016-07-27

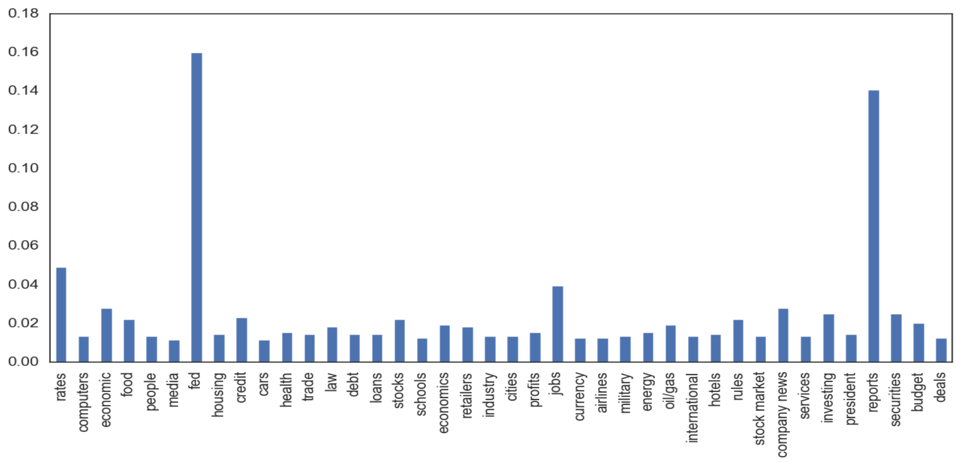


Figure C.8: Topic proportions for the paragraph 8

9. The coronavirus outbreak is causing tremendous human and economic hardship across the united states and around the world. the virus and the measures taken to protect public health are inducing sharp declines in economic activity and a surge in job losses. weaker demand and significantly lower oil prices are holding down consumer price inflation. the disruptions to economic activity here and abroad have significantly affected financial conditions and have impaired the flow of credit to u.s. households and businesses. 2020-04-29

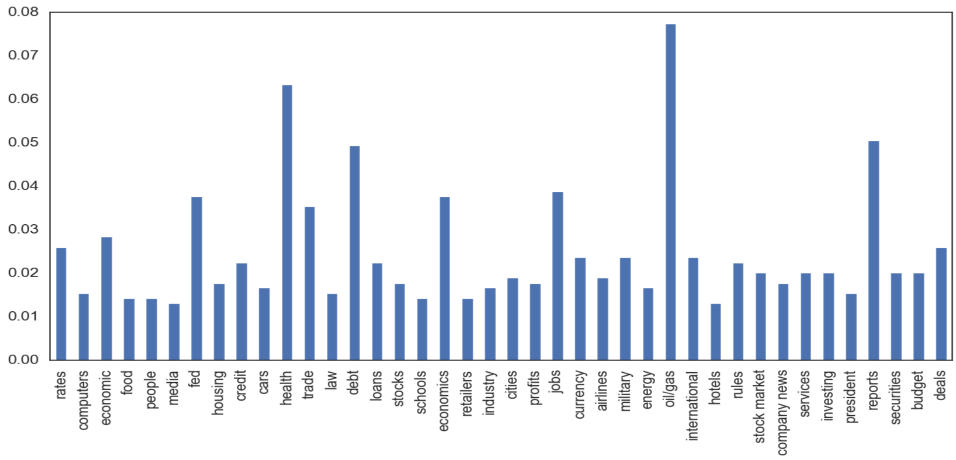


Figure C.9: Topic proportions for the paragraph 9

C.2 Performance of LDA by sentences

1. Job gains have been strong, on average, in recent months, and the unemployment rate has remained low. 2018-12-19

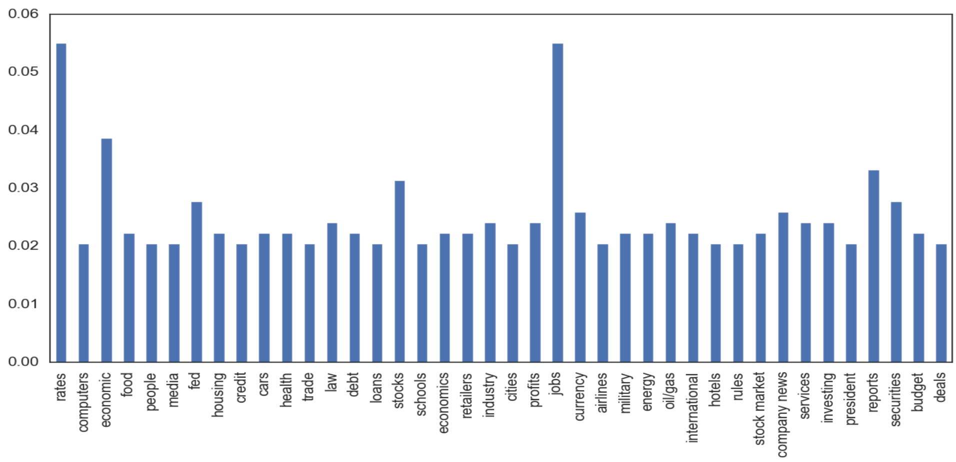


Figure C.10: Topic proportions for the sentence 1

2. Household spending has continued to grow strongly, while growth of business fixed investment has moderated from its rapid pace earlier in the year. 2018-12-19

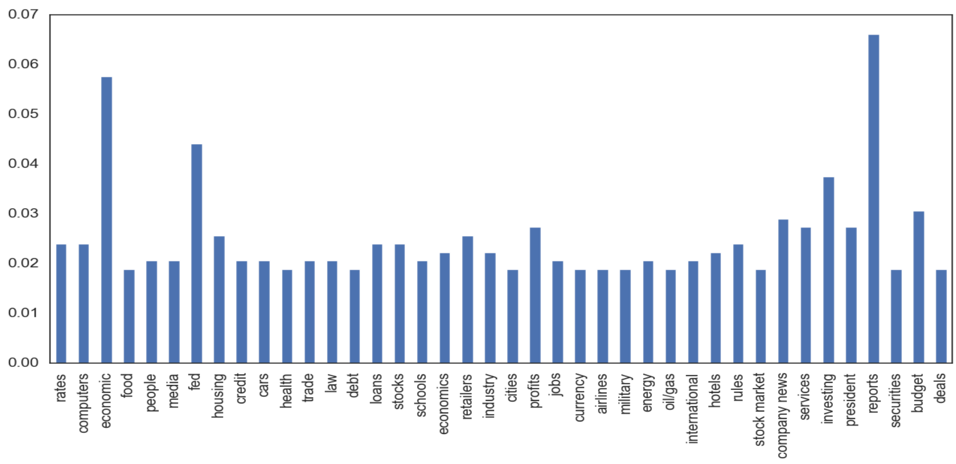


Figure C.11: Topic proportions for the sentence 2

3. On a 12-month basis, both overall inflation and inflation for items other than food and energy remain near 2 percent. 2018-12-19

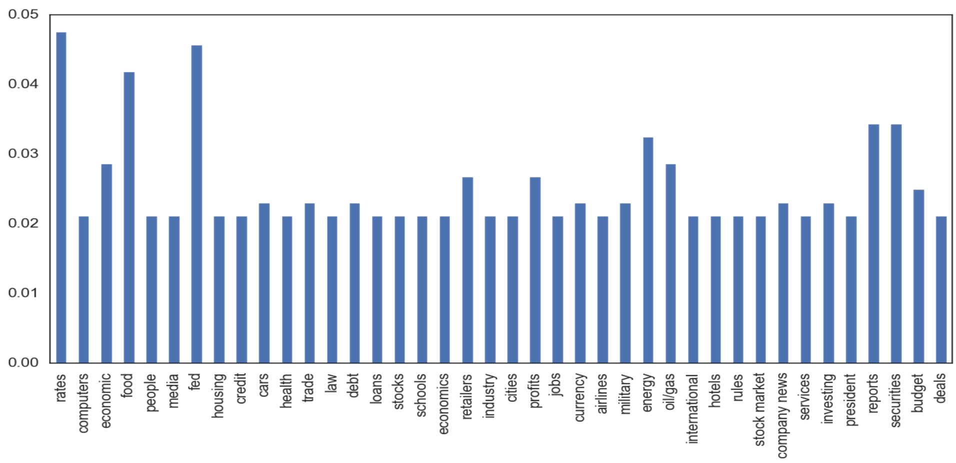


Figure C.12: Topic proportions for the sentence 3

4. Indicators of longer-term inflation expectations are little changed, on balance. 2018-12-19

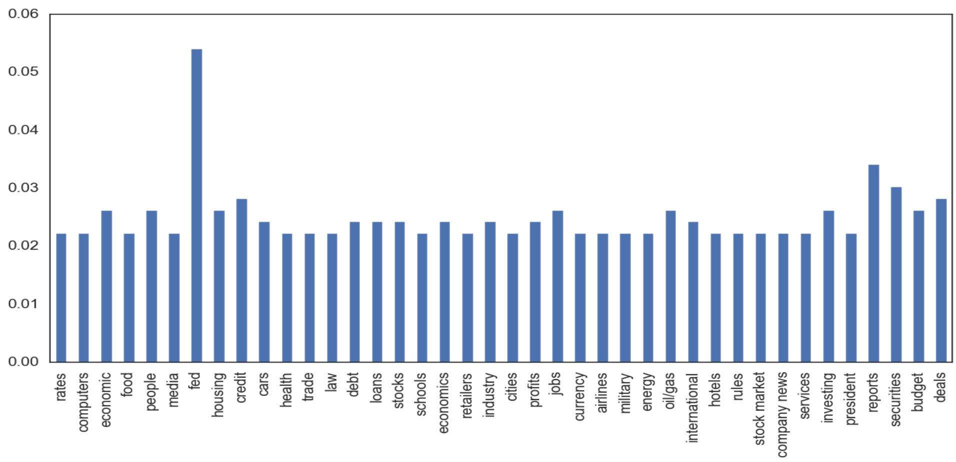


Figure C.13: Topic proportions for the sentence 4

5. Consistent with its statutory mandate, the committee seeks to foster maximum employment and price stability. 2018-12-19

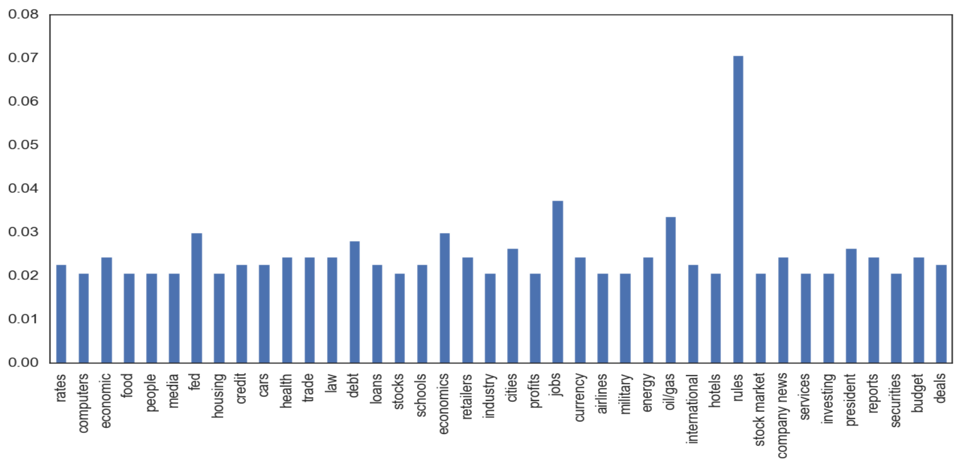


Figure C.14: Topic proportions for the sentence 5

6. The committee judges that some further gradual increases in the target range for the federal funds rate will be consistent with sustained expansion of economic activity, strong labor market conditions, and inflation near the committee's symmetric 2 percent objective over the medium term. 2018-12-19

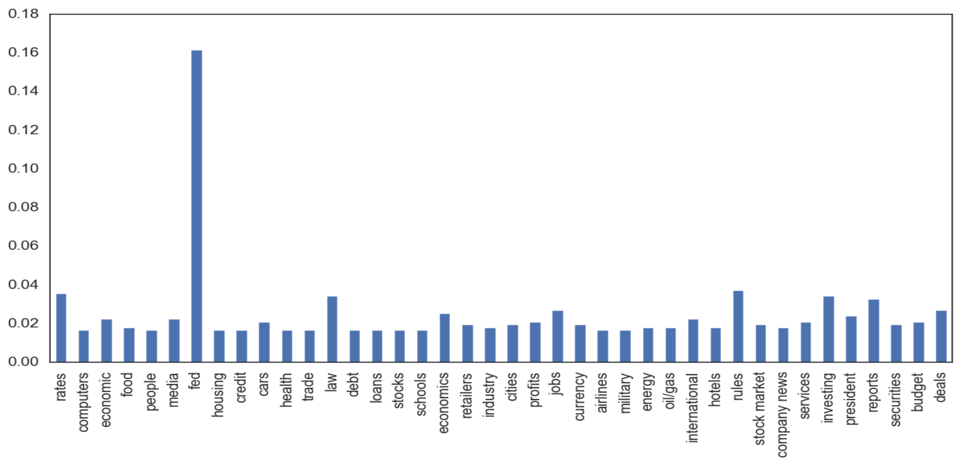


Figure C.15: Topic proportions for the sentence 6

7. The committee judges that risks to the economic outlook are roughly balanced, but will continue to monitor global economic and financial developments and assess their implications for the economic outlook. 2018-12-19

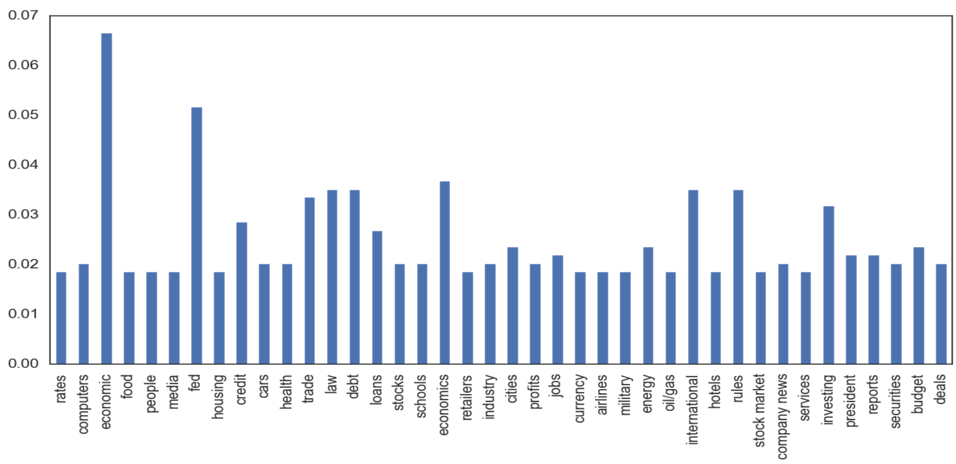


Figure C.16: Topic proportions for the sentence 7

8. In view of realized and expected labor market conditions and inflation, the committee decided to raise the target range for the federal funds rate to 2-1/4 to 2-1/2 percent. 2018-12-19

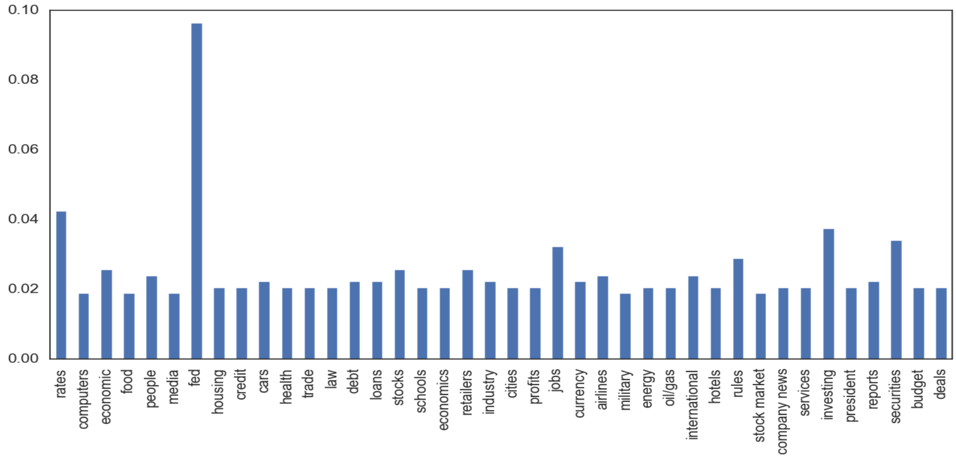


Figure C.17: Topic proportions for the sentence 8

9. In determining the timing and size of future adjustments to the target range for the federal funds rate, the committee will assess realized and expected economic conditions relative to its maximum employment objective and its symmetric 2 percent inflation objective. 2018-12-19

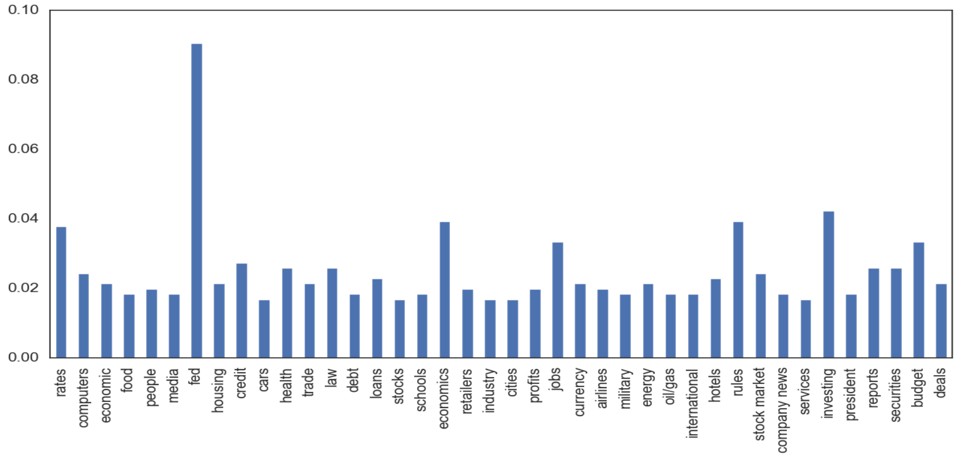


Figure C.18: Topic proportions for the sentence 9

C.3 Classifying QE sentences

1. As previously announced, over the next few quarters the federal reserve will purchase large quantities of agency debt and mortgage-backed securities to provide support to the mortgage and housing markets, and it stands ready to expand its purchases of agency debt and mortgage-backed securities as conditions warrant. 2008-12-16

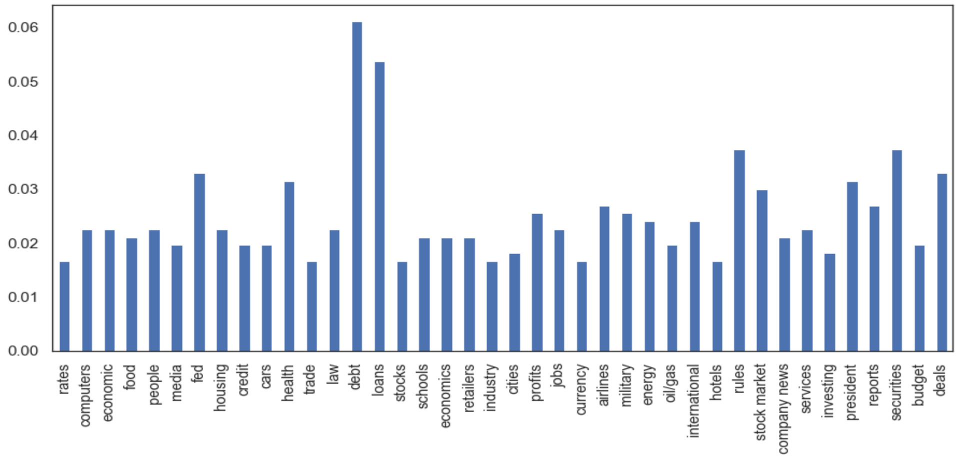


Figure C.19: Topic proportions for the sentence 1

2. The committee also is prepared to purchase longer-term treasury securities if evolving circumstances indicate that such transactions would be particularly effective in improving conditions in private credit markets. 2009-01-28

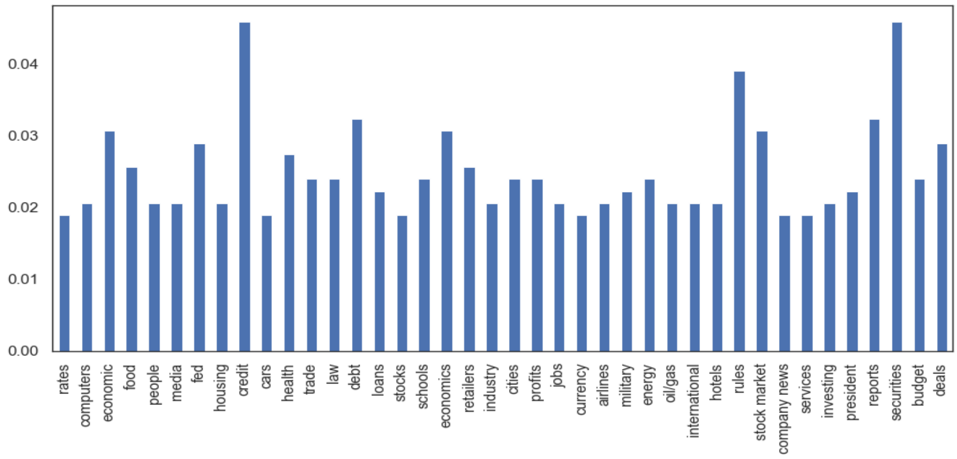


Figure C.20: Topic proportions for the sentence 2

3. To provide greater support to mortgage lending and housing markets, the committee decided today to increase the size of the federal reserve?s balance sheet further by purchasing up to an additional $750 billion of agency mortgage-backed securities, bringing its total purchases of these securities to up to. 2009-03-18

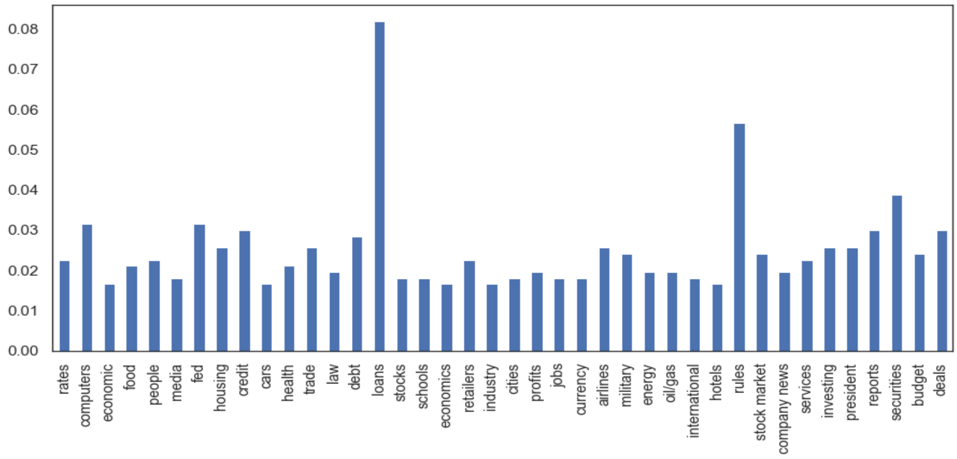


Figure C.21: Topic proportions for the sentence 3

4. 125 trillion this year, and to increase its purchases of agency debt this year by up to $100 billion to a total of up to $200 billion

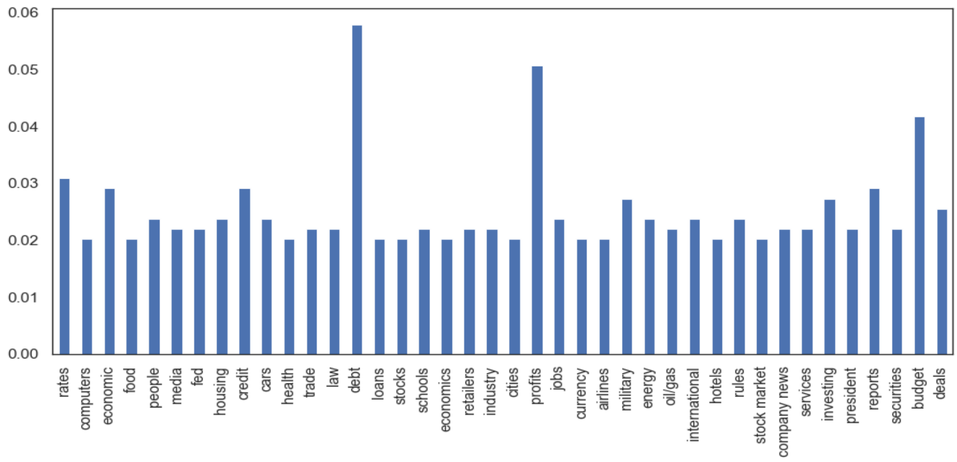


Figure C.22: Topic proportions for the sentence 4

5. in addition, the committee intends to purchase a further $600 billion of longer-term treasury securities by the end of the second quarter of 2011, a pace of about $75 billion per month. 2010-11-03

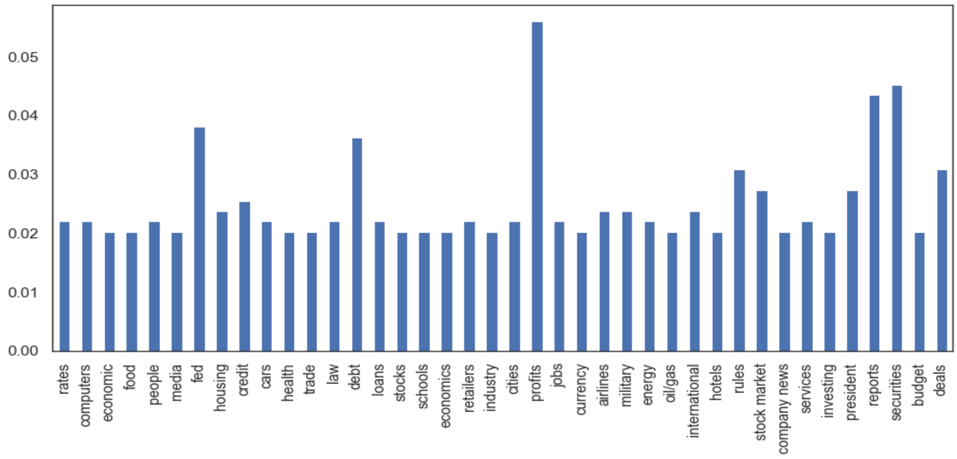


Figure C.23: Topic proportions for the sentence 5

6. The committee will closely monitor incoming information on economic and financial developments in coming months and will continue its purchases of treasury and agency mortgage-backed securities, and employ its other policy tools as appropriate, until the outlook for the labor market has improved substantially in a context of price stability. 2014-09-17

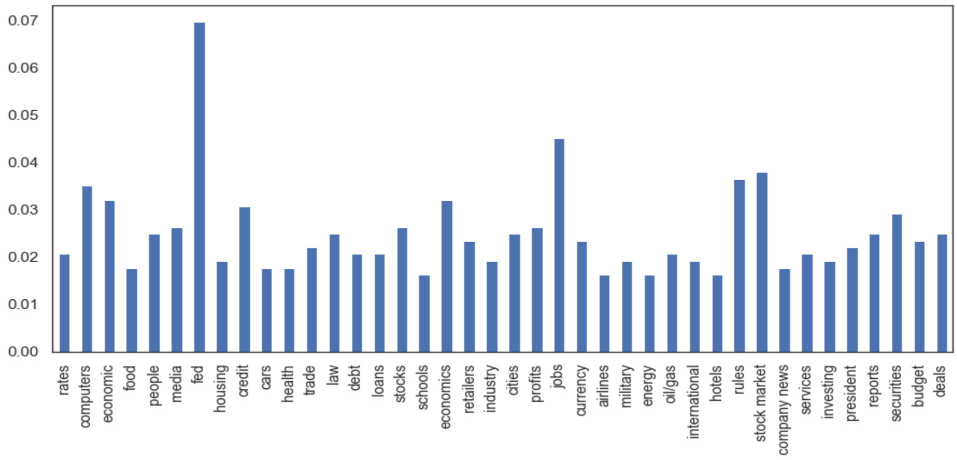


Figure C.24: Topic proportions for the sentence 6

7. In addition, the federal reserve will conduct term and overnight repurchase agreement operations at least through january of next year to ensure that the supply of reserves remains ample even during periods of sharp increases in non-reserve liabilities, and to mitigate the risk of money market pressures that could adversely affect policy implementation. 2019-10-11

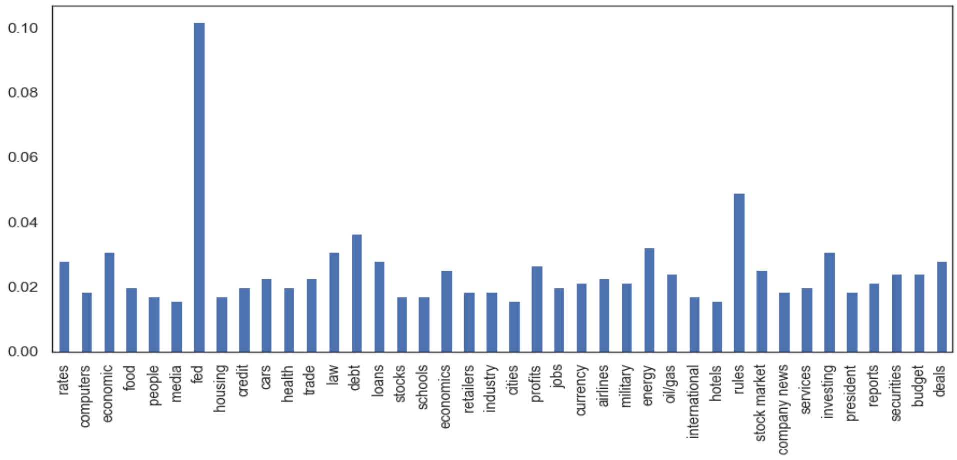


Figure C.25: Topic proportions for the sentence 7

C.4 Classifying Forward Guidance sentences

1. the committee anticipates, based on its current assessment, that it likely will be appropriate to maintain the 0 to 1/4 percent target range for the federal funds rate for a considerable time following the end of its asset purchase program this month, especially if projected inflation continues to run below the committee's 2 percent longer-run goal, and provided that longer-term inflation expectations remain well anchored. 2014-10-29

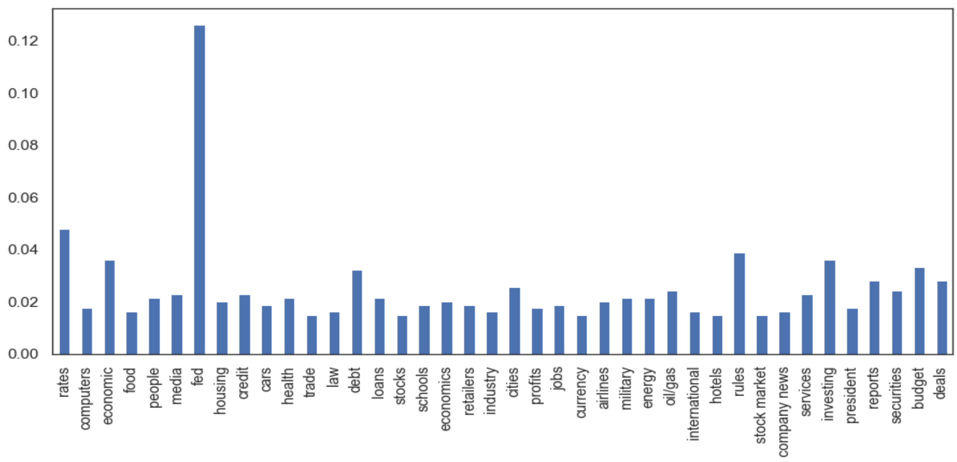


Figure C.26: Topic proportions for the sentence 1

2. The committee sees this guidance as consistent with its previous statement that it likely will be appropriate to maintain the 0 to 1/4 percent target range for the federal funds rate for a considerable time following the end of its asset purchase program in october,

especially if projected inflation continues to run below the committee's 2 percent longer-run goal, and provided that longer-term inflation expectations remain well anchored. 2014-12-17

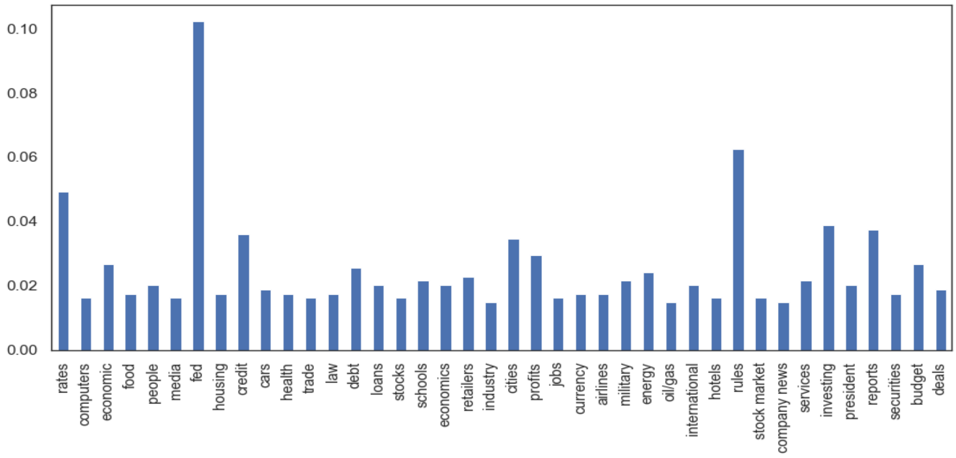


Figure C.27: Topic proportions for the sentence 2

3. The committee continues to anticipate, based on its assessment of these factors, that it likely will be appropriate to maintain the current target range for the federal funds rate well past the time that the unemployment rate declines below 6-1/2 percent, especially if projected inflation continues to run below the committee's 2 percent longer-run goal. 2014-01-29

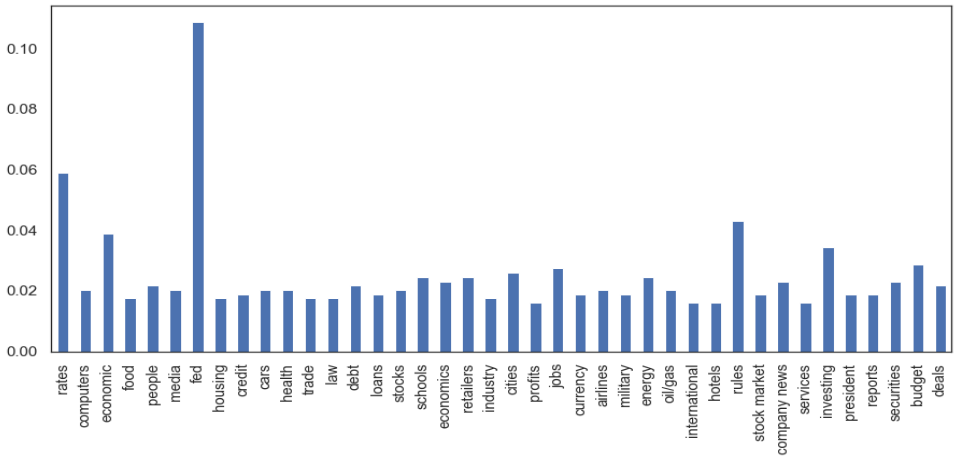


Figure C.28: Topic proportions for the sentence 3

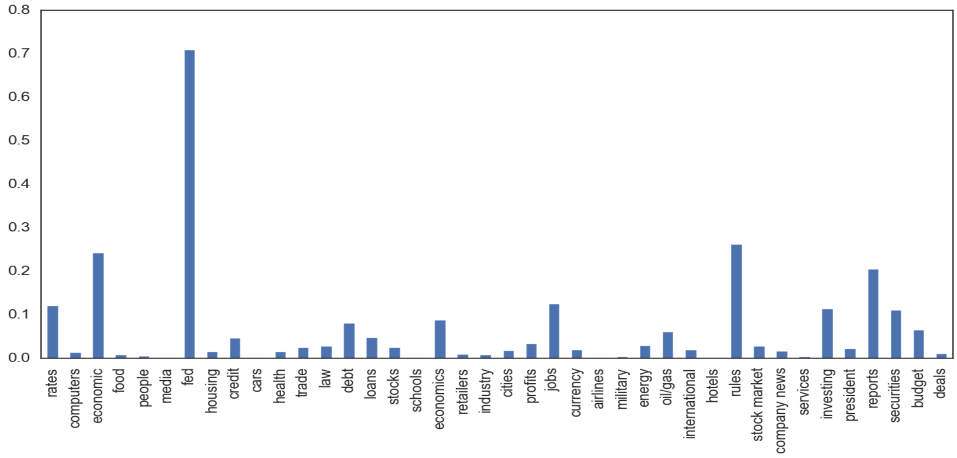


Figure C.29: Aggregated topic proportions by sentence

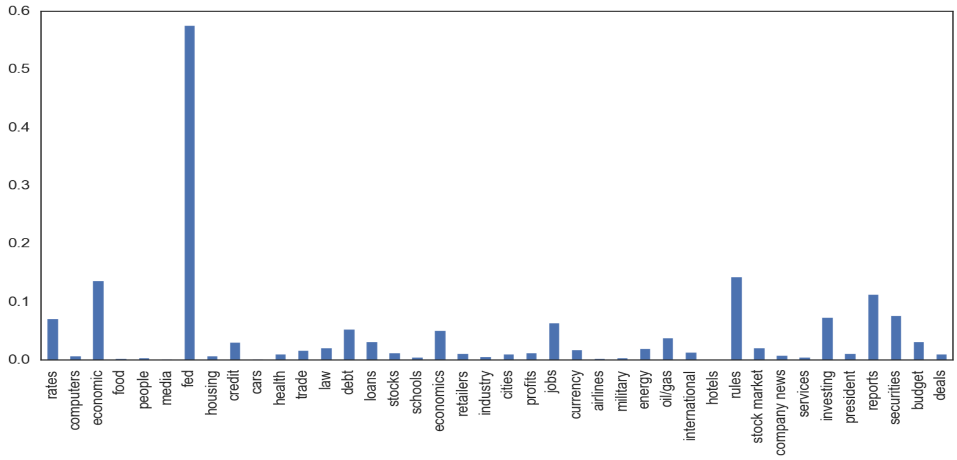


Figure C.30: Aggregated topic proportions by paragraph

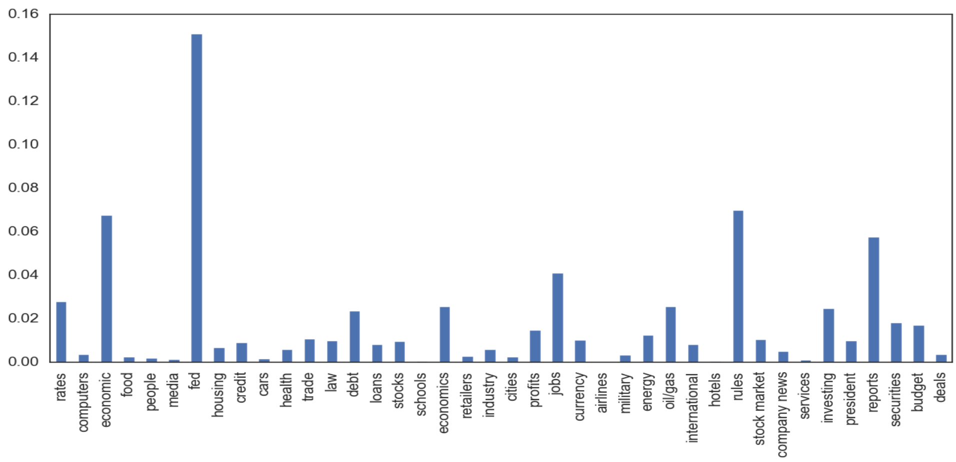


Figure C.31: Aggregated topic proportions by sentence with sign adjustment

Appendix D. Information in FOMC statements

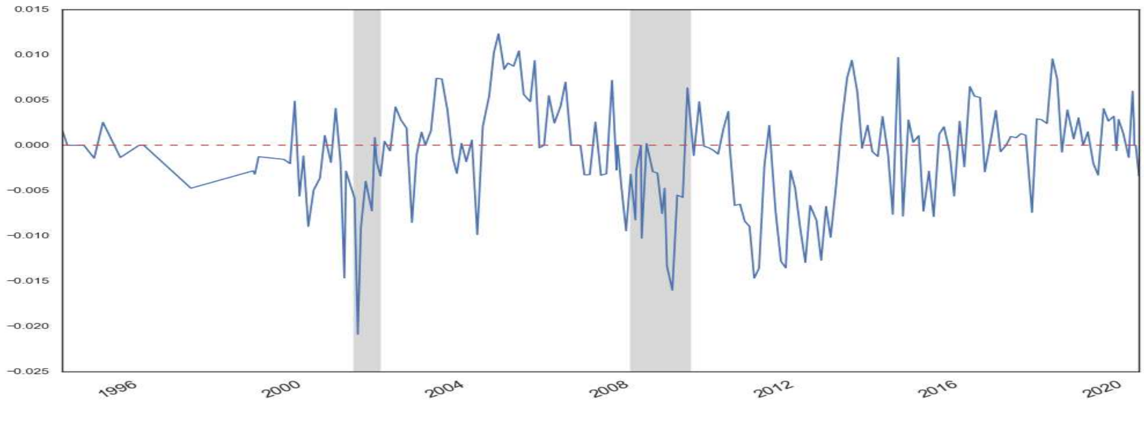


Figure D.1: Economic topic

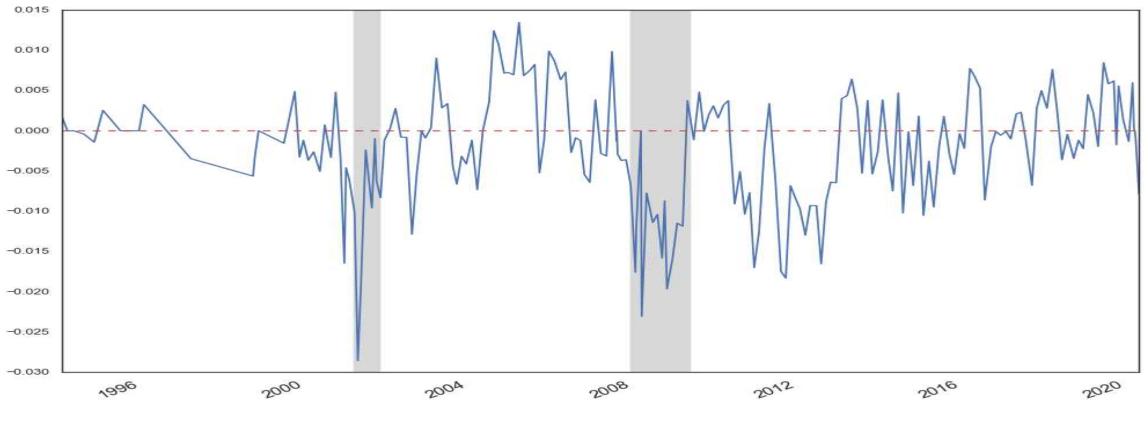


Figure D.2: Economic topic from combination of dictionaries without directional words

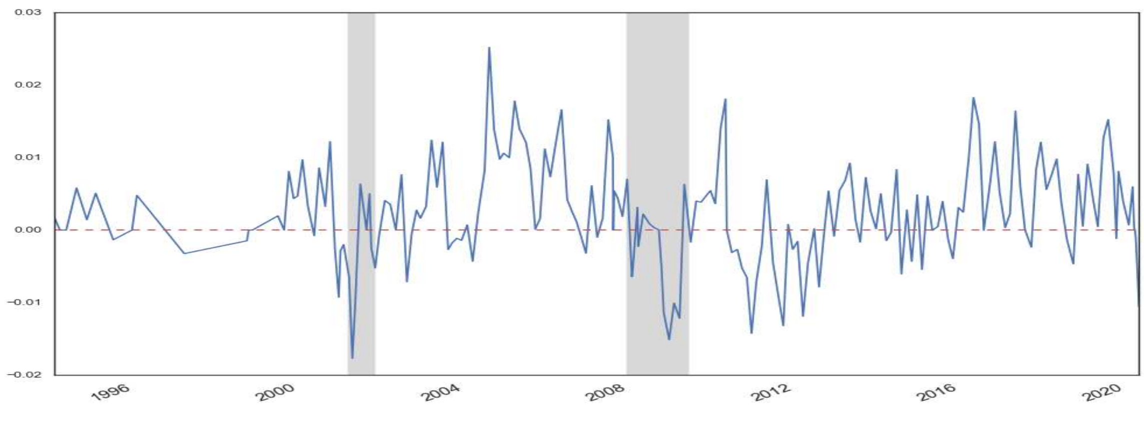


Figure D.3: Economic topic from combination of dictionaries with directional words

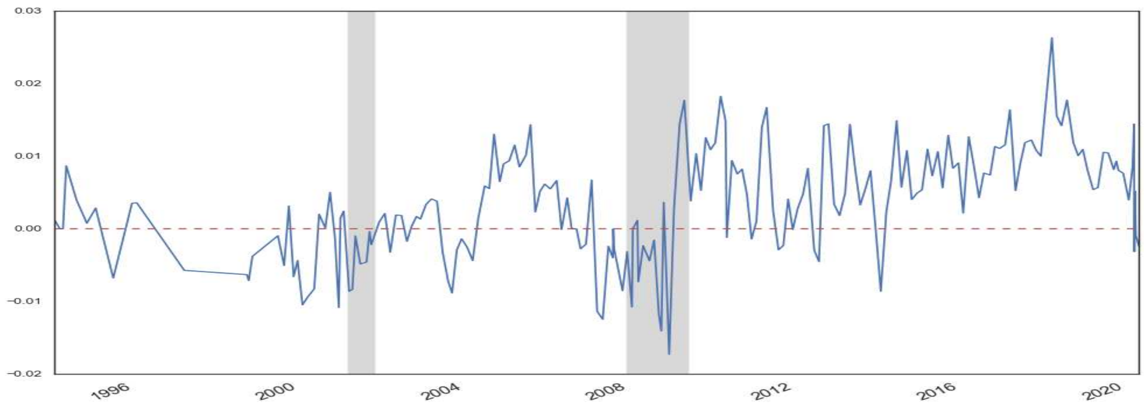


Figure D.4: Fed topic

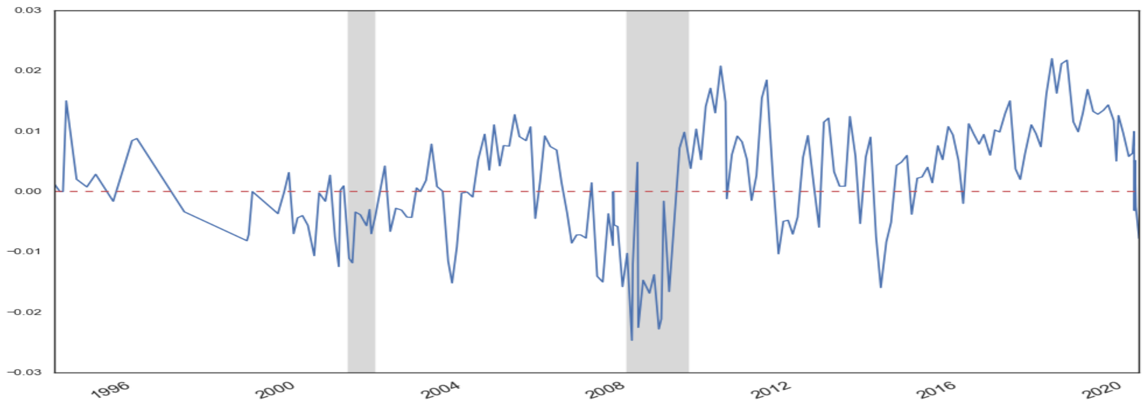


Figure D.5: Fed topic from combination of dictionaries without directional words

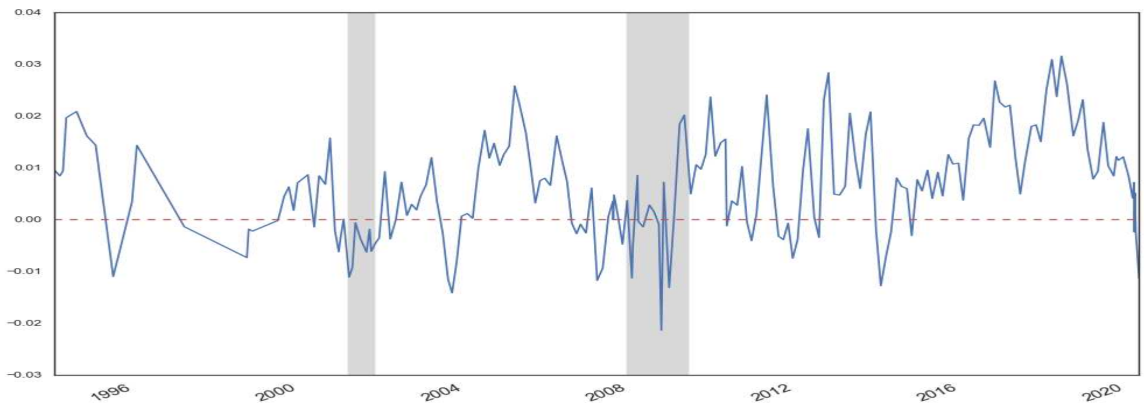


Figure D.6: Fed topic from combination of dictionaries with directional words

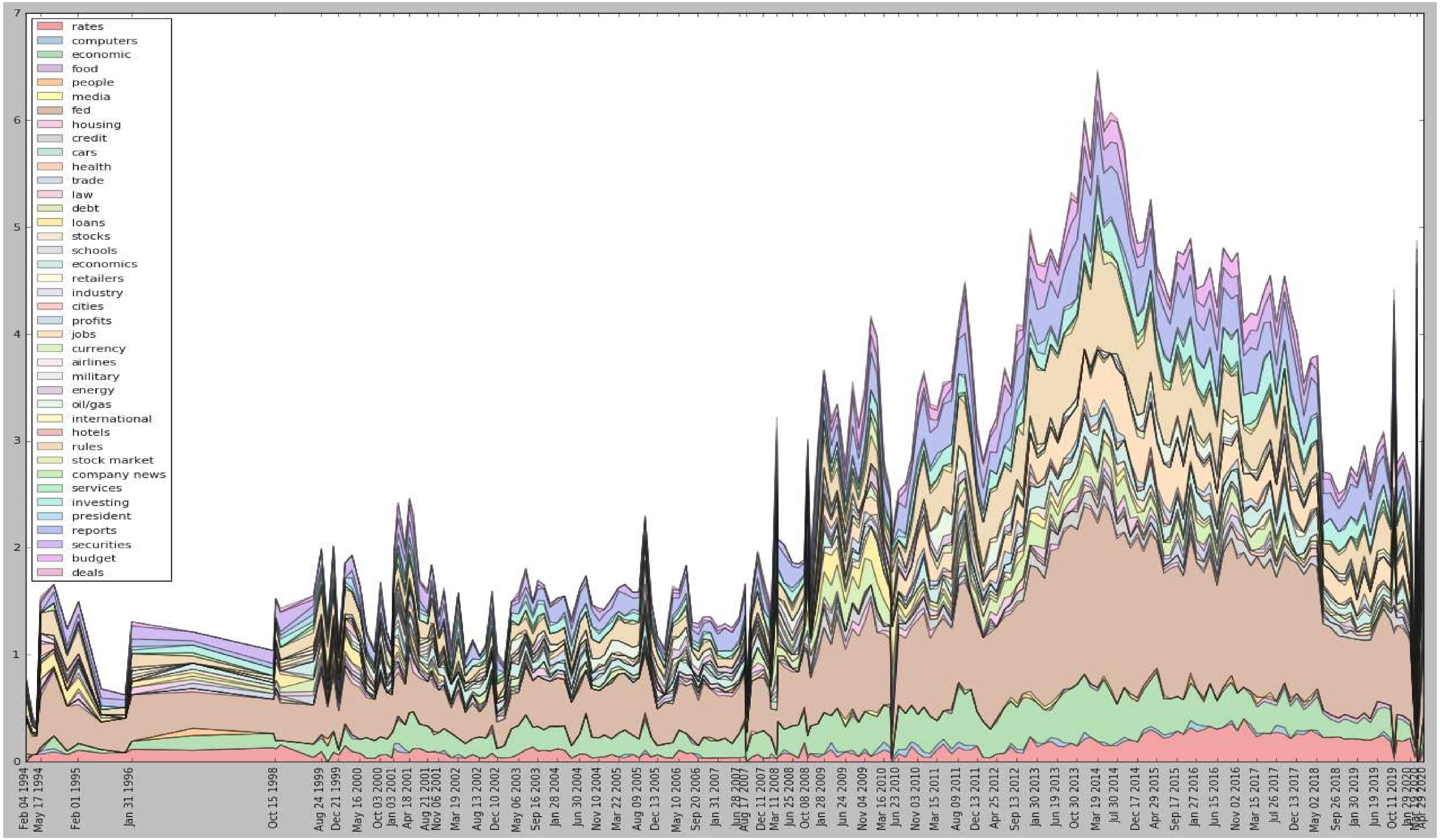


Figure D.7: Topic frequencies over time

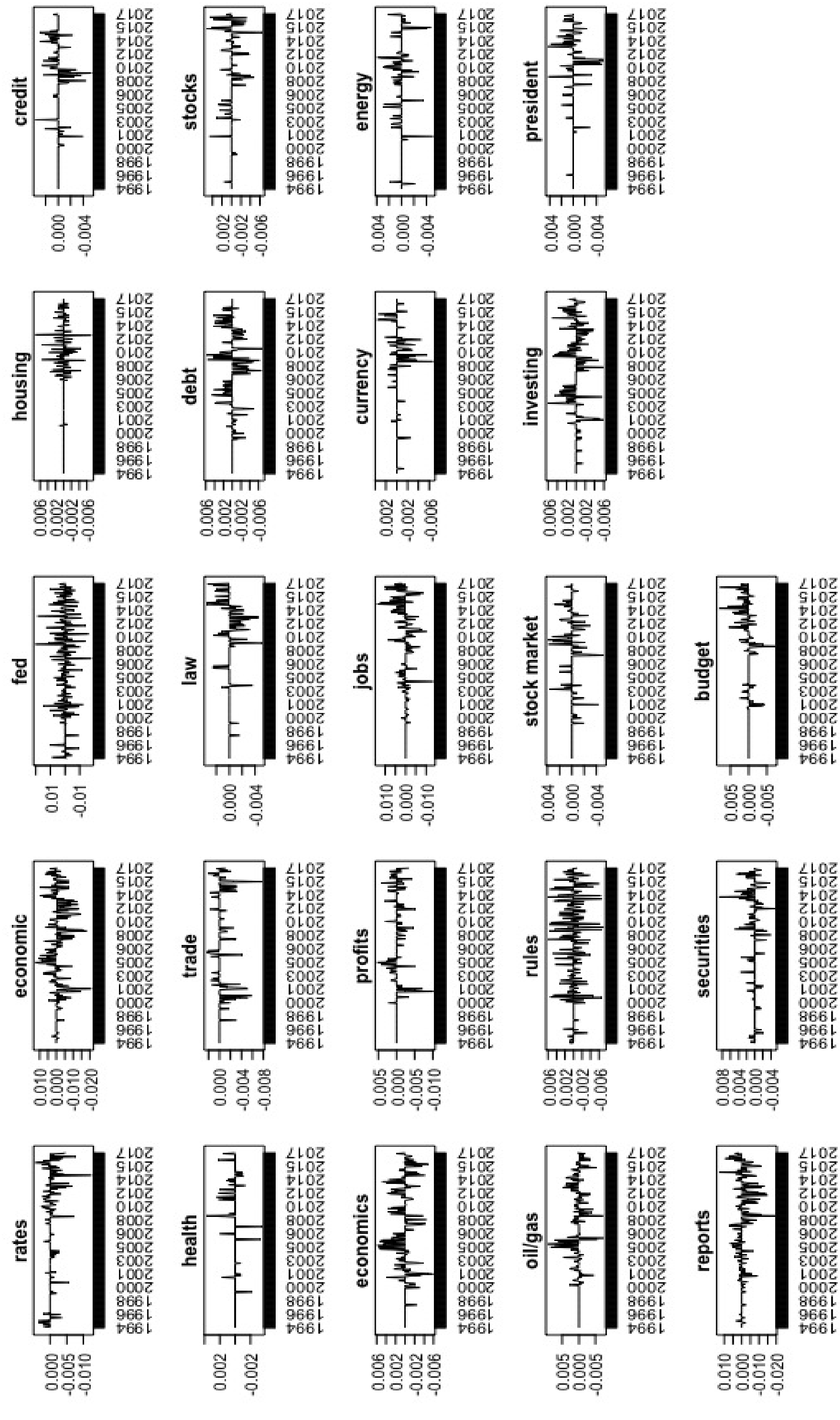


Figure D.8: Topic time series positiveness tone adjusted

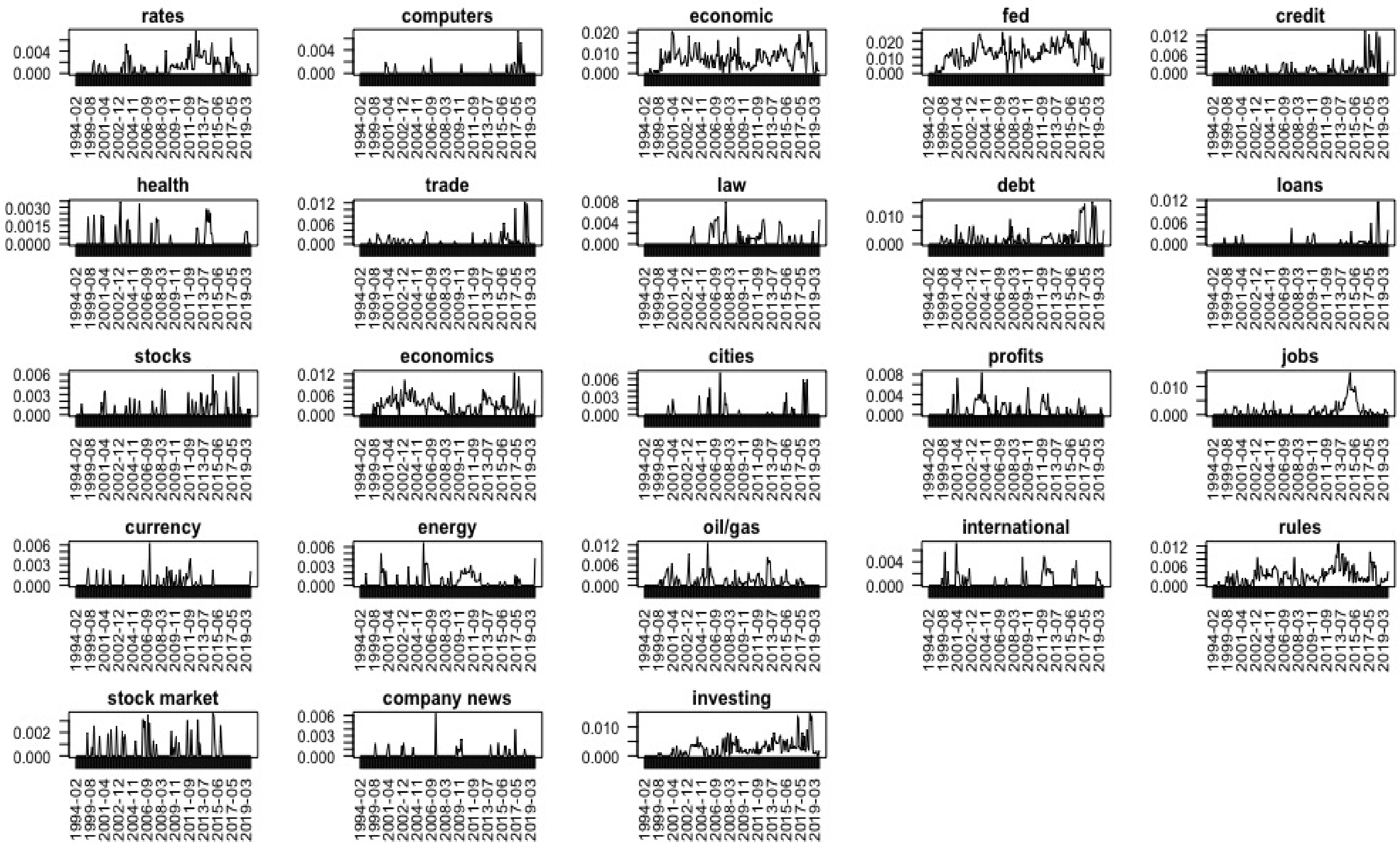
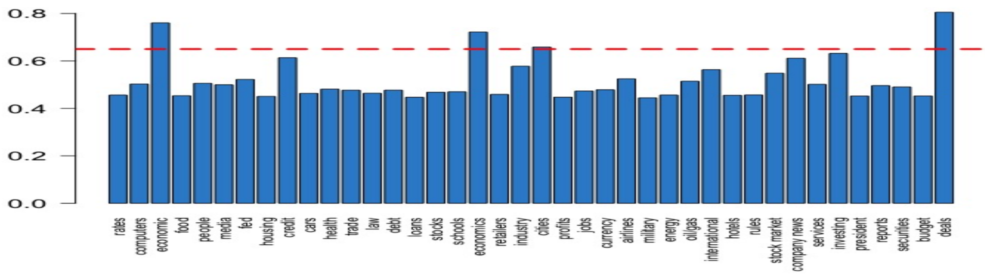
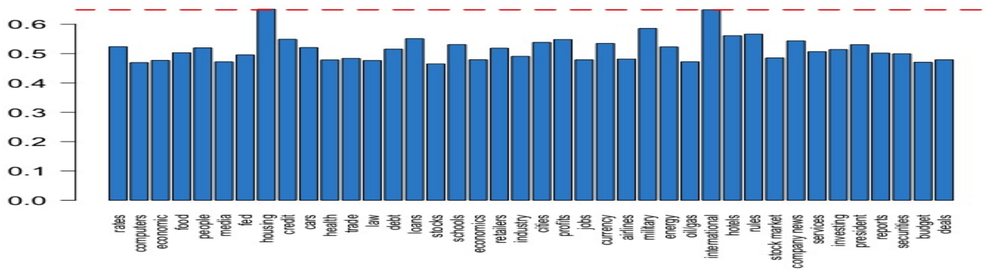


Figure D.9: Topic time series uncertainty tone adjusted

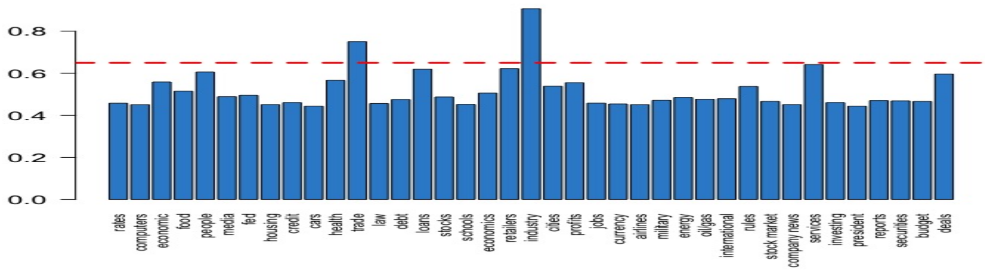
Appendix E. Model selection



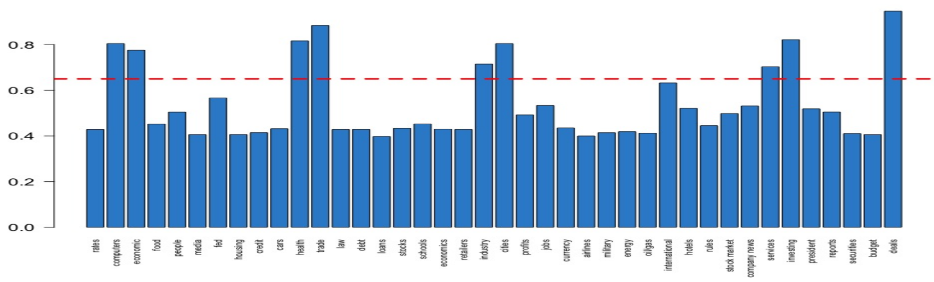
(a) Sign adjustment



(b) Non-adjusted frequency



(c) Uncertainty



(d) Positive tone for shocks from Gertler & Karadi (2015)

Figure E.1: Posterior inclusion probabilities

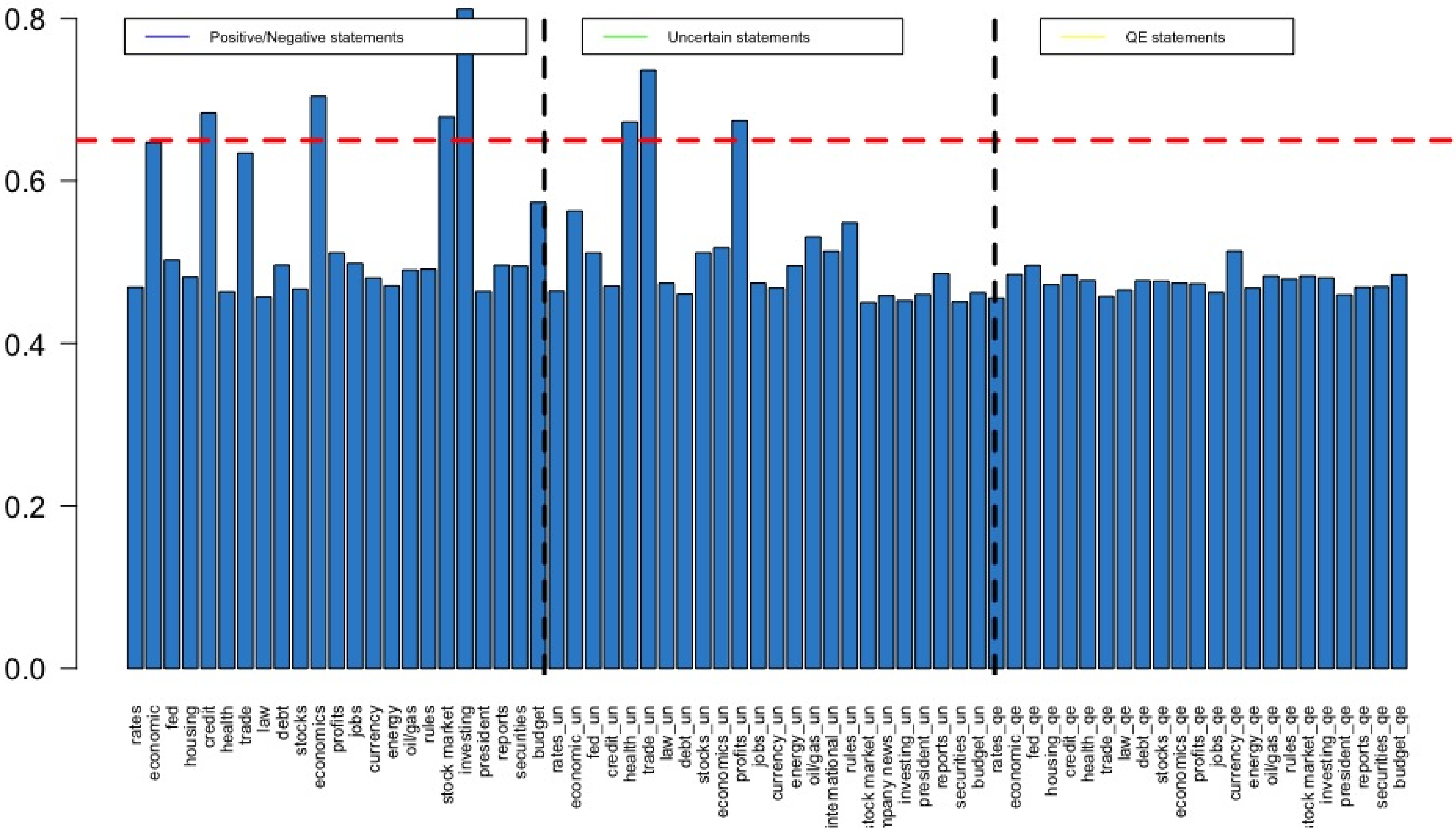


Figure E.2: Bayesian Lasso for surprises in 3m federal funds futures

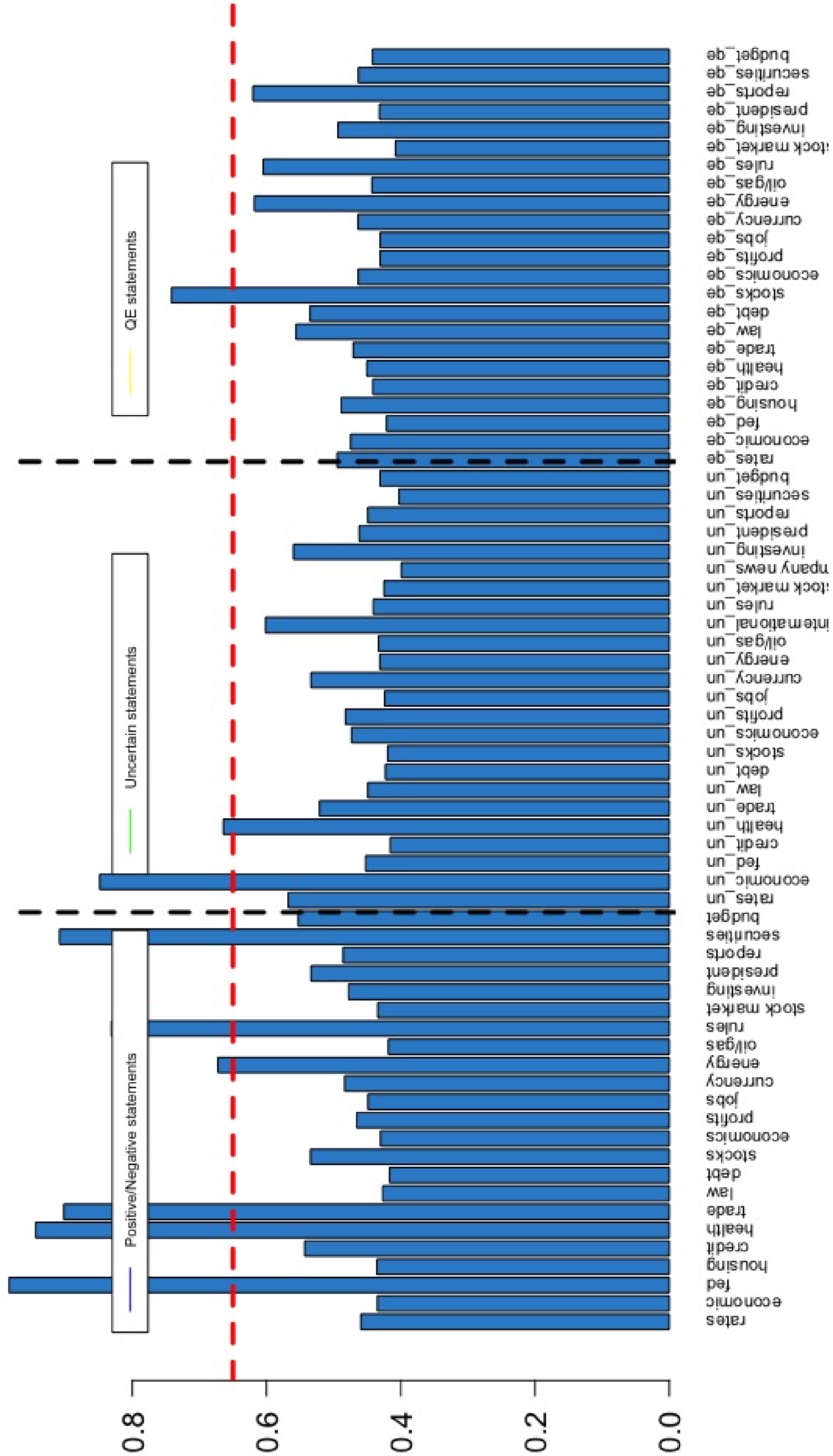


Figure E.3: Bayesian Lasso for surprises in S&P

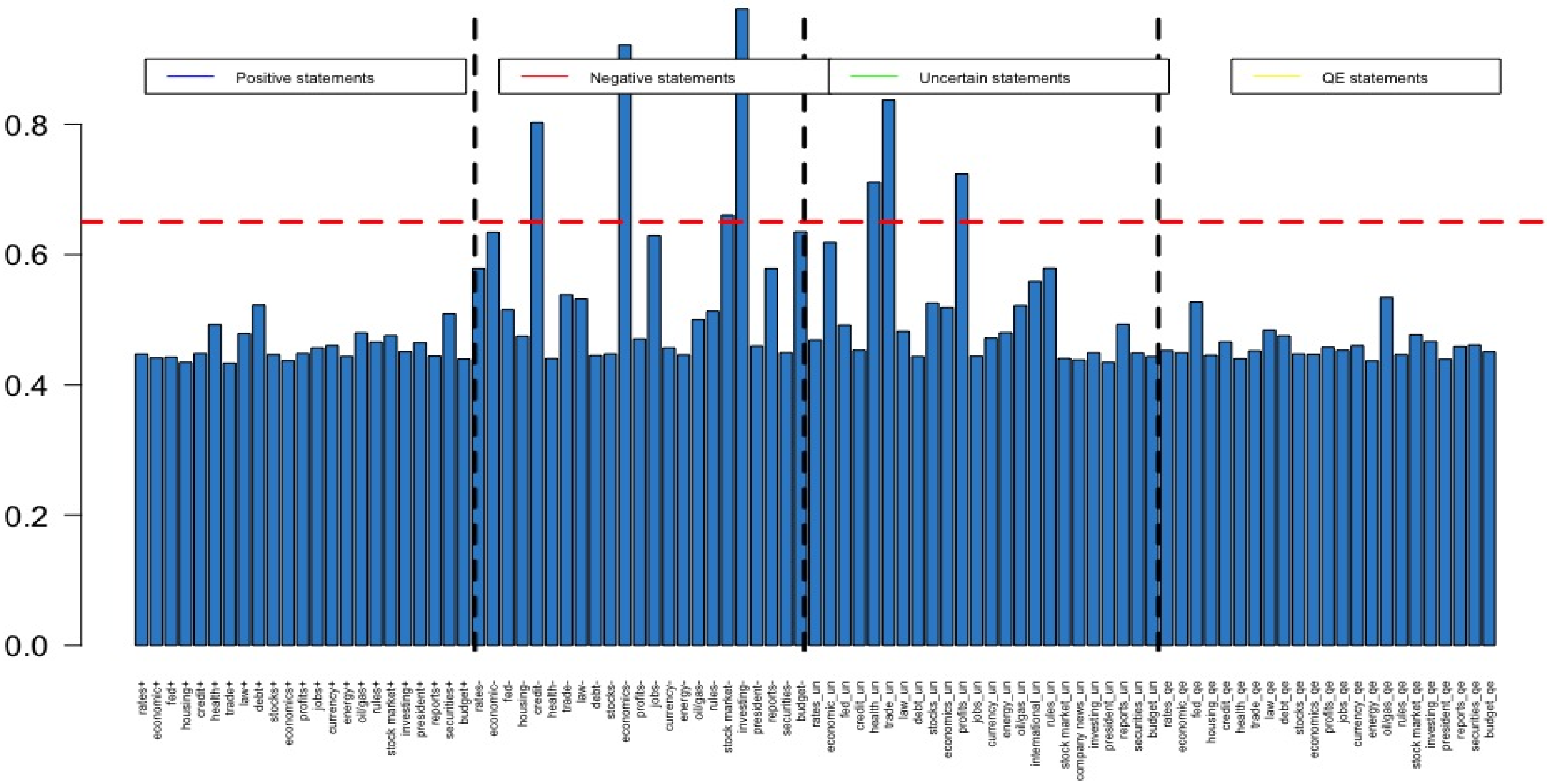


Figure E.4: Bayesian Lasso for surprises in n 3m federal funds futures with asymmetric effect

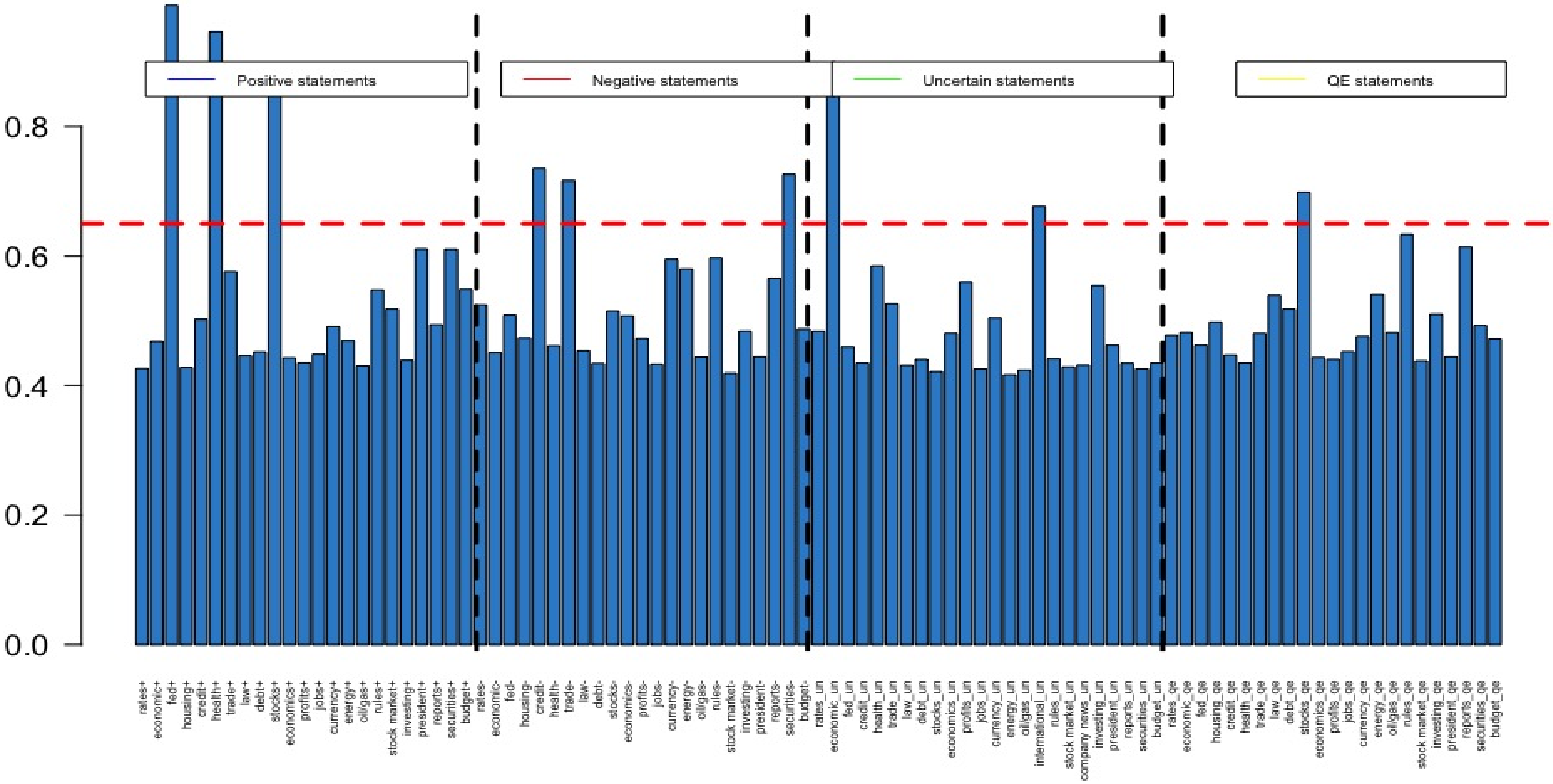


Figure E.5: Bayesian Lasso for surprises in S&P with asymmetric effect

Table E.1: Predictability of topic time series

	Dependent variable:									
	rates	computers	economic	food	people	media	fed	housing	credit	cars
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ NEER USA	−0.015	0.007	−0.003	−0.0002	−0.036*	0.006	−0.005	0.025	0.018	0.010
	(0.009)	(0.012)	(0.011)	(0.005)	(0.019)	(0.006)	(0.014)	(0.017)	(0.012)	(0.007)
Δ NEER Euro	0.020*	−0.012	0.013	0.002	0.037**	−0.005	0.030*	−0.022	−0.019*	−0.010
	(0.011)	(0.014)	(0.011)	(0.005)	(0.018)	(0.009)	(0.016)	(0.020)	(0.011)	(0.007)
Δ TEDRATE	−0.099	0.227	0.675**	−0.023	−0.373	0.119	−0.029	0.723***	0.190	0.168
	(0.179)	(0.260)	(0.286)	(0.080)	(0.260)	(0.150)	(0.307)	(0.154)	(0.255)	(0.105)
Δ S&P500	−0.0003*	0.0001	0.0003	−0.00002	0.0003	0.0001	−0.001**	0.0003	−0.0002	0.0002
	(0.0002)	(0.0002)	(0.0003)	(0.0001)	(0.0003)	(0.0001)	(0.0003)	(0.0002)	(0.0003)	(0.0003)
Δ AAA10Y	−0.004	−0.707	0.228	0.164	−0.055	0.538	−1.804**	−0.129	0.675	0.426
	(0.473)	(0.726)	(0.498)	(0.251)	(0.707)	(0.558)	(0.812)	(0.413)	(0.532)	(0.587)
Δ BAA10Y	0.132	0.371	−0.797*	−0.127	0.067	−0.481	0.758	−0.607*	−0.514	−0.404
	(0.346)	(0.457)	(0.413)	(0.256)	(0.542)	(0.593)	(0.700)	(0.313)	(0.612)	(0.518)
Constant	0.004	−0.002	0.001	0.001	−0.002	0.001	0.009	−0.001	0.002	−0.001
	(0.086)	(0.076)	(0.090)	(0.094)	(0.067)	(0.067)	(0.061)	(0.035)	(0.082)	(0.073)
Observations	195	195	195	195	195	195	195	195	195	195
R^2	0.016	0.019	0.063	0.001	0.070	0.008	0.113	0.068	0.024	0.011
Adjusted R^2	-0.016	-0.012	0.033	-0.031	0.041	-0.024	0.085	0.038	-0.007	-0.020

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table E.2: Predictability of topic time series

	Dependent variable:									
	health	trade	law	debt	loans	stocks	schools	economics	retailers	industry
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ NEER USA	0.005	−0.015	−0.010	0.011	−0.003	0.007	0.008	−0.007	−0.002	0.002
	(0.006)	(0.012)	(0.007)	(0.012)	(0.010)	(0.014)	(0.006)	(0.009)	(0.007)	(0.008)
Δ NEER Euro	−0.011	0.019	0.011	0.007	0.020	−0.001	−0.005	0.011	0.012	−0.005
	(0.008)	(0.015)	(0.008)	(0.015)	(0.013)	(0.016)	(0.007)	(0.010)	(0.009)	(0.009)
Δ TEDRATE	0.388	0.240	−0.189*	0.038	−0.044	0.148	−0.161	−0.152	0.076	0.843***
	(0.282)	(0.348)	(0.108)	(0.431)	(0.260)	(0.343)	(0.167)	(0.324)	(0.131)	(0.319)
Δ S&P500	−0.001	0.001	−0.00003	0.0005	−0.0003	0.0005**	0.0001	0.001**	0.0001	0.0002
	(0.0004)	(0.001)	(0.0001)	(0.0003)	(0.0002)	(0.0002)	(0.0001)	(0.0004)	(0.0002)	(0.0002)
Δ AAA10Y	−0.555	0.078	−0.008	−0.099	0.527	0.326	−0.060	−0.454	0.713	−0.079
	(0.574)	(0.640)	(0.481)	(0.705)	(0.649)	(0.467)	(0.418)	(0.430)	(0.672)	(0.768)
Δ BAA10Y	0.731	−0.288	0.148	−0.922	−0.796	−0.732**	−0.149	−0.128	−0.819	−0.212
	(0.581)	(0.393)	(0.327)	(0.643)	(0.565)	(0.366)	(0.369)	(0.292)	(0.709)	(0.513)
Constant	0.002	−0.005	0.0001	0.001	0.008	−0.002	−0.0001	−0.007	0.003	−0.003
	(0.079)	(0.087)	(0.097)	(0.070)	(0.097)	(0.084)	(0.073)	(0.075)	(0.072)	(0.088)
Observations	195	195	195	195	195	195	195	195	195	195
R^2	0.054	0.049	0.007	0.094	0.045	0.031	0.009	0.053	0.023	0.056
Adjusted R^2	0.024	0.019	-0.025	0.065	0.015	-0.0001	-0.022	0.023	-0.008	0.026

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table E.3: Predictability of topic time series

	Dependent variable:									
	cities	profits	jobs	currency	airlines	military	energy	oil/gas	international	hotels
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ NEER USA	0.003	0.005	0.004	−0.001	−0.005	−0.005	−0.007	−0.008	−0.012	0.025
	(0.008)	(0.010)	(0.009)	(0.010)	(0.010)	(0.015)	(0.009)	(0.010)	(0.008)	(0.017)
Δ NEER Euro	−0.001	0.00001	0.005	−0.005	0.014	0.003	0.002	0.011	0.023**	−0.013
	(0.008)	(0.011)	(0.010)	(0.013)	(0.011)	(0.013)	(0.010)	(0.012)	(0.010)	(0.014)
Δ TEDRATE	−0.156	0.261	0.334	0.036	−0.183	−0.048	−0.274**	0.266	−0.480	−0.010
	(0.183)	(0.185)	(0.203)	(0.509)	(0.173)	(0.164)	(0.136)	(0.305)	(0.444)	(0.139)
Δ S&P500	0.0001	0.0003	0.00001	0.00000	−0.00003	0.001*	0.001	0.0002	0.001	0.0001
	(0.0001)	(0.0002)	(0.0004)	(0.0003)	(0.0002)	(0.001)	(0.0004)	(0.0003)	(0.0004)	(0.0004)
Δ AAA10Y	−0.709	−0.136	1.044**	0.048	−1.023	−0.961*	−0.349	−0.936*	−0.663	0.863
	(0.451)	(0.499)	(0.500)	(0.740)	(0.886)	(0.512)	(0.399)	(0.562)	(0.529)	(0.676)
Δ BAA10Y	0.348	−0.368	−1.159***	0.150	0.430	0.246	0.279	0.288	0.055	−0.993
	(0.361)	(0.315)	(0.418)	(0.886)	(0.330)	(0.286)	(0.343)	(0.468)	(0.293)	(0.710)
Constant	−0.001	−0.001	0.004	−0.001	0.001	−0.010	−0.008	−0.002	−0.003	0.003
	(0.076)	(0.086)	(0.085)	(0.093)	(0.070)	(0.071)	(0.086)	(0.087)	(0.081)	(0.069)
Observations	195	195	195	195	195	195	195	195	195	195
R^2	0.011	0.019	0.044	0.005	0.030	0.061	0.040	0.034	0.068	0.057
Adjusted R^2	-0.021	-0.012	0.013	-0.027	-0.001	0.031	0.009	0.003	0.038	0.027

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table E.4: Predictability of topic time series

	Dependent variable:									
	rules	stock market	company news	services	investing	president	reports	securities	budget	deals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Δ NEER USA	−0.005	0.001	−0.022**	0.00002	0.005	0.012	0.001	0.001	−0.005	−0.002
	(0.011)	(0.008)	(0.009)	(0.006)	(0.010)	(0.011)	(0.010)	(0.009)	(0.010)	(0.006)
Δ NEER Euro	0.024**	0.016*	0.032***	−0.008	0.010	−0.018	0.006	0.007	0.012	0.004
	(0.011)	(0.009)	(0.012)	(0.010)	(0.012)	(0.013)	(0.011)	(0.009)	(0.012)	(0.009)
Δ TEDRATE	0.171	0.238	0.003	−0.389	0.534*	0.759***	0.533**	−0.391	0.350*	0.138
	(0.262)	(0.253)	(0.206)	(0.269)	(0.303)	(0.229)	(0.258)	(0.329)	(0.183)	(0.205)
Δ S&P500	−0.001**	0.0003	−0.0002	0.002*	0.0001	−0.0002	0.0004*	0.0001	0.001***	−0.0003
	(0.0005)	(0.0004)	(0.0002)	(0.001)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Δ AAA10Y	−0.227	0.551	0.444	−0.056	−0.464	0.056	1.240**	−1.215**	1.076*	1.586**
	(0.557)	(0.700)	(0.710)	(0.654)	(0.737)	(0.415)	(0.562)	(0.529)	(0.609)	(0.739)
Δ BAA10Y	−0.018	−1.147**	−0.338	−0.299	−0.425	−0.116	−1.393***	0.509	−1.233**	−0.976*
	(0.397)	(0.574)	(0.665)	(0.416)	(0.609)	(0.379)	(0.455)	(0.434)	(0.517)	(0.588)
Constant	0.015	0.002	0.004	−0.019	0.002	0.001	0.001	−0.0003	−0.002	0.005
	(0.043)	(0.082)	(0.089)	(0.069)	(0.091)	(0.095)	(0.089)	(0.055)	(0.099)	(0.083)
Observations	195	195	195	195	195	195	195	195	195	195
R^2	0.098	0.066	0.033	0.208	0.055	0.059	0.068	0.047	0.062	0.042
Adjusted R^2	0.069	0.037	0.002	0.182	0.025	0.029	0.039	0.016	0.032	0.012

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Appendix F. Effect of Central bank communication

F.1 Central bank communication and Yield curves

Table F.1: ΔYields, one day difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	−0.114	0.741	1.672*	1.818**	1.720**	1.608**	1.486**	1.357**
	(0.810)	(0.848)	(0.930)	(0.908)	(0.795)	(0.701)	(0.666)	(0.677)
Fed news	−0.193	0.017	−0.172	−0.350	−0.319	−0.271	−0.250	−0.264
	(0.910)	(1.123)	(1.146)	(1.015)	(0.896)	(0.833)	(0.781)	(0.753)
Fed news on FG dates	0.312	−0.506	−1.214	−1.110	−0.806	−0.654	−0.655	−0.742
	(0.805)	(0.855)	(0.981)	(0.911)	(0.820)	(0.759)	(0.742)	(0.752)
Constant	−0.003	−0.008	−0.013	−0.014	−0.013	−0.012	−0.011	−0.009
	(0.011)	(0.014)	(0.014)	(0.014)	(0.013)	(0.012)	(0.011)	(0.010)
Observations	186	186	186	186	186	186	186	186
R^2	0.001	0.006	0.023	0.028	0.030	0.031	0.030	0.027
Adjusted R^2	-0.015	-0.011	0.007	0.012	0.014	0.016	0.014	0.011

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.2: Δ Yields, one day difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	0.721	1.459	3.110*	3.739**	3.329**	2.838***	2.471***	2.231**
	(0.935)	(1.226)	(1.723)	(1.830)	(1.460)	(1.086)	(0.909)	(0.936)
ΔFed news	0.496	0.530	−1.144	−1.767	−1.090	−0.600	−0.591	−0.927
	(0.997)	(1.320)	(1.628)	(1.420)	(1.079)	(0.921)	(0.974)	(1.075)
Δ Fed news on FG dates	−0.066	−0.743	0.040	0.564	0.179	−0.080	0.135	0.739
	(1.753)	(2.161)	(2.478)	(2.145)	(1.676)	(1.509)	(1.561)	(1.636)
Constant	−0.005	−0.003	−0.004	−0.004	−0.002	−0.001	−0.0003	−0.001
	(0.005)	(0.005)	(0.006)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
Observations	185	185	185	185	185	185	185	185
R^2	0.010	0.021	0.048	0.079	0.088	0.082	0.069	0.053
Adjusted R^2	-0.006	0.004	0.032	0.064	0.073	0.067	0.053	0.038

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.3: Δ Forward Rates, one day difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	2.036**	2.290**	1.678**	1.396*	1.144	0.855	0.581	2.371**
	(1.034)	(1.125)	(0.852)	(0.745)	(0.717)	(0.869)	(1.223)	(1.145)
Fed news	0.088	−0.556	−0.390	−0.163	−0.122	−0.237	−0.448	−0.501
	(1.366)	(1.242)	(0.924)	(0.915)	(0.876)	(1.050)	(1.517)	(1.306)
Fed news on FG dates	−1.602	−1.559	−0.472	−0.079	−0.389	−0.924	−1.414	−1.660
	(1.118)	(1.099)	(0.844)	(0.785)	(0.770)	(0.918)	(1.250)	(1.136)
Constant	−0.015	−0.016	−0.013	−0.011	−0.008	−0.003	0.002	−0.017
	(0.017)	(0.016)	(0.014)	(0.013)	(0.011)	(0.011)	(0.014)	(0.017)
Observations	186	186	186	186	186	186	186	186
R^2	0.028	0.030	0.023	0.021	0.014	0.012	0.013	0.031
Adjusted R^2	0.012	0.014	0.007	0.005	-0.002	-0.004	-0.003	0.015

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.4: Δ Forward Rates, one day difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	2.855	4.940**	3.417**	1.772***	1.089	0.988	1.075	4.913**
	(1.805)	(2.421)	(1.334)	(0.671)	(0.735)	(0.982)	(1.896)	(2.467)
Δ Fed news	−0.198	−3.323*	−0.925	1.009	0.374	−1.582	−3.575*	−3.252*
	(1.890)	(1.835)	(1.157)	(1.683)	(1.940)	(1.785)	(2.040)	(1.862)
Δ Fed news on FG dates	−0.973	1.427	0.272	−1.140	−0.196	2.355	5.110*	1.328
	(2.836)	(2.758)	(1.519)	(2.101)	(2.490)	(2.436)	(2.735)	(2.851)
Constant	−0.001	−0.006	−0.001	0.004	0.002	−0.001	−0.005	−0.006
	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)	(0.006)	(0.008)	(0.007)
Observations	185	185	185	185	185	185	185	185
R^2	0.035	0.082	0.087	0.045	0.016	0.010	0.016	0.075
Adjusted R^2	0.019	0.067	0.071	0.029	-0.001	-0.006	0.0001	0.060

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.5: Δ Yields, two days difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	0.171	1.476	3.046^{***}	3.276^{***}	2.883^{**}	2.414^{**}	1.913^{**}	1.385
	(0.981)	(0.950)	(1.147)	(1.231)	(1.174)	(1.064)	(0.971)	(0.949)
Fed news	0.377	1.107	1.722	2.349^{*}	2.472^{*}	2.167^{*}	1.622	0.969
	(1.116)	(1.286)	(1.427)	(1.404)	(1.298)	(1.226)	(1.200)	(1.275)
Fed news on FG dates	−0.109	−1.343	-2.293^{*}	-2.454^{**}	-2.277^{*}	-1.969^{*}	−1.589	−1.167
	(0.824)	(0.901)	(1.186)	(1.222)	(1.173)	(1.130)	(1.110)	(1.131)
Constant	−0.020	-0.031^{*}	-0.051^{***}	-0.062^{***}	-0.058^{***}	-0.049^{***}	-0.038^{**}	−0.025
	(0.014)	(0.016)	(0.017)	(0.018)	(0.017)	(0.016)	(0.015)	(0.016)
Observations	186	186	186	186	186	186	186	186
R^2	0.001	0.027	0.066	0.075	0.074	0.063	0.043	0.020
Adjusted R^2	-0.015	0.011	0.051	0.060	0.058	0.048	0.027	0.003

Note: HAC standard errors are in parentheses; $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table F.6: Δ Yields, two days difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	−0.702	0.229	2.777	4.250*	3.962*	3.257*	2.566*	1.999*
	(0.991)	(1.203)	(2.032)	(2.451)	(2.164)	(1.701)	(1.322)	(1.205)
Δ Fed news	1.676	2.413	1.442	1.029	1.716	2.001	1.561	0.634
	(1.269)	(1.472)	(1.360)	(1.761)	(1.862)	(1.879)	(2.126)	(2.480)
Δ Fed news on FG dates	−2.183	−2.862	−2.039	−1.288	−1.621	−1.696	−1.005	0.279
	(1.380)	(1.806)	(2.241)	(2.621)	(2.514)	(2.461)	(2.681)	(3.124)
Constant	−0.016***	−0.010	−0.011	−0.012*	−0.011	−0.009	−0.007	−0.006
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)
Observations	185	185	185	185	185	185	185	185
R^2	0.007	0.013	0.041	0.073	0.081	0.073	0.052	0.028
Adjusted R^2	-0.009	-0.003	0.025	0.058	0.066	0.058	0.037	0.012

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.7: Δ Forward Rates, two days difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	3.432***	4.225***	2.720*	1.536	0.476	−0.673	−1.817	4.355***
	(1.298)	(1.514)	(1.398)	(1.115)	(1.125)	(1.544)	(2.144)	(1.523)
Fed news	1.950	2.465	3.154**	2.092	0.359	−1.460	−3.089	2.371
	(1.636)	(1.754)	(1.401)	(1.305)	(1.473)	(2.177)	(3.264)	(1.805)
Fed news on FG dates	−2.873**	−2.857*	−2.313*	−1.506	−0.569	0.442	1.434	−2.945*
	(1.292)	(1.524)	(1.340)	(1.218)	(1.246)	(1.563)	(2.119)	(1.548)
Constant	−0.049***	−0.074***	−0.065***	−0.037**	−0.007	0.022	0.051	−0.074***
	(0.019)	(0.022)	(0.020)	(0.017)	(0.018)	(0.030)	(0.048)	(0.022)
Observations	186	186	186	186	186	186	186	186
R^2	0.072	0.071	0.060	0.032	0.002	0.006	0.014	0.073
Adjusted R^2	0.056	0.056	0.044	0.016	-0.014	-0.011	-0.002	0.057

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.8: Δ Forward Rates, two days difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	2.151	5.946*	4.739**	2.117*	0.330	−0.616	−0.968	5.732*
	(1.919)	(3.076)	(2.350)	(1.244)	(1.355)	(1.992)	(2.697)	(3.060)
Δ Fed news	2.603	−0.220	2.030	3.578	1.628	−2.128	−5.756	−0.059
	(1.812)	(2.085)	(2.576)	(2.748)	(3.223)	(4.198)	(5.505)	(1.973)
Δ Fed news on FG dates	−3.058	−0.426	−1.362	−2.744	−0.491	4.205	9.105	−0.673
	(2.575)	(3.287)	(3.021)	(3.246)	(4.041)	(5.250)	(6.789)	(3.229)
Constant	−0.005	−0.015	−0.011	−0.004	−0.001	0.001	0.003	−0.015
	(0.008)	(0.009)	(0.008)	(0.007)	(0.008)	(0.011)	(0.016)	(0.009)
Observations	185	185	185	185	185	185	185	185
R^2	0.031	0.077	0.086	0.054	0.007	0.007	0.016	0.072
Adjusted R^2	0.015	0.062	0.071	0.038	-0.010	-0.009	0.0002	0.056

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.9: Δ TIPS Yields, one day difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	2.526**	2.220*	2.011*	1.952**	2.568**	1.538	1.729*	1.678**
	(1.264)	(1.163)	(1.066)	(0.958)	(1.305)	(1.142)	(0.980)	(0.841)
Fed news	−1.006	−1.004	−0.922	−0.781	−1.116	−0.930	−0.525	−0.346
	(1.688)	(1.378)	(1.204)	(1.105)	(1.465)	(1.202)	(1.094)	(1.135)
Fed news on FG dates	−1.879*	−1.208	−1.014	−1.027	−1.318	−0.323	−0.951	−0.998
	(1.139)	(1.027)	(0.930)	(0.853)	(1.124)	(1.012)	(0.895)	(0.804)
Constant	−0.008	−0.010	−0.011	−0.011	−0.012	−0.010	−0.014	−0.011
	(0.026)	(0.021)	(0.019)	(0.018)	(0.021)	(0.021)	(0.018)	(0.018)
Observations	132	132	132	132	132	132	132	132
R^2	0.041	0.034	0.036	0.045	0.036	0.017	0.040	0.046
Adjusted R^2	0.019	0.011	0.014	0.022	0.013	-0.006	0.018	0.024

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.10: Δ TIPS Yields, one day difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	4.813**	4.587**	4.324**	3.982**	4.856*	4.013*	3.530***	2.155***
	(2.372)	(2.263)	(2.067)	(1.749)	(2.588)	(2.066)	(1.280)	(0.810)
Δ Fed news	−3.915	−3.428	−2.579	−1.709	−4.251*	−1.830	0.086	1.519
	(2.579)	(2.243)	(1.735)	(1.239)	(2.534)	(1.607)	(0.889)	(1.769)
Δ Fed news on FG dates	1.206	1.549	0.909	0.009	2.361	0.959	−1.713	−3.351
	(3.510)	(2.971)	(2.342)	(1.810)	(3.243)	(2.228)	(1.356)	(2.126)
Constant	−0.005	−0.005	−0.006	−0.005	−0.006	−0.006	−0.006	−0.002
	(0.009)	(0.008)	(0.006)	(0.006)	(0.008)	(0.006)	(0.004)	(0.005)
Observations	132	132	132	132	132	132	132	132
R^2	0.082	0.099	0.123	0.140	0.092	0.113	0.150	0.102
Adjusted R^2	0.060	0.078	0.102	0.120	0.071	0.092	0.130	0.081

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.11: Δ Inflation Compensation, one day difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
Economic aggregated	−0.279	−0.504	−0.311	−0.488	−0.728*
	(0.727)	(0.434)	(0.374)	(0.363)	(0.387)
Fed news	−0.832	0.304	0.189	0.004	−0.158
	(1.177)	(0.593)	(0.446)	(0.451)	(0.490)
Fed news on FG dates	0.617	0.252	−0.265	−0.004	0.286
	(0.611)	(0.435)	(0.354)	(0.332)	(0.355)
Constant	0.018	0.006	0.008	0.013*	0.017**
	(0.018)	(0.008)	(0.006)	(0.007)	(0.008)
Observations	132	132	132	132	132
R^2	0.005	0.008	0.007	0.010	0.020
Adjusted R^2	-0.018	-0.015	-0.016	-0.013	-0.003
Note:	HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01				

Table F.12: Δ Inflation Compensation, one day difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
ΔEconomic aggregated	−2.301*	−0.945	−0.158	−0.520	−0.814
	(1.174)	(0.633)	(0.411)	(0.531)	(0.650)
ΔFed news	2.170	2.495**	1.301	1.243	0.974
	(1.886)	(1.185)	(0.823)	(0.858)	(1.018)
Δ Fed news on FG dates	−0.782	−1.197	−0.860	−0.598	0.001
	(2.526)	(1.472)	(1.040)	(1.106)	(1.336)
Constant	0.008	0.006	0.005	0.007**	0.008**
	(0.007)	(0.004)	(0.003)	(0.003)	(0.004)
Observations	132	132	132	132	132
R^2	0.040	0.051	0.019	0.020	0.025
Adjusted R^2	0.017	0.029	-0.004	-0.003	0.002

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.13: Δ TIPS Yields, two days difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	3.517**	3.159**	2.611**	2.504**	4.096**	1.771	1.608*	2.909**
	(1.443)	(1.394)	(1.195)	(1.069)	(1.794)	(1.224)	(0.945)	(1.195)
Fed news	2.244	2.010	1.967	2.134	2.065	1.546	2.366	2.528*
	(2.323)	(1.909)	(1.656)	(1.539)	(2.051)	(1.584)	(1.508)	(1.355)
Fed news on FG dates	−2.459*	−1.926	−1.523	−1.555	−2.352	−0.730	−0.974	−2.493**
	(1.351)	(1.289)	(1.190)	(1.143)	(1.518)	(1.284)	(1.186)	(1.214)
Constant	−0.072*	−0.066**	−0.062**	−0.063***	−0.073**	−0.050**	−0.063***	−0.063***
	(0.038)	(0.031)	(0.026)	(0.023)	(0.031)	(0.024)	(0.019)	(0.019)
Observations	132	132	132	132	132	132	132	132
R^2	0.048	0.050	0.050	0.061	0.057	0.027	0.051	0.094
Adjusted R^2	0.026	0.027	0.028	0.039	0.035	0.004	0.029	0.073
Note:	HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01							

Table F.14: Δ TIPS Yields, two days difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	5.579**	5.433**	4.605*	4.271**	6.660**	3.719	2.710***	4.068***
	(2.828)	(2.645)	(2.472)	(2.071)	(3.130)	(2.337)	(0.921)	(1.395)
ΔFed news	−2.209	−2.501	−1.673	−0.576	−4.136	−1.497	1.507	3.505*
	(3.118)	(2.732)	(2.082)	(1.513)	(3.458)	(1.967)	(1.606)	(2.012)
Δ Fed news on FG dates	−1.269	−0.034	−0.133	−0.878	1.448	0.687	−1.583	−4.662*
	(4.067)	(3.537)	(2.722)	(2.142)	(4.231)	(2.656)	(2.246)	(2.405)
Constant	−0.018	−0.015	−0.015*	−0.016**	−0.013	−0.013	−0.019***	−0.013*
	(0.012)	(0.010)	(0.009)	(0.008)	(0.012)	(0.009)	(0.007)	(0.007)
Observations	132	132	132	132	132	132	132	132
R^2	0.068	0.082	0.082	0.093	0.088	0.055	0.069	0.153
Adjusted R^2	0.047	0.060	0.060	0.072	0.067	0.033	0.047	0.133

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.15: Δ Inflation Compensation, two days difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
Economic aggregated	−0.446	−0.281	0.165	0.031	−0.519
	(0.962)	(0.704)	(0.678)	(0.721)	(0.704)
Fed news	−1.766	0.394	1.177	1.082	0.551
	(2.603)	(1.406)	(0.827)	(0.827)	(0.907)
Fed news on FG dates	0.136	−0.327	−0.857	−0.933	−0.463
	(0.975)	(0.751)	(0.646)	(0.650)	(0.685)
Constant	0.041	0.012	−0.005	0.001	0.012
	(0.046)	(0.026)	(0.013)	(0.012)	(0.013)
Observations	132	132	132	132	132
R^2	0.008	0.001	0.011	0.012	0.005
Adjusted R^2	-0.016	-0.022	-0.012	-0.011	-0.018

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.16: Δ Inflation Compensation, two days difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
ΔEconomic aggregated	−3.740**	−2.018	−0.351	0.034	−0.500
	(1.862)	(1.344)	(0.773)	(0.742)	(0.876)
Δ Fed news	−0.0005	2.973	2.132	2.058	1.544
	(3.716)	(2.627)	(1.956)	(1.720)	(1.978)
Δ Fed news on FG dates	2.071	−0.784	−0.677	−0.806	−0.316
	(4.367)	(3.117)	(2.364)	(2.097)	(2.454)
Constant	0.013	0.010	0.005	0.007	0.009*
	(0.014)	(0.009)	(0.006)	(0.005)	(0.005)
Observations	132	132	132	132	132
R^2	0.039	0.030	0.021	0.025	0.012
Adjusted R^2	0.016	0.007	-0.002	0.002	-0.011

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

F.2 Central bank communication and MP shocks

Table F.17: Δ Yields, one day difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	1.401	2.373	4.138*	4.627*	3.902**	3.128**	2.554**	2.166*
	(0.939)	(1.458)	(2.463)	(2.583)	(1.961)	(1.415)	(1.168)	(1.168)
Δ Fed news	1.013	1.121	−0.751	−1.739	−0.935	−0.242	−0.113	−0.409
	(1.672)	(2.018)	(2.485)	(2.390)	(1.704)	(1.295)	(1.326)	(1.529)
ΔFed news on FG dates	−1.360	−2.571	−1.906	−0.596	−0.774	−1.134	−0.936	−0.162
	(1.638)	(2.110)	(2.790)	(2.721)	(1.956)	(1.565)	(1.689)	(2.045)
PCA_ffr4_hf	0.478***	0.487***	0.373***	0.211**	0.125*	0.075	0.042	0.015
	(0.105)	(0.117)	(0.111)	(0.086)	(0.076)	(0.069)	(0.062)	(0.059)
Constant	−0.009***	−0.007	−0.008	−0.006	−0.003	−0.001	0.0002	0.0003
	(0.003)	(0.004)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Observations	155	155	155	155	155	155	155	155
R^2	0.382	0.308	0.180	0.131	0.115	0.095	0.071	0.048
Adjusted R^2	0.365	0.289	0.158	0.108	0.091	0.070	0.046	0.023

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.18: Δ Yields, two days difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	0.055	1.281	4.255*	5.706*	5.006**	3.912**	2.919**	2.082
	(0.972)	(1.399)	(2.395)	(2.946)	(2.532)	(1.924)	(1.469)	(1.457)
Δ Fed news	1.570	2.348	1.146	0.502	1.482	2.038	1.658	0.609
	(1.308)	(1.743)	(2.200)	(2.586)	(2.641)	(2.648)	(2.815)	(3.002)
ΔFed news on FG dates	−2.476*	−3.875**	−3.073	−1.560	−1.762	−1.911	−1.084	0.650
	(1.372)	(1.827)	(2.735)	(3.172)	(3.024)	(3.146)	(3.650)	(4.011)
PCA_ffr4_hf	0.607***	0.578***	0.470***	0.310**	0.219	0.158	0.102	0.042
	(0.083)	(0.116)	(0.146)	(0.146)	(0.147)	(0.135)	(0.117)	(0.121)
Constant	−0.016***	−0.011*	−0.013	−0.014	−0.012	−0.009	−0.006	−0.003
	(0.005)	(0.007)	(0.009)	(0.010)	(0.009)	(0.008)	(0.008)	(0.008)
Observations	155	155	155	155	155	155	155	155
R^2	0.420	0.299	0.170	0.129	0.115	0.095	0.062	0.029
Adjusted R^2	0.405	0.281	0.148	0.105	0.091	0.071	0.037	0.003

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.19: Δ Forward Rates, one day difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	4.044	5.984*	3.753**	1.392	0.402	0.208	0.233	5.997*
	(2.477)	(3.421)	(1.730)	(0.937)	(0.979)	(1.188)	(2.245)	(3.491)
Δ Fed news	0.458	−3.538	−0.991	1.814	1.406	−0.738	−2.960	−3.313
	(2.678)	(3.090)	(1.733)	(2.060)	(2.404)	(2.208)	(3.142)	(3.162)
ΔFed news on FG dates	−3.462	0.155	0.197	−2.210	−1.633	1.663	5.747	−0.259
	(3.056)	(3.738)	(2.015)	(2.535)	(2.968)	(3.006)	(4.281)	(3.800)
PCA_ffr4_hf	0.454***	0.163*	−0.022	−0.064	−0.082	−0.105	−0.136	0.206**
	(0.140)	(0.084)	(0.068)	(0.070)	(0.068)	(0.077)	(0.092)	(0.093)
Constant	−0.006	−0.009	−0.0005	0.006	0.006	0.003	−0.001	−0.009
	(0.007)	(0.008)	(0.007)	(0.005)	(0.005)	(0.006)	(0.009)	(0.008)
Observations	155	155	155	155	155	155	155	155
R^2	0.188	0.103	0.089	0.050	0.023	0.016	0.027	0.105
Adjusted R^2	0.167	0.079	0.065	0.024	-0.003	-0.010	0.001	0.081

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.20: Δ Forward Rates, two days difference

	Dependent variable:							
	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year	1 Year Forward 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Economic aggregated	3.677	7.807**	5.547*	1.866	−0.374	−1.639	−2.518	7.624**
	(2.328)	(3.751)	(2.903)	(1.552)	(1.795)	(2.891)	(3.793)	(3.671)
Fed news	2.550	−1.084	1.776	4.380	2.342	−2.250	−6.896	−0.812
	(2.739)	(3.106)	(3.573)	(3.441)	(4.022)	(4.849)	(6.737)	(3.015)
Fed news on FG dates	−4.832	−0.629	−0.756	−3.098	−0.735	5.593	13.036	−1.162
	(3.139)	(4.175)	(3.913)	(4.025)	(5.146)	(6.480)	(8.800)	(4.106)
PCA_ffr4_hf	0.513***	0.280*	0.068	0.009	−0.065	−0.187	−0.339	0.325*
	(0.181)	(0.161)	(0.167)	(0.142)	(0.126)	(0.250)	(0.424)	(0.169)
Constant	−0.007	−0.017	−0.011	−0.003	0.003	0.007	0.012	−0.017
	(0.010)	(0.012)	(0.010)	(0.009)	(0.009)	(0.012)	(0.018)	(0.012)
Observations	155	155	155	155	155	155	155	155
R^2	0.162	0.113	0.095	0.055	0.008	0.021	0.042	0.116
Adjusted R^2	0.140	0.089	0.071	0.030	-0.018	-0.005	0.017	0.092

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.21: Δ TIPS Yields, one day difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔEconomic aggregated	7.996**	7.076**	6.214**	5.435**	7.476**	5.147*	3.869**	2.173**
	(3.289)	(3.223)	(2.759)	(2.250)	(3.622)	(2.664)	(1.617)	(1.071)
ΔFed news	−5.656	−4.372	−3.051	−1.752	−5.029	−1.652	0.906	3.216
	(4.840)	(3.760)	(3.119)	(2.608)	(3.896)	(2.896)	(2.160)	(3.292)
Δ Fed news on FG dates	−0.274	0.004	−0.416	−1.370	0.397	−0.084	−2.727	−5.562
	(5.324)	(4.126)	(3.463)	(2.981)	(4.289)	(3.200)	(2.624)	(3.625)
PCA_ffr4_hf	−0.041	−0.092	−0.100	−0.100	−0.129	−0.137	−0.103	−0.098
	(0.330)	(0.289)	(0.251)	(0.220)	(0.330)	(0.220)	(0.160)	(0.126)
Constant	−0.006	−0.005	−0.004	−0.004	−0.005	−0.003	−0.004	−0.0001
	(0.012)	(0.010)	(0.009)	(0.008)	(0.012)	(0.008)	(0.007)	(0.006)
Observations	104	104	104	104	104	104	104	104
R^2	0.149	0.161	0.169	0.174	0.148	0.134	0.138	0.107
Adjusted R^2	0.115	0.127	0.136	0.140	0.114	0.099	0.103	0.071

Note: *p<0.1; **p<0.05; ***p<0.01

Table F.22: Δ TIPS Yields, two days difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EC	7.996**	7.076**	6.214**	5.435**	7.476**	5.147*	3.869**	2.173**
	(3.289)	(3.223)	(2.759)	(2.250)	(3.622)	(2.664)	(1.617)	(1.071)
X7	−5.656	−4.372	−3.051	−1.752	−5.029	−1.652	0.906	3.216
	(4.840)	(3.760)	(3.119)	(2.608)	(3.896)	(2.896)	(2.160)	(3.292)
FG	−0.274	0.004	−0.416	−1.370	0.397	−0.084	−2.727	−5.562
	(5.324)	(4.126)	(3.463)	(2.981)	(4.289)	(3.200)	(2.624)	(3.625)
pc1ff1_hf	−0.041	−0.092	−0.100	−0.100	−0.129	−0.137	−0.103	−0.098
	(0.330)	(0.289)	(0.251)	(0.220)	(0.330)	(0.220)	(0.160)	(0.126)
Constant	−0.006	−0.005	−0.004	−0.004	−0.005	−0.003	−0.004	−0.0001
	(0.012)	(0.010)	(0.009)	(0.008)	(0.012)	(0.008)	(0.007)	(0.006)
Observations	104	104	104	104	104	104	104	104
R^2	0.149	0.161	0.169	0.174	0.148	0.134	0.138	0.107
Adjusted R^2	0.115	0.127	0.136	0.140	0.114	0.099	0.103	0.071

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.23: Δ Inflation Compensation, one day difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
Δ Economic aggregated	−4.198**	−2.277**	−0.871*	−1.020	−1.303
	(1.740)	(0.985)	(0.501)	(0.749)	(0.924)
ΔFed news	6.007*	5.345**	2.942**	2.526*	2.174
	(3.073)	(2.329)	(1.190)	(1.293)	(1.600)
Δ Fed news on FG date	−1.977	−2.509	−1.736	−1.446	−0.839
	(2.911)	(2.047)	(1.359)	(1.525)	(1.900)
PCA_ffr4_hf	−0.011	0.041	0.031	0.046	0.104
	(0.116)	(0.096)	(0.060)	(0.064)	(0.076)
Constant	0.010	0.007	0.005	0.008**	0.009**
	(0.008)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	104	104	104	104	104
R^2	0.127	0.153	0.062	0.052	0.071
Adjusted R^2	0.091	0.119	0.024	0.014	0.033
Note:			*p<0.1; **p<0.05; ***p<0.01		

Table F.24: Δ Inflation Compensation, two days difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
ΔEconomic aggregated	−4.198**	−2.277**	−0.871*	−1.020	−1.303
	(1.740)	(0.985)	(0.501)	(0.749)	(0.924)
ΔFed news	6.007*	5.345**	2.942**	2.526*	2.174
	(3.073)	(2.329)	(1.190)	(1.293)	(1.600)
ΔFed news on FG dates	−1.977	−2.509	−1.736	−1.446	−0.839
	(2.911)	(2.047)	(1.359)	(1.525)	(1.900)
PCA_ffr4_hf	−0.011	0.041	0.031	0.046	0.104
	(0.116)	(0.096)	(0.060)	(0.064)	(0.076)
Constant	0.010	0.007	0.005	0.008**	0.009**
	(0.008)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	104	104	104	104	104
R^2	0.127	0.153	0.062	0.052	0.071
Adjusted R^2	0.091	0.119	0.024	0.014	0.033

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

F.3 On measurement error and bad controls

Table F.25: Δ Yields, one day difference

	Dependent variable:							
	1 Year	2 Year	5 Year	10 Year	15 Year	20 Year	25 Year	30 Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PCA_ffr4_hf	0.461***	0.460***	0.335***	0.172**	0.090	0.045	0.017	−0.005
	(0.099)	(0.109)	(0.105)	(0.085)	(0.075)	(0.068)	(0.061)	(0.057)
Constant	−0.009***	−0.007	−0.007	−0.006	−0.003	−0.0002	0.001	0.001
	(0.003)	(0.005)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Observations	155	155	155	155	155	155	155	155
R^2	0.350	0.254	0.101	0.030	0.011	0.003	0.001	0.00005
Adjusted R^2	0.346	0.249	0.095	0.024	0.005	-0.003	-0.006	-0.006

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.26: Δ TIPS Yields, one day difference

	Dependent variable:							
	5 Year	10 Year	15 Year	20 Year	5 Year F	10 Year F	15 Year F	20 Year F
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PCA_ffr4_hf	−0.085	−0.127	−0.133	−0.135	−0.163	−0.159	−0.138	−0.146
	(0.349)	(0.305)	(0.264)	(0.231)	(0.344)	(0.228)	(0.170)	(0.135)
Constant	−0.005	−0.004	−0.003	−0.003	−0.004	−0.002	−0.003	0.001
	(0.013)	(0.011)	(0.009)	(0.008)	(0.011)	(0.008)	(0.006)	(0.006)
Observations	104	104	104	104	104	104	104	104
R^2	0.002	0.007	0.010	0.013	0.009	0.014	0.016	0.020
Adjusted R^2	-0.008	-0.003	0.0001	0.003	-0.001	0.005	0.006	0.010

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.27: Δ Inflation Compensation, one day difference

	Dependent variable:				
	2 Year	5 Year	10 Year	15 Year	20 Year
	(1)	(2)	(3)	(4)	(5)
PCA_ffr4_hf	0.001	0.039	0.025	0.043	0.106
	(0.130)	(0.106)	(0.065)	(0.065)	(0.074)
Constant	0.009	0.007	0.005	0.008**	0.009**
	(0.008)	(0.005)	(0.004)	(0.004)	(0.004)
Observations	104	104	104	104	104
R^2	0.00000	0.003	0.002	0.006	0.030
Adjusted R^2	-0.010	-0.006	-0.008	-0.004	0.020

Note: HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01

Table F.28: Δ Yields, one day difference

	Dependent variable:	
	1 Year	high frequency surprises
	(1)	(2)
PCA_ffr4_hf	0.481***	
	(0.137)	
PCA_S&P500_hf	0.002	
	(0.011)	
ff4_hf	−0.021	
	(0.268)	
Economic aggregated		−1.655
		(1.485)
Fed news on FG dates		1.154
		(2.720)
Fed news		−0.085
		(2.877)
Constant	−0.009**	0.002
	(0.005)	(0.007)
Observations	155	155
R^2	0.350	0.017
Adjusted R^2	0.337	-0.003
Note:	HAC standard errors are in parentheses; *p<0.1; **p<0.05; ***p<0.01	

Appendix G. The Bayesian Vector Autoregression

I use Bayesian Vector Autoregression (BVAR) with an independent normal-inverted Wishart prior for the reduced form coefficients (see Koop & Korobilis (2010) for more details):

$$p(\beta, Q) = p(\beta)p(Q)$$

$$p(\beta) \sim f_N(\beta|\underline{\beta}, \underline{V_\beta})$$

$$p(Q) \sim f_{IW}(Q|\underline{Q}, \underline{v_Q})$$

For dealing with overfitting I entertain a prior in Minnesota fashion. Prior for β_m (3-month federal funds futures and S&P 500 surprises) is set to 0, other β at 1 for its own lags, and zero everywhere else. $\underline{V_\beta}$ is a diagonal matrix implying that the standard deviation of lag l of variable j in equation i is $\frac{\lambda_1 \lambda_2 \sigma_i}{\sigma_j l^{\lambda_3}}$ for $j \neq i$, $\frac{\lambda_1}{l^{\lambda_3}}$ for $j = i$ and $\lambda_4 \sigma_i$ for a constant. I use standard hyperparameters from the literature: $\lambda_1 = 0.2$, $\lambda_2 = 0.5$, $\lambda_3 = 1$, $\lambda_4 = 100$. σ_i, σ_j are scaled measures of the variance associated with the AR(p) equation estimate. $\underline{Q}$ is a diagonal matrix. Lastly, I set $\underline{v_Q} = 10$. Based on the priors the conditional posterior for β is:

$$\beta|y, Q^{-1} \sim N(\overline{\beta}, \overline{V_b})_{I_{s(\beta)}}$$

$$\overline{V_\beta} = (\underline{V_\beta}^{-1} + \sum_{t=1}^{T} X_t' Q^{-1} X_t)^{-1}$$

$$\overline{V_b} = \overline{V_\beta}(\underline{V_\beta}^{-1}\underline{\beta} + \sum_{t=1}^{T} X_t' Q^{-1} y_t)$$

$I_{s(\beta)}$ is an indicator function used to denote that the roots of β lie outside the unit circle.

The conditional posterior of Q is:

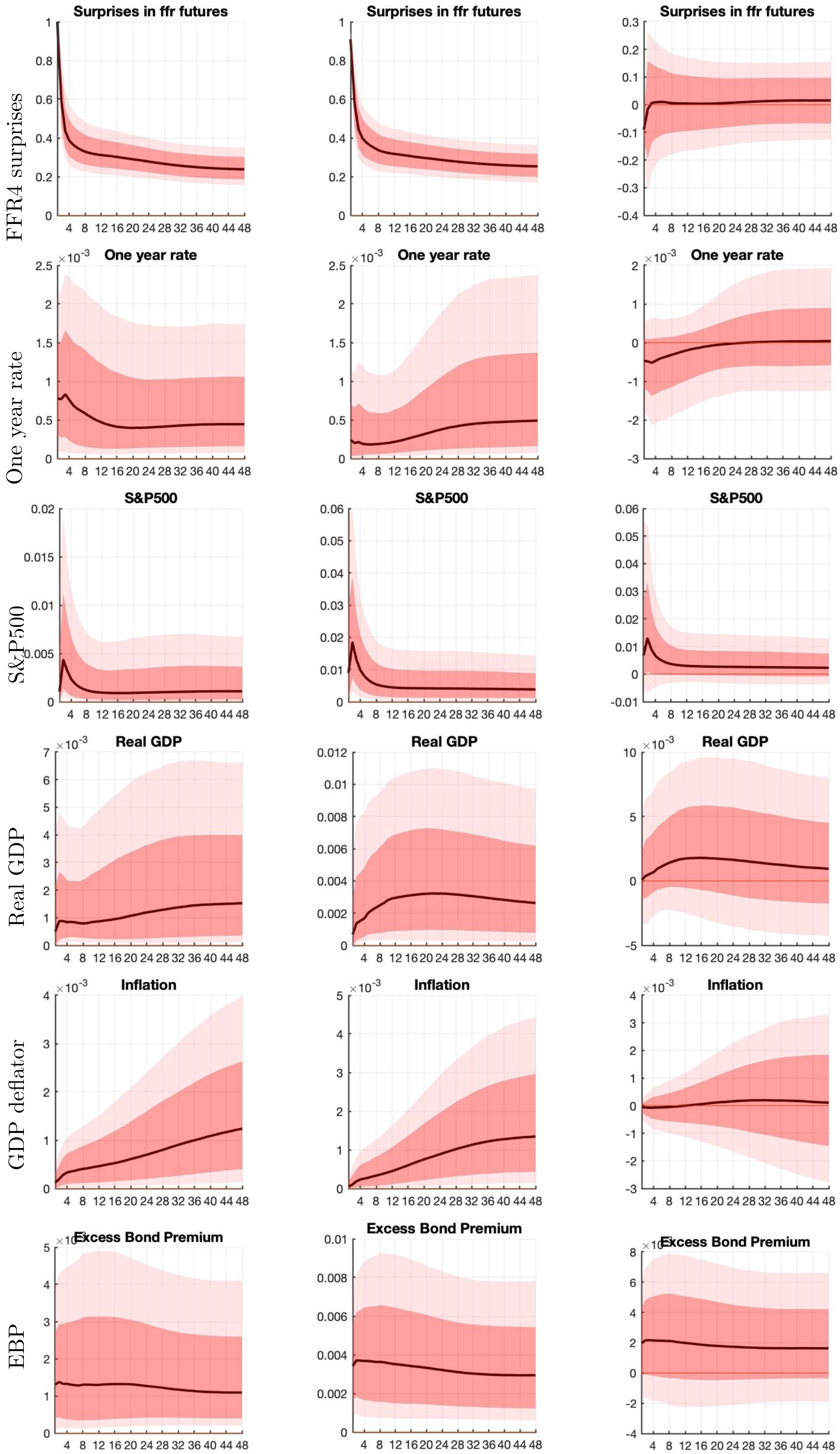
$$Q|y, \beta \sim IW(\overline{Q}, \overline{v_Q})$$

$$\overline{v_Q} = \underline{v_Q} + T$$

$$\overline{Q} = \underline{Q} + \sum_{t=1}^{T}(y_t - X_t'\beta)(y_t - X_t'\beta)'$$

12,000 Gibbs sampler draws were taken in total and 2,000 were discarded after burn-in. The SVAR has 12 lags. The sample is monthly, from March 1994 to December 2016.

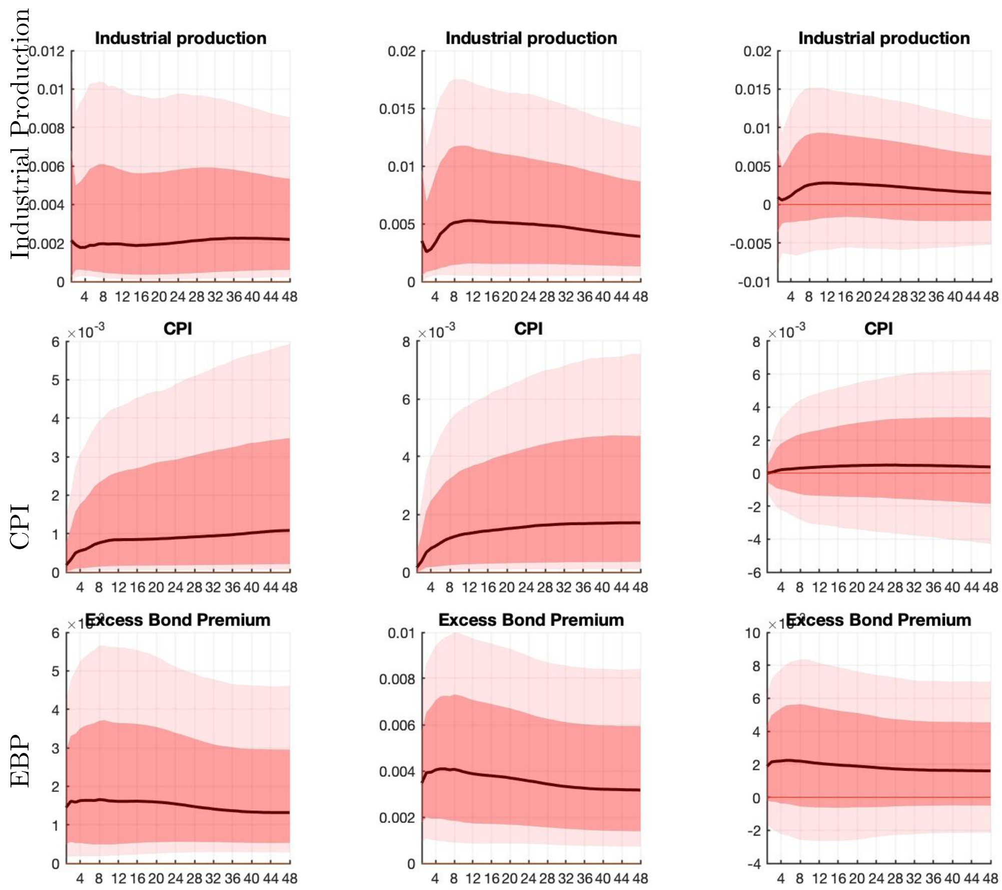
Appendix H. FEVD results



(a) Baseline (b) Policy shock (c) Difference

Figure H.1: Comparison between monetary policy and information shocks

shaded 5%,16%, 84% and 95% percentiles



(a) Baseline (b) Policy shock (c) Difference

Figure H.2: Comparison between monetary policy and information shocks. 3m federal funds futures shaded 5%,16%, 84% and 95% percentiles