ONLINE APPENDIX:
Monetary Communication Rules

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Contents

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A Summary Statistics

Table A.1 summarizes the policy and forecast variables. Observations are at the FOMC meeting frequency, which is eight times per year. The sample begins in May 1999 and continues through May 2022. First we will describe the policy variables and then the macroeconomic forecast variables.

Table A.1: Summary Statistics for Policy and Macro Variables

	Count	Mean	Stdv	Min	Median	Max
Target FFR	184.0	1.74	1.95	0.12	1.00	6.50
Change in Target FFR	184.0	0.00	0.19	-0.88	0.00	0.50
Target FFR Next Year	176.0	1.58	1.83	0.12	1.00	6.50
Shadow Rate	182.0	1.21	2.45	-2.89	1.02	6.65
Treasury 10Y less FFR	184.0	1.55	1.21	-1.14	1.63	3.80
Fed Total Assets	154.0	3226.43	2181.88	712.81	2892.72	8937.14
RGDP Growth Next Quarter	150.0	2.56	1.46	-5.00	2.50	5.40
Inflation (CPI) Next Quarter	150.0	1.85	1.15	-3.20	1.80	7.60
Core Inflation (CPI) Next Quarter	150.0	2.03	0.47	0.70	2.00	2.90
Unemployment Next Quarter	150.0	6.11	1.78	3.80	5.50	10.10
RGDP Growth Next Year	150.0	3.12	0.88	0.70	3.15	5.30
Inflation (CPI) Next Year	150.0	1.79	0.43	0.90	1.85	2.60
Core Inflation (CPI) Next Year	150.0	1.96	0.50	0.80	2.00	3.00
Unemployment Next Year	150.0	6.00	1.65	3.60	5.40	9.90

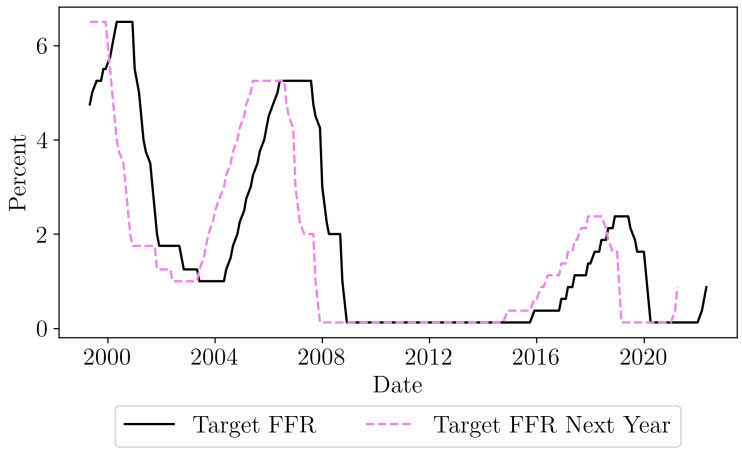
The target federal funds rate is the midpoint of the target rate when a range is stated as policy. The Target Rate, Next Year is the realized target federal funds rate one year in the future. This acts as a proxy measure for communication about forward guidance. Figure A.1 shows the current and shifted target federal funds rate. The Shadow Rate is as constructed by Wu and Xia (2020). The 10-year Treasury less the federal funds rate captures longer interest rates. The Fed's total assets are in billions of dollars.

The macroeconomic forecast variables are from the Tealbooks Data Set from the Federal Reserve Bank of Philadelphia. Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points. Inflation is measured as the quarter-over-quarter growth in headline CPI in annualized percentage points. Similarly, core inflation is measured as quarter-over-quarter growth in core CPI in annualized percentage points. The unemployment rate is measured in percentage points. The next quarter forecasts are the Federal Reserve forecasts for next quarter and the next year forecasts are the forecasts for four quarters into the future. The annualized quarter-over-quarter growth for a variable X in quarter t is:

$$G_t = 100 \times \left[\left(\frac{X_t}{X_{t-1}} \right)^4 - 1 \right]$$

There are new forecasts at each meeting for the macroeconomic variables even if two FOMC meetings are in the same quarter. For more information on the Tealbooks Data Set, please reference the Philadelphia Fed's documentation.

Figure A.1: Target FFR vs. Next Year



B Text Representation: Bag-of-Words and N-Grams

This section describes our process for converting text to a numerical representation. At a high level, we use a bag-of-words model with n-grams. Bag-of-words models are text representation models that rely on counting the frequency of words or tokens in text. In our case, we are using n-grams – sequences of "n" words in a row – as tokens. This model abstracts from the order between tokens; only focusing on how often they occur. In this framework, we create a data frame where the rows are different documents and the columns are different tokens from the vocabulary – the set of tokens used across documents in our sample. Then elements inside the data frame are the frequency of a token used in a particular document. This then provides us a meeting-level, quantitative measure of the FOMC statement text. The remainder of this section will walk through our text processing in more detail.

First, we perform a variety of cleaning tasks on the raw strings of the FOMC statements. We implement lemmatization using the default package from the Python library `spacy`. Lemmatization is the process of converting words to their root. This allows us to abstract from slight variations in word spelling due to grammatical structure. For example, it would make "meet" and "meeting" count as the same. This standardization of wording is important for token counting approaches to generate a smaller vocabulary and higher frequencies for the words.

Second, we merge together words that represent single concepts in FOMC statements but are multiple words. For example, we merge "federal open market committee" into "fomc" and "funds rate" into "funds_rate". Table B.2 shows all the merged words. This process, also known as "entity encoding," allows us to include more information into each quadgram that references one of these concepts.

Third, we remove stopwords, numbers, and punctuation from the FOMC text. Stopwords refer to words that are very common and are not helpful in telling the difference between

Table B.2: Entity Encoding

Encoding	Wording
fomc	federal open market committee
fedres	federal reserve
funds_rate	funds rate
bp	basis point, basis points
long_run	long run, long term
medium_run	medium run, medium term
short_run	short run, short term
near_run	near run, near term
mb_securities	mortgage backed securities, mortgage back securities
monetary_policy	monetary policy

texts. For example, words like "a" or "the" can dilute the information content in the text and thus we drop such words. Table B.3 lists the stopwords we remove from the FOMC statements. After removing stopwords, we also remove numbers and punctuation.[1] The numbers almost exclusively refer to the target federal funds rate or the Fed's asset purchasing plan.

After this cleaning, we create our n-grams. In the baseline specification we work with quadgrams or 4-grams which are sequences of four words in a row. Table B.4 shows the FOMC statement from May 1999 going from its original form, through cleaning, and to quadgrams. In Appendix C, we show that the fixed communication rules looks similar for trigrams/3-grams and quintgrams/5-grams. We use quadgrams because they provide enough information within the token for us to verify that their correlation with outcome variables makes sense, but the sequence of words is short enough for there to be frequent uses across FOMC statements.

Finally, we drop quadgrams that occur in fewer than five percent of FOMC statements. This serves multiple functions. First, we are interested in systematic communication in this paper and therefore we want to focus on phrases that are used multiple times. Phrases

[1]Results are robust to keeping numbers in, but in our baseline we focus on textual information alone.

Table B.3: Stopwords

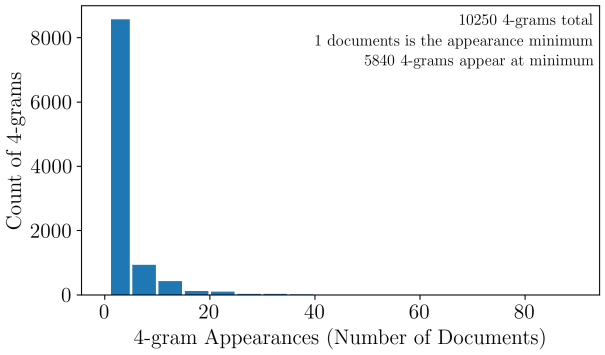
a	can	had	is	mustn't	then	who
about	committee	hadn	isn	my	there	whom
ain	committees	hadn't	isn't	myself	these	why
all	couldn	has	it	needn	they	will
am	couldn't	hasn	it's	needn't	this	with
an	d	hasn't	its	no	those	won
and	december	have	itself	nor	through	won't
any	did	haven	january	november	to	wouldn
april	didn	haven't	july	now	today	wouldn't
are	didn't	having	june	o	too	y
aren	do	he	just	october	ve	you
aren't	does	her	ll	of	very	you'd
as	doesn	here	m	on	was	you'll
at	doesn't	hers	ma	open	wasn	you're
august	doing	herself	march	or	wasn't	you've
be	don	him	market	other	we	your
because	don't	himself	may	our	were	yours
been	each	his	me	ours	weren	yourself
before	februrary	how	met	ourselves	weren't	yourselves
being	federal	i	mightn	out	what	
between	few	if	mightn't	own	when	
but	for	in	most	percent	where	
by	from	into	mustn	re	which	

Note: The stopwords are based on the list from the `NLTK` *package in Python. We have added some words specific to FOMC statements, such as the months of the year. We have also removed important words from the stopword lists such as "above", "below", and others that are useful for understanding FOMC statements.*

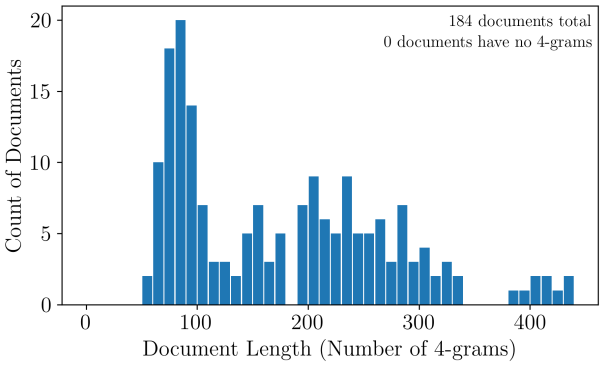
that are used only once or twice are likely referring to idiosyncratic factors that we think are likely not reflecting the systematic component of communication. Figure B.2 shows both the distribution of 4-gram occurrences and the distribution of document length as we vary the thresholds. With a threshold of zero, which means that we do not drop any quadgrams, we have almost 6000 quadgrams that just appear once. Including these in the ridge regressions would be like having a fixed effect for each FOMC meeting, which would allow us to mechanically fit everything in-sample. On the other side, with a threshold of 10 percent, there are seven FOMC meetings that have no quadgrams and thus effectively get dropped from the sample. We see the five percent threshold as an ideal middle ground.

Figure B.2: Comparison Across Thresholds

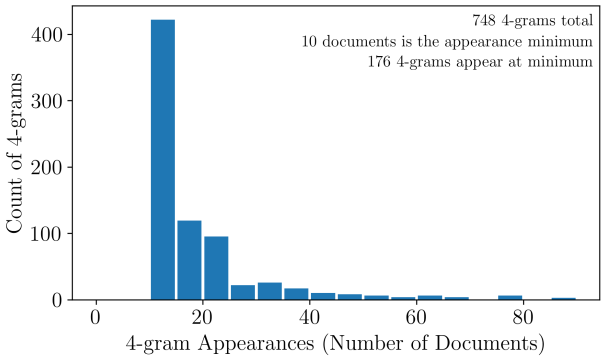
(a) Token Distribution, 0% Threshold



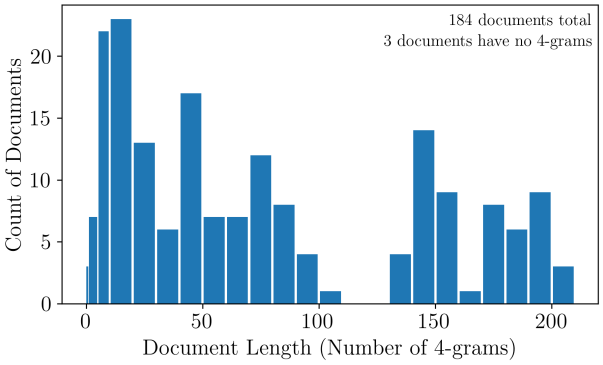
(b) Document Distribution, 0% Threshold



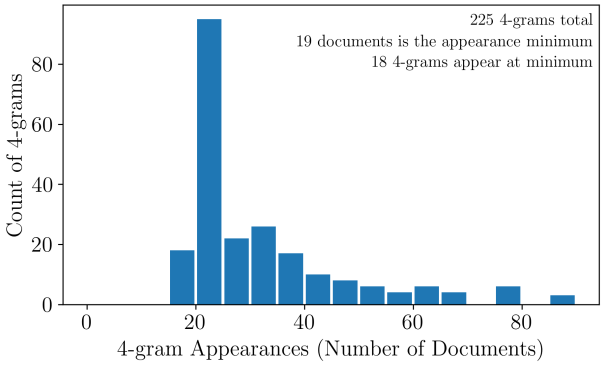
(c) Token Distribution, 5% Threshold



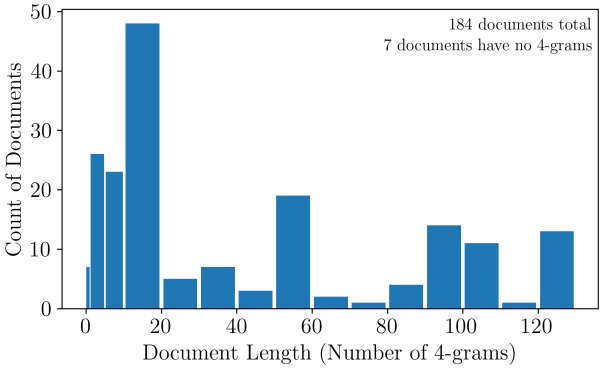
(d) Document Distribution, 5% Threshold



(e) Token Distribution, 10% Threshold



(f) Document Distribution, 10% Threshold



Note: Baseline model in the paper uses a threshold of 5%. All graphs use the baseline specification of 4-grams.

Table B.4: Example of Text Processing for May 1999 Statement

Original	"The Federal Reserve released the following statement after today's Federal Open Market Committee meeting: While the FOMC did not take action today to alter the stance of monetary policy, the Committee was concerned about the potential for a buildup of inflationary imbalances that could undermine the favorable performance of the economy and therefore adopted a directive that is tilted toward the possibility of a firming in the stance of monetary policy. Trend increases in costs and core prices have generally remained quite subdued. But domestic financial markets have recovered and foreign economic prospects have improved since the easing of monetary policy last fall. Against the background of already-tight domestic labor markets and ongoing strength in demand in excess of productivity gains, the Committee recognizes the need to be alert to developments over coming months that might indicate that financial conditions may no longer be consistent with containing inflation."
Cleaned	"fedres release follow statement after fomc meeting while fomc not take action alter stance monetary_policy concern potential buildup inflationary imbalance could undermine favorable performance economy therefore adopt directive tilt toward possibility firming stance monetary_policy trend increase cost core price generally remain quite subdued domestic financial recover foreign economic prospect improve since easing monetary_policy last fall against background already tight domestic labor ongoing strength demand excess productivity gain recognize need alert development over come month might indicate financial condition long consistent contain inflation"
Quadgrams	["fedres release follow statement", "release follow statement after", "follow statement after fomc", "statement after fomc meeting", ... , "condition long consistent contain", "long consistent contain inflation"]

Second, the threshold restricts the number of tokens we need to keep track of. As one increases the length of n-grams – going from 1-grams to 2-grams and up to 3-, 4-, and 5-grams – this will mechanically blow up the vocabulary size. Each individual *word* is counted multiple times because it is included in multiple n-grams. Table B.4 shows that the word "statement" occurs in four different quadgrams. Unadjusted, this increases the dimensionality of the analysis to a potentially intractable size. Using the threshold, we keep the sample size reasonable. Table B.5 shows that using a threshold of five percent keeps the number of n-grams around 700 to 800 tokens whether using bi-, tri-, quad-, or quint-grams.

Rather than work with raw counts, we use term-frequency-inverse-document-frequency

Table B.5: Comparison Across N-Grams

N-gram	(Baseline) 4	2	3	5
Threshold	0.05	0.05	0.05	0.05
Number of N-grams	748	817	795	695
Mimimum Appearance of N-gram	10	10	10	10
Number of Empty Documents	3	0	2	4

(TFIDF) weighted counts to measure the use of quadgrams. Term-frequency of a token is the number of times a token is used in a document divided by the total number of tokens in that document. It allows us to scale token use by the length of the text. Document-frequency is the number of documents that use a particular token across the corpus. Then, inverse-document-frequency is one divided by the document frequency. When applied to a single token, TFIDF scales the usage of the token by the length of the current document and by the prevalence of that token across the sample of documents. We use the `TFIDFVectorizer` from `sklearn`, also known as `scikit-learn`, which is collection of machine learning tools for Python. The TFIDF vectorizer in default uses some smoothing parameters to smooth out the token count representation. More precisely, it uses the following specification:

$$tfidf(j,t) = tf(j,t) \times idf(j) = \left[\frac{w_{j,t}}{W_t}\right] \times \left[\log\left(\frac{1+N}{1+df(j)}\right) + 1\right]$$

where j indexes the token, t indexes the FOMC statement, $w_{j,t}$ is the number of times token j occurs in statement t, W_t is the total number of tokens in statement t, and N is the total number of FOMC Statements. Then the TFIDF vectors are normalized by the Euclidean norm. Ultimately, the combination of techniques highlight the variation of word-use between statements while restricting to phrases that occur frequently enough for statistical power.

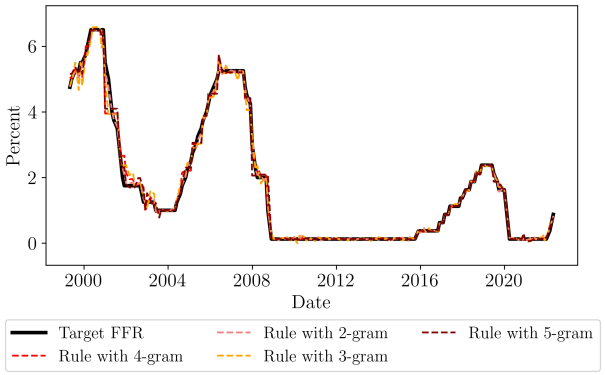
C Robustness for Text Representations

In this section, we estimate fixed communication rules under different parameter assumptions for the length of n-grams and the threshold for dropping infrequent tokens. Figure C.3, C.4 and C.5 plot the fitted values from communication rules for policy and macroeconomic forecast variables when we have different types of n-grams: 2-grams, 3-grams, 4-grams, and 5-grams. All plots have the same truncation threshold of five percent. The fitted values look almost identical across the different types of n-grams.

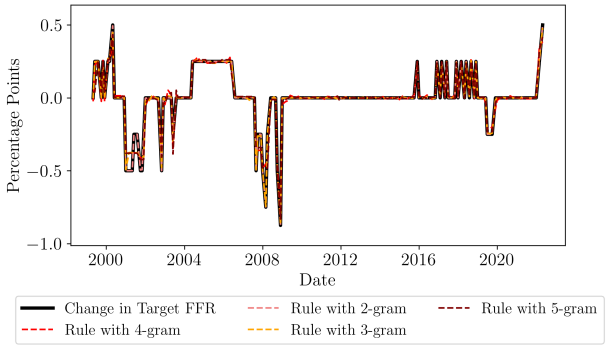
Figure C.6, C.7 and C.8 plot the fitted values from communication rules for policy and macroeconomic forecast variables when we have different truncation thresholds: 0, 5, and 10 percent. Here we focus on only 4-grams. A threshold of five percent of FOMC statements maps to a quadgram occurring in at least 10 statements, and a 10 percent threshold maps to at least 19 statements. Figure B.2 highlights how the different thresholds change the measured text. From the plots of the fitted values, we see very similarly close fits to the data. However, there is more noise in the 10 percent threshold during the early years in the sample due to multiple Greenspan FOMC statements having very few to no quadgrams for estimation. Another difference comes from the 0 percent threshold: there is a perfect fit for the next-quarter inflation forecast. This is driven by the fact that there are almost 6000 quadgrams that occur in only one statement which act as a fixed effect for each observation.

Figure C.3: N-Gram Comparison of Fixed Rules for Policy

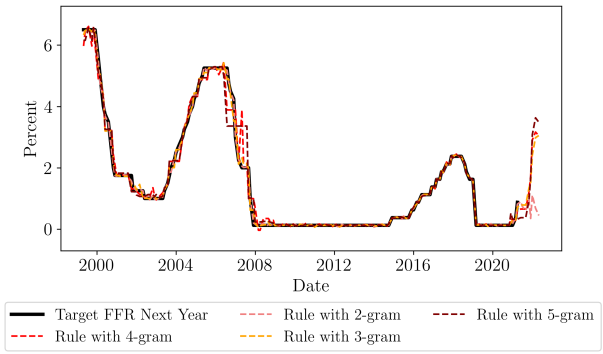
(a) Target Federal Funds Rate



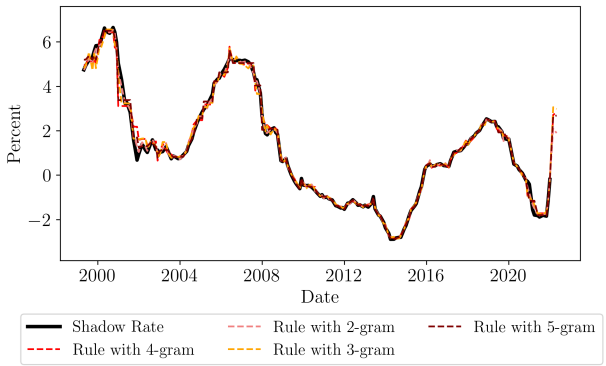
(b) Change in Target Rate



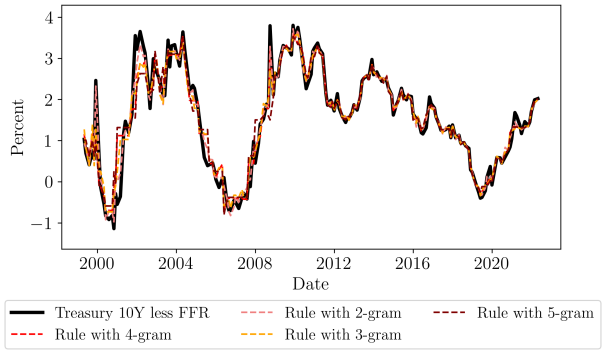
(c) Target Rate Next Year



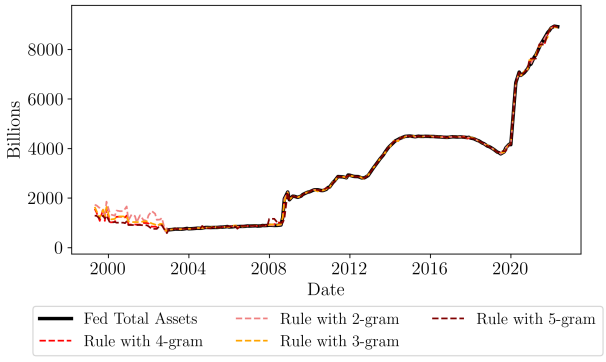
(d) Shadow Rate



(e) 10 Year Treasury Less FFR



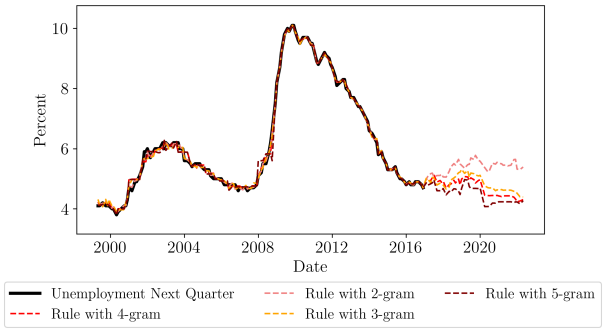
(f) Federal Reserve Total Assets



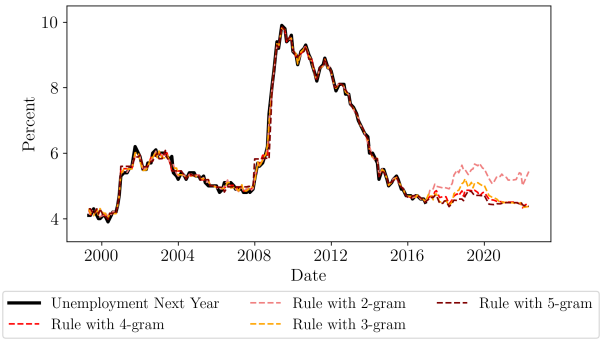
Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual policy variable.

Figure C.4: N-Gram Comparison of Fixed Rules for Real Macroeconomic Forecasts

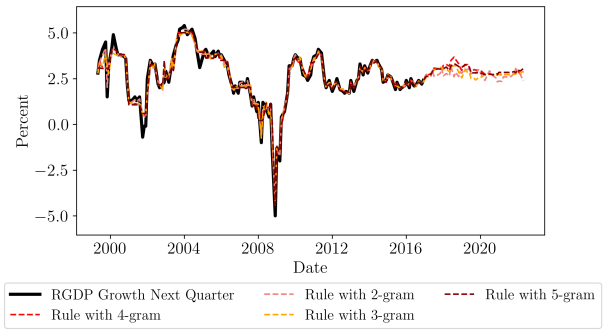
(a) Unemployment, Next Quarter



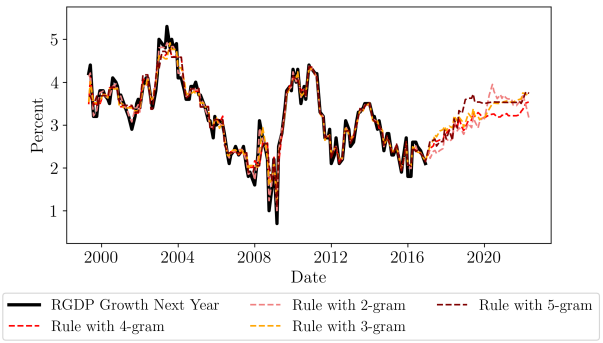
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



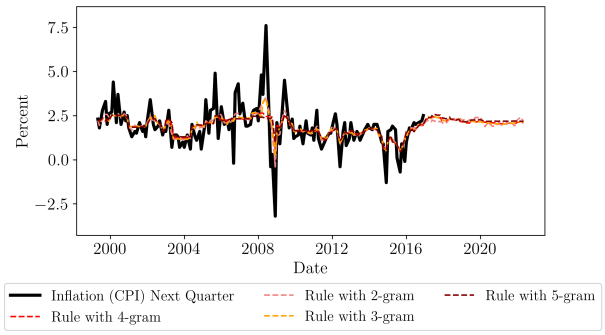
(d) Real GDP Growth, Next Year



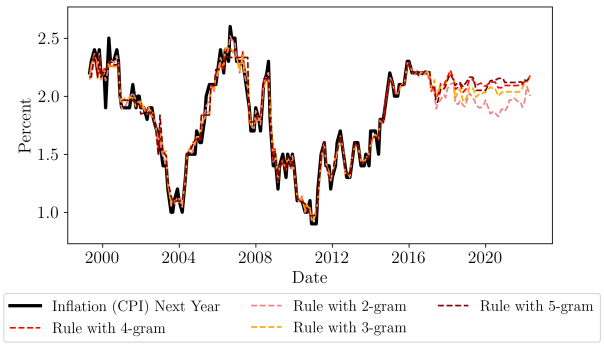
Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual macroeconomic forecast variable.

Figure C.5: N-Gram Comparison of Fixed Rules for Nominal Macroeconomic Forecasts

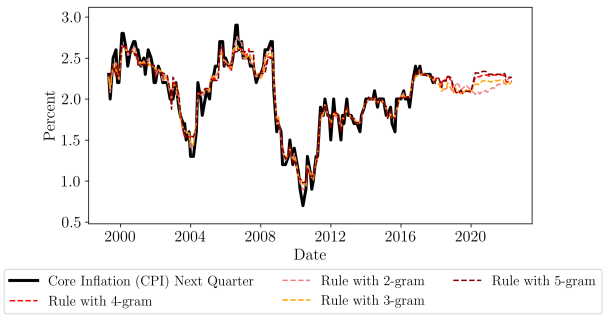
(a) Inflation, Next Quarter



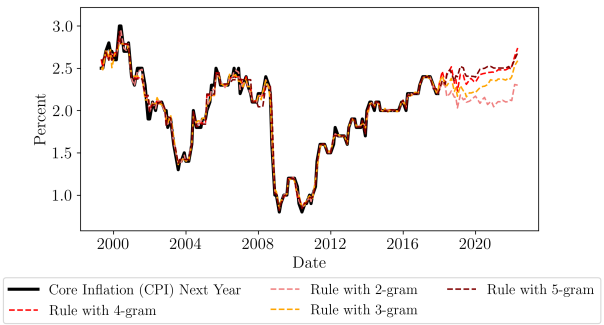
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



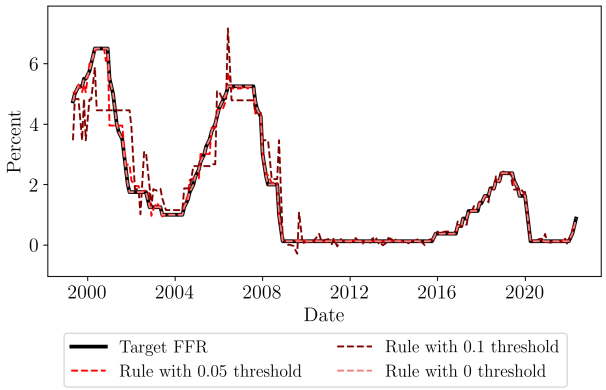
(d) Core Inflation, Next Year



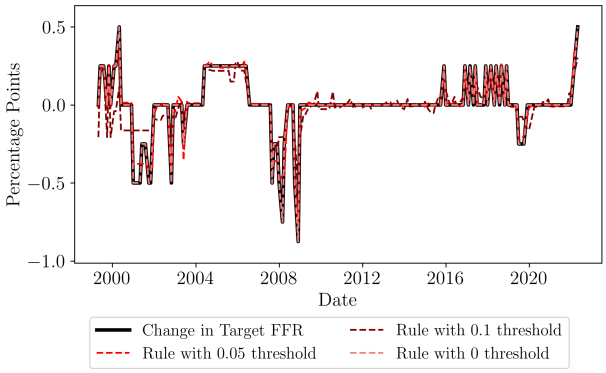
Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual macroeconomic forecast variable.

Figure C.6: Threshold Comparison of Fixed Rules for Policy

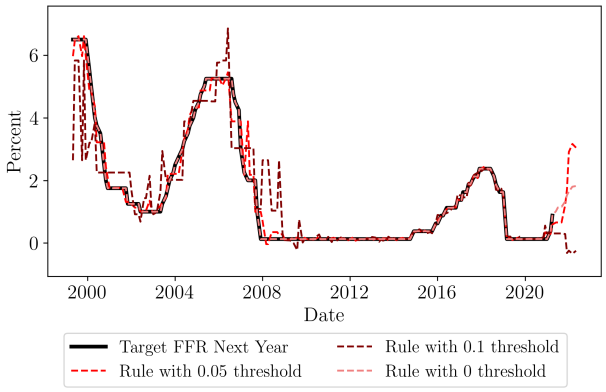
(a) Target Federal Funds Rate



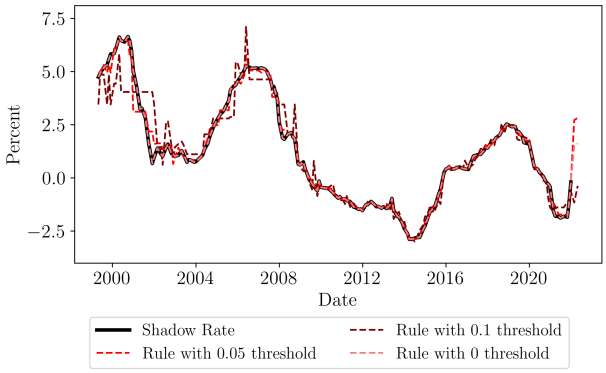
(b) Change in Target Rate



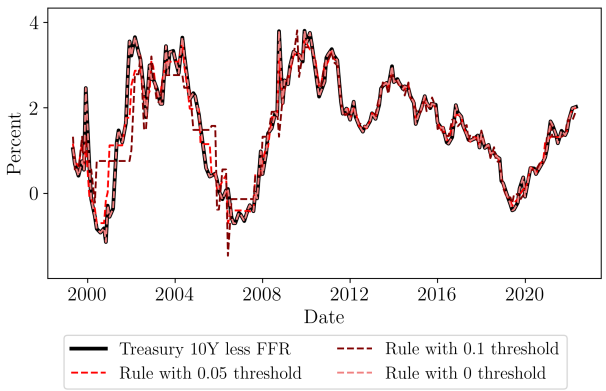
(c) Target Rate Next Year



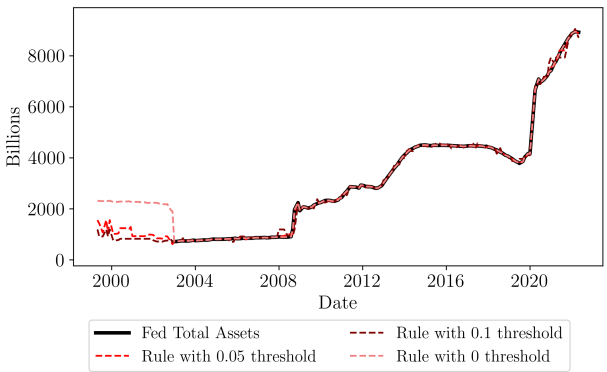
(d) Shadow Rate



(e) 10 Year Treasury Less FFR

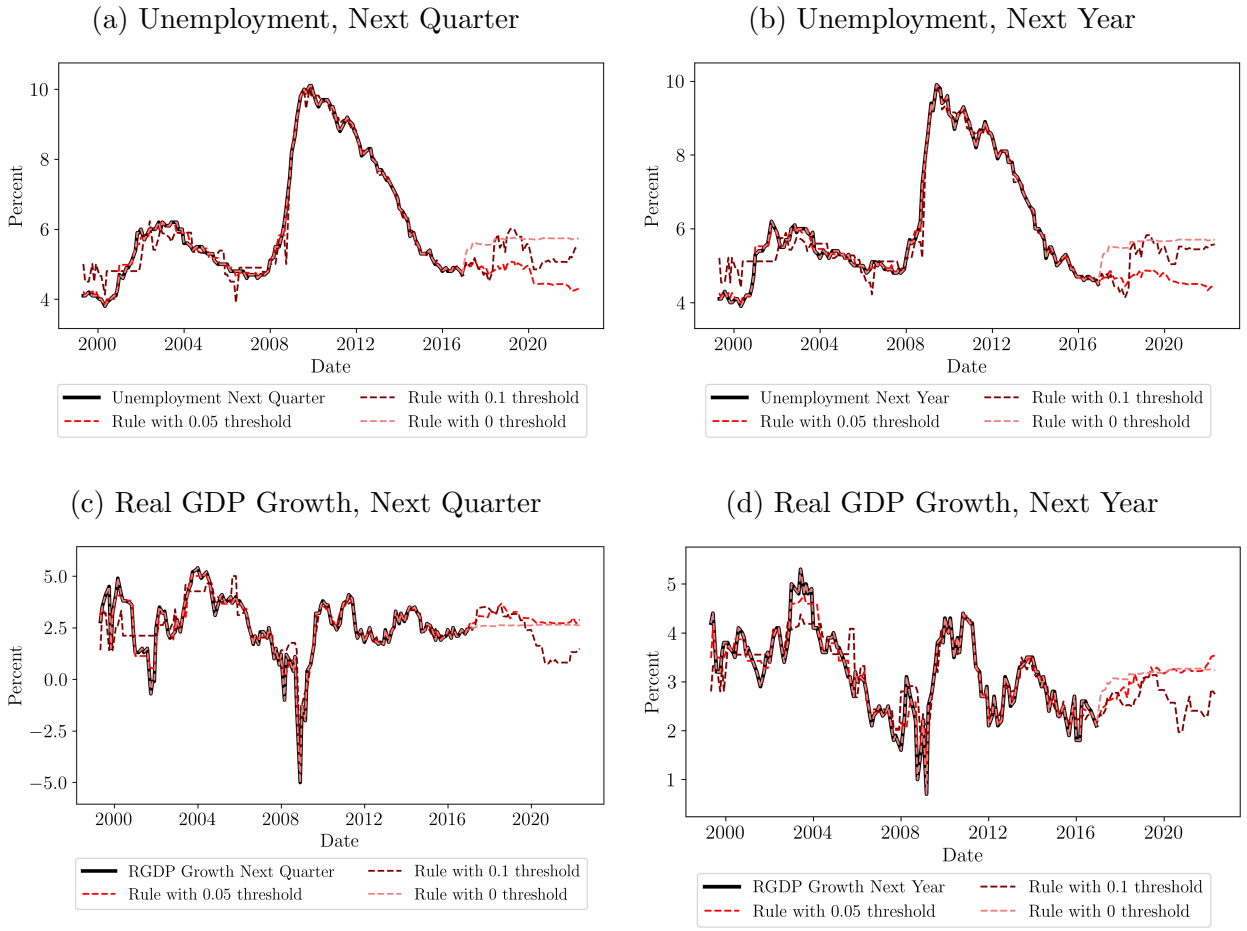


(f) Federal Reserve Total Assets



Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual policy variable.

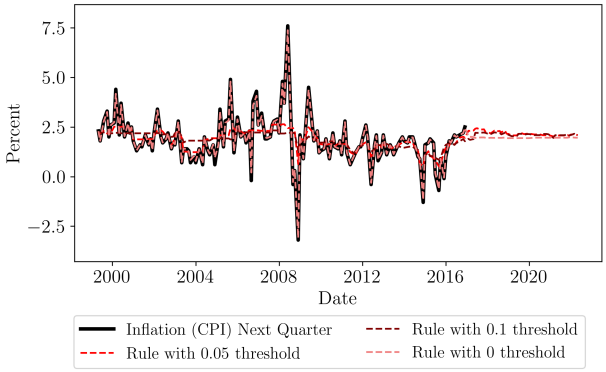
Figure C.7: Threshold Comparison of Fixed Rules for Real Macroeconomic Forecasts



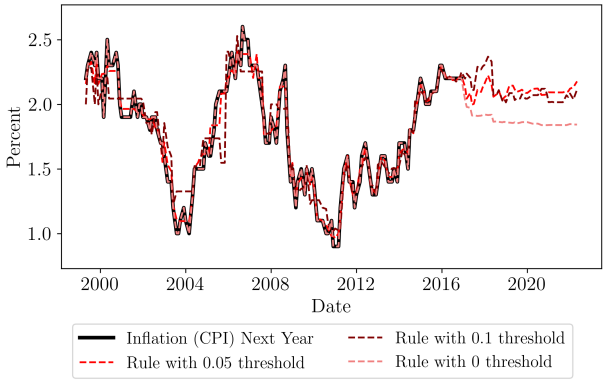
Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual macroeconomic forecast variable.

Figure C.8: Threshold Comparison of Fixed Rules for Nominal Macroeconomic Forecasts

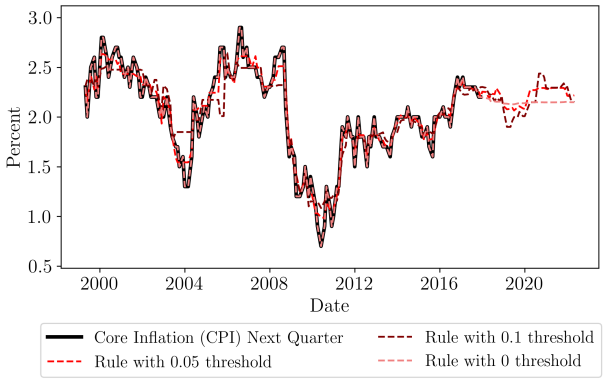
(a) Inflation, Next Quarter



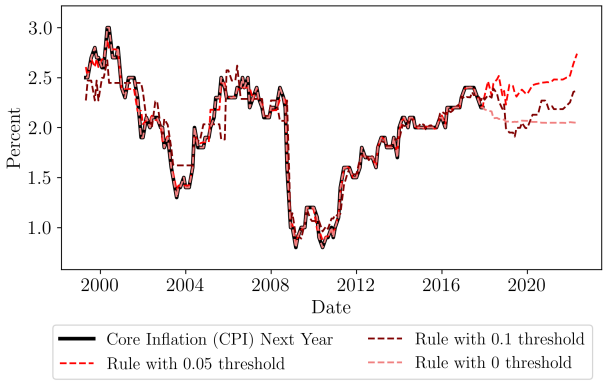
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



(d) Core Inflation, Next Year



Note: Each dashed line represents the fitted values from fixed communication rules estimated when text is measured using either 2-grams, 3-grams, 4-grams (baseline), or 5-grams. The black line is the actual macroeconomic forecast variable.

D Optimal Penalty Parameter Selection Procedure

D.1 Baseline Cross Validation Results

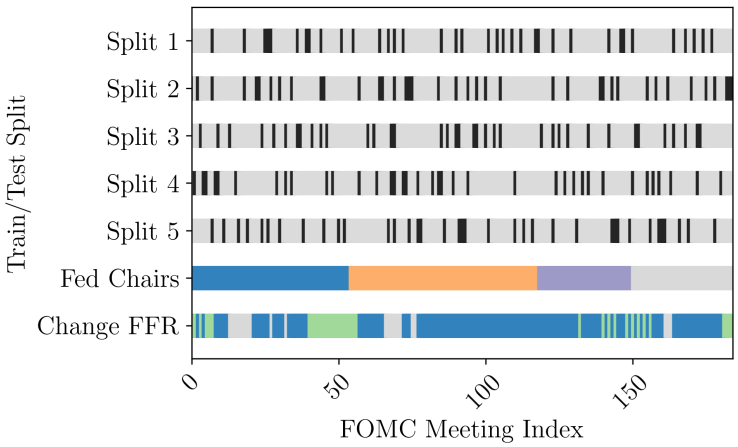
In this section we detail the selection of the optimal penalty parameter, α. We implement a K-fold cross validation technique. This involves splitting data into training subsets that estimate coefficients β_j given a value for α and then evaluating that model "out-of-sample" on a testing subset of the data. Then we vary the α parameter to find the α^* that produces the lowest out-of-sample error. We repeat this on five different versions of splitting the data into training and testing samples.

In particular, we split the data into five different folds using a stratified approach. That is, we split the data into five different groups such that there are a similar number of observations under each Fed chair and with changes to the target rate. Then we have five different versions of training/testing data such that each of the folds or splits is used as the testing set once. When a fold of the data is not used for testing, it is one of the four that are used for training, that is, for estimating the regression coefficients. Figure D.9 shows the five different train/test splits of the data and how they correspond to the Fed chair and policy changes.

Figure D.10 and D.11 provide graphs of the mean squared error (MSE) for different variables and different splits. The horizontal axis represents different values of the penalty parameter α. Each colored dot is the mean squared error on the testing set given the value of α specified by the horizontal axis. The different colors represent different train-test splits. Thus, there are five colors. The solid black line is the average MSE across the different folds. The optimal α is the one that produces the the lowest MSE on average. The optimal α is specific to the output variable. Graphically, we indicate this with the vertical dashed line.

In Table D.6, the R^2 and mean square error (MSE) are reported to compare the similarity between what is predicted from the model with the "best" penalty parameter for that set of training/testing data and the actual value for the output variable for the corresponding row.

Figure D.9: Stratified Cross Validation Sets



Note: For each split of the data, the black lines represent observations in the testing set and the light gray represents the remaining observations in the training set. The row labeled Fed Chairs switches colors when the Fed chair switches from Greenspan (blue), to Bernanke (orange), to Yellen (purple), and to Powell (gray). The final row, Change FFR, shows when the target policy rate increases (green), decreases (gray), or remains the same (blue).

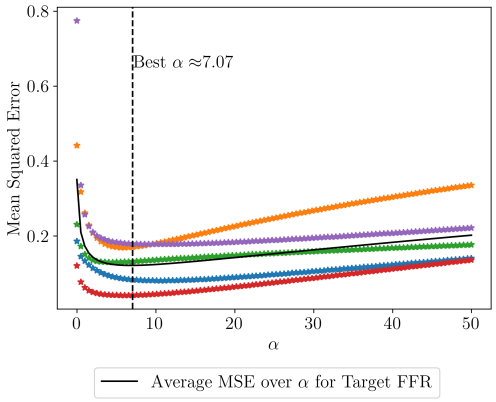
Here "best" is determined by the lowest MSE on the testing set. The in-sample fit (accuracy on training set) is better than the out-of-sample fit (accuracy on the testing set) for all of the splits. The final columns of the table report the average training R^2 and MSE against the average testing values. Note that across all splits, the accuracy values for one-quarter-ahead headline inflation are much worse than the other variables. This translates into the paper where we conclude the fixed communication rule for short-run headline inflation is a poor fit.

D.2 Robustness for Cross Validation

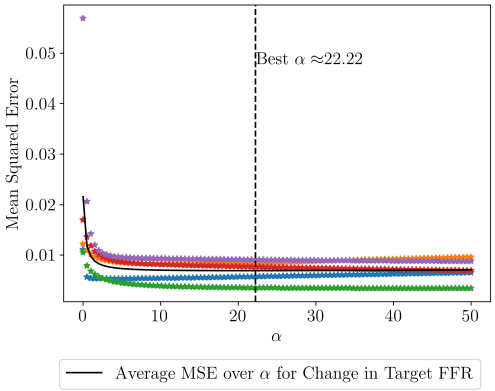
The splits for the five different training/testing samples for the baseline analysis uses a stratified approach. Again, this is where we randomly assign observations to one of five subsets in the data, but restrict the assignment such that there is a similar representation of the data in each set. For example, we want a similar number of statements written under Bernanke's tenure where the federal funds rate target increased in each subset (or fold) of

Figure D.10: Penalty Parameter Selection for Fixed Communication Rules (Policy)

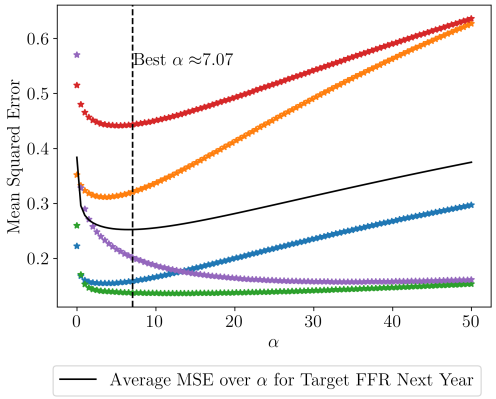
(a) Target Rate



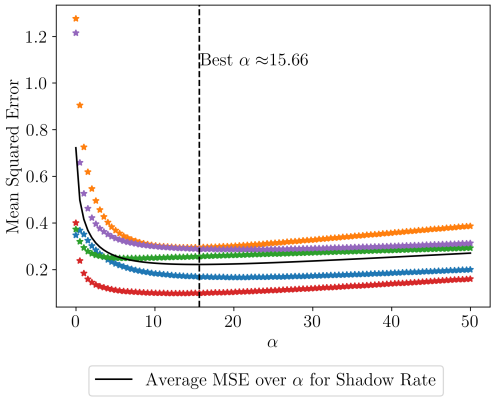
(b) Change in Target Rate



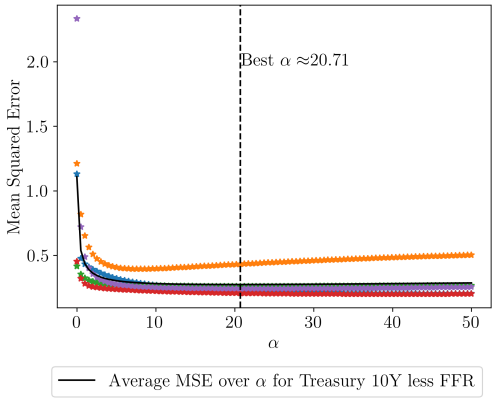
(c) Target Rate Next Year



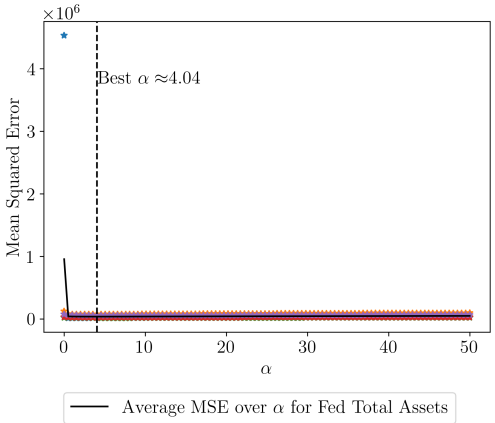
(d) Shadow Rate



(e) 10Y Treasury - FFR



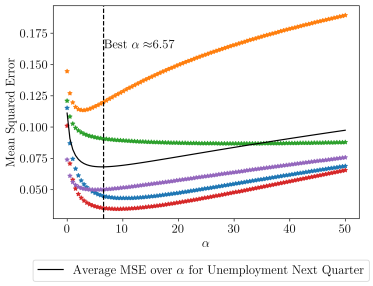
(f) Fed Total Assets



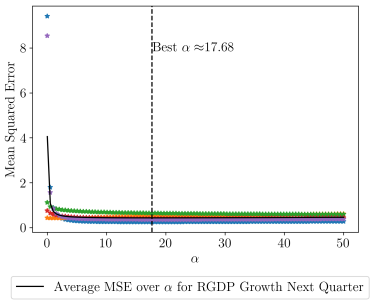
Note: α is the penalty parameter. Different colored lines represent out-of-sample MSE for different train/test splits. The solid black line is the average MSE across the different splits.

Figure D.11: Penalty Parameter Selection for Fixed Communication Rules (Forecasts)

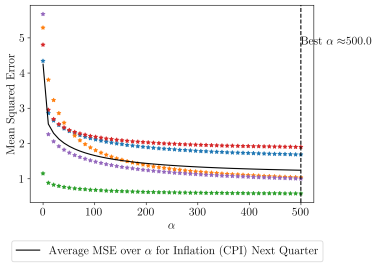
(a) Unemployment, Next Qtr.



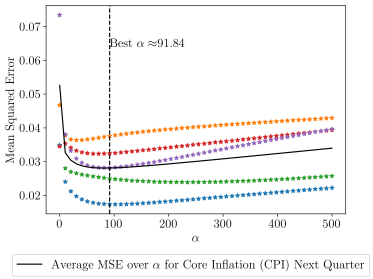
(b) RGDP, Next Quarter



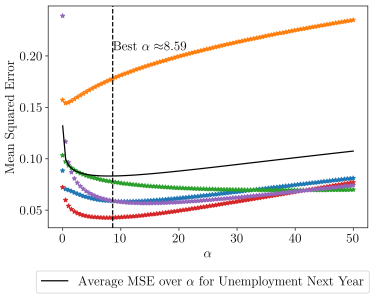
(c) Inflation, Next Quarter



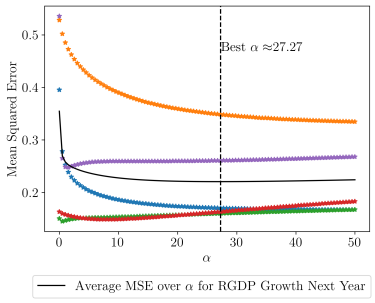
(d) Core Infl., Next Quarter



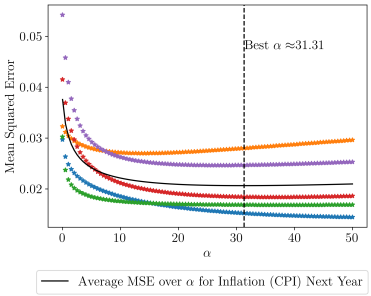
(e) Unemp., Next Year



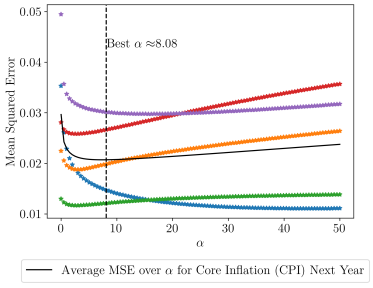
(f) RGDP, Next Year



(g) Inflation, Next Year



(h) Core Inflation, Next Year



Note: α is the penalty parameter. Different colored lines represent out-of-sample MSE for different train/test splits. The solid black line is the average MSE across the different splits.

Table D.6: Accuracy for All Splits with Stratified Cross Validation

		Split 0		Split 1		Split 2		Split 3		Split 4		Average	
	Metric	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Target FFR	R^2	0.988	0.973	0.988	0.948	0.991	0.962	0.986	0.99	0.988	0.941	0.988	0.963
	MSE	0.05	0.08	0.05	0.17	0.03	0.13	0.05	0.04	0.05	0.18	0.05	0.12
Change in Target FFR	R^2	0.932	0.852	0.929	0.826	0.936	0.877	0.936	0.733	0.937	0.732	0.934	0.804
	MSE	0.0	0.01	0.0	0.01	0.0	0.0	0.0	0.01	0.0	0.01	0.0	0.01
Target FFR Next Year	R^2	0.972	0.947	0.977	0.906	0.975	0.948	0.987	0.89	0.974	0.908	0.977	0.92
	MSE	0.1	0.16	0.08	0.32	0.09	0.14	0.04	0.44	0.09	0.2	0.08	0.25
Shadow Rate	R^2	0.984	0.969	0.984	0.944	0.987	0.956	0.982	0.983	0.985	0.941	0.984	0.958
	MSE	0.1	0.17	0.1	0.3	0.07	0.26	0.1	0.1	0.1	0.29	0.09	0.22
Treasury 10Y less FFR	R^2	0.918	0.806	0.912	0.705	0.926	0.824	0.923	0.858	0.916	0.841	0.919	0.807
	MSE	0.13	0.23	0.13	0.43	0.11	0.26	0.11	0.21	0.12	0.24	0.12	0.27
Fed Total Assets	R^2	1.0	0.997	1.0	0.987	1.0	0.996	1.0	0.994	1.0	0.985	1.0	0.992
	MSE	1117	15849	900	73995	1722	15232	1408	22719	1245	56273	1278	36814
RGDP Growth Next Quarter	R^2	0.931	0.84	0.938	0.723	0.956	0.548	0.937	0.767	0.921	0.859	0.937	0.747
	MSE	0.15	0.26	0.14	0.51	0.1	0.61	0.14	0.41	0.16	0.33	0.14	0.42
RGDP Growth Next Year	R^2	0.937	0.757	0.94	0.676	0.935	0.815	0.929	0.842	0.931	0.764	0.934	0.771
	MSE	0.05	0.16	0.04	0.32	0.05	0.16	0.05	0.16	0.05	0.24	0.05	0.21
Unemployment Next Quarter	R^2	0.997	0.985	0.997	0.962	0.996	0.983	0.996	0.991	0.997	0.984	0.997	0.981
	MSE	0.01	0.04	0.01	0.12	0.01	0.06	0.01	0.03	0.01	0.05	0.01	0.06
Unemployment Next Year	R^2	0.997	0.977	0.998	0.936	0.997	0.974	0.998	0.986	0.997	0.98	0.997	0.971
	MSE	0.01	0.06	0.01	0.17	0.01	0.07	0.01	0.04	0.01	0.06	0.01	0.08
Inflation (CPI) Next Quarter	R^2	0.42	0.035	0.443	-0.469	0.364	0.137	0.388	0.088	0.412	-0.179	0.406	-0.077
	MSE	0.72	1.53	0.82	0.97	0.94	0.56	0.67	1.9	0.85	0.9	0.8	1.17
Core Inflation (CPI) Next Quarter	R^2	0.937	0.901	0.947	0.779	0.939	0.872	0.941	0.865	0.934	0.894	0.94	0.862
	MSE	0.01	0.02	0.01	0.04	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.03
Inflation (CPI) Next Year	R^2	0.965	0.903	0.967	0.854	0.967	0.895	0.964	0.899	0.963	0.881	0.965	0.887
	MSE	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.02
Core Inflation (CPI) Next Year	R^2	0.986	0.926	0.985	0.91	0.985	0.947	0.984	0.916	0.982	0.91	0.984	0.922
	MSE	0.0	0.01	0.0	0.02	0.0	0.01	0.0	0.03	0.0	0.03	0.0	0.02

Note: Different train/test splits are generated using stratified approach (baseline). Values in the table are accuracy metrics with penalty parameter that returns the lowest MSE for the training/testing split.

the data. This is commonly done in machine learning in order to have a comparable group of observations for training and testing; that is, we can compare apples to apples. Additionally, this stratified approach makes sense given that we are assuming within a specific window of time that the communication rule is fixed.

When using time-varying regularized regressions for prediction, one may want to consider alternative methods for selecting an optimal penalty parameter.[2] Here, we explore different time-series based cross-validation approaches: sequential, expanding, and rolling, and compare them with our baseline, stratified approach. These methods for splitting are more often used for forecasting exercises as they implicitly embed accuracy in future out-of-sample when selecting the penalty parameter. Figure D.12 compares the different train-test splits for all four strategies of K-fold cross validation.

Then in Table D.7, we present the average accuracy on the training and testing sets with the optimal penalty parameter across the different ways of splitting data into the training-testing sets. We consider penalty parameter values from just above zero up to 1000. When the optimal penalty parameter is assigned the maximum value of 1000, this indicates that the increasing α continued to decrease the prediction error on the testing set all the way to our upper α bound. This is further evidence of shifts in communication rules since the extremely high αs indicate that models estimated in the training are poor fits for the subsequent testing set. In particular, we get very high penalty parameter values when we look at the rolling and expanding cross validation approaches, indicating that language in the past is not always good a predicting language in the future. When exactly these breaks occur is motivation for our shift indicator. Ultimately, given our framework and assumption that communication rules are fixed within a window of time, we treat the estimation of α within that window as a cross-sectional problem. Accordingly, it is most appropriate to use a stratified approach.

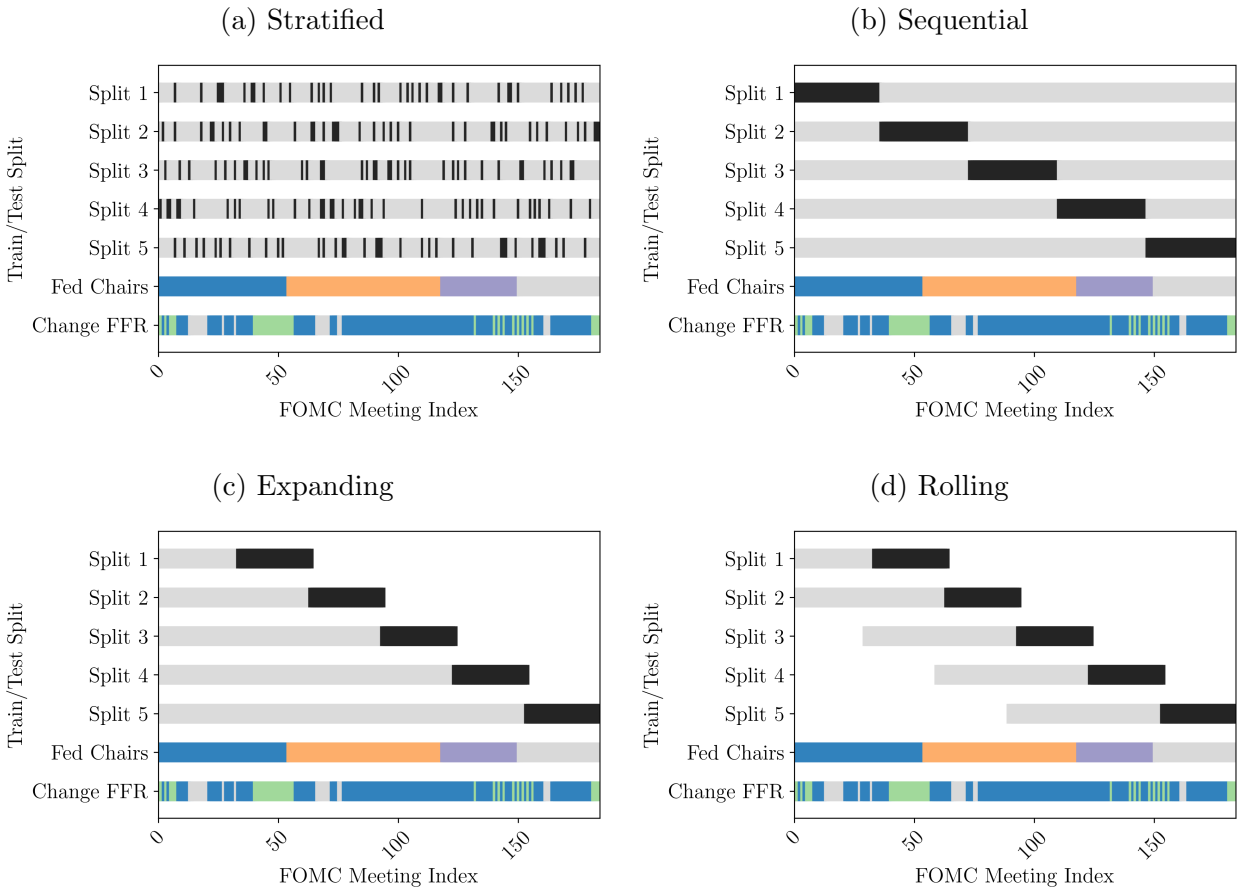
[2]This is what Liang et al. (2022) do in their project with earnings calls.

Table D.7: Average Accuracy and Penalty Parameter for Different CV Approaches

	Stratified			Sequential			Rolling			Expanding		
	Train	Test	α	Train	Test	α	Train	Test	α	Train	Test	α
Target FFR	0.99	0.96	7.07	0.81	-12.58	1000.00	0.73	-0.99	1000.00	0.67	-2.86	1000.00
Change in Target FFR	0.93	0.80	22.22	0.93	0.35	40.82	0.93	-0.65	40.82	0.93	-0.12	40.82
Target FFR Next Year	0.98	0.92	7.07	0.74	-0.71	1000.00	0.71	-5.73	1000.00	0.66	-7.02	1000.00
Shadow Rate	0.98	0.96	15.66	0.86	-3.00	1000.00	0.75	-7.55	1000.00	0.69	-10.65	1000.00
Treasury 10Y less FFR	0.92	0.81	20.71	0.68	-1.42	1000.00	0.85	-0.49	102.04	0.77	-0.46	142.86
Fed Total Assets	1.00	0.99	4.04	1.00	-264.07	40.82	0.98	-595.08	40.82	0.98	-658.47	40.82
RGDP Growth Next Quarter	0.92	0.55	39.39	0.91	-1.30	40.82	0.89	-2.72	40.82	0.89	-0.25	20.41
RGDP Growth Next Year	0.93	0.72	31.31	0.84	-1.26	224.49	0.82	-2.21	40.82	0.65	-3.30	428.57
Unemployment Next Quarter	1.00	0.98	3.54	0.98	-1.04	163.27	0.78	-8.16	346.94	0.65	-7.42	1000.00
Unemployment Next Year	1.00	0.96	7.07	0.98	-1.13	122.45	0.78	-8.85	428.57	0.66	-7.90	1000.00
Inflation (CPI) Next Quarter	0.36	0.04	500.00	0.30	-0.29	1000.00	0.28	-0.59	1000.00	0.28	-0.62	1000.00
Inflation (CPI) Next Year	0.97	0.87	24.24	0.91	-0.99	224.49	0.68	-5.53	1000.00	0.67	-5.10	1000.00
Core Inflation (CPI) Next Quarter	0.94	0.83	102.04	0.93	-0.03	122.45	0.67	-2.50	1000.00	0.80	-2.76	183.67
Core Inflation (CPI) Next Year	0.99	0.89	2.53	0.88	-0.60	408.16	0.93	-5.02	20.41	0.65	-4.26	1000.00

Note: α is the penalty parameter. Values in the table are R^2 between actual and predicted output values. The stratified splits are the baseline approach, and split into training and testing such that there is similar distribution of observations in each fold. Sequential splits have sequential observations grouped together within a fold, but train/test distinction may have future or past observations. Rolling approach has the window for the training and testing sets rolling throughout the whole sample. Expanding approach has an expanding window for the training set and a fixed size testing set. The first two approaches ignore timing of observations between train/test. The last two approaches respect time ordering.

Figure D.12: Cross Validation Splits Comparison



E Top Word Lists for Estimated Rules

In this section, we report the quadgrams that are most predictive – having the largest magnitude coefficients – for each fixed communication rule using the baseline specification (4-grams with a five percent threshold). For example, a quadgram that is highly predictive of a higher unemployment rate forecast will have a large positive coefficient from the ridge regression used to estimate the fixed communication rule of unemployment. We also report the coefficients in the columns labeled β_j. The magnitude for these coefficients are not comparable across output variables, since they are of different scales. However, within the same table, one can interpret a higher or lower coefficient to be indicative of how associative the language is with the output variable.

Table E.8: Top Words for Target Policy Rate

	Higher Target FFR	β_j	Lower Target FFR	β_j
1	provide ongoing support economic	0.20	achieve decide keep target	-0.59
2	condition generate economic weakness	0.20	long_run goal maximum employment	-0.38
3	continue monitor economic outlook	0.15	after action stance monetary_policy	-0.26
4	only gradual increase fundsrate	0.15	achieve inflation moderately above	-0.19
5	risk weight mainly toward	0.11	progress toward maximum employment	-0.19
6	long_run inflation expectation continue	0.08	fundsrate bp related action	-0.19
7	stance monetary_policy economic activity	0.05	near mandate consistent level	-0.16
8	include low rate resource	0.05	economic outlook inform incoming	-0.16
9	stance monetary_policy remain appropriate	0.04	fundsrate likely remain time	-0.16
10	likely measure nonetheless respond	0.04	fundsrate bp believe even	-0.16
11	lower target fundsrate bp	0.04	expect toward objective maximum	-0.16
12	decide keep target range	0.04	target fundsrate bp related	-0.16
13	inflation carefully monitor actual	0.04	employment inflation assessment take	-0.15
14	moderate pace labor indicator	0.04	energy import price dissipate	-0.11
15	carefully monitor actual expect	0.04	financial condition remain accommodative	-0.11

	Higher Change in Target FFR	β_j	Lower Change in Target FFR	β_j
1	determine timing size future	0.03	continue believe accommodative stance	-0.03
2	public health labor condition	0.03	target fundsrate bp related	-0.03
3	fundsrate fundsrate likely remain	0.02	upside downside risk attainment	-0.03
4	security roll over mature	0.02	support strong economic recovery	-0.03
5	near_term risk economic outlook	0.02	energy price price non	-0.03
6	growth information currently available	0.01	see risk outlook economic	-0.02
7	security agency mortgage_backed security	0.01	base measure long_run inflation	-0.02
8	purchase treasury agency mortgage_backed	0.01	employment price stability expect	-0.02
9	condition include low rate	0.01	long_run goal price stability	-0.02
10	level economic condition time	0.01	remain accommodative part reflect	-0.01
11	monetary_policy appropriate risk emerge	0.01	price non energy import	-0.01
12	purchase additional agency mortgage_backed	0.01	provide important ongoing support	-0.01
13	mortgage_backed security roll over	0.01	support mortgage help make	-0.01
14	assessment maximum employment inflation	0.01	meet suggest economic activity	-0.01
15	inflation over time rate	0.01	cost purchase support continued	-0.01

	Higher Target FFR Next Year	β_j	Lower Target FFR Next Year	β_j
1	currently anticipate exceptionally low	0.14	increase holding treasury security	-0.39
2	goal assessment take account	0.13	employ policy tool appropriate	-0.37
3	believe policy accommodation remove	0.10	condition relative objective maximum	-0.35
4	information include additional measure	0.10	mandate seek foster maximum	-0.25
5	least billion per month	0.10	attainment both sustainable growth	-0.25
6	sustainable growth price stability	0.10	maximum employment inflation rate	-0.25
7	recovery housing sector remain	0.07	continue purchase treasury agency	-0.24
8	business fix investment advance	0.07	stable inflation expectation likely	-0.22
9	economic growth imply incoming	0.05	pressure long_run interest rate	-0.22
10	account wide range information	0.04	international development carefully monitor	-0.22
11	purchase additional agency mortgage_backed	0.04	economic outlook financial development	-0.20
12	fundsrate depend economic outlook	0.03	time below level expect	-0.18
13	objective symmetric inflation objective	0.03	activity labor nearly balanced	-0.18
14	security auction anticipate until	0.02	consistent statutory mandate seek	-0.14
15	reaffirm view highly accommodative	0.02	accommodative financial condition thereby	-0.14

Table E.9: Top Words for Other Rates and Policy

	Higher Shadow Rate	β_j	Lower Shadow Rate	β_j
1	continue purchase treasury agency	0.22	recent month unemployment rate	-0.44
2	unemployment rate remain above	0.22	subdued outlook inflation over	-0.33
3	range tool support us	0.11	adjust stance monetary_policy appropriate	-0.19
4	modest income growth low	0.11	after action stance monetary_policy	-0.19
5	economic growth price stability	0.09	labor condition inflation decide	-0.18
6	continue strengthen economic activity	0.09	economic condition evolve manner	-0.16
7	roll over mature treasury	0.06	time below level expect	-0.16
8	fundsrate bp believe even	0.06	basis both overall inflation	-0.16
9	policy keep holding long_run	0.04	commit use full range	-0.14
10	fundsrate continue anticipate economic	0.04	monitor incoming information economic	-0.14
11	growth productivity provide ongoing	0.04	subdue inflation trend stable	-0.14
12	household business assess appropriate	0.04	appropriate policy accommodation economic	-0.14
13	remain low survey base	0.04	financial international development light	-0.13
14	over long_run inflation run	0.04	expect inflation development relative	-0.11
15	billion per month agency	0.03	asset purchase program end	-0.11

	Higher Treasury 10Y less FFR	β_j	Lower Treasury 10Y less FFR	β_j
1	mortgage_backed security agency mortgage_backed	0.29	pace labor condition strengthen	-0.23
2	economic recovery strengthen particular	0.22	time below level expect	-0.23
3	one two year ahead	0.16	inflation average over time	-0.16
4	target range fundsrate stance	0.16	next quarter roughly equal	-0.16
5	accommodative couple robust underlying	0.10	assess realize expect economic	-0.09
6	information economic financial development	0.10	board governors approve bp	-0.08
7	time thereby promote maximum	0.09	stable inflation expectation likely	-0.08
8	growth productivity provide important	0.09	outlook would prepare adjust	-0.06
9	inflation currently anticipate even	0.08	fundsrate appropriate least long	-0.06
10	price stability expect appropriate	0.07	economic activity employment inflation	-0.06
11	condition return inflation determine	0.07	two year ahead project	-0.06
12	after asset purchase program	0.04	achieve inflation moderately above	-0.06
13	long_run treasury security pace	0.04	sustain return inflation determine	-0.05
14	inflation expectation remain well	0.04	financial international development carefully	-0.05
15	accommodation take balanced approach	0.04	improve substantially context price	-0.05

	Higher Fed Total Assets	β_j	Lower Fed Total Assets	β_j
1	gradual adjustment stance monetary_policy	65.19	public health labor condition	-84.10
2	couple robust underlying growth	50.58	price stability reaffirm view	-79.81
3	inflation moderately above time	50.58	tool support us economy	-66.30
4	realize expect labor condition	50.58	least billion per month	-66.30
5	employment objective symmetric inflation	50.58	price stability sustainable economic	-60.21
6	economic condition include low	50.58	economic outlook financial development	-57.81
7	outlook economic activity labor	45.21	anticipate gradual return high	-52.17
8	labor condition reach level	43.83	risk economic outlook appear	-32.87
9	maximum employment objective symmetric	39.27	against background long_run goal	-28.95
10	even after employment inflation	39.03	expect economic condition evolve	-28.10
11	expand moderate pace labor	36.79	condition return inflation determine	-26.45
12	normalization level fundsrate well	36.25	toward inflation goal expect	-23.30
13	continued progress toward maximum	35.51	international development light current	-23.30
14	inflation average over time	35.51	agency mortgage_backed security pace	-23.30
15	inflation expectation remain well	35.51	health labor condition inflation	-23.30

Table E.10: Top Words for Next Quarter Real Macro Forecasts

	Higher Unemployment Next Quarter	β_j	Lower Unemployment Next Quarter	β_j
1	policy accommodation economic growth	0.27	anticipate gradual return high	-0.06
2	change balance consistent statutory	0.13	maintain accommodative stance monetary_policy	-0.06
3	downside risk economic outlook	0.13	tool support us economy	-0.06
4	symmetric inflation goal expect	0.13	long_run interest rate support	-0.06
5	warrant exceptionally low level	0.13	improve substantially context price	-0.04
6	current shortfall inflation carefully	0.11	economic outlook would prepare	-0.03
7	purchase support continued progress	0.10	information economic financial development	-0.03
8	fundsrate appropriate least long	0.10	expect labor condition inflation	-0.03
9	fundsrate continue anticipate economic	0.10	security agency mortgage_backed security	-0.03
10	anticipate economic condition include	0.07	inflation assessment take account	-0.03
11	range information include measure	0.07	above time inflation average	-0.03
12	below long_run objective partly	0.07	include measure labor condition	-0.02
13	expect economic condition evolve	0.07	condition return inflation determine	-0.02
14	part reflect policy measure	0.06	financial condition remain accommodative	-0.02
15	activity expand moderate pace	0.06	long_run inflation expectation remain	-0.02

	Higher RGDP Growth Next Quarter	β_j	Lower RGDP Growth Next Quarter	β_j
1	judge consistent dual mandate	0.17	however actual path fundsrate	-0.29
2	expansion economic activity strong	0.13	provide important ongoing support	-0.29
3	policy accommodation economic growth	0.12	expect maintain accommodative stance	-0.29
4	remain elevated household spending	0.11	maintain exist policy reinveste	-0.29
5	exceptionally low level fundsrate	0.10	even after action stance	-0.24
6	appropriate determine long maintain	0.10	low level fundsrate extended	-0.15
7	path fundsrate depend economic	0.07	consistent dual mandate continue	-0.15
8	information receive since fomc	0.07	half percentage point above	-0.12
9	recent month unemployment rate	0.06	gradual return high level	-0.12
10	business fix investment advance	0.05	level help maintain accommodative	-0.11
11	advance while recovery housing	0.05	keep target fundsrate unchanged	-0.10
12	long_run objective partly reflect	0.05	expectation reading financial development	-0.09
13	survey base measure long_run	0.05	mortgage_backed security pace billion	-0.08
14	stance monetary_policy remain accommodative	0.05	adjustment stance monetary_policy economic	-0.07
15	fomc meet suggest economic	0.04	sustain return inflation determine	-0.06

Table E.11: Top Words for Next Quarter Nominal Macro Forecasts

	Higher Inflation (CPI) Next Quarter	β_j	Lower Inflation (CPI) Next Quarter	β_j
1	foster maximum employment price	0.04	long_run however actual path	-0.06
2	maximum employment inflation assessment	0.03	measure inflation compensation remain	-0.06
3	accommodative stance monetary_policy until	0.03	expectation reading financial development	-0.06
4	objective symmetric inflation objective	0.02	reach level consistent assessment	-0.03
5	half percentage point above	0.02	low housing wealth tight	-0.03
6	well anchor expect maintain	0.02	condition relative objective maximum	-0.03
7	security employ policy tool	0.02	long_run interest rate support	-0.02
8	range fundsrate appropriate least	0.02	range information include measure	-0.02
9	size future adjustment target	0.02	impede attainment goal assessment	-0.02
10	decide keep target range	0.02	support mortgage help make	-0.02
11	anticipate economic condition include	0.02	labor continue strengthen economic	-0.02
12	likely efficacy cost purchase	0.02	warrant exceptionally low level	-0.02
13	price price non energy	0.01	until labor condition reach	-0.02
14	high level resource utilization	0.01	pressure inflation expectation reading	-0.02
15	maximum employment inflation rise	0.01	support flow credit household	-0.01

	Higher Core Inflation (CPI) Next Quarter		Lower Core Inflation (CPI) Next Quarter	
1	stance monetary_policy also consider	0.02	level fundsrate extended period	-0.03
2	expectation reading financial international	0.02	stance monetary_policy appropriate risk	-0.03
3	stability reaffirm view highly	0.02	us household business path	-0.02
4	reach level consistent assessment	0.01	inflation economic growth imply	-0.02
5	promote maximum employment price	0.01	maximum employment inflation rise	-0.02
6	security pace billion per	0.01	pace labor condition strengthen	-0.02
7	reflect policy measure support	0.01	range fundsrate appropriate least	-0.02
8	consistent dual mandate see	0.01	decide keep target range	-0.02
9	expectation little change balance	0.01	symmetric inflation objective assessment	-0.02
10	expansion economic activity strong	0.01	rate support mortgage help	-0.02
11	decide raise target fundsrate	0.01	emerge could impede attainment	-0.02
12	expectation remain stable consistent	0.01	employment inflation currently anticipate	-0.01
13	consistent long_run goal maximum	0.01	growth productivity provide ongoing	-0.01
14	incoming information economic financial	0.01	elevated household spending business	-0.01
15	strengthen economic activity rise	0.01	agency mortgage_backed security agency	-0.01

Table E.12: Top Words for Next Year Real Macro Forecasts

	Higher Unemployment Next Year	β_j	Lower Unemployment Next Year	β_j
1	continue strengthen economic activity	0.20	elevated household spending business	-0.08
2	policy tool appropriate until	0.15	future adjustment target range	-0.08
3	employment inflation rate over	0.15	energy import price dissipate	-0.06
4	inflation moderately above time	0.15	meet suggest economic activity	-0.04
5	return high level resource	0.15	measure nonetheless respond change	-0.04
6	fundsrate currently anticipate exceptionally	0.10	decide keep target range	-0.03
7	inflation carefully monitor actual	0.09	treasury security least billion	-0.03
8	condition sustain return inflation	0.09	need fulfill obligation maintain	-0.03
9	rate consistent dual mandate	0.08	maintain downward pressure long_run	-0.03
10	economic condition evolve manner	0.08	security pace billion per	-0.03
11	housing wealth tight credit	0.07	full range tool support	-0.02
12	currently available risk weight	0.07	pressure long_run interest rate	-0.02
13	target range fundsrate expect	0.07	long_run however actual path	-0.02
14	agency mortgage_backed security roll	0.07	economic growth price stability	-0.02
15	while recovery housing sector	0.06	underlying growth productivity provide	-0.02

	Higher RGDP Growth Next Year	β_j	Lower RGDP Growth Next Year	β_j
1	expectation remain stable consistent	0.12	keep target fundsrate unchanged	-0.10
2	condition relative objective maximum	0.11	commit use full range	-0.10
3	range information include measure	0.11	asset purchase program end	-0.07
4	accommodation economic activity expand	0.09	include measure labor condition	-0.07
5	security least billion per	0.07	support economy flow credit	-0.07
6	timing size future adjustment	0.07	strong labor condition inflation	-0.07
7	condition generate economic weakness	0.07	us economy challenging time	-0.06
8	moderate pace labor indicator	0.06	shortfall inflation carefully monitor	-0.06
9	decide keep target fundsrate	0.06	include additional measure labor	-0.05
10	expect gradual adjustment stance	0.06	monetary_policy remain accommodative thereby	-0.04
11	continue run below long_run	0.06	closely monitor incoming information	-0.04
12	gradual adjustment stance monetary_policy	0.06	decide keep target range	-0.04
13	maintain target range fundsrate	0.06	expand moderate pace labor	-0.04
14	mortgage_backed security roll over	0.04	indicator inflation pressure inflation	-0.04
15	adjustment stance monetary_policy economic	0.03	range fundsrate stance monetary_policy	-0.04

Table E.13: Top Words for Next Year Nominal Macro Forecasts

	Higher Inflation (CPI) Next Year	β_j	Lower Inflation (CPI) Next Year	β_j
1	us economy challenging time	0.02	tool appropriate until outlook	-0.05
2	expect economic condition relative	0.02	implication incoming information economic	-0.04
3	maximum employment inflation rise	0.01	maintain target range until	-0.04
4	economic growth price stability	0.01	normalization level fundsrate well	-0.04
5	non energy import base	0.01	continue run below long_run	-0.04
6	keep holding long_run security	0.01	achieve inflation moderately above	-0.03
7	both sustainable growth price	0.01	decide keep target range	-0.03
8	include measure labor condition	0.01	target range fundsrate expect	-0.03
9	anticipate economic condition include	0.01	believe policy accommodation remove	-0.03
10	even after action stance	0.01	toward condition generate economic	-0.02
11	consider information include additional	0.01	fundsrate assess realize expect	-0.02
12	maintain accommodative financial condition	0.01	inflation moderately above time	-0.02
13	expect prevail long_run however	0.01	cost purchase support continued	-0.02
14	inflation currently anticipate even	0.01	monitor economic outlook financial	-0.02
15	accommodation economic activity expand	0.01	time thereby promote maximum	-0.02

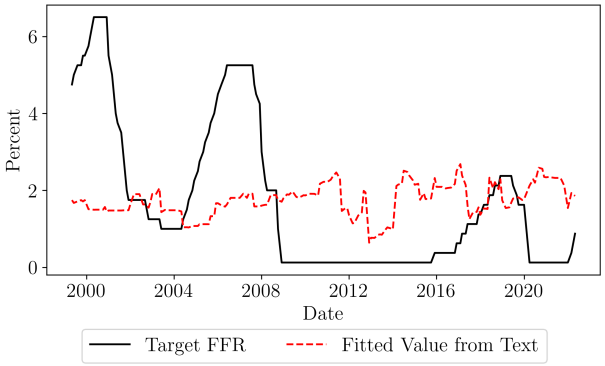
	Higher Core Inflation (CPI) Next Year		Lower Core Inflation (CPI) Next Year	
1	begin remove policy accommodation	0.04	inflation expectation continue well	-0.10
2	economic prospect need fulfill	0.04	maximum employment inflation currently	-0.06
3	cost purchase support continued	0.03	recovery help ensure inflation	-0.06
4	maximum employment inflation rise	0.03	accommodative financial condition thereby	-0.06
5	economic activity labor nearly	0.02	moderately above time inflation	-0.06
6	accommodation remove pace likely	0.02	security pace billion per	-0.06
7	month basis overall inflation	0.01	level judge consistent dual	-0.06
8	elevated household spending business	0.01	above long_run goal long_run	-0.05
9	assess realize expect economic	0.01	increase holding treasury security	-0.03
10	condition inflation pressure inflation	0.01	employment inflation currently anticipate	-0.03
11	rate resource utilization subdued	0.01	maintain target range until	-0.03
12	least billion per month	0.01	growth productivity provide important	-0.03
13	fundsrate below level view	0.01	economic condition relative maximum	-0.03
14	economic outlook appear roughly	0.01	until outlook labor improve	-0.03
15	month unemployment rate remain	0.01	inflation continue run below	-0.03

F Shuffled Communication Rules

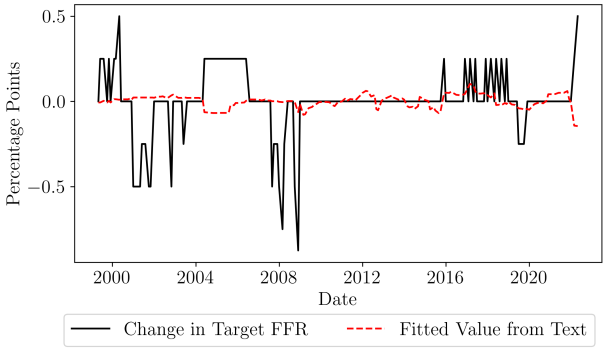
This section provides additional results from the robustness exercise where we shuffle the timing of the FOMC meetings. The goal is to test if the baseline methodology would mechanically be able to provide a good fit of policy and macroeconomic forecast variables due to the large number of regressors. Figure F.13 shows the fitted values from the shuffled communication rules for policy variables. Figure F.14 and Figure F.15 contain plots with fitted values for the shuffled communication rules for macroeconomic forecasts. The flatter, random-looking fitted values show that it matters which statements occur with the policy and forecast variables. The penalty parameter pushes towards its upper bound in this exercise, which flattens the fitted values. Thus, the text regressors are not able to mechanically fit the observables by virtue of their large number alone. This underscores that our baseline model is truly picking up systematic language from the Fed.

Figure F.13: Shuffled Communication Rules for Monetary Policy

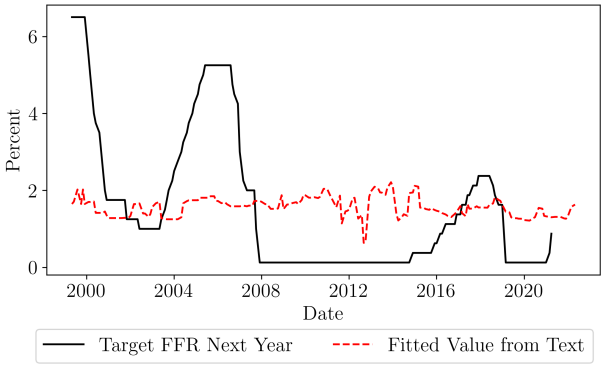
(a) Target Federal Funds Rate



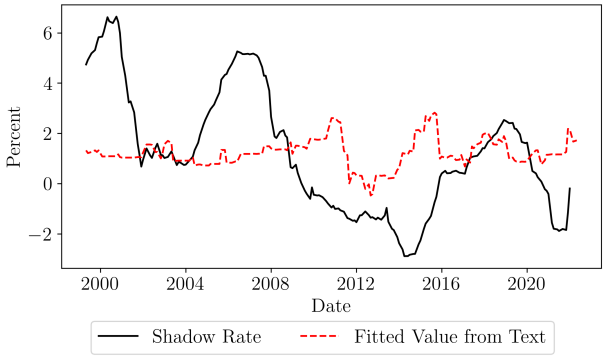
(b) Change in Target Rate



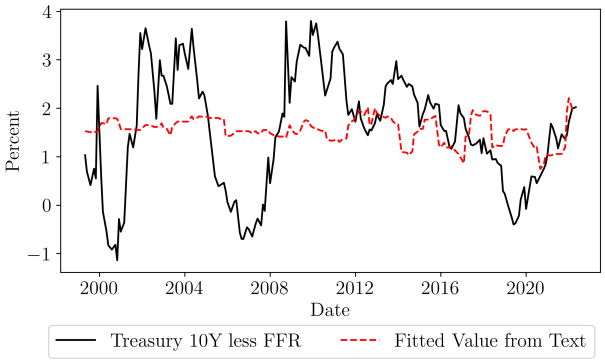
(c) Target Rate, Next Year



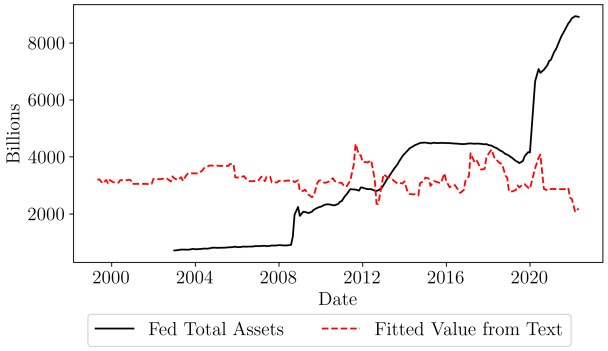
(d) Shadow Rate



(e) 10-year Treasury Minus Federal Funds Rate



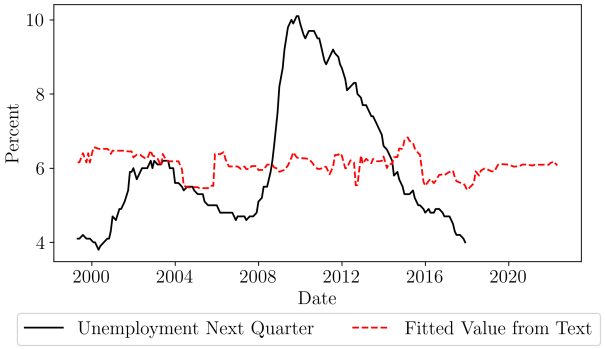
(f) Federal Reserve Total Assets



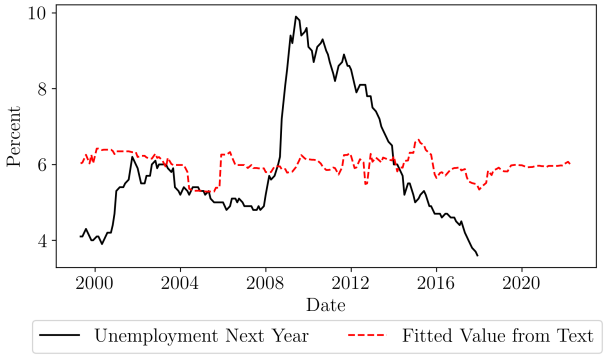
Note: The red dashed lines are the fitted value from shuffled communication rules for the corresponding policy and macro variables, assuming the communication rule is stable over the entire sample and the statement text is randomly assigned to a different date. That is, we have shuffled our observations.The target federal funds rate is the midpoint of the target rate when a range is stated as policy. The Year-Ahead Target Federal Funds Rate is the realized target federal funds rate one year in the future. This acts as a proxy measure for communication about forward guidance. The Shadow Rate is as constructed by Wu and Xia (2020).

Figure F.14: Shuffled Communication Rules for Real Macroeconomic Forecasts

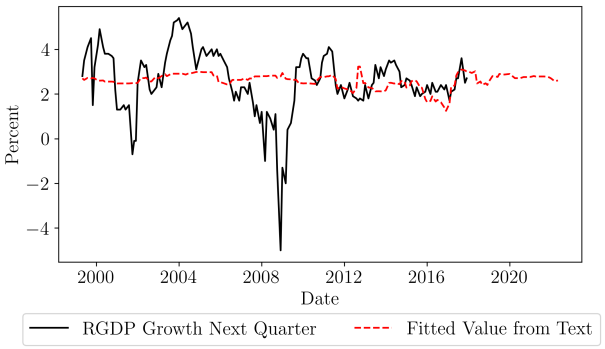
(a) Unemployment, Next Quarter



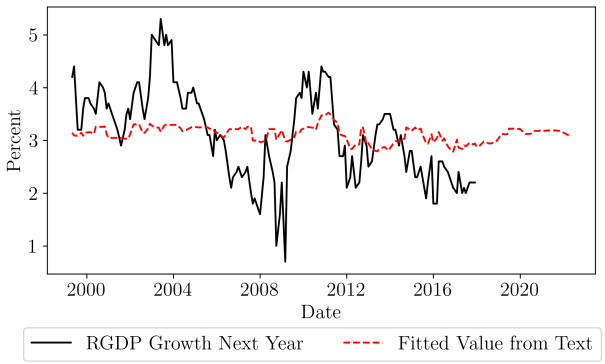
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



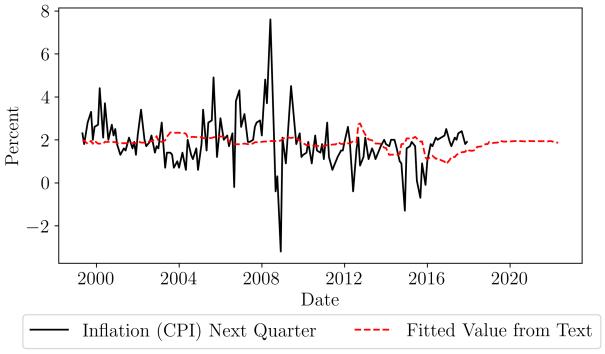
(d) Real GDP Growth, Next Year



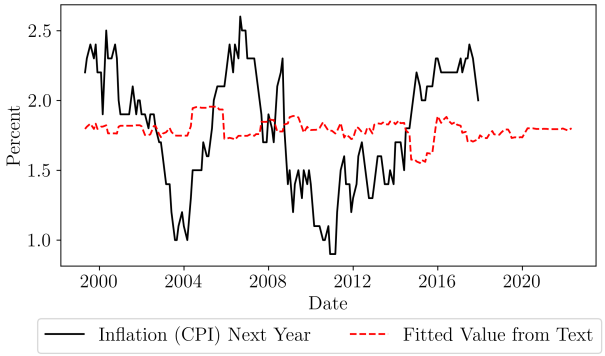
Note: The red dashed lines are the fitted value from shuffled communication rules for the corresponding forecasts of macro variables from the Greenbooks/Tealbooks, assuming the communication rule is stable over the entire sample and the statement text is randomly assigned to a different date. That is, we have shuffled our observations. Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points. The next quarter forecasts are the Federal Reserve forecasts for next quarter and the next year forecasts are the forecasts for four quarters into the future.

Figure F.15: Shuffled Communication Rules for Nominal Macroeconomic Forecasts

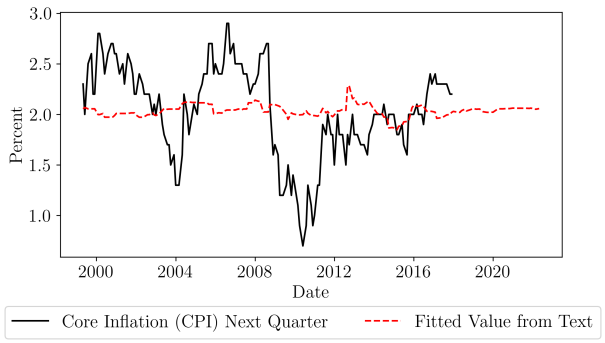
(a) Inflation, Next Quarter



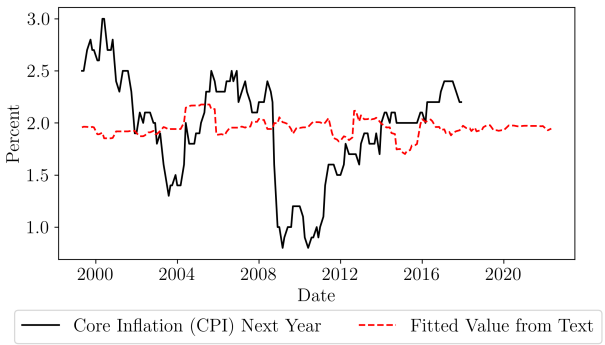
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



(d) Core Inflation, Next Year

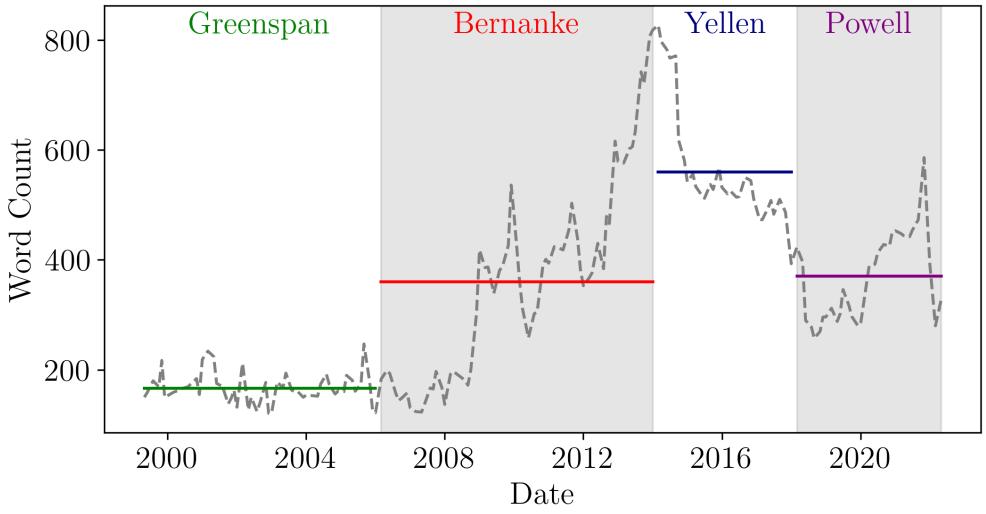


Note: The red dashed lines are the fitted value from shuffled communication rules for the corresponding forecasts of macro variables from the Greenbooks/Tealbooks, assuming the communication rule is stable over the entire sample and the statement text is randomly assigned to a different date. That is, we have shuffled our observations. Inflation is measured as the quarter-over-quarter growth in (headline or core) CPI in annualized percentage points. The next quarter forecasts are the Federal Reserve forecasts for next quarter and the next year forecasts are the forecasts for four quarters into the future.

G Chair-specific Communication Rules

Another way to think about communication rules changing over time is to split the full sample by Federal Reserve leadership. The idea that each Federal Reserve chair may be associated with a different communication rule is supported by Figure G.16, showing the number of words used in FOMC statements over time. As the figure depicts, the length of FOMC statements over time varies with the Fed chair.

Figure G.16: Fed Chair and Length of FOMC Statements



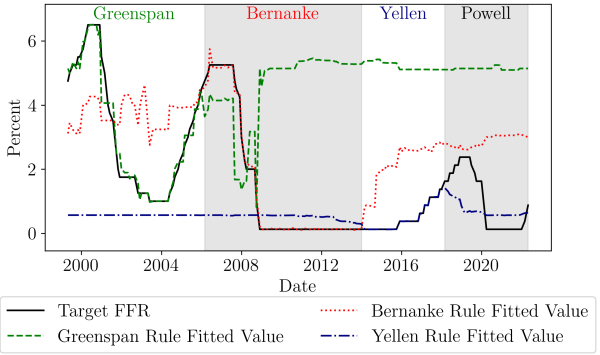
Note: This figure graphs the length of post-FOMC-meeting statements using the number of words in each announcement. Each horizontal bar represents the average statement length under the Fed Chair's respective tenure. For example, the red line shows that statements under Bernanke were about 400 words on average. The width of the lines correspond to each Fed Chair's tenure.

We estimate rules in association with the target federal funds rate for Greenspan, Bernanke, and Yellen. We do this by restricting the sample to the chair's tenure and then following the previous estimation procedure. Figure G.17 shows this for the policy variables, while Figure G.18 and Figure G.19 show this for the macro forecasts.

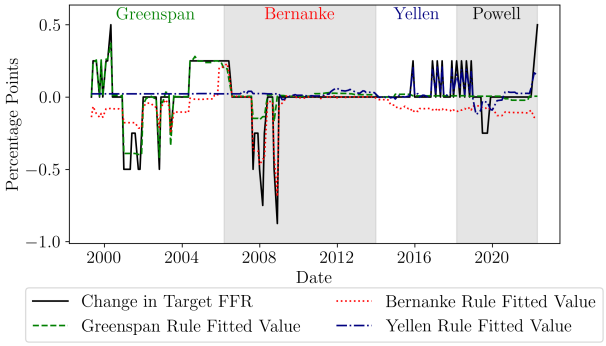
Unsurprisingly, we find that Yellen's communication rule predicts an almost zero target federal funds rate for the early sample. This is due to the minimal variation in the target

Figure G.17: Chair-Specific Communication Rules for Monetary Policy

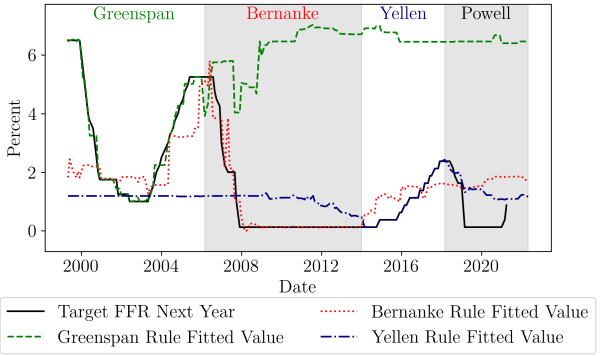
(a) Target Federal Funds Rate



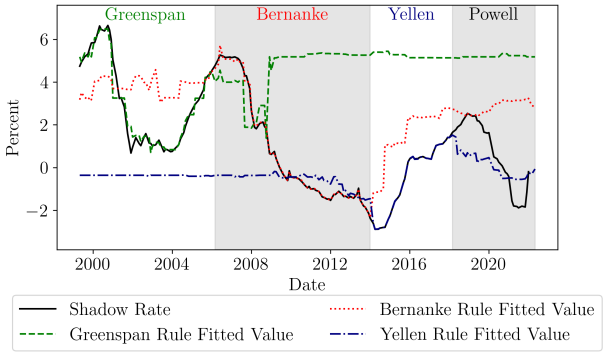
(b) Change in Target Rate



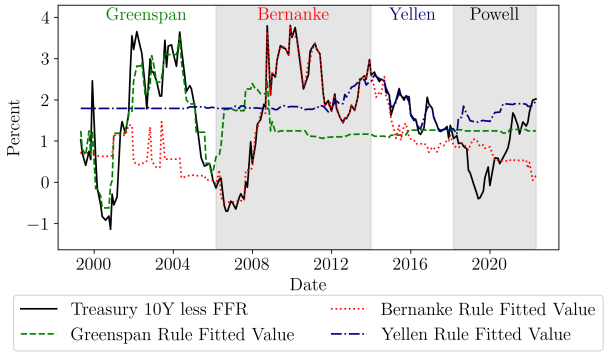
(c) Target Rate Next Year



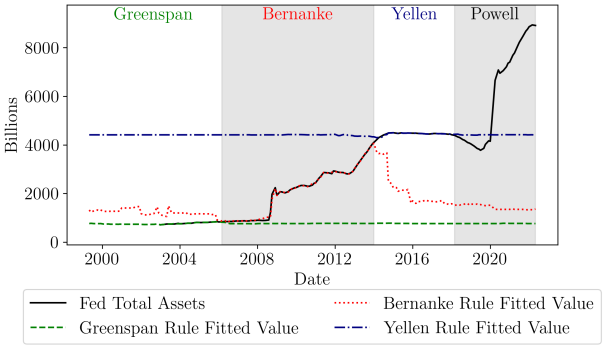
(d) Shadow Rate



(e) 10-year Treasury Minus Federal Funds Rate



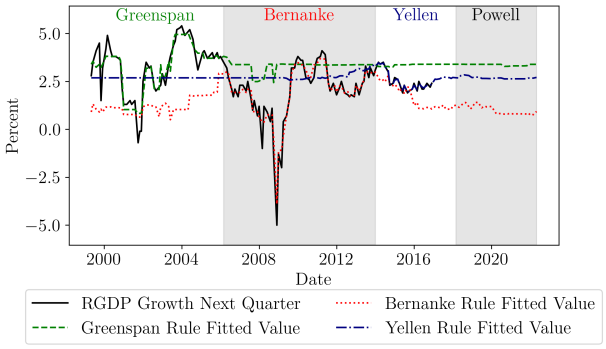
(f) Federal Reserve Total Assets



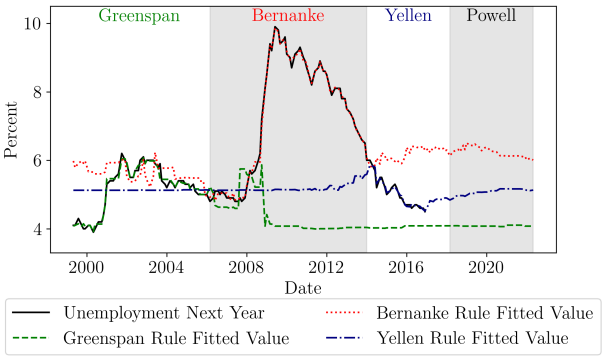
Note: The dashed lines are the fitted value from communication rules for the corresponding policy and macro variables estimated for the tenure of each Fed Chair.

Figure G.18: Chair-Specific Communication Rules for Real Macroeconomic Forecasts

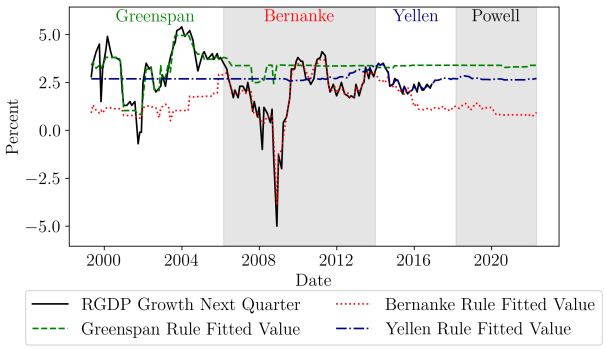
(a) Unemployment, Next Quarter



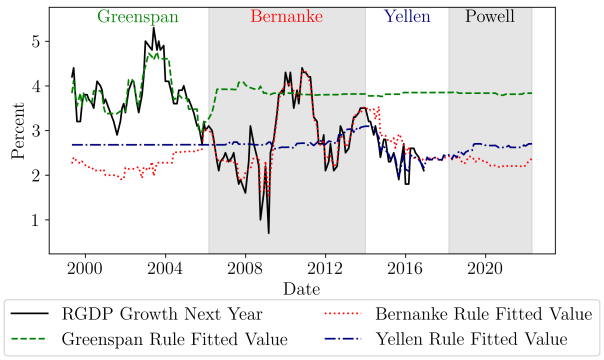
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



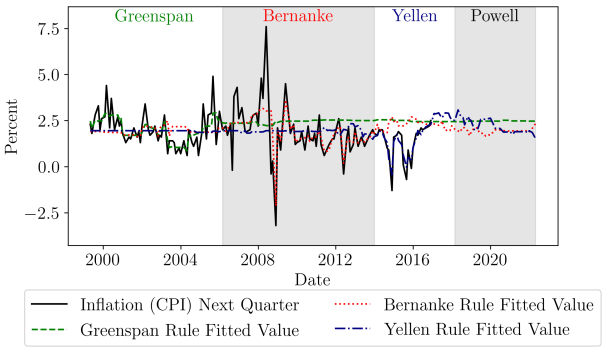
(d) Real GDP Growth, Next Year



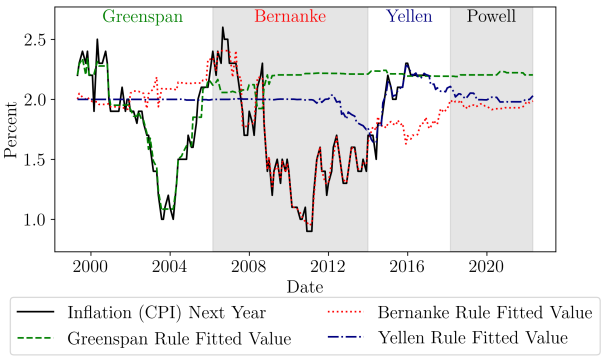
Note: The dashed lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated for the tenure of each Fed Chair. Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points.

Figure G.19: Chair-Specific Communication Rules for Nominal Macroeconomic Forecasts

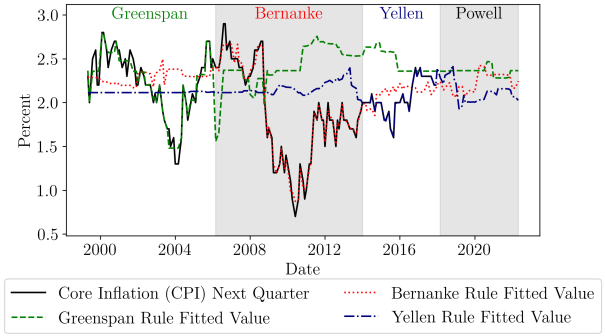
(a) Inflation, Next Quarter



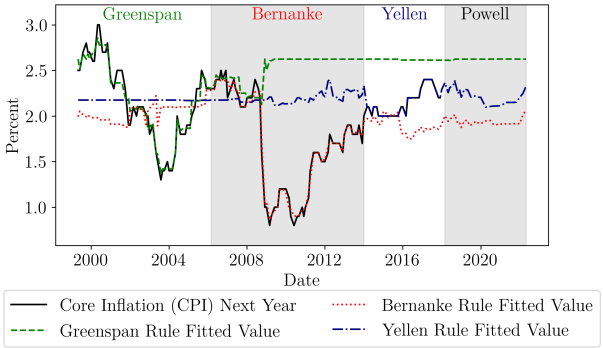
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



(d) Core Inflation, Next Year



Note: The dashed lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated for the tenure of each Fed Chair. Headline and core CPI inflation are the quarter-over-quarter growth rate in annualized percentage points.

federal funds rate during her tenure as Fed chair. The Greenspan and Bernanke rules seem to parallel each other in the early part of the sample, but have a level shift after 2009, such that the Bernanke rule captures the low target federal funds rate during the ZLB period. This is not surprising given that a large part of Bernanke's tenure was at the ZLB, so the algorithm is picking that up. Furthermore, with the Bernanke rule one can also see the signaling for early lift-off starting around 2015.

H Time-Varying Communication Rules

In this section we provide additional results for the time-varying communication rules, including the fitted values for communication rules estimated on expanding and rolling windows, and the shift indicator when estimated on rolling windows. For simplicity, we only plot the fitted values from four windows. However, we used all the window-specific communication rules for calculating the shift indicators.

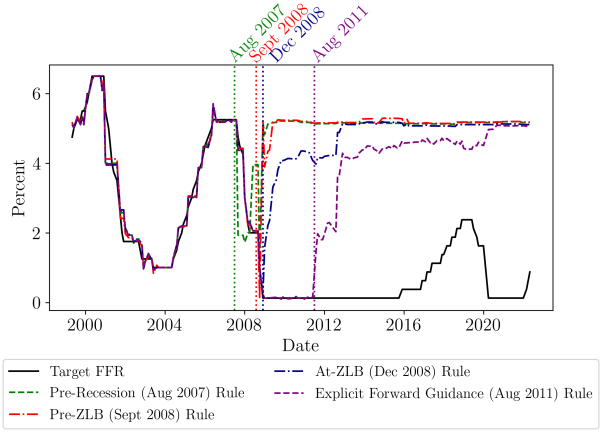
H.1 Communication Rules around the 2008 Crisis

In the paper, we see major shifts in the communication rules for policy and macroeconomic forecast variables around the start of the 2008 Financial Crisis. Here, we investigate the changes in the communication rule in more detail. We plot the fitted values for four different windows that end at key dates from the onset of the crisis in 2007, to the start of the zero-lower bound (ZLB) in 2008, to a change in forward guidance language in 2011.

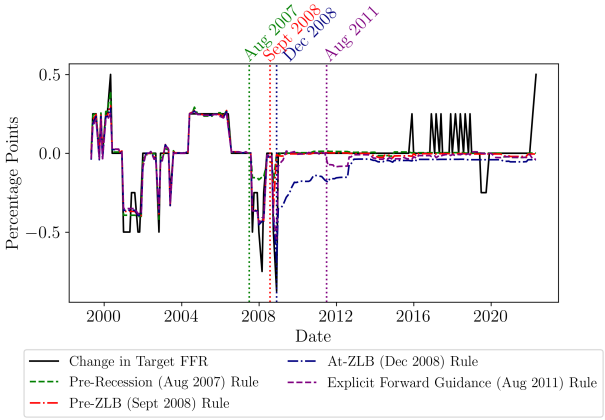
Throughout the panels of Figure H.20, H.21, and H.22, the black lines correspond to the realizations of the y-variables, and the colored, dashed lines show the fitted values coming from communication rules estimated from various windows. Note that these fitted values are for a mix of in- and out-of-sample observations. The vertical, color-coded lines show the stopping times for each window, such that left of the line is in-sample and right of the

Figure H.20: Time-Varying Communication Rules for Monetary Policy

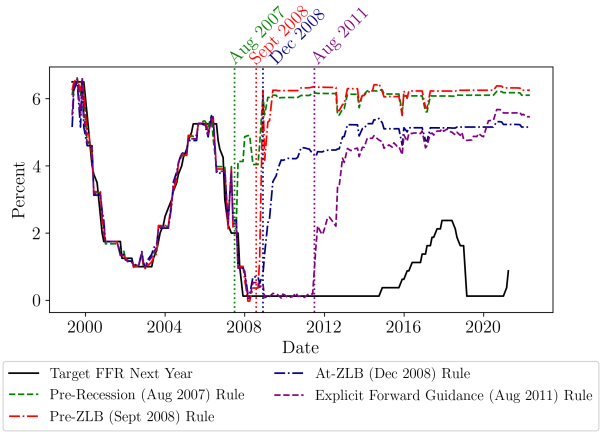
(a) Target Federal Funds Rate



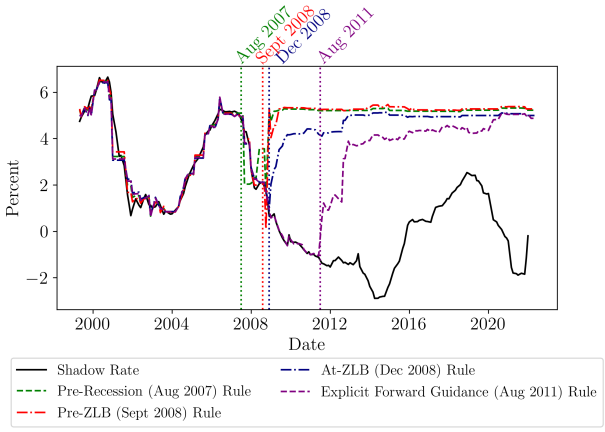
(b) Change in Target Rate



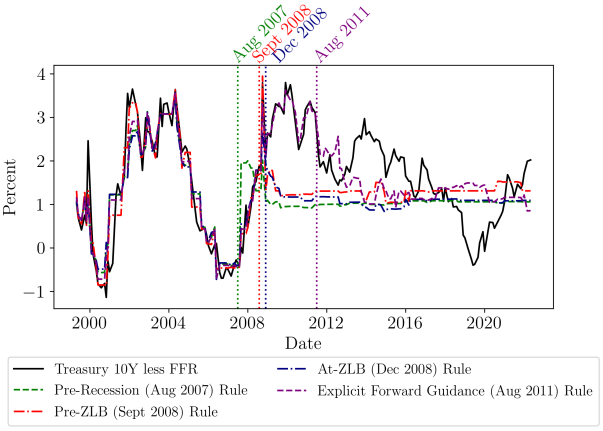
(c) Target Rate, Next Year



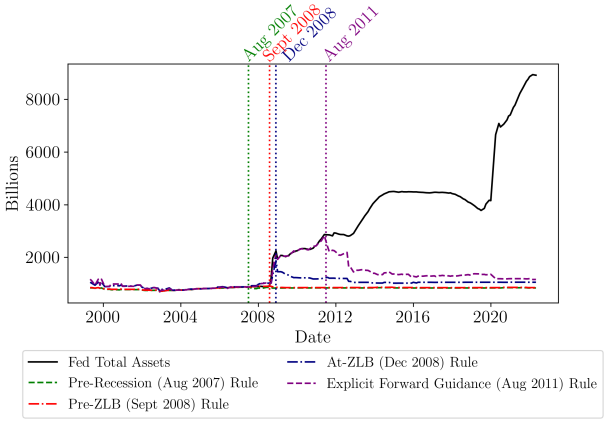
(d) Shadow Rate



(e) 10-Year Treasury Minus Federal Funds Rate



(f) Federal Reserve Total Assets



Note: The dashed lines are the fitted value from communication rules for the corresponding policy and macroeconomic variables estimated on different subperiods in our sample. We use an expanding window to capture time variation in the communication rule.

line is out-of-sample. The green lines correspond to the shortest window which ends in August 2007, right before the Great Recession. The next window, in red, ends in September 2008, and thus already captures some of the Great Recession, but not yet the ZLB. The blue window ends just three months later, in December 2008, right as the economy hit the ZLB. The longest window, in purple, ends in August 2011 to capture some explicit forward guidance announcements of the Fed in addition to many months at the ZLB.

Looking first at Figure H.20, we see that the in-sample forecasts continue to exhibit the good fit from the fixed rules in the main text. The out-of-sample fit degenerates, however, for all communication rules. This indicates that the Fed either introduced new language in this period, or changed the way it used existing language (or both). The objective here is not to provide a method that perfectly predicts economic variables from past text of the Fed. It is to understand how the FOMC's information connects with the language they use in their policy statements, and how that relationship changes over time.

It is interesting to note that even though the out-of-sample forecasts coming from all windows are off, they are all off in a similar fashion. There seems to be a level shift in them early on, reflecting that longer windows incorporate more data, but out-of-sample forecasts from the different rules converge to one another towards the end of the sample. This means that while some changes to the Fed's language use occurred around the onset of the Great Recession and the ZLB, the Fed made a concerted effort to communicate consistently over time overall. When getting far enough out-of-sample, though, the novel language of newer rules has replaced old language to the extent that the only thing that predicts the left-hand-side variable is the intercept.[3]

How exactly did the Fed's language change early on in the crisis? To investigate this, let us focus on the target fed funds rate in Figure H.20a. We see that all out-of-sample forecasts

[3]It is interesting to note that the estimated constants seem to reflect meaningful long-run concepts, such as the inflation target or the natural rate of unemployment.

overestimate the target fed funds rate. This has the interpretation that if one was reading an FOMC statement for example in 2013 through the lens communication rules trained on the green, red or blue windows, one would have expected the Fed's current target rate to be around 5%, while in truth the target rate was stuck at the ZLB. Even the longest window with a stopping time of August 2011, in purple, would have had one expect a 4% target rate from the wording of the 2013 FOMC statement. One way to read this is as an early signalling of lift-off.

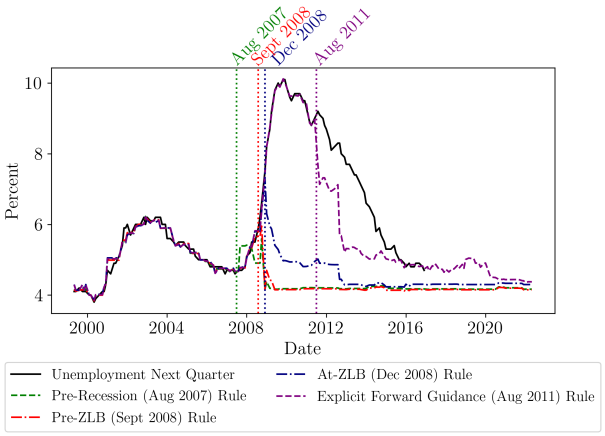
This means that the FOMC statements after 2008 continued to use words that were previously associated with a higher target fed funds rate. The Fed continued to use words throughout the crisis that reflected stronger economic fundamentals than what the near-zero target rate suggested. Indeed, looking at the other policy variables on the other panels of Figure H.20, we see that the out-of-sample forecasts suggest much more contractionary paths for policy than what was realized. For example, for the total assets of the Fed on Figure H.20f, the out-of-sample forecasts all suggests that the Fed will decrease their balance sheet in the decade following the crisis, whereas the Fed had only just gotten started increasing their balance sheet in 2012.

The fitted values for communication rules about Fed forecasts in Figure H.21 and H.22 underscore this interpretation by and large. Out-of-sample, the communication rules underpredict unemployment and overpredict GDP growth and inflation compared to the Fed's actual forecasts. Also here, we see that the Fed used words during the recession that reflected a more optimistic economic outlook (lower unemployment, higher GDP growth and inflation closer to target) in the old communication rules.[4] This is evidence of the Fed trying to support the economic recovery by systematically using language that in previous communication was associated with a stronger economy. Again, this suggests the Fed relying on

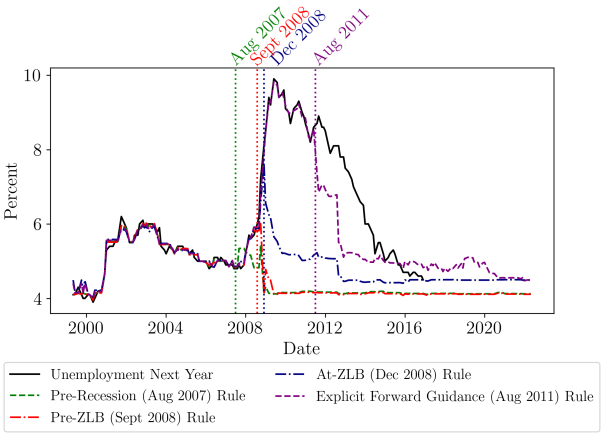
[4]In the case of the Fed's one-year-ahead unemployment expectation, the August 2011 rule is an exception to this, presenting a more pessimistic unemployment outlook starting about in 2015.

Figure H.21: Time-Varying Communication Rules for Real Macroeconomic Forecasts

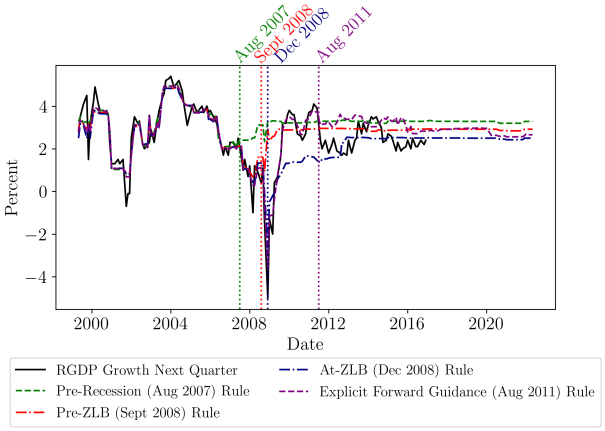
(a) Unemployment, Next Quarter



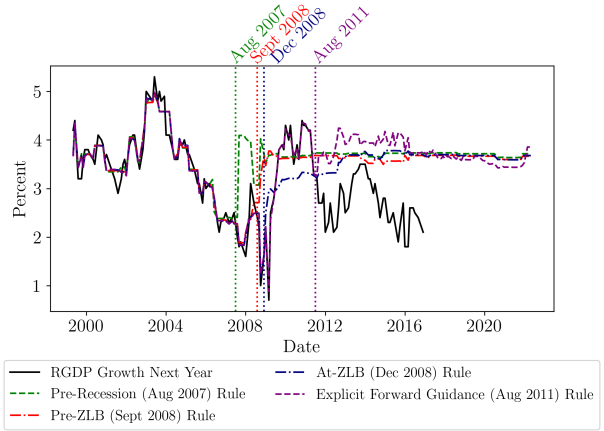
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



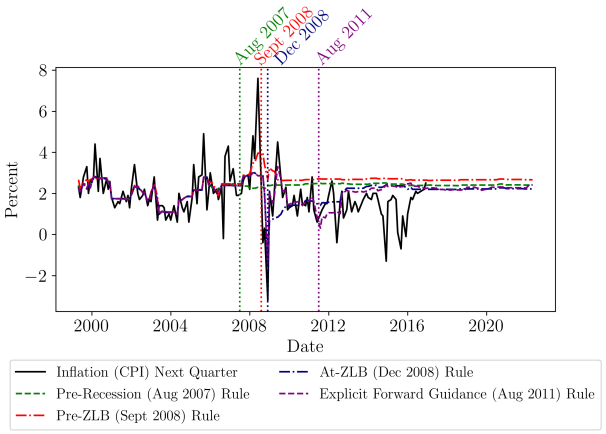
(d) Real GDP Growth, Next Year



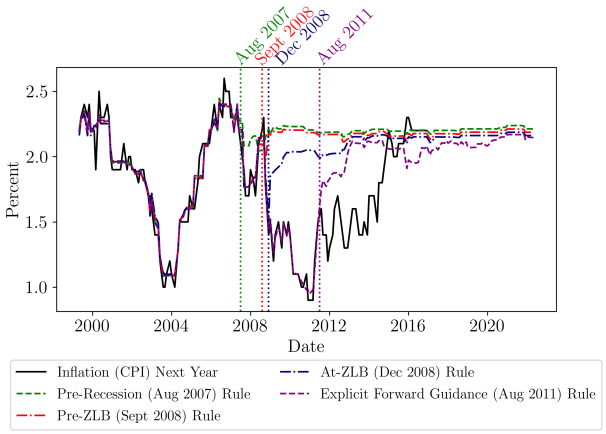
Note: The dashed lines are the fitted value from communication rules for the corresponding forecasts of macroeconomic variables estimated on different subperiods in our sample. We use an expanding window. Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points.

Figure H.22: Time-Varying Communication Rules for Nominal Macroeconomic Forecasts

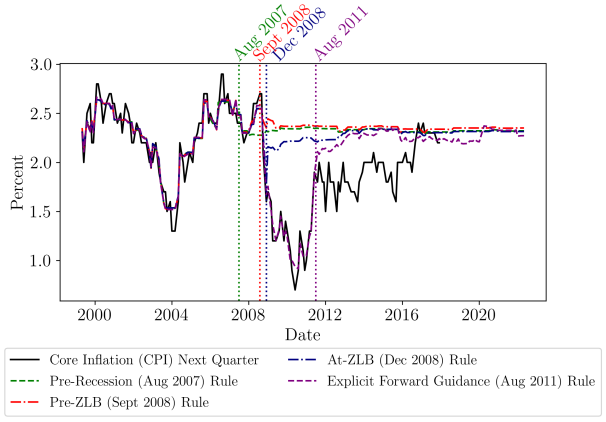
(a) Inflation, Next Quarter



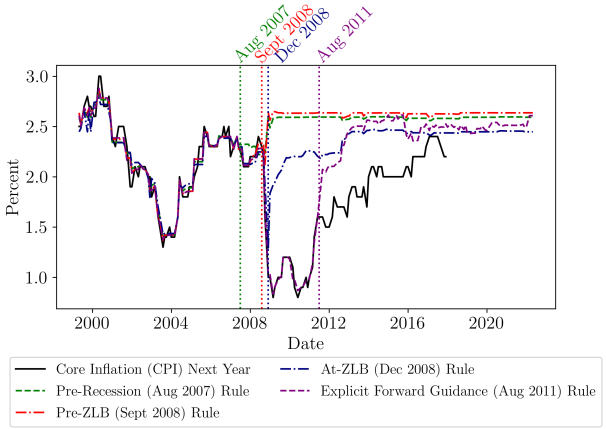
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



(d) Core Inflation, Next Year



Note: The dashed lines are the fitted value from communication rules for the corresponding forecasts of macroeconomic variables estimated on different subperiods in our sample. We use an expanding window. Headline and core CPI inflation are the quarter-over-quarter growth rate in annualized percentage points.

communication as a policy tool, which became increasingly relevant when the Fed's standard policy tool, the fed funds rate, was stuck at the ZLB.

H.2 Expanding Window Communication Rule

In Figure H.23, H.24, and H.25, we plot the fitted values from four different communication rules estimated on expanding subsets of the data. The vertical dotted lines indicate the end of the training sample for the corresponding communication rule. For example, for the vertical line labeled "Window 0" in the lightest blue line, all fitted values to the left of that line are in-sample for the communication rule and everything to the right is out-of-sample. We have fitted values for every window, but we only graph four of them for visual interpretability.

H.3 Expanding Window Shift Indicator

In this section, we present versions of the expanding window shift indicators that we do not normalize the same way that we did in the main text. Recall that the shift indicator represents the degree of changes between communication rules estimated on subsequent windows. More precisely,

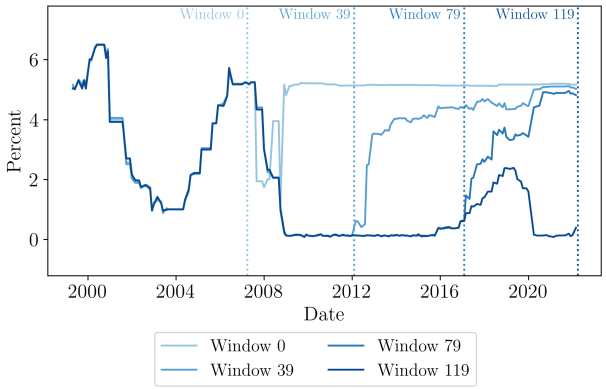
$$\text{Shift Indicator}^{h,h-1,y} \equiv 1 - Corr\left(\hat{y}^h, \hat{y}^{h-1}\right)$$

where h is the estimation window, and y is the output variable, and $\hat{y}^h$ denotes the fitted values from the estimated communication rule. Then, as in the main text, we plot Shift Indicator$^{h,h-1,y}$ for all h windows. We assign the Shift Indicator$^{h,h-1,y}$ with the last date in window h.

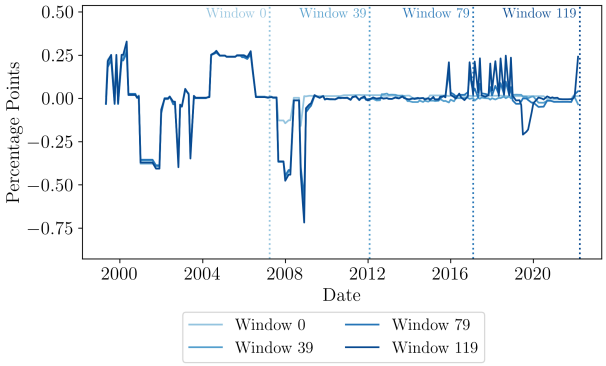
We construct standard errors for the shift indicator with a bootstrap approach. We resample 2500 times for each Shift Indicator$^{h,h+1,y}$ and we plot the 95% confidence intervals in

Figure H.23: Expanding Window Communication Rules for Monetary Policy

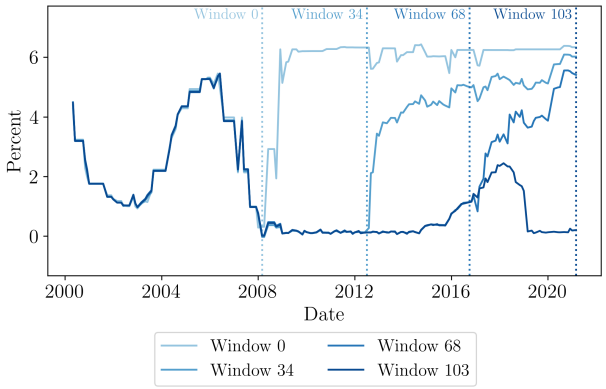
(a) Target Federal Funds Rate



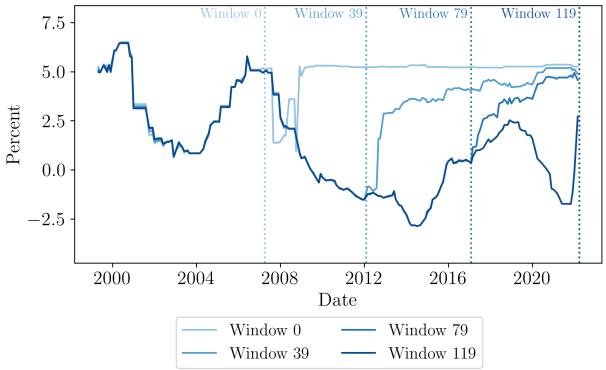
(b) Change in Target Rate



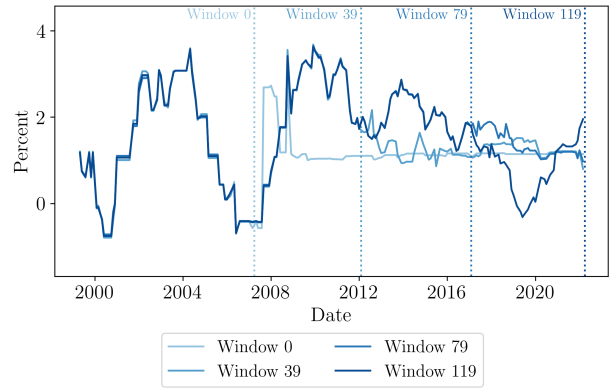
(c) Target Rate Next Year



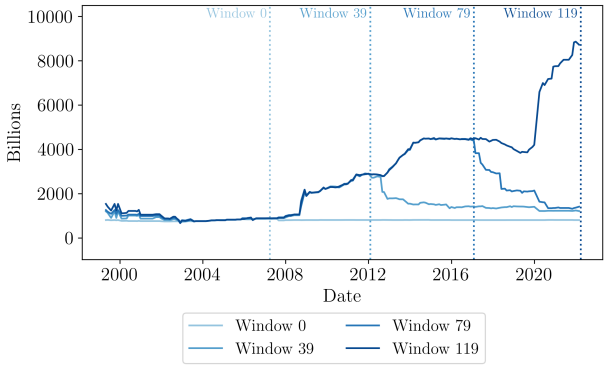
(d) Shadow Rate



(e) 10-year Treasury Minus Federal Funds Rate

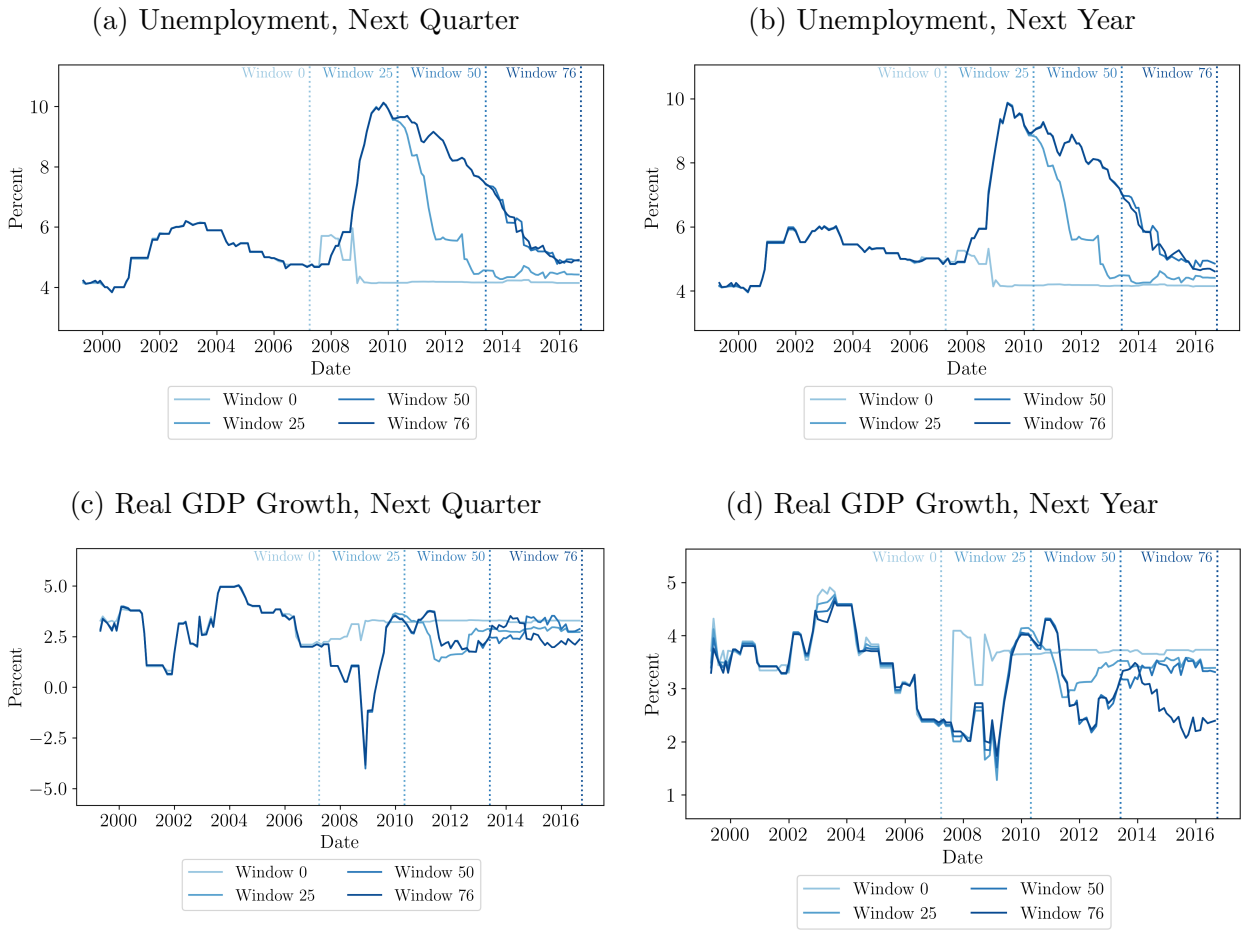


(f) Federal Reserve Total Assets



Note: The lines are the fitted value from communication rules for the corresponding policy estimated on different subsamples of the data (windows). The subsamples are expanding such that window 1 uses all the same training data as window 0 but with one additional observation. We have fitted values for every window, but we only graph four of them for visual interpretability.

Figure H.24: Expanding Window Communication Rules for Real Macro Forecasts



Note: The lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated on different subsamples of the data (windows). Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points. The subsamples are expanding such that window 1 uses all the same training data as window 0 but with one additional observation. We have fitted values for every window, but we only graph four of them for visual interpretability.

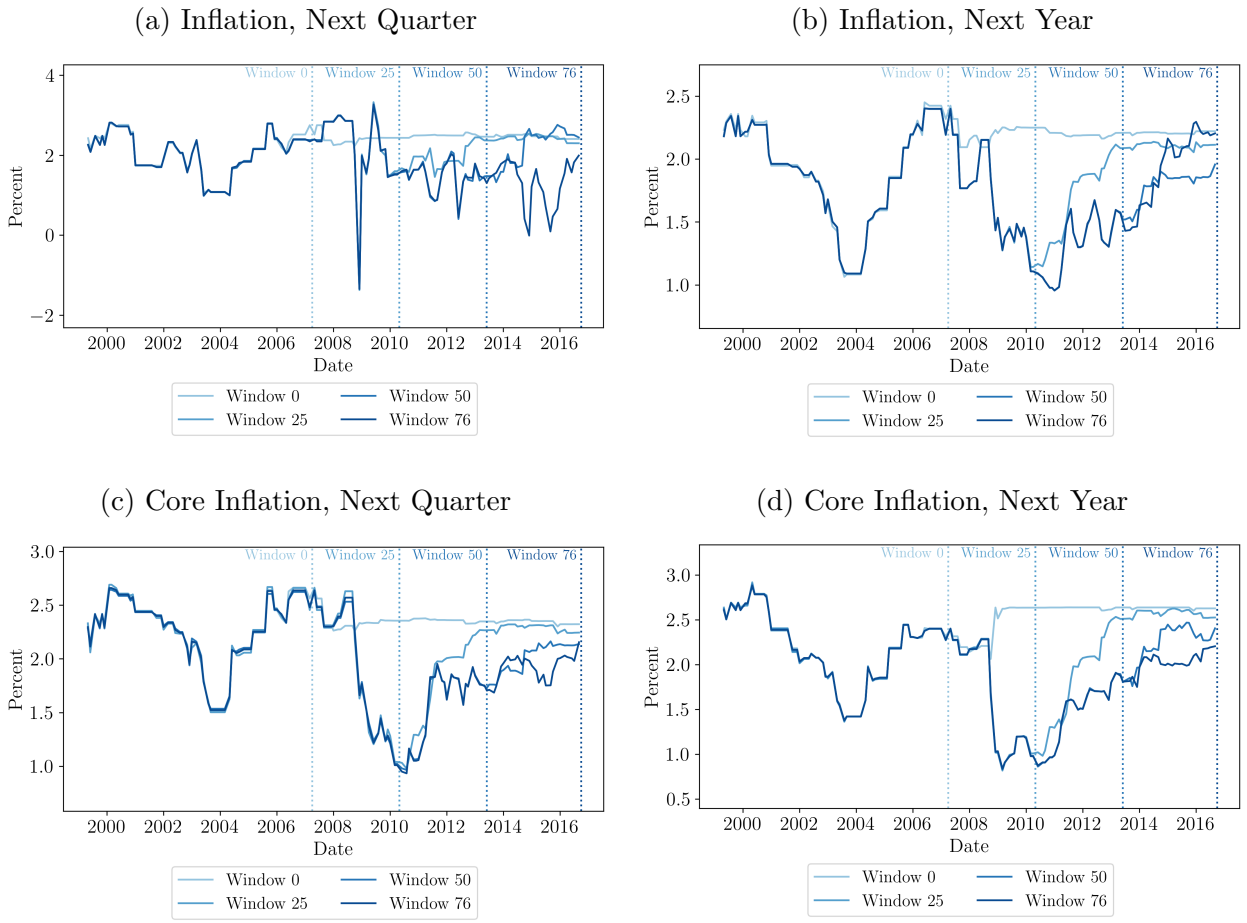
a lighter blue.

In the main text we normalize the shift indicators according to the following expression:

$$\text{Normalized Indicator}^{h,h-1,y} = \frac{\text{Shift Indicator}^{h,h-1,y} - min(\text{Lower CI}^y)}{max(\text{Upper CI}^y) - min(\text{Lower CI}^y)},$$

where $min(\text{Lower CI}^y)$ is the minimum value of the bottom confidence interval for variable y and $max(\text{Upper CI}^y)$ is the maximum value of the upper confidence interval for variable y.

Figure H.25: Expanding Window Communication Rules for Nominal Macro Forecasts



Note: The lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated on different subsamples of the data (windows). Headline and core CPI inflation are the quarter-over-quarter growth rate in annualized percentage points. The subsamples are expanding such that window 1 uses all the same training data as window 0 but with one additional observation. We have fitted values for every window, but we only graph four of them for visual interpretability.

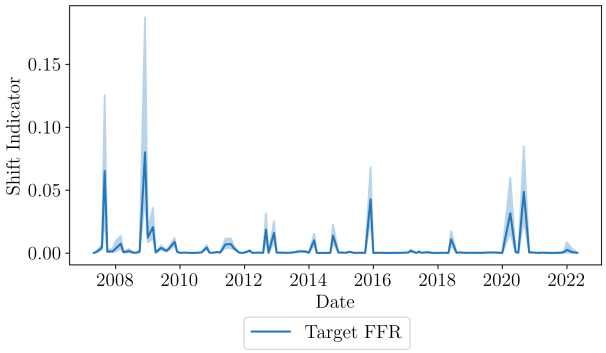
Here in the appendix, in Figure H.26, H.27, and H.28, we now provide the non-normalized figures. The y-axis scales thus vary from plot to plot.

H.4 Pairwise Correlation of Shift Indicators

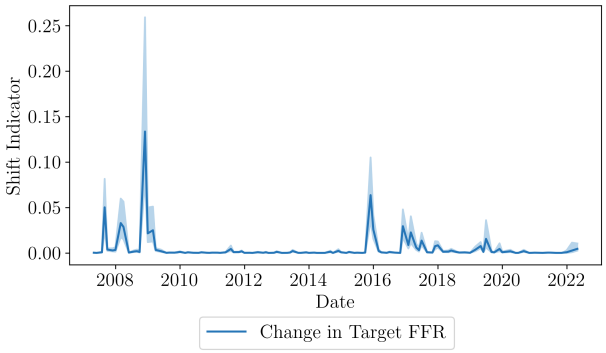
The pairwise correlations between the shift indicators across different communication rules are reported in Table H.14.

Figure H.26: Shifts in Communication Rules for Monetary Policy

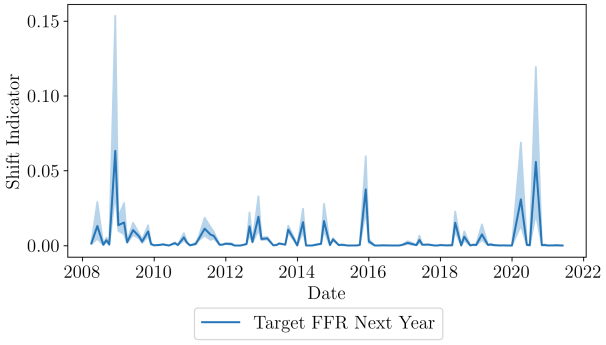
(a) Target Federal Funds Rate



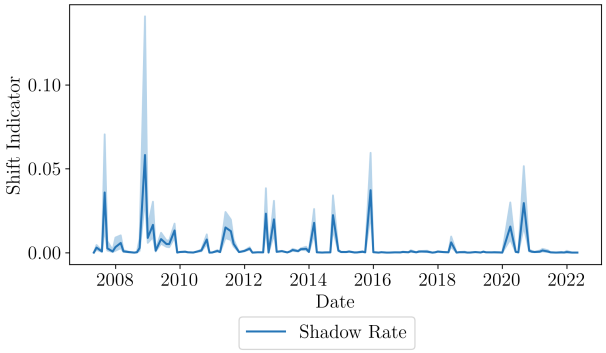
(b) Change in Target Rate



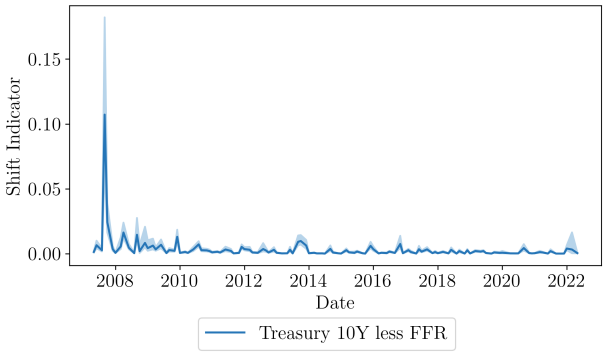
(c) Target Rate Next Year



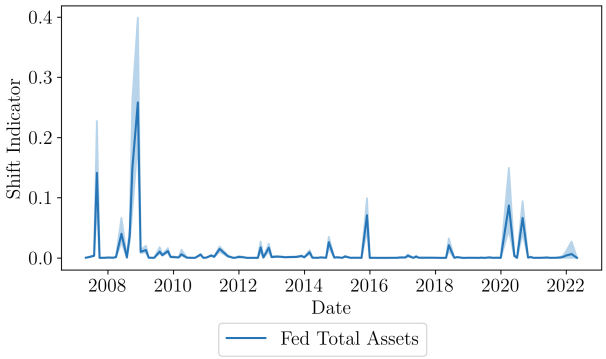
(d) Shadow Rate



(e) 10-year Treasury Minus Federal Funds Rate



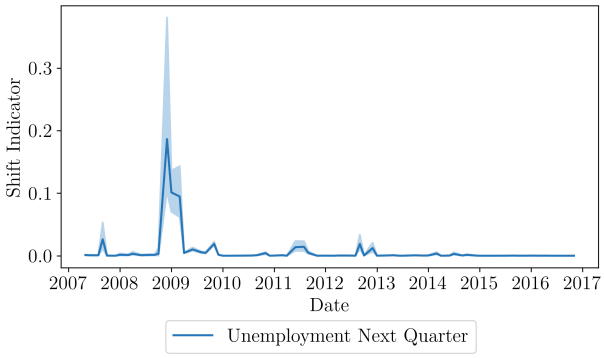
(f) Federal Reserve Total Assets



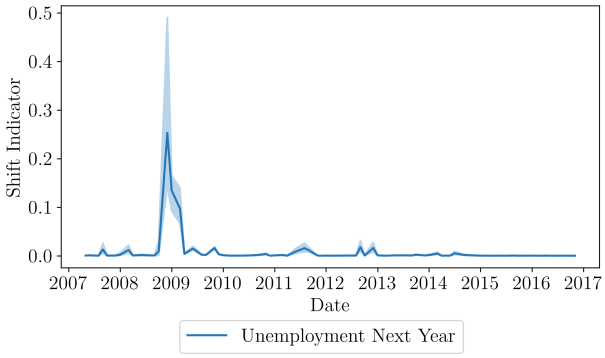
Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

Figure H.27: Shift in Communication Rules for Real Macroeconomic Forecasts

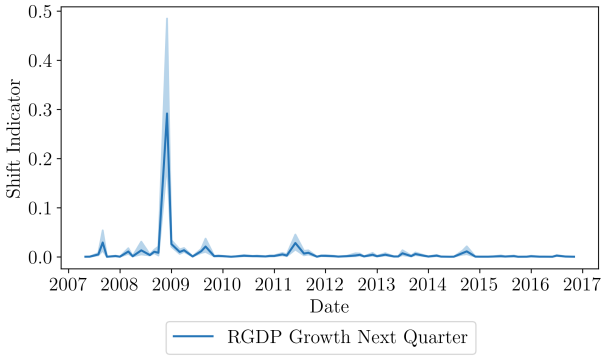
(a) Unemployment, Next Quarter



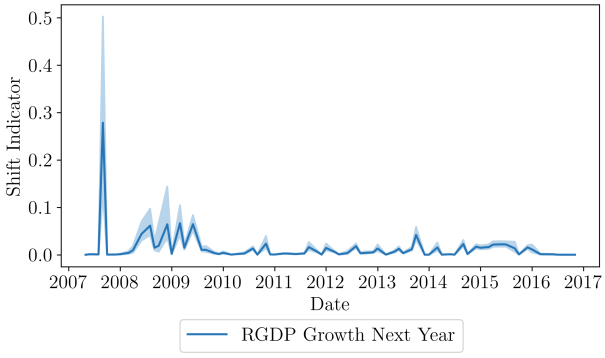
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



(d) Real GDP Growth, Next Year



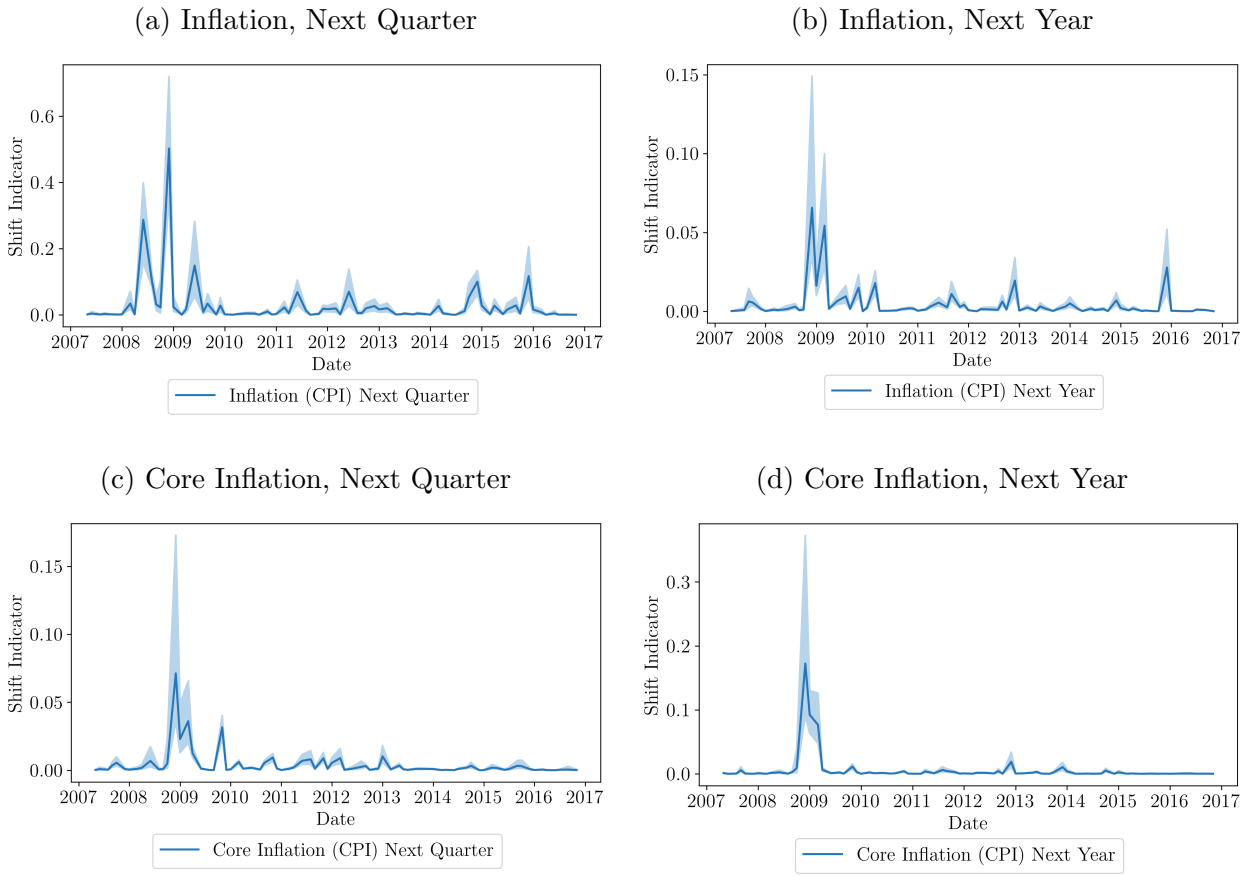
Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on expanding windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

H.5 Rolling Window Communication Rule

In addition to the expanding window, in this section we provide results on a rolling or sliding window. This makes the training sample *size* consistent across windows, but the actual observations enter and exit the training sample as we progress from one window to the next. That is, when we shift to window h we gain the next observation after the end of window $h-1$ and we also drop the oldest observation of $h-1$. The length of the window is fixed at 64 FOMC meetings, which spans 8 years.

We have fitted values (communication rules) for all variables and all windows. To sim-

Figure H.28: Shift in Communication Rules for Nominal Macroeconomic Forecasts



Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on expanding windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

plify the visuals, we plot the communication rules from four windows for each variable. Figure H.29 plots the communication rules for policy variables. Figure H.30 and H.31 plot the communication rules for macroeconomic forecast variables.

H.6 Rolling Window Shift Indicator

This section presents the shift indicators when the time-varying communication rules are estimated with rolling windows. The procedure for the shift indicator estimation is the same as described for the expanding windows. To be consistent with the non-normalized expand-

Figure H.29: Rolling Window Communication Rules for Monetary Policy

Note: The lines are the fitted value from communication rules for the corresponding policy estimated on different subsamples of the data (windows). The subsamples are rolling or sliding windows. We have fitted values for every window, but we only graph four of them for visual interpretability.

ing window shift indicators of Section H.3 above, here we also present the non-normalized indicators.

Figure H.30: Rolling Window Communication Rules for Real Macroeconomic Forecasts

(a) Unemployment, Next Quarter

(b) Unemployment, Next Year

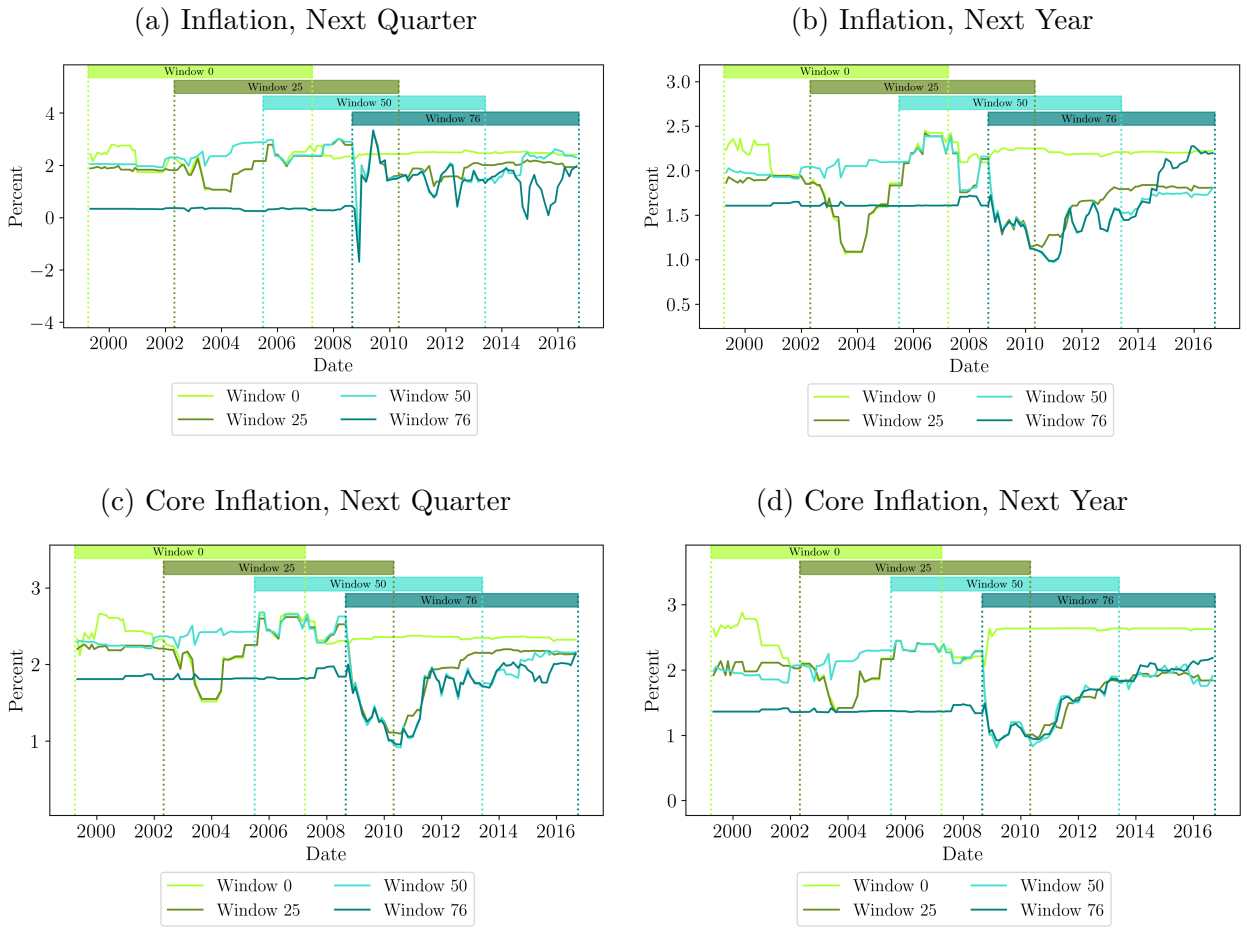
(c) Real GDP Growth, Next Quarter

(d) Real GDP Growth, Next Year

Note: The lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated on different subsamples of the data (windows). Real GDP growth is the quarter-over-quarter growth rate in annualized percentage points. The subsamples are rolling or sliding windows. We have fitted values for every window, but we only graph four of them for visual interpretability.

The reason we prefer the expanding windows specification for our shift indicators is because for expanding windows, the only difference between window h and window $h-1$ is the first FOMC meeting that is out-of-sample for window $h-1$. For a rolling window specification, instead, window h and $h-1$ also differ in that the first observation in $h-1$ is no longer in-sample for window h. Therefore it is less clear whether a rolling window shift indicator that is dated t indicates a shift because of the new observation that entered the sample or the old one that dropped from the sample. In this manner, rolling window shift

Figure H.31: Rolling Window Communication Rules for Nominal Macroeconomic Forecasts

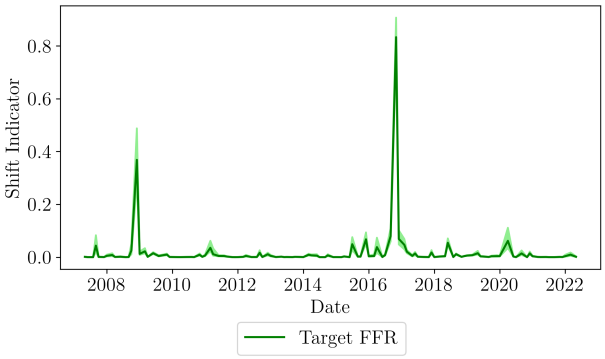


Note: The lines are the fitted value from communication rules for the corresponding forecasts of macro variables estimated on different subsamples of the data (windows). Headline and core CPI inflation are the quarter-over-quarter growth rate in annualized percentage points. The subsamples are rolling or sliding windows. We have fitted values for every window, but we only graph four of them for visual interpretability.

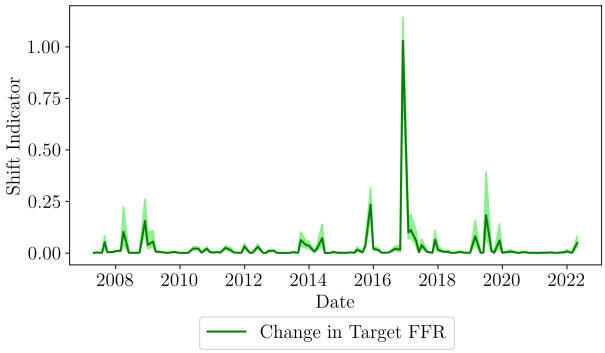
indicators pick up on the same shift *twice*: first when the time of the shift enters the sample, and then again when that same observation drops out from the sample.

Figure H.32: Shifts in Rolling Communication Rules for Monetary Policy

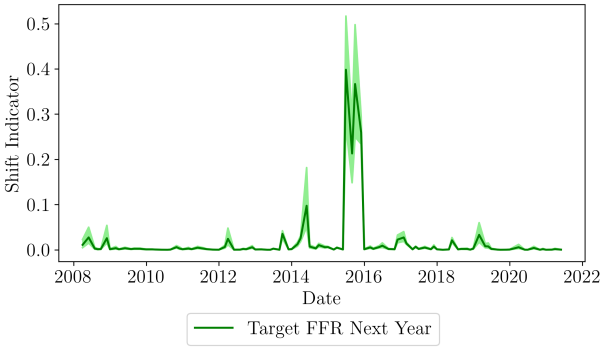
(a) Target Federal Funds Rate



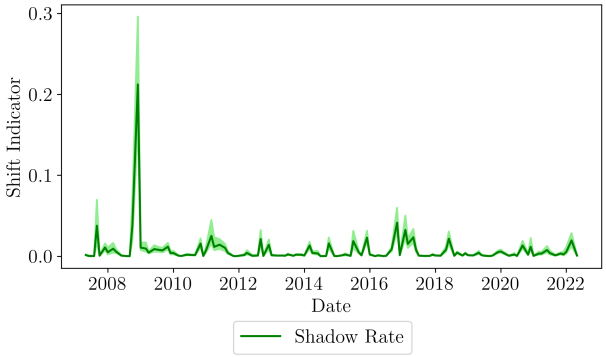
(b) Change in Target Rate



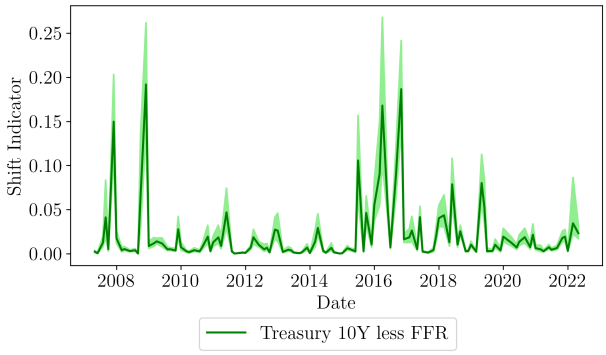
(c) Target Rate Next Year



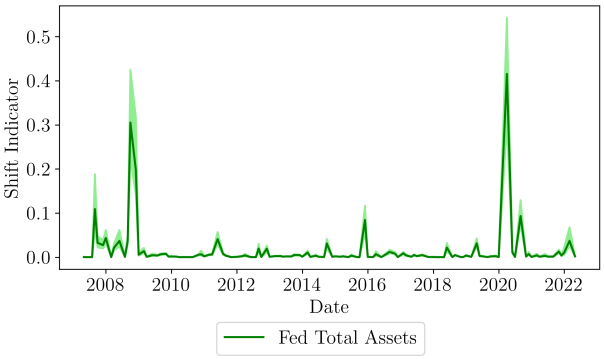
(d) Shadow Rate



(e) 10-year Treasury Minus Federal Funds Rate



(f) Federal Reserve Total Assets



Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on rolling windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

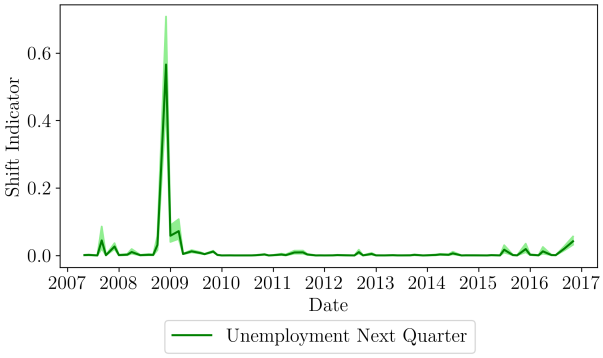
Table H.14: Shift Indicator Pairwise Correlation

	Target FFR	Change in TFFR	TFFR Next Year	Shadow Rate	Fed Total Assets	Treas. 10Y - FFR	Unemp. Next Quarter	Unemp. Next Year	RGDP Next Quarter	RGDP Next Year	Inflation Next Quarter	Inflation Next Year	Core Infl. Next Quarter	Core Infl. Next Year
Target FFR	**1.00**	0.75	0.96	0.94	0.84	0.51	0.71	0.69	0.73	0.64	0.59	0.72	0.63	0.67
Change in Target FFR	0.75	**1.00**	0.63	0.71	0.73	0.34	0.76	0.77	0.83	0.42	0.69	0.74	0.69	0.75
Target FFR Next Year	0.96	0.63	**1.00**	0.92	0.75	0.27	0.75	0.76	0.77	0.46	0.76	0.80	0.71	0.74
Shadow Rate	0.94	0.71	0.92	**1.00**	0.77	0.39	0.68	0.65	0.68	0.48	0.58	0.72	0.62	0.63
Fed Total Assets	0.84	0.73	0.75	0.77	**1.00**	0.41	0.66	0.66	0.79	0.52	0.68	0.60	0.62	0.65
Treasury 10Y less FFR	0.51	0.34	0.27	0.39	0.41	**1.00**	0.13	0.07	0.12	0.87	0.01	0.07	0.05	0.05
Unemployment Next Quarter	0.71	0.76	0.75	0.68	0.66	0.13	**1.00**	0.99	0.83	0.29	0.62	0.85	0.90	0.99
Unemployment Next Year	0.69	0.77	0.76	0.65	0.66	0.07	0.99	**1.00**	0.86	0.22	0.66	0.83	0.89	0.99
RGDP Growth Next Quarter	0.73	0.83	0.77	0.68	0.79	0.12	0.83	0.86	**1.00**	0.25	0.81	0.69	0.80	0.85
RGDP Growth Next Year	0.64	0.42	0.46	0.48	0.52	0.87	0.29	0.22	0.25	**1.00**	0.23	0.25	0.20	0.20
Inflation (CPI) Next Quarter	0.59	0.69	0.76	0.58	0.68	0.01	0.62	0.66	0.81	0.23	**1.00**	0.58	0.62	0.64
Inflation (CPI) Next Year	0.72	0.74	0.80	0.72	0.60	0.07	0.85	0.83	0.69	0.25	0.58	**1.00**	0.83	0.84
Core Inflation (CPI) Next Quarter	0.63	0.69	0.71	0.62	0.62	0.05	0.90	0.89	0.80	0.20	0.62	0.83	**1.00**	0.90
Core Inflation (CPI) Next Year	0.67	0.75	0.74	0.63	0.65	0.05	0.99	0.99	0.85	0.20	0.64	0.84	0.90	**1.00**
Average	**0.74**	**0.70**	**0.73**	**0.70**	**0.69**	**0.31**	**0.73**	**0.72**	**0.72**	**0.43**	**0.61**	**0.68**	**0.68**	**0.71**

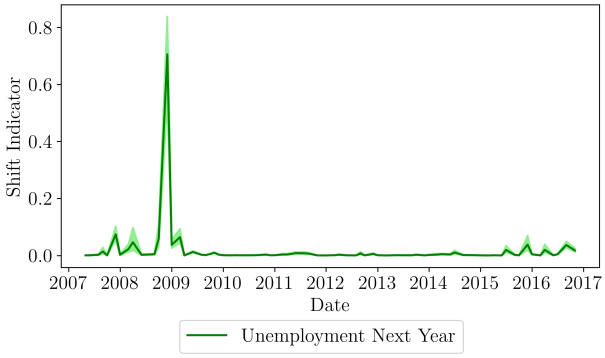
Note: This table reports the pairwise correlation between the shift indicator series. We log transform and standardize the shift indicators. In the appendix, we have included the standard errors and R^2 values.

Figure H.33: Shift in Rolling Communication Rules for Real Macroeconomic Forecasts

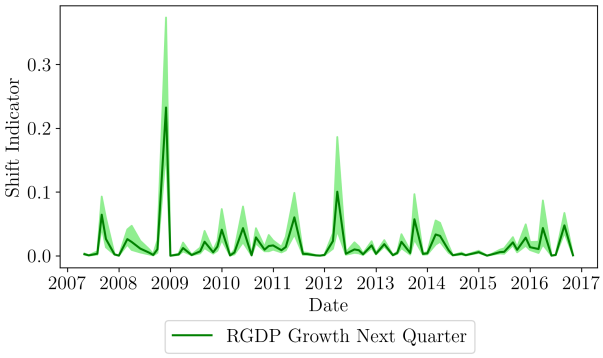
(a) Unemployment, Next Quarter



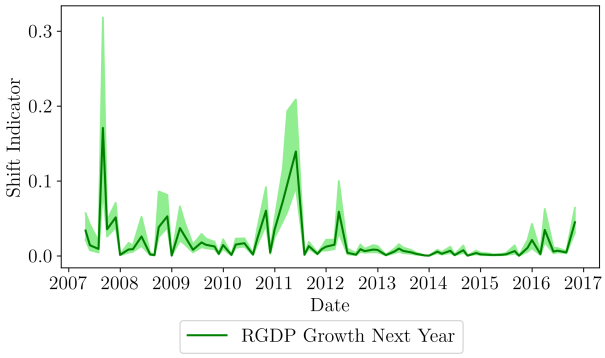
(b) Unemployment, Next Year



(c) Real GDP Growth, Next Quarter



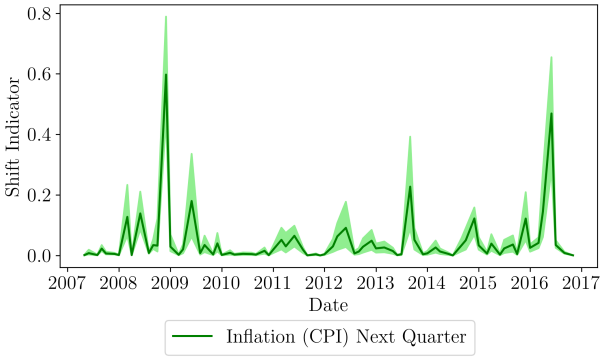
(d) Real GDP Growth, Next Year



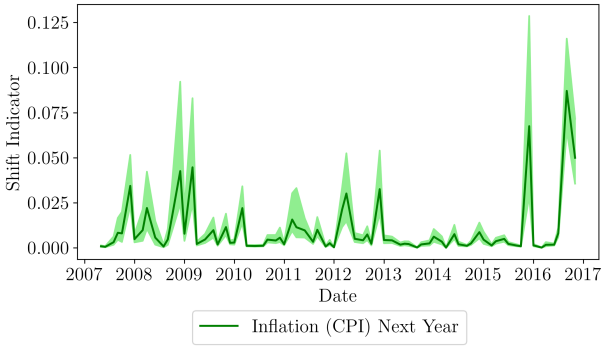
Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on rolling windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

Figure H.34: Shift in Rolling Communication Rules for Nominal Macroeconomic Forecasts

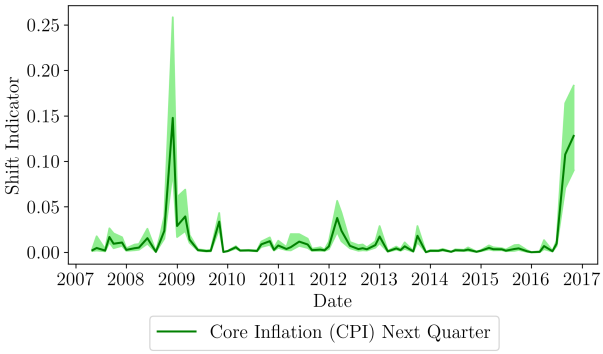
(a) Inflation, Next Quarter



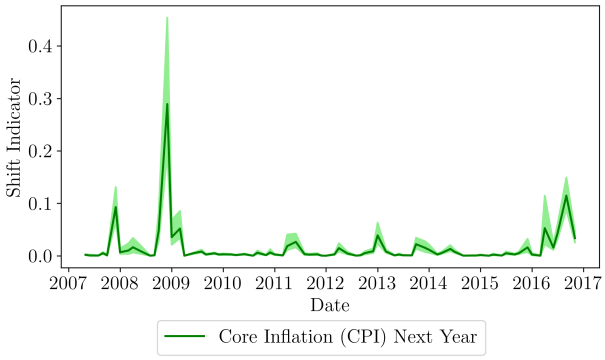
(b) Inflation, Next Year



(c) Core Inflation, Next Quarter



(d) Core Inflation, Next Year



Note: The shift indicator is one minus the correlation between the fitted values from communication rules estimated on rolling windows ending with meeting t and meeting $t-1$. The higher this indicator, the more the communication rule changed from meeting $t-1$ to t.

I Professional Forecaster Dispersion

In this section we provide the full regression outputs for our analysis that compares our shift indicator with the dispersion of SPF forecasts of macroeconomic variables: RGDP growth, employment, headline and core inflation, and housing starts. In addition to the shift indicator for the communication rule for the target federal funds rate, we include regressors for the monetary surprise (Nakamura and Steinsson, 2018), lagged dispersion, and year fixed effects. We interact the monetary surprise measure with our shift indicator. The following regressions are at the quarterly frequency, and we sum monetary surprises and shift indicators for FOMC meetings within the same quarter.

For all variables in the regression, we apply a log transformation. Furthermore, in order to simplify the interpretation of the coefficient on the interaction term, we also shift our transformed variables so they are all positive. So for a variable x, we transform it as follows:

$$\log(x) - \min(\log(x))$$

Table I.15: SPF Dispersion in RGDP Growth Forecasts

	Horizon, k				
	(0)	(1)	(2)	(3)	(4)
Shift Indicator	0.219***	0.259***	0.161***	0.13***	0.124***
	(0.055)	(0.058)	(0.042)	(0.037)	(0.042)
NS Monetary Surprise	0.581***	0.553***	0.328**	0.215	0.221
	(0.186)	(0.198)	(0.144)	(0.13)	(0.15)
Interaction	-0.082***	-0.093***	-0.052***	-0.049***	-0.045**
	(0.024)	(0.026)	(0.019)	(0.017)	(0.02)
Lagged Dispersion	-0.057	-0.13	-0.068	-0.206	-0.263*
	(0.122)	(0.119)	(0.121)	(0.125)	(0.141)
Year FE	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
N	58	58	58	58	58
R^2	0.805	0.81	0.819	0.803	0.693
Adj. R^2	0.708	0.715	0.728	0.704	0.54

Table I.16: SPF Dispersion in Employment Forecasts

	Horizon, k				
	(0)	(1)	(2)	(3)	(4)
Shift Indicator	0.292***	0.262***	0.201***	0.145**	0.195***
	(0.083)	(0.071)	(0.058)	(0.066)	(0.053)
NS Monetary Surprise	0.562*	0.528**	0.371*	0.097	0.317*
	(0.291)	(0.246)	(0.195)	(0.226)	(0.184)
Interaction	-0.097**	-0.093***	-0.068**	-0.031	-0.056**
	(0.038)	(0.032)	(0.026)	(0.03)	(0.024)
Lagged Dispersion	0.12	0.014	-0.026	-0.084	-0.127
	(0.118)	(0.115)	(0.124)	(0.152)	(0.129)
Year FE	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
N	58	58	58	58	58
R^2	0.806	0.855	0.869	0.789	0.795
Adj. R^2	0.709	0.782	0.803	0.683	0.692

Table I.17: SPF Dispersion in Inflation Forecasts

	Horizon, k				
	(0)	(1)	(2)	(3)	(4)
Shift Indicator	0.15**	0.06	0.12***	0.122***	0.06*
	(0.065)	(0.04)	(0.033)	(0.031)	(0.033)
NS Monetary Surprise	0.468**	0.199	0.359***	0.318***	0.19
	(0.229)	(0.143)	(0.118)	(0.107)	(0.115)
Interaction	-0.056*	-0.02	-0.045***	-0.041***	-0.027*
	(0.03)	(0.018)	(0.015)	(0.014)	(0.015)
Lagged Dispersion	-0.089	0.119	-0.059	-0.198	-0.169
	(0.152)	(0.171)	(0.132)	(0.119)	(0.162)
Year FE	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
N	58	58	58	58	58
R^2	0.487	0.735	0.765	0.79	0.68
Adj. R^2	0.231	0.603	0.647	0.685	0.52

Table I.18: SPF Dispersion in Core Inflation Forecasts

	Horizon, k				
	(0)	(1)	(2)	(3)	(4)
Shift Indicator	0.113**	0.054	0.105***	0.067*	0.072**
	(0.047)	(0.045)	(0.035)	(0.037)	(0.035)
NS Monetary Surprise	0.428**	0.104	0.279**	0.147	0.302**
	(0.165)	(0.16)	(0.127)	(0.131)	(0.123)
Interaction	-0.05**	-0.016	-0.036**	-0.02	-0.032*
	(0.021)	(0.021)	(0.016)	(0.017)	(0.016)
Lagged Dispersion	0.007	0.019	0.207	0.057	0.161
	(0.151)	(0.172)	(0.166)	(0.17)	(0.148)
Year FE	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
N	58	58	58	58	58
R^2	0.744	0.803	0.85	0.808	0.791
Adj. R^2	0.616	0.705	0.775	0.712	0.686

Table I.19: SPF Dispersion in Housing Forecasts

	Horizon, k				
	(0)	(1)	(2)	(3)	(4)
Shift Indicator	0.091*	0.218***	0.175***	0.181***	0.19***
	(0.046)	(0.071)	(0.057)	(0.052)	(0.058)
NS Monetary Surprise	0.308*	0.487*	0.504**	0.461**	0.501**
	(0.161)	(0.241)	(0.2)	(0.182)	(0.196)
Interaction	-0.05**	-0.095***	-0.083***	-0.076***	-0.073***
	(0.021)	(0.032)	(0.026)	(0.024)	(0.026)
Lagged Dispersion	-0.254*	-0.071	-0.137	-0.303*	-0.24
	(0.141)	(0.153)	(0.161)	(0.159)	(0.159)
Year FE	Yes	Yes	Yes	Yes	Yes
Intercept	Yes	Yes	Yes	Yes	Yes
N	58	58	58	58	58
R^2	0.645	0.714	0.796	0.828	0.833
Adj. R^2	0.467	0.571	0.694	0.741	0.75

J Alternative Text Representations

In this section we provide more information on the alternative text analysis approaches presented in the main text. First, we describe the dictionary approach in more detail, including word lists and cleaning processes. Second, we discuss the GPT approach, including prompt engineering.

J.1 Dictionary Approach

In the dictionary approach, we specify lists of words that represent either topics or measurement and count how many times those key words occur in the text to produce dictionary-based communication rules. Implicitly, the dictionary is like the fixed communication rule in that the association between words and meaning is assumed to be fixed. However, the dictionary method assigns coefficient values ex ante and independent of the output variable data while the baseline approach does not.

Table J.20 contains the word lists we use to identify topics, direction, and some key grammar indicators. In the lists, we provide word stems. For example, with the stem "increas" we would be able to count any words that contain this substring, such as "increase," "increasing," and "increased."

We consider five topics: unemployment, inflation, federal funds rate, large-scale asset purchases (LSAP), and economic growth. We abstract from the timing dimension as there is not enough specific wording to distinguish between one quarter and one year into the future. Additionally, we do not create a word list for our other measure of interest rates, such as the shadow rate or treasuries, because there is not enough distinct vocabulary to distinguish that word list from the target policy rate.

For direction, we make an increasing and a decreasing word list. These lists include words that are indicative of both level and changes. So we have both "increase" and "high" in the

Table J.20: Dictionary-Approach Word Lists

Increasing	['increas', 'rise', 'rising', 'rais', 'elevat', 'up', 'lift', 'strength', 'high', 'jump', 'pressure', 'expan', 'accelerat', 'boost', 'enlarg', 'compound', 'heighten', 'spik', 'inflating', 'swell', 'climb', 'hik', 'escalat', 'gain', 'surg', 'peak', 'large', 'growing', 'amplify', 'intensify', 'pressure', 'build', 'firming', 'favorable', 'grow', 'max', 'recover', 'boom', 'strong', 'robust']
Decreasing	['reduc', 'decreas', 'fall', 'drop', 'low', 'down', 'contract', 'dimish', 'lessen', 'shrink', 'compress', 'small', 'deplet', 'slash', 'ease', 'easing', 'abat', 'dwindl', 'cut', 'curtail', 'subsid', 'taper', 'reced', 'weaken', 'deflat', 'declin', 'soften', 'unfavorable', 'min', 'falter', 'weak', 'frail', 'soft']
Policy	['monetary_policy', 'fundsrate', 'interest', 'stance', 'policy', 'intrate']
Assets	['asset', 'purchas', 'reinvest', 'sheet', 'holdings', 'bond']
Employment	['employ', 'job', 'labor', 'payroll', 'work', 'vacancy', 'vacancies', 'unemploy', 'lay', 'off', 'quit']
Growth	['output', 'growth', 'product', 'perform', 'activity', 'economy', 'economic', 'manufactur', 'industr', 'goods', 'service']
Inflation	['inflati', 'price']
Conjunctions	['nor', 'but', 'or', 'yet', 'so', 'accordingly', 'after', 'also', 'before', 'besides', 'consequently', 'conversely', 'finally', 'furthermore', 'hence', 'however', 'indeed', 'instead', 'likewise', 'meanwhile', 'moreover', 'nevertheless', 'next', 'nonetheless', 'otherwise', 'similarly', 'still', 'subsequently', 'then', 'therefore', 'thus']
Negation	['not']

same list to indicate a statement is generally higher. Being more abstract with the direction list also helps us get a largest number of counts for each FOMC statement due to slight variations in word use.

There is an iterative procedure to construct the dictionary-based communication rules. First we split FOMC statements into sentences. Then we identify the topic of the sentence based on the occurrence of topic words. Finally, we assign direction based on the occurrence of increasing or decreasing words within 10 words of the topic word. Then based on the sentence score, we aggregate up to the statement level. Finally, we use the difference between

the increasing and decreasing sentence counts for each macroeconomic variable to create the final, sentiment-style dictionary measure.

There are a couple special cases that we account for when building the dictionary-based measures. First is negation handling. When the word "not" occurs in a sentence, we flip the sign of the increasing or decreasing count. Similarly, we flip the count for the "employment" words to such that they are consistent with "unemployment." That is, we count increasing employment as decreasing unemployment.

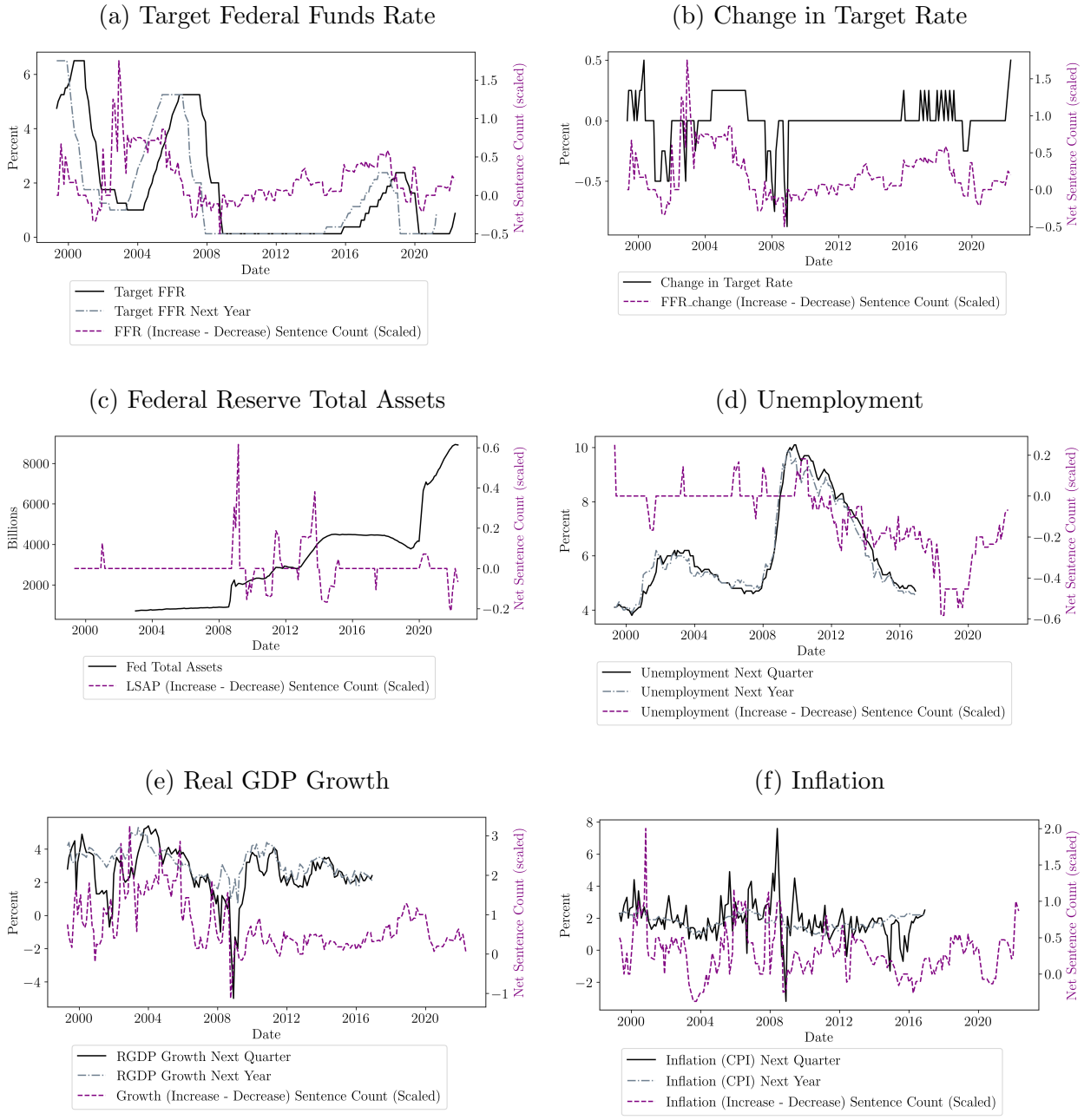
The graphs for the main specification for the dictionary approach are presented in the main text. Here, in Figure J.35, we show the dictionary measures scaled by the length of each FOMC statement. Dictionary measures are based on counting the occurrences of words from the word lists. Therefore, in longer statements there may mechanically be higher counts. This scaling shows some slight differences from what is in the paper, but similarly shows poorer fit compared to the main methodology from the paper.

We consider another robustness exercise where we further split sentences into subsentences when there are conjunctions. The idea is that the FOMC may have a long sentence that has two separate ideas joined by a conjunction. For example, this procedure would split the sentence "unemployment is increasing but inflation is decreasing" into "unemployment is increasing" and "inflation is decreasing." The dictionary-measures with subsentences is displayed in Figure J.36.

J.2 ChatGPT Approach

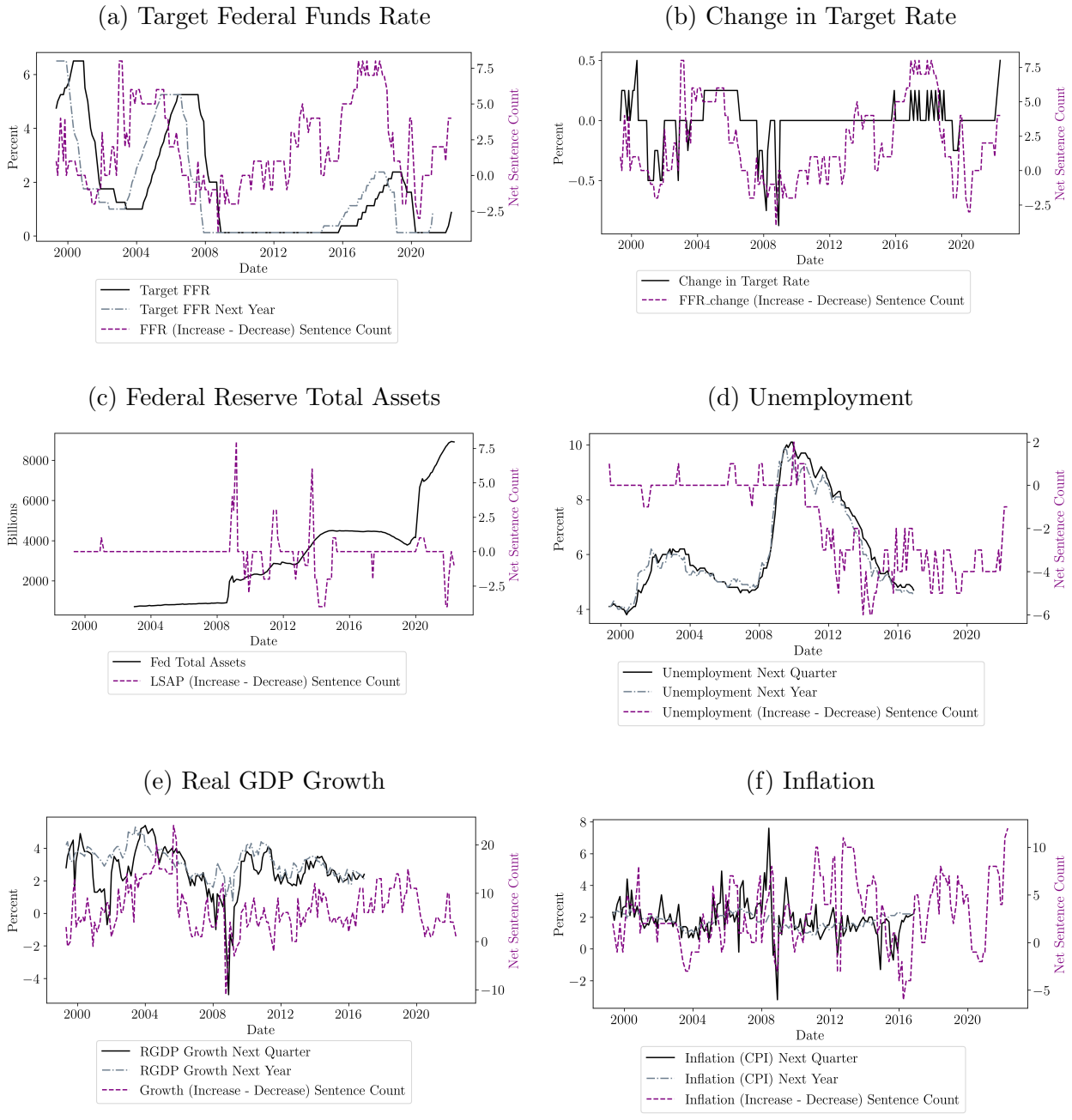
We use GPT-3.5-turbo for the GPT approach. The version of the model was the most recent GPT-3.5 model as of September 2023. We fine-tune the model using a three-shot learning strategy where we show the GPT-3.5-turbo *three* examples of FOMC statement text and match it with the corresponding policy or macro variable of interest. The training

Figure J.35: Dictionary-Based Communication Rules Scaled by Statement Length



Note: The purple line is the dictionary-based measure of the policy variable or macroeconomic forecast. The list of increasing and decreasing words are in the appendix. Implicitly, by using a fixed dictionary we assume the communication rule is stable over the entire sample. However, we are limited in our measure of direction to occurrences of increasing/decreasing words near our variable-relevant words.

Figure J.36: Dictionary-Based Communication Rules with Subsentences



Note: The purple line is the dictionary-based measure of the policy variable or macroeconomic forecast. The list of increasing and decreasing words are in the appendix. Implicitly, by using a fixed dictionary we assume the communication rule is stable over the entire sample. However, we are limited in our measure of direction to occurrences of increasing/decreasing words near our variable-relevant words.

examples we use are from the May 1999, April 2009, and April 2014 FOMC meetings.

We use tailored prompts for every policy and macroeconomic variable we are trying to relate to the text. The skeleton of the prompt is as follows:

> *"Based on the following FOMC statement, what is your best guess of the* `<measure>` *the Federal Reserve thinks the* `<variable>` *will be* `<horizon>`*? FOMC statement:* `<statement>`*"*

Then based on the variable of interest, we fill in the different elements in `< >` based on the variable of analysis. For each FOMC meeting, we input the corresponding statement in `<statement>` and process the responses. The variable-specific prompt entries are displayed in Table J.21. The full prompt includes the three training examples where we pose the question in this format and the supply the answer to the model.

The output from GPT models are strings. Thus, the next step is to extract the numerical forecast from the text response. For this procedure we use regular expressions to identify numbers. We use neighboring references to "percent", "percentage points", "basis points", and "dollars" to determine the unit of the number and to rule out situations where a year or date is extracted. Finally, for the change in the target rate, we also use a dictionary of increasing and decreasing words to assign direction to the extracted number. Many GPT responses state that "there is not enough information" to make a guess, or that "it is too difficult to determine." In those types of situations we report the GPT guess as missing.

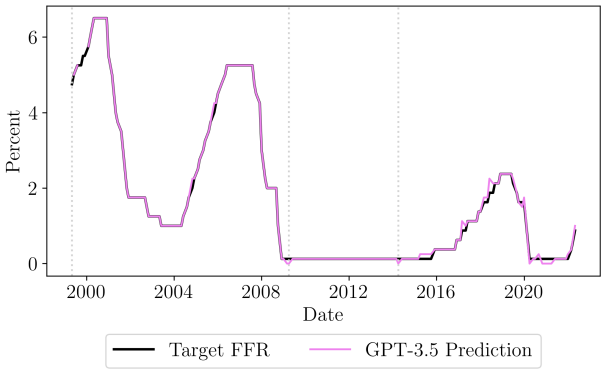
In the graphs below we leave numbers in the FOMC statements. When we remove numbers from the text before entering it into the prompt, then GPT does much worse at predicting the target fed funds rate and responds much more often with null answers. This comparison is in the main text for the target federal funds rate communication rules with GPT.

At present, GPT-3.5 performs better with general text tasks and is unable to handle

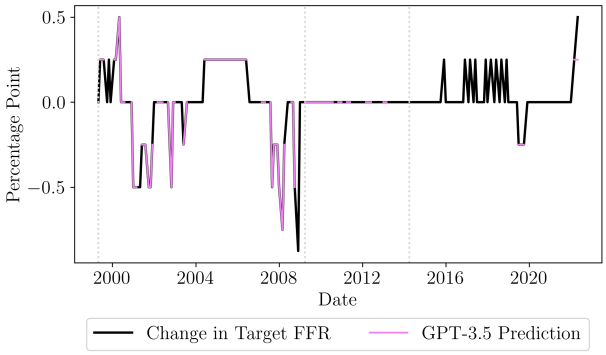
context-specific language without sufficient fine-tuning and training to produce numerical estimates. As we employ a three-shot learning approach, this is very limited fine-tuning. Rather that pursuing additional training, one could choose to simplfy the estimation problem. That is, one may try to use GPT to predict *discretized* outcome variables, such as "high" versus "low" values for unemployment or "increase" versus "decrease" categories for changes in the target policy rate. As is generally the case with NLP approaches, GPT appears to be more tailored to perform high accuracy classification tasks rather than regression tasks.

Figure J.37: ChatGPT Communication Rules for Monetary Policy

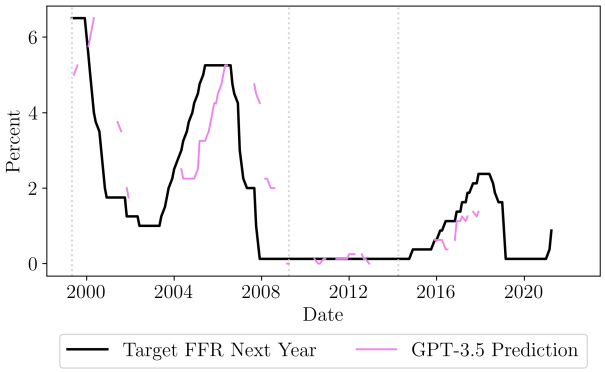
(a) Target Federal Funds Rate



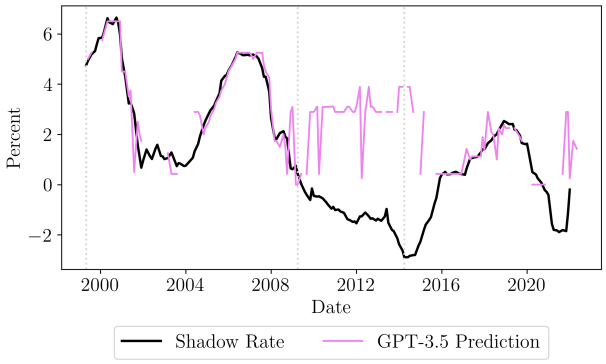
(b) Change in Target Rate



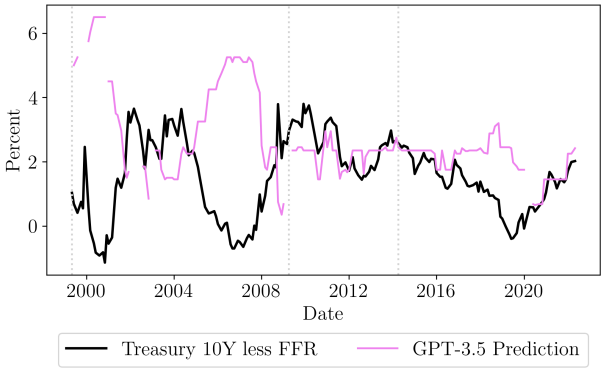
(c) Target Rate, Next Year



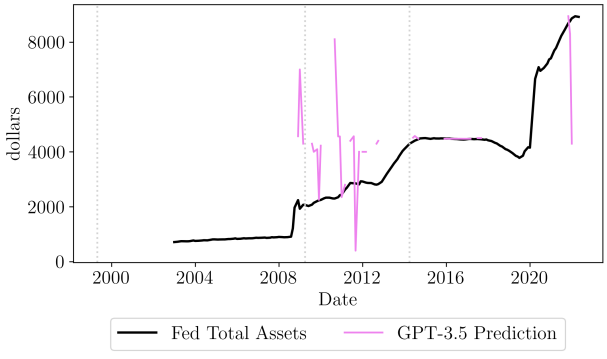
(d) Shadow



(e) 10-year Treasury Minus Federal Funds Rate



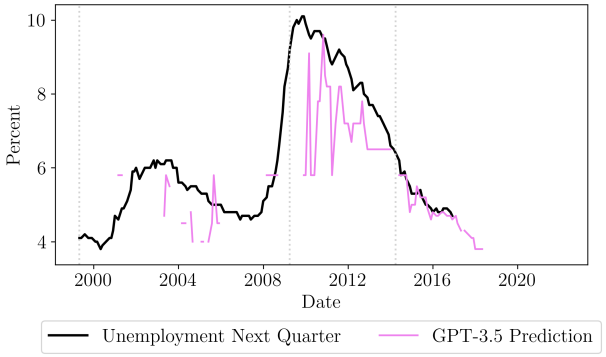
(f) Federal Reserve Total Assets



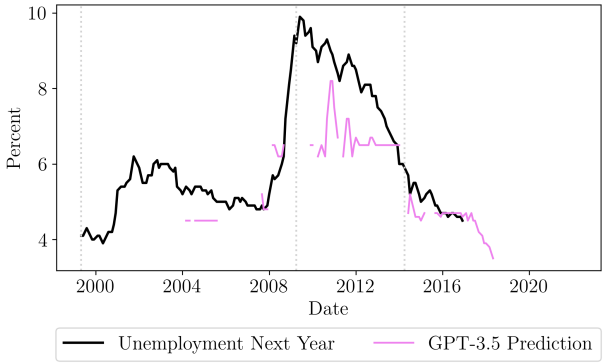
Note: The pink line is the GPT-3.5 communication rule. The vertical gray dotted lines represent the three observations used in training for three-shot learning. Implicitly, we assume the communication rule is stable over the entire sample. If GPT-3.5 responded without a number, then the value is documented as missing.

Figure J.38: ChatGPT Communication Rules for Macroeconomic Forecasts

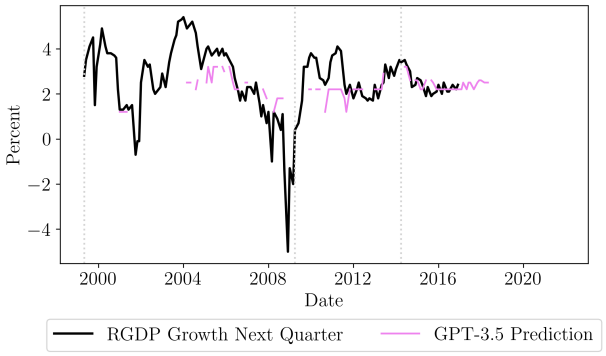
(a) Unemployment, Next Quarter



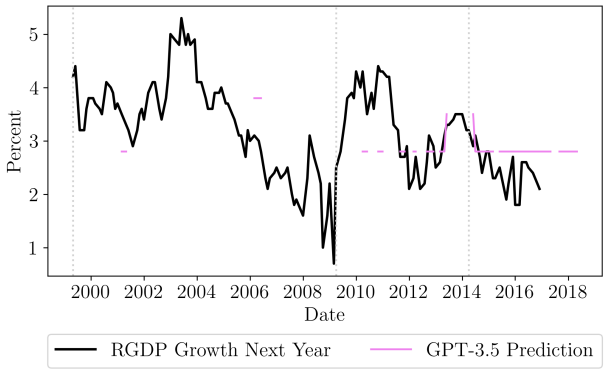
(b) Unemployment, Next Year



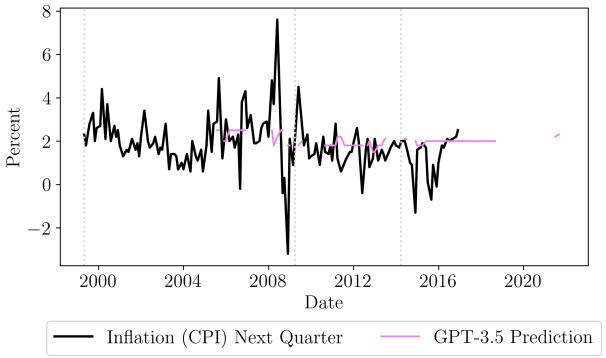
(c) Real GDP Growth, Next Quarter



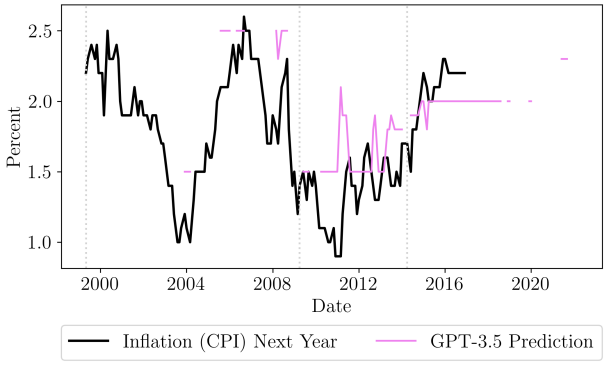
(d) Real GDP Growth, Next Year



(e) Inflation, Next Quarter



(f) Inflation, Next Year



Note: The pink line is the GPT-3.5 communication rule. The vertical gray dotted lines represent the three observations used in training for three-shot learning. Implicitly, we assume the communication rule is stable over the entire sample. If GPT-3.5 responded without a number, then the value is documented as missing.

Table J.21: ChatGPT Prompt Options by Variable

	Measure `<measure>`	In-text Variable Description `<variable>`	Horizon `<horizon>`
Target FFR	percent	target interest rate, called the federal funds rate,	when they release this statement
Change in Target FFR	percentage point change	change in the target interest rate, called the federal funds rate,	when they release this statement
Target FFR Next Year	percent	target interest rate, called the federal funds rate,	next year
Shadow Rate	percent	implied target rate, also called the shadow rate,	when they release this statement
Treasury 10Y less FFR	percent	10 year Treasury bond yield	when they release this statement
Fed Total Assets	billions of dollars	Fed's total asset holdings	when they release this statement
Unemployment Next Quarter	percent	unemployment rate	next quarter
Unemployment Next Year	percent	unemployment rate	next year
RGDP Growth Next Quarter	percent	economic output growth	next quarter
RGDP Growth Next Year	percent	economic output growth	next year
Inflation (CPI) Next Quarter	percent	inflation	next quarter
Inflation (CPI) Next Year	percent	inflation	next year