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## ORIGINAL ARTICLE

# Financial stability and the Fed: Evidence from congressional hearings

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## Abstract

This article retraces how financial stability considerations interacted with US monetary policy before and during the Great Recession. Using text-mining techniques, this article innovates by constructing indicators for financial stability sentiment expressed during testimonies of five Federal Reserve Chairs. Including these text-based measures adds explanatory power to Taylor-rule models. Negative financial stability sentiment coincided with a more accommodative monetary policy stance than implied by standard Taylor-rule factors, even during the decades before the Great Recession. These findings are consistent with a preference for monetary policy reacting to financial instability rather than acting pre-emptively to a perceived build-up of risks.

## KEYWORDS

financial stability, monetary policy, Taylor rule, text mining

## JEL CLASSIFICATION

E52; E58; N12

## 1 | INTRODUCTION

This article retraces how financial stability considerations interacted with US monetary policy before and during the Great Recession. An important contribution compared to related papers (Oet & Lyytinen, 2017; Peek et al., 2016) is our focus on congressional hearings on monetary policy. With some exceptions, such as Jansen (2011) and Schonhardt-Bailey (2013), these so-called Humphrey–Hawkins hearings have received little attention so far in the literature. Given the broader debate on monetary policy objectives to which this article seeks to contribute, focusing on such hearings is important. It is in this particular context that Federal Reserve Chairs most directly interact with the politicians who decide on the monetary policy mandate.

We use a range of text-mining techniques to construct indicators for the Fed's financial stability concerns. A key technique that we employ is the dictionary for financial stability that was recently proposed by Correa et al. (2020). We

**Abbreviations:** AIC, Akaike information criterion; CBO, Congressional Budget Office; ECB, European Central Bank; FOMC, Federal Open Market Committee; FSS, financial stability sentiment; IT, inflation targeting; LDA, latent Dirichlet allocation; NFCI, National Financial Conditions Index; ZLB, zero-lower bound.

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apply this and other text-mining techniques to 72 testimonies of five Federal Reserve Chairs at Congressional hearings on monetary policy. The sample period starts in February 1979, when Chair William Miller testified during the first so-called Humphrey–Hawkins testimony. We also include testimonies by Paul Volcker, Alan Greenspan, Ben Bernanke, and Janet Yellen. The sample ends in July 2014, which allows us to analyze the Fed's policy response to the financial crisis and the Great Recession.<sup>1</sup>

We estimate a number of different Taylor-rule models rather than relying on one single specification. For instance, we estimate models relying on projections given in the semiannual Monetary Policy Reports, Greenbook forecasts, as well as output gap projections by the Congressional Budget Office (CBO). In addition, in line with the recent literature (Coibion & Gorodnichenko, 2012), we allow for both interest rate smoothing and persistent monetary-policy shocks in the estimations.

Our key finding is that indicators for sentiment on financial stability add explanatory power to conventional Taylor-rule models. This finding indicates that when the Federal Reserve Chair pointed to financial stability in discussing the monetary policy stance with members of Congress, the Fed also acted according to these considerations. There are two key dimensions to our findings. First, our conclusions do not depend on including the Great Recession or the aftermath of the 1987 stock market crash in the sample. This indicates that financial stability was, to some extent, already considered to be a relevant factor during more tranquil times. Second, we find that negative sentiment matters to a greater extent than positive sentiment. In particular, negative financial stability sentiment (FSS) coincided with a more accommodative monetary policy stance than implied by standard Taylor-rule factors. Taken together, this would confirm a preference for reacting to episodes of financial instability rather than acting pre-emptively to a perceived build-up of risks. Such a preference would be in line with comments by several Fed officials, such as Greenspan (2002) or Bernanke (2002).

This article's findings are related to current discussions on the interactions between monetary and financial stability. Central bankers now widely agree that macroprudential policy is an important addition to their toolkit (Blinder et al., 2017). However, there is still an ongoing debate among academics and policymakers on the precise implications of the crisis for the interactions between monetary and financial stability (Adrian & Liang, 2018; Smets, 2014; Svensson, 2017). In Norway and New Zealand, the mandate for monetary policy has recently been broadened. In the United States, meanwhile, the Fed's postcrisis role in financial stability remains limited, and responsibility for this policy domain is shared with a number of other institutions (Haltom & Weinberg, 2017). As in the decade before the financial crisis, the debate centers around the question of whether macroprudential policy and financial regulation are sufficiently equipped to deal with financial instability or whether monetary policy should also, at times, be used for leaning against the wind. Our findings suggest that under a dual mandate such as that of the Federal Reserve, financial stability can, at least to some extent, already be factored into monetary policy deliberations.

## 2 | BACKGROUND

### 2.1 | Financial stability and (Fed) monetary policy

One could argue that financial stability would not have figured prominently in monetary policy deliberations at the Federal Reserve in the years before the 2007/08 financial crisis. Since the late 1970s, when its monetary policy objectives were last amended by US Congress, the Fed has operated under a dual mandate of maximum employment and stable prices.<sup>2</sup> In addition, the Federal Reserve Act does not explicitly mention financial stability, although some of its elements do have a clear financial stability connotation.<sup>3</sup> Moreover, prior to the crisis, several Federal Reserve officials expressed doubts on whether the Fed should actively engage with potential asset price booms (Bernanke, 2002; Greenspan, 2002). Financial stability in itself was, therefore, most likely not an explicit—and perhaps an even somewhat overlooked—element of the Fed's monetary policy remit in the decades leading up to the Great Recession. In fact, then-Chair Ben Bernanke concluded as much in a paper marking the Fed's centenary (Bernanke, 2013, p. 9).

Treating monetary stability as separate from financial stability was, of course, common practice before the Great Recession. During the 1990s and 2000s, inflation targeting (IT) became a commonly used monetary policy strategy. First introduced by the Reserve Bank of New Zealand in 1989, around 30 countries had adopted IT by the time the financial crisis started (Hammond, 2012). The key element of IT is a strong emphasis on delivering low and stable inflation (Bernanke, 2003). In addition, an IT strategy involves extensive communication regarding economic forecasts (Bernanke, 2003; Blinder et al., 2008; Svensson, 1997). In practice, central banks usually use a flexible form of IT, meaning that they try to stabilize both inflation and economic growth (Svensson, 2009). However, as discussed by Mishkin (2011),

monetary policy instruments would only focus on minimizing inflation and output gaps, while prudential regulation and supervision would be relied upon to prevent excessive risk-taking that might impair financial stability.

Even so, there had been an active debate on whether such a dichotomy between monetary and financial stability was indeed optimal. In particular, some academics and policymakers pointed to the detrimental effects of asset price boom/bust cycles on the macroeconomy. These effects led them to conclude that asset-price misalignments should play a role in setting monetary policy. By leaning against the wind—that is, pre-emptively tightening monetary policy when asset prices were out of line with fundamentals—the central bank could reduce the likelihood of asset-price busts, or at least limit the fallout. Overall, this approach would lead to improved macroeconomic performance (Borio & Lowe, 2002; Borio & White, 2004; Cecchetti et al., 2000, 2002; Crockett, 2001).

In the end, however, the arguments for a leaning-against-the-wind approach to monetary policy had not carried the day. Under the so-called Jackson Hole consensus, monetary policymakers generally did not target asset prices, did not deflate bubbles by raising rates, and reacted—if at all—only after an asset-price bubble had burst (Issing, 2010). An often-used argument was that it was difficult to identify the existence of bubbles (Greenspan, 2002). Another argument was that monetary policy could only have small effects on the probability of financial crises, which would make intervention prohibitively costly (Bernanke & Gertler, 1999).

## 2.2 | Related literature and contribution

In focusing on the interactions of US monetary policy with financial stability, our article is related to recent work by Peek et al. (2016) and Oet and Lyytinen (2017). These papers both argue that US monetary policy before 2008 already acted in a manner consistent with having financial stability as an additional mandate. Both papers construct measures for financial stability concerns from textual data and show that these measures are relevant variables in Taylor-rule estimations for Fed policy.<sup>4</sup> Given the prior that financial stability would not have figured prominently in monetary policy deliberations, these two papers' findings are both interesting and unexpected, which is why we further study the interaction between these policy areas in this article.

There are three distinctive aspects of our analysis of the interactions between monetary policy and financial stability. First, our article uses evidence from congressional hearings, thus switching the focus to a source of information that has—with some exceptions (Jansen, 2011; Schonhardt-Bailey, 2013)—received little attention so far in the literature. It is in this particular setting that Fed policymakers would most directly interact with the politicians who decide on the monetary policy mandate. If anywhere, this would be the place where Fed Chairs would be expected to outline the extent to which various factors, including financial stability, did or did not interact with monetary policy considerations. Naturally, the hearings would not be the only place where this information could become available. In a robustness check, we will, therefore, compare the information in the hearings with that in statements and minutes of the Federal Open Market Committee (FOMC).

Second, using these hearings enables us to use a communication instrument with a history stretching back to the late 1970s. In contrast, Peek et al. (2016) analyze a sample starting in 1982, while the sample in Oet and Lyytinen (2017) starts in February 1990. A long time series is especially useful in this context, since financial cycles are generally thought to be longer than business cycles (Claessens et al., 2012). In addition, the Fed has operated under a consistent mandate throughout the whole sample period.

Third, we apply a wide range of text-mining techniques. Text mining is helpful to track the concerns that were actually on the minds of policymakers. Therefore, it presents an interesting addition to studies using market indicators (e.g., Baxa et al., 2013). So far, Peek et al. (2016) have used a fairly small set of keywords to measure sentiment in FOMC transcripts, while Oet and Lyytinen (2017) mainly rely on content analysis, that is, a hand-coding of the FOMC minutes. In contrast, our article relies on a broader range of methods for sentiment analysis and topic modeling. In particular, we will rely on a recent sentiment dictionary by Correa et al. (2020) that especially focuses on financial stability in central bank communications.

This article also contributes to a recent literature that applies linguistic methods to the study of monetary policy. Closely related is the book by Schonhardt-Bailey (2013), who uses textual-analysis software to establish the themes of Congressional hearings. One of her conclusions is that members of Congress were most active in challenging the Fed on the themes of governance, accountability, and transparency, while also focusing on fiscal-policy issues. Based on her classification of themes, there seems to have been little direct attention for financial stability. One additional contribution of our article is to reassess this by explicitly trying to establish the role of financial stability in these hearings.

Another related paper using linguistic methods is Friedrich et al. (2019). They measure the prominence of financial stability references in monetary policy statements and subsequently show that this measure is significant in Taylor-rule models for 10 central banks in major advanced countries. Their sample, however, only tracks back to 2000, and for the Fed the relatively short monetary policy press releases are studied.

Our article is also related to work by Correa et al. (2020), who use text-mining techniques to analyze the relation between the financial cycle and sentiment expressed in financial stability reports published by a sample of 35 banks. For the United States, however, their work has to rely on annual reports of the Financial Stability Oversight Committee, as the Federal Reserve only started publishing a Financial Stability Report in November 2018.<sup>5</sup> A final related paper is by Cieslak and Vissing-Jorgensen (2020), who use textual analysis of FOMC minutes and transcripts to present evidence for the Fed put, that is, the idea that monetary policy becomes more accommodative following poor stock returns. Our article differs in having a broader approach to financial stability than only stock market conditions.<sup>6</sup>

### 2.3 | Humphrey–Hawkins hearings

The high levels of inflation and unemployment of the early 1970s motivated US lawmakers to be more closely involved in the formulation of monetary policy. In 1975, Congress adopted House Concurrent Resolution 133. This resolution suggested that the Fed should encourage lower long-term interest rates and focus on promoting maximum employment and stable prices. The resolution also asked that the Board of Governors would regularly consult with Congress. On the one hand, the resolution was nonbinding, and the Fed was formally not required to follow up on these suggestions (Binder & Spindel, 2017). However, starting in May 1975, Fed Chair Arthur Burns regularly appeared before Congressional committees as part of the so-called quarterly dialogue on monetary policy.

Following the Concurrent Resolution, Congress did further formalize oversight over monetary policy in two subsequent acts. The first was the Federal Reserve Reform Act of 1977. Using language very similar to the 1975 concurrent resolution, this Reform Act gave the Fed its dual mandate, while also instructing the Board to consult with Congress at semiannual hearings (Zhu, 2013). The second act was the 1978 Full Employment and Balanced Growth Act. This act had, in fact, a focus that was much broader than monetary policy alone. However, Section 108 of this act—often colloquially referred to as the Humphrey–Hawkins Act after its two main sponsors—gave quite detailed instructions on the information that the Fed was to provide to Congress in the context of the semiannual hearings. For instance, the Fed had to provide written information concerning its objectives and plans with respect to growth in money and credit. Also, it had to discuss the relationship between these objectives and the short-term goals detailed in the Economic Report of the President as well as any goals approved by Congress (Steelman, 2013).<sup>7</sup>

This article uses textual evidence from these Congressional hearings between 1979 and 2014. Each of the congressional hearings has two distinct parts. The starting point is a prepared statement by the Fed Chair, which is largely based on the semiannual Monetary Policy Report. Following this statement, there is a Q&A session in which members of the Congressional committees debate various topics related to monetary policy with the Fed Chair. This article focuses on the introductory statements, given that these would presumably contain the most important information that the Fed wanted to present to Congress on monetary policy. Also, the analysis by Schonhardt-Bailey (2013) suggests that there was often little attention for financial stability in the Q&A session, at least for the earlier part of the sample period.

## 3 | METHODOLOGY

### 3.1 | Measuring FSS

We downloaded all transcripts of the hearings in PDF format from the St. Louis Fed's Fraser web site. We then converted the introductory statements to individual plain-text files. In our analysis, we always use the version that was presented at the House hearings. Using the versions prepared for Senate hearings would lead to similar conclusions, as the text versions of the prepared statements are always nearly identical. Our sample includes 72 Humphrey–Hawkins hearings between 1979 and 2014. Using the R package *quanteda* (Benoit et al., 2018), we create and analyze a corpus of the 72 introductory statements.<sup>8</sup> In creating the corpus, we take a number of standard text-mining steps, such as



removing stopwords and performing word-stemming. Regarding stopwords, we always start from the lists drawn up by Loughran and McDonald (2011).<sup>9</sup> We also remove punctuation and separators as well as transform all characters to lower case.

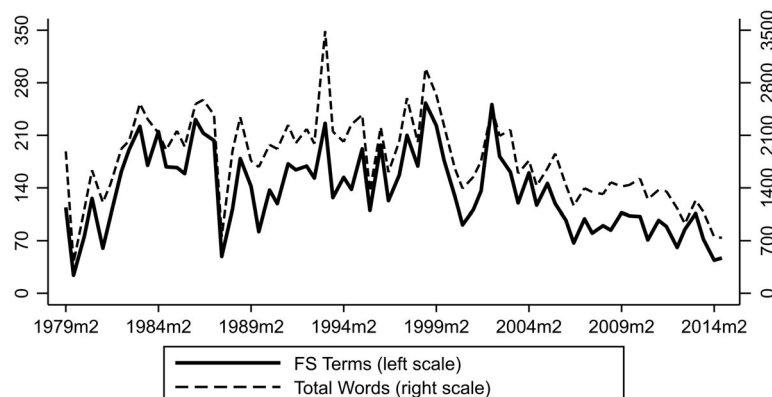
To build indicators for FSS, we mainly use the dictionary proposed by Correa et al. (2020).<sup>10</sup> Their dictionary consists of 391 words, of which 96 are deemed to have a positive (e.g., *calm* and *resilient*) and 295 a negative (e.g., *alarming* and *turmoil*) connotation with respect to financial stability. They constructed this dictionary by having two teams of two independent coders classify individual words from a sample of financial stability reports published by central banks in 35 countries. Positive or negative tones were then attributed to individual words by determining how each of these contributed to the sentiment of the sentence as a whole.

We use the Correa et al. (2020) dictionary as it is specifically tailored to the context of financial stability. Using alternatives such as Harvard-IV might be problematic, as words in that lists could have very different connotations in the context of financial stability. A similar caveat still applies to using the word lists by Loughran and McDonald (2011), even though their lists are already more tailored to a financial-economics context. One concern may be that Correa et al. (2020) focus on a context of financial stability, whereas we are studying communication on monetary policy. To some extent, this concern may be alleviated by the fact that many financial stability discussions during the period for which the dictionary was constructed also discussed links with monetary policy. Nevertheless, we control for standard monetary policy communication indicators as part of our robustness tests.

As an alternative to the dictionary by Correa et al. (2020), we considered using the word list by Peek et al. (2016). However, that list is much shorter than that from Correa et al. (2020), and applying it to the Humphrey–Hawkins testimonies generated too little variation to be included in the Taylor rule models.<sup>11</sup> Lastly, it is also important to note that we go beyond the so-called plain bag-of-words approach and moderate the influence of contextual language by accounting for simple negation patterns of positive terms, as in Loughran and McDonald (2011) and Correa et al. (2020).<sup>12</sup>

Over the years, the relative occurrence of words conveying FSS has remained fairly stable. To illustrate this, Figure 1 plots the number of total words in each statement (dashed line, right scale) alongside the number of financial-stability related terms (solid line, left scale). There is no obvious trend in either the total number of words nor the number of financial-stability related terms. However, there is quite substantial comovement between both series ( $\rho = 0.93$ ). This indicates that financial-stability considerations do not come at the expense of other topics in the Fed Chair's introductory statements.

Table 1 provides a more in-depth look into the frequencies of financial-stability related word counts with stemming (upper panel) and without stemming (lower panel).<sup>13</sup> In the following discussion, we focus on the broader indicator with stemming. It is worth noting, however, that the correlation of both types of indicators is substantial (see also the note to Table 1). In contrast to Correa et al. (2020), our baseline analysis uses only the stemmed versions of individual words. However, as we will discuss in Section 5, stemming does not materially affect the conclusions.



**FIGURE 1** Length of opening statements and financial stability terms. This figure shows the length of the opening statements by five Federal Reserve Chairs at congressional hearings on monetary policy (dashed line, right scale) and the number of financial-stability related terms in these statements (solid line, left scale). Financial stability terms are counted using the dictionary by Correa et al. (2020). The sample period is February 1979–July 2014

**TABLE 1** Financial stability terms in congressional hearings

	Mean	SD	Minimum	Maximum
<i>With stemming</i>				
Negative + positive FS terms	7.65	1.24	5.02	10.55
Negative FS terms	4.41	0.93	2.44	6.85
Positive FS terms	3.24	0.78	1.39	4.91
Negative – positive FS terms	1.17	1.19	–1.21	3.67
<i>Without stemming</i>				
Negative + positive FS terms	3.80	0.76	2.15	5.77
Negative FS terms	2.36	0.71	0.92	4.30
Positive FS terms	1.44	0.43	0.43	2.55
Negative – positive FS terms	0.92	0.89	–1.17	2.83

Notes: This table reports the relative frequency of occurrences of keywords with a financial stability connotation in opening statements (over all words) by five Federal Reserve Chairs at congressional hearings on monetary policy. The word list is taken from Correa et al. (2020). The sample period is February 1979–July 2014. The correlations of the indicators with stemming and without stemming are as follows: Negative + positive:  $\rho = -0.76$ , negative:  $\rho = -0.85$ , positive:  $\rho = -0.75$ , negative – positive:  $\rho = -0.86$ .

As already indicated by Figure 1, financial-stability related terms make up to 10.6% of the total words in each introductory statement with a mean of 7.7% in our sample. On average, there are more negative terms (4.4%) than positive ones (3.2%). Consequently, the difference between negative and positive terms in the bottom line of the upper panel is, on average, larger than zero (1.2%).<sup>14</sup>

### 3.2 | Specifying Taylor rules

To analyze the role of FSS in setting monetary policy, we start by estimating benchmark Taylor rules. These benchmark models include standard macroeconomic factors, but they exclude the text-based indicators. In line with the recent empirical literature (Coibion & Gorodnichenko, 2012), we allow for both interest rate smoothing and a first-order autoregressive error-term specification<sup>15</sup>:

$$i_t = \rho_i i_{t-1} + \alpha + \beta_1 E_t \pi_{t+k} + \beta_2 E_t y_t + u_t \quad (1)$$

$$u_t = \rho_u u_{t-1} + e_t \quad (2)$$

where  $t$  indexes the semiannual frequency,  $i_t$  is the federal funds rate,  $E_t \pi_{t+k}$  is the  $k$  quarters ahead expected inflation rate, and  $E_t y_t$  is the nowcast of the real macroeconomic indicator (see below).

This article studies whether the Fed considered financial stability issues in its monetary policy beyond the reaction to inflation and real activity dynamics. Hence, the benchmark Taylor rules without the financial stability indicators should ideally capture as much of the Fed's interest-rate-setting process as possible. Of course, one can always debate the precise specification and choice of variables in the Taylor rule. Therefore, our approach is estimating a battery of benchmark Taylor rules based on Equations (1) and (2), in the process employing four different sets of forecasts.

First, we follow Orphanides and Wieland (2008) and Jansen (2011) in relying on the projections reported in the semi-annual Monetary Policy Reports. The benefit of this set is that it is timed simultaneously to the Humphrey-Hawkins (HH) hearings. We use the output forecast for the current year as real activity indicator and employ two different nominal indicators: (i) the 12-month ahead expected inflation rate and (ii) the current year inflation forecast. The projections are communicated as a range, rather than a point estimate, so we use the midpoint of the central tendency. The second set is based on the Greenbook forecasts prepared by the Fed's staff before each FOMC meeting. Here, following Coibion and Gorodnichenko (2012), we employ the output growth nowcast as real indicator. As the nominal indicator, we again utilize two different variables: (i) the two-quarter ahead expected inflation rate and (ii) the inflation nowcast. In the third set, we

replace output growth with the corresponding nowcast for the unemployment rate, since the Fed's dual mandate focuses on employment rather than growth. All three specifications rely on the nowcast of gross domestic product (GDP) growth or the unemployment rate rather than an output gap measure, thereby also reflecting the difficulties of measuring the latter in real time (Orphanides & van Norden, 2002).<sup>16</sup> To account for time-variation in potential growth, we employ a fourth specification where we utilize the output gap measure by the CBO as real macroeconomic indicator alongside the inflation forecasts and nowcasts of the Greenbook.<sup>17</sup> In addition to the variation in the type of forecasts employed, we also estimate Taylor rules with and without the autoregressive error term in Equation (2).

We select, for each type of forecast, the Taylor rule with the best fit. That is, we check whether the expected inflation rate or the nowcast of inflation better describes the Fed's interest rate setting and whether or not to include an autoregressive error term. Reflecting the findings of Orphanides (2001) and more recent research of Nikolsko-Rzhevskyy and Papell (2015), we analyze monetary-policy decisions in real-time, which implies that the federal funds rate at the time of the testimony is regressed on the respective latest available forecast. Since all right-hand side variables are observables, we estimate the semiannual Taylor-rule models using maximum likelihood.

In the last step of the analysis, we add indicators for FSS to the Taylor-rule models. We use the information on financial stability in three ways. First, we consider the relevance of any term conveying FSS. This amounts to using the relative frequency of financial stability terms in each introductory statement, that is, the sum of the number of negative and positive words divided by the total number of words. Second, we distinguish between the connotations of the individual terms and include the relative frequency of negative and positive sentiment terms separately in the regression models. Third, we follow Correa et al. (2020) in computing a FSS index as follows:

$$FSS_t = \frac{\#Negativewords_t - \#Positivewords_t}{\#Totalwords_t} \quad (3)$$

This FSS index expresses the net sentiment of the Fed Chair's introduction at each hearing as a fraction of the total number of words in his statement. A negative (positive) value for the FSS index would indicate that the introductory statement, on balance, signaled positive (negative) sentiment on financial stability.

## 4 | MAIN RESULTS

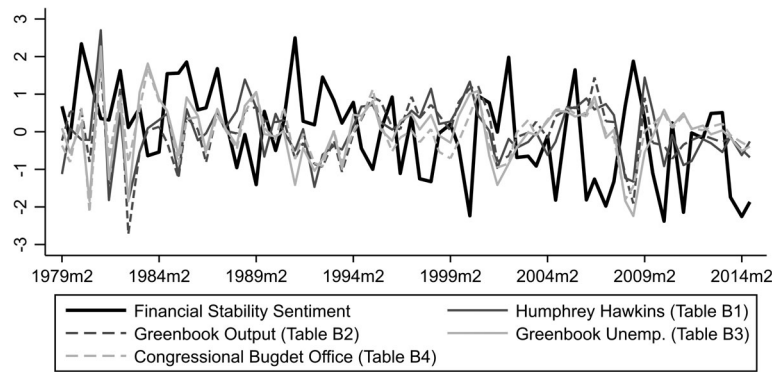
### 4.1 | Benchmark Taylor rules

As the benchmark model, we will use Taylor rules with inflation forecasts and persistent monetary policy shocks for all types of forecasts considered with the exception of the set where we utilize the CBO output gap as real macroeconomic indicator. In this case, the specification without a persistent monetary policy shock features a slightly better fit.<sup>18</sup> This choice follows from a comparison of the log-likelihood and AIC of various models that do not yet include measures for FSS. Tables C1–C4 in Appendix C provide the estimates for the various Taylor rule models. In all four tables, columns 1 and 3 utilize inflation gap forecasts, whereas columns 2 and 4 use the corresponding nowcasts. In addition, columns 1 and 2 account for interest rate smoothing behavior, whereas columns 3 and 4 additionally incorporate persistent monetary policy shocks. In the first three sets of estimations, the models in column 3—that is, those with inflation forecasts and persistent monetary policy shocks—provide the best fit, as indicated by the highest log-likelihood and the lowest AIC. In the final set, the AIC in column 1—that is, for a model with inflation forecasts but without persistent monetary policy shocks—is slightly smaller than in column 3.

In general, the results for standard Taylor-rule factors are intuitive. The coefficients indicate that the Fed tightens policy when expected inflation increases or when the output gap widens. In addition, the estimates indicate that policy is loosened when unemployment increases. Finally, we find evidence for interest rate smoothing, while monetary policy shocks are found to be persistent in Tables C1–C3.

According to the results in column 3 of Table C1, the interest rate smoothing parameter (0.60) is smaller than in previous research (e.g., Coibion & Gorodnichenko, 2012). However, this smaller smoothing parameter can be explained by the lower frequency of our analysis: we consider semiannual hearings, while other papers focus on the eight or so FOMC meetings in a calendar year. We find that 37.8% of the previous period's error carries over into the current period as indicated by the coefficient on the MA(1) term. When calculating the steady state reaction—that is, when dividing the short-run coefficients in Table C1 by 1 minus the interest rate smoothing parameter—the Fed's response to expected





**FIGURE 2** Financial stability sentiment and benchmark Taylor-rule residuals. This figure compares sentiment on financial stability to residuals from the Taylor-rule models in column 3 of Tables C1–C4. The sentiment index is the number of negative words minus the number of positive words, scaled by the total number of words. The word connotations are determined according to the financial-stability dictionary by Correa et al. (2020). For illustrative purposes, the index has been demeaned. The correlations of the FSS indicator with the Taylor-rule residuals are as follows: Humphrey–Hawkins:  $\rho = -0.16$ , Greenbook Output:  $\rho = -0.19$ , Greenbook Unemployment:  $\rho = -0.26$ , Congressional Budget Office:  $\rho = -0.23$

inflation (2.22) meets the Taylor principle. In addition, the adjustment to changes in the output gap nowcast (0.96) and the equilibrium interest rate (1.89) are economically reasonable as well.

Next, we take a closer look at the residuals of the benchmark Taylor rules. Figure 2 shows the demeaned FSS index (solid black line) and the residuals of the benchmark Taylor rules over time. Only 1% of the variation in the federal funds rate is not accounted for by the macroeconomic factors. However, in all four cases there is a negative correlation between the residuals and the FSS index, which ranges between  $-0.16$  and  $-0.26$ . This correlation is a first indication that the Fed's policy stance deviated from that implied by benchmark Taylor rules in connection with financial stability considerations.

## 4.2 | Taylor rules with FSS

We now augment the benchmark Taylor-rule models with measures for the Fed's FSS. Tables 2–5 display various estimation results, where the difference is related to the data source for the macroeconomic forecasts: Table 2 uses the semiannual Monetary Policy Reports; Tables 3 and 4 use the Greenbook; and Table 5 uses CBO data. The first column of each of these four tables always replicates the benchmark result reported in the respective Tables C1–C4. Column 2 then include an indicator for the relative frequency of the financial-stability-sentiment terms (negative plus positive terms over total words). Column 3 look at the separate impact of negative and positive terms. Column 4 use the FSS index as a covariate.

Overall, we find that the tone on financial stability rather than the total amount of attention for this topic is relevant in the Taylor rules. Our first measure, which looks at the combined occurrence of positive and negative terms, does not enter significantly into the Taylor models (column 2 of Tables 2–5). However, when considering negative and positive sentiment words separately (column 3), we find that a one percentage point (pp) increase in the share of negative words is associated with a 0.15–0.21 pp lower federal funds rate.<sup>19</sup> This implies that, at times, the Fed Chair has pointed to adverse developments in financial stability to motivate deviations of the monetary policy stance from a Taylor rule benchmark. When using the SD of the negative-sentiment indicator (0.93) as a yardstick, it follows that the effect of FSS is of economic relevance, as this amounts to 0.14–0.19 pp. The share of positive words, in contrast, is only significant at the 10% level in one of the models (column 3 in Table 5). Such an asymmetry in the role of positive and negative sentiment is in line with findings reported by Peek et al. (2016). Finally, when using the FSS index (columns 4), we generally observe a negative coefficient for FSS. A 1 pp increase in the FSS indicator is associated with a 0.14–0.22 pp lower federal funds rate.<sup>20</sup> Similar to the results in column 3, this effect is of economic relevance when considering the SD of the FSS indicator (1.19). Finally, it is worth noting that the significance of the persistency of monetary policy shocks is reduced when including the financial stability measures, which points toward an omitted-variable bias in the baseline Taylor Rules in Tables C1–C3.

**TABLE 2** Role of financial stability sentiment (forecasts from MP report)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.604*** (0.088)	0.615*** (0.081)	0.644*** (0.077)	0.637*** (0.086)
Constant	0.747*** (0.259)	1.008 (0.635)	0.979 (0.639)	0.780*** (0.244)
Inflation 4Q forecast Gap	0.879*** (0.219)	0.857*** (0.196)	0.832*** (0.171)	0.847*** (0.194)
GDP CY forecast gap	0.381*** (0.109)	0.378*** (0.104)	0.360*** (0.100)	0.361*** (0.103)
Persistent MP shocks	0.378*** (0.146)	0.369*** (0.140)	0.283** (0.138)	0.285** (0.143)
Negative + positive FS terms		−0.038 (0.076)		
Negative FS terms			−0.166 (0.104)	
Positive FS terms			0.108 (0.141)	
Negative – positive FS terms				−0.140 (0.096)
$\sigma$	0.774*** (0.082)	0.773*** (0.080)	0.762*** (0.080)	0.762*** (0.082)
AIC	179.55	181.36	181.24	179.35
Log likelihood	−83.777	−83.681	−82.619	−82.676
Improvement over (1)		0.11%	1.38%	1.31%

*Notes:* This table shows estimates of Taylor rules following Equations (1) and (2). Robust SEs are in parentheses. Columns 2–4 use measures of financial stability sentiment based on introductory statements by Federal Reserve Chairs at Humphrey–Hawkins testimonies. In this table, forecasts for macroeconomic variables are obtained from the semiannual Monetary Policy Reports. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.  $\sigma$ : SE of regression. AIC: Akaike information criterion. Improvement over (1): Relative improvement in log likelihood over the benchmark Taylor rule in column 1.

## 5 | ROBUSTNESS

We consider the robustness of our findings on the role of FSS along 10 dimensions. To conserve space, we will report only the estimates for FSS indicators. A complete overview of estimation results is available on request.

First, we test if FSS expressed by the Fed Chair contains information beyond market-based financial-stability measures. Hence, the National Financial Conditions Index (NFCI)—which is based on 100 financial variables and available from the 1970s onwards—is included as an additional covariate.<sup>21</sup> As indicated by Table 6, the significance of FSS increases when controlling for this market-based measure. In addition, the coefficients on the financial stability indicators are even larger than in Tables 2–5 without the NFCI.

Second, we address the possible critique that the indicators by Correa et al. (2020) are designed for communications on financial stability, whereas we apply them in a context of monetary policy. This may mean that our financial stability indicators also pick up sentiment on monetary policy. In that case, it would not be surprising that the indicators which we construct add explanatory power to Taylor-rule models. To study this point, we follow a common approach in the literature on monetary policy communication (see Blinder et al., 2008) and add indicators based on content analysis to the regression models. We extend the dataset of Jansen (2011), who used two ternary indicators—one for the monetary policy inclination and one for the economic outlook—in his analysis of clarity of Humphrey–Hawkins testimonies and US market volatility. When adding these two indicators for monetary policy communication to the Taylor-rule regressions, we find even stronger indications that financial stability was relevant

**TABLE 3** Role of financial stability sentiment (Greenbook output)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.700*** (0.068)	0.715*** (0.061)	0.729*** (0.062)	0.719*** (0.069)
Constant	0.626*** (0.228)	1.158* (0.675)	1.092 (0.684)	0.696*** (0.209)
Inflation 2Q forecast gap	0.643*** (0.123)	0.615*** (0.111)	0.617*** (0.106)	0.637*** (0.116)
GDP nowcast gap	0.231*** (0.046)	0.230*** (0.046)	0.220*** (0.043)	0.220*** (0.043)
Persistent MP shocks	0.201** (0.087)	0.196** (0.090)	0.141 (0.091)	0.139 (0.092)
Negative + positive FS terms		−0.075 (0.076)		
Negative FS terms			−0.189** (0.090)	
Positive FS terms			0.075 (0.161)	
Negative – positive FS terms				−0.143 (0.097)
$\sigma$	0.760*** (0.083)	0.756*** (0.080)	0.745*** (0.081)	0.748*** (0.084)
AIC	176.94	178.11	178.01	176.50
Log likelihood	−82.472	−82.053	−81.005	−81.249
Improvement over (1)		0.51%	1.78%	1.48%

Notes: See also notes to Table 2. In this table, forecasts for macroeconomic variables are obtained from the Greenbook. The measure for real activity is GDP growth.

for Fed monetary policy. As Table 7 reports, the indicators for FSS are now sometimes significant at the 1% level. The table also shows that the indicators for the monetary policy inclination and the economic outlook have the expected positive sign.

Third, we consider what happens when we exclude the period after which the federal funds rate reached the zero-lower bound (ZLB), that is, our estimations now end with the February 2009 hearing. There are at least two reasons for this sample restriction: (i) the period after February 2009 is an obvious instance where the Fed would point to financial stability considerations and (ii) unconventional monetary policy measures other than interest rate changes were put into action causing the federal funds rate to be an incomplete indicator of the monetary policy stance. As shown in Table 8, the FSS indicator are significant in all four specifications when the sample restriction is in place. In addition, the point estimates for the pre-ZLB period are slightly larger than those for the 1979–2014 sample.

Fourth, we account for the aftermath of the 1987 stock market crash and the onset of the Global Financial Crisis, as these are other obvious times at which the Fed would have pointed to financial instability. We implement the sensitivity check by re-estimating the Taylor rules for the period 1979–2007, but without including the two hearings immediately following the Wall Street crash, that is, those in 1988. As indicated by Table 9, we still find evidence that particularly negative FSS was relevant.

Fifth, we present results using the Wu and Xia (2016) shadow rate instead of the federal funds rate during the zero lower bound period. As Table 10 shows, using this alternative measure for the monetary policy stance—that also account for unconventional monetary policy measures—leads to smaller and insignificant estimates for the sentiment indicators. Further analysis reveals that this is driven by the hearings in 2014, the year when the shadow rate reached its all-time low of −2.99%. An additional contributing factor could be some change in communication starting in 2014.

**TABLE 4** Role of financial stability sentiment (Greenbook unemployment)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.658*** (0.068)	0.665*** (0.065)	0.692*** (0.066)	0.694*** (0.069)
Constant	0.830*** (0.220)	1.067 (0.656)	0.830 (0.685)	0.906*** (0.199)
Inflation 2Q forecast gap	0.665*** (0.146)	0.652*** (0.139)	0.655*** (0.129)	0.651*** (0.131)
Unemployment nowcast gap	-0.274*** (0.087)	-0.269*** (0.085)	-0.258*** (0.077)	-0.256*** (0.081)
Persistent MP shocks	0.229** (0.097)	0.232** (0.097)	0.120 (0.112)	0.123 (0.105)
Negative + positive FS terms		-0.033 (0.079)		
Negative FS terms			-0.208* (0.108)	
Positive FS terms			0.230 (0.181)	
Negative – positive FS terms				-0.216* (0.111)
$\sigma$	0.816*** (0.081)	0.815*** (0.080)	0.789*** (0.073)	0.789*** (0.072)
AIC	187.08	188.94	186.29	184.30
Log likelihood	-87.538	-87.469	-85.145	-85.152
Improvement over (1)		0.08%	2.73%	2.73%

Notes: See also notes to Table 2. In this table, forecasts for macroeconomic variables are obtained from the Greenbook. The measure for real activity is the unemployment rate.

To give an example, common terms like “demand” or “supply” are for the first time not mentioned a single time in the hearings of Chair Yellen. In fact, when restricting the estimations until 2013, the indicator for negative sentiment is significant in all four specifications and the FSS indicator is significant in columns 3 and 4.

The sixth point is more technical, as it relates to the details of the text-mining approach. Here, we consider possible effects of word-stemming, by also estimating augmented Taylor rules where the “raw” words have been counted in the creation of the financial-stability indexes. The results are in Table 11. Skipping stemming in the data processing would have no material impact on the conclusions, as the key results are replicated in that case. In particular, negative sentiment on financial stability is still reflected in the Fed’s interest rate setting. When weighting the coefficients in Table 11 with the respective SDs (0.71 for negative terms and 0.89 for the FSS index), we find that the effects of financial-stability concerns on the federal funds rate are even more pronounced compared to the results with stemming. Finally, it is also worth noting that the relative frequency of total financial-stability related words is significantly negative in this robustness test when using Greenbook output nowcasts (column 2).

Seventh, we consider one potential drawback of the wordlist by Correa et al. (2020). As the number of negative words is about three times as large as the number of positive words, this may introduce a bias toward negative sentiment in the overall sentiment index. To overcome this asymmetry, we weight the absolute frequency of negative and positive words found in each of the introductory statements with the total number of negative and positive words in the dictionary, respectively. Most importantly, the results in Table 12 consistently indicate that negative FSS was associated with a more accommodative policy stance. However, there are now some indications that positive sentiment was associated with a more hawkish policy stance (Table 12, columns 3 and 4). However, we only find this when using either the Greenbook series for unemployment or the CBO data. In these cases, the coefficients are, in an absolute sense, smaller than those for negative sentiment.

**TABLE 5** Role of financial stability sentiment (Greenbook infl. and CBO output gap)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.694*** (0.044)	0.695*** (0.045)	0.705*** (0.047)	0.711*** (0.046)
Constant	1.220*** (0.171)	1.235** (0.552)	1.105** (0.543)	1.291*** (0.178)
Inflation 2Q forecast gap	0.594*** (0.113)	0.593*** (0.115)	0.611*** (0.116)	0.601*** (0.111)
GDP gap (CBO)	0.312*** (0.040)	0.312*** (0.040)	0.295*** (0.043)	0.293*** (0.043)
Persistent MP shocks				
Negative + positive FS terms		-0.002 (0.073)		
Negative FS terms			-0.149* (0.088)	
Positive FS terms			0.204* (0.121)	
Negative – positive FS terms				-0.171** (0.076)
$\sigma$	0.707*** (0.072)	0.707*** (0.072)	0.683*** (0.066)	0.683*** (0.065)
AIC	164.46	166.46	163.37	161.51
Log likelihood	-77.229	-77.229	-74.687	-74.756
Improvement over (1)		0.00%	3.29%	3.20%

Notes: See also notes to Table 2. In this table, forecasts for inflation are obtained from the Fed's Greenbook, while the measure for real activity is the CBO's estimate of the output gap.

Eighth, based on topic models, we find additional evidence that financial stability was discussed throughout the whole sample period, although attention did strongly increase during the Great Recession. As in Hansen et al. (2018), we estimate a latent Dirichlet allocation (LDA) model. To do so, we use the R package *topicmodels* by Grün and Hornik (2011). In contrast to supervised machine learning where the data are labeled in advance, the (probabilistic) topic modeling is an unsupervised machine learning algorithm that allocates texts to themes one might not have even considered (Blei, 2012). Here, we only present the results when setting the number of topics equal to six.<sup>22</sup>

Figure 3 shows the relative importance of these six topics during the sample period. One way to assess the validity of topics is to compare the dynamic importance of them with external events which should explain spikes in attention to one or another topic (Grimmer, 2010; Quinn et al., 2010). The increased importance of financial stability during the financial crisis is indicated by the larger black bars that denote the frequency of the topic “Financial Markets and Stability” after 2007.<sup>23</sup> However, we also find evidence that this topic received attention prior to the Great Recession. Concerning other topics, we find that international factors (e.g., such as international trade and exchange rates) were more relevant during the 1980s. In the 1990s, the importance of demand factors (e.g., household spending and business capital) and supply factors (e.g., labor market and production) increased. The relevance of inflation and prices is roughly the same over time until financial stability concerns picked up in importance in July 2007. The peak value for the financial stability topic is found in the hearing of July 2009 with a share of 53% of the introductory statements and gradually decreasing since then. Finally, the topic related to money and credit received less attention since the 1990s, which presumably reflects the move away from the Volcker-era monetary targeting.

Ninth, we use an alternative approach to sentiment analysis and topic modeling based on the R package *sentometrics* (Ardia et al., 2020). One benefit of the *sentometrics* approach is that, in addition to negation, it takes two



**TABLE 6** Robustness test controlling for the NFCI

	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Negative + positive FS terms	-0.046 (0.075)	-0.087 (0.074)	-0.051 (0.074)	-0.007 (0.069)
NFCI	-0.107 (0.300)	-0.291 (0.273)	-0.360* (0.212)	-0.063 (0.184)
Negative FS terms	-0.179* (0.103)	-0.213** (0.097)	-0.246** (0.115)	-0.160* (0.088)
Positive FS terms	0.105 (0.141)	0.080 (0.161)	0.245 (0.181)	0.201* (0.117)
NFCI	-0.124 (0.285)	-0.305 (0.265)	-0.390** (0.192)	-0.092 (0.182)
Negative – positive FS terms	-0.146 (0.096)	-0.160 (0.103)	-0.245** (0.119)	-0.177** (0.077)
NFCI	-0.116 (0.289)	-0.297 (0.267)	-0.390** (0.193)	-0.098 (0.187)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

**TABLE 7** Robustness test controlling for MP inclination and economic outlook

	HH	Gbk output	Gbk unemp	CBO
Negative + positive FS terms	-0.074 (0.077)	-0.111 (0.076)	-0.094 (0.076)	-0.047 (0.070)
Monetary policy inclination	0.667*** (0.141)	0.607*** (0.145)	0.530*** (0.151)	0.341** (0.149)
Economic outlook	0.100 (0.179)	0.057 (0.167)	0.298** (0.148)	0.225* (0.136)
Negative FS terms	-0.252** (0.101)	-0.272*** (0.085)	-0.282*** (0.099)	-0.210** (0.084)
Positive FS terms	0.141 (0.140)	0.111 (0.142)	0.190 (0.154)	0.173 (0.108)
Monetary policy inclination	0.680*** (0.130)	0.639*** (0.134)	0.538*** (0.142)	0.396*** (0.140)
Economic outlook	0.102 (0.129)	0.047 (0.150)	0.269** (0.125)	0.196* (0.119)
Negative – positive FS terms	-0.206** (0.096)	-0.210** (0.083)	-0.249** (0.097)	-0.195*** (0.066)
Monetary policy inclination	0.675*** (0.130)	0.631*** (0.129)	0.518*** (0.128)	0.391*** (0.132)
Economic outlook	0.099 (0.129)	0.039 (0.151)	0.268** (0.125)	0.194 (0.120)

Notes: This table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. These regressions use measures for the monetary policy inclination and the economic outlook at the time of the hearing. The two measures are an updated version of the series in Jansen (2011). Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

**TABLE 8** Robustness test excluding the zero-lower bound episode

	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Negative + positive FS terms	-0.052 (0.096)	-0.121 (0.094)	-0.021 (0.107)	-0.004 (0.090)
Negative FS terms	-0.286** (0.123)	-0.342*** (0.111)	-0.271* (0.150)	-0.202* (0.117)
Positive FS terms	0.178 (0.150)	0.139 (0.188)	0.314 (0.221)	0.224* (0.136)
Negative – positive FS terms	-0.232** (0.107)	-0.254** (0.123)	-0.288* (0.148)	-0.212** (0.095)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 61. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

**TABLE 9** Robustness test for period 1979–2007, excluding 1988

	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Negative + positive FS terms	-0.093 (0.096)	-0.200** (0.088)	-0.101 (0.107)	-0.089 (0.089)
Negative FS terms	-0.273** (0.120)	-0.346*** (0.111)	-0.292* (0.155)	-0.238** (0.119)
Positive FS terms	0.080 (0.139)	-0.030 (0.158)	0.140 (0.183)	0.094 (0.127)
Negative – positive FS terms	-0.175* (0.101)	-0.179 (0.122)	-0.229 (0.141)	-0.174* (0.092)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 56. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

**TABLE 10** Robustness test using the Wu and Xia (2016) shadow rate

	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Negative + positive FS terms	-0.023 (0.086)	-0.046 (0.085)	0.017 (0.085)	0.040 (0.076)
Negative FS terms	-0.116 (0.118)	-0.119 (0.108)	-0.117 (0.121)	-0.055 (0.106)
Positive FS terms	0.088 (0.144)	0.050 (0.164)	0.215 (0.174)	0.172 (0.121)
Negative – positive FS terms	-0.104 (0.097)	-0.090 (0.102)	-0.154 (0.113)	-0.103 (0.086)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

additional linguistic patterns into account. These additional patterns track whether sentiment is strengthened (*amplified*) or weakened (*deamplified*). We use the so-called valence-shifting clusters approach, where the text sentiment scores are calculated taking the three linguistic elements (negation, amplification, deamplification) into account. Per document, *sentometrics* then calculates an index by computing the difference between the number of positive and

**TABLE 11** Robustness test without stemming

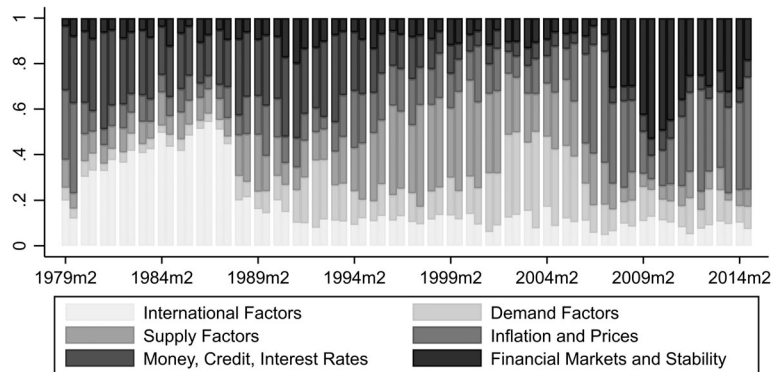
	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Negative + positive FS terms	-0.179 (0.177)	-0.349** (0.165)	-0.237 (0.150)	-0.159 (0.127)
Negative FS terms	-0.295 (0.193)	-0.440** (0.171)	-0.385** (0.192)	-0.250 (0.154)
Positive FS terms	-0.031 (0.234)	-0.156 (0.275)	0.077 (0.236)	0.070 (0.207)
Negative – positive FS terms	-0.149 (0.149)	-0.220 (0.141)	-0.279* (0.158)	-0.189 (0.118)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.

**TABLE 12** Robustness test with weighted FS terms

	(1) HH	(2) Gbk output	(3) Gbk unemp	(4) CBO
Weighted negative words	-1.516* (0.891)	-1.783** (0.821)	-2.114** (1.011)	-1.739*** (0.658)
Weighted positive words	0.684 (0.490)	0.626 (0.471)	1.106** (0.552)	0.846** (0.384)

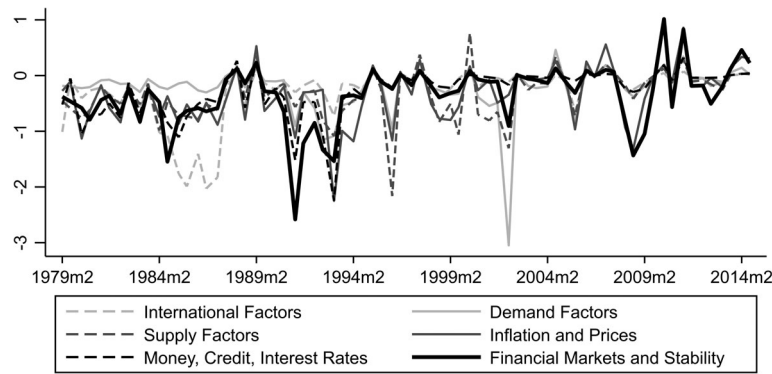
Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.



**FIGURE 3** Topics in congressional hearings according to LDA model. This figure shows the frequency of topics in the opening statements by five Federal Reserve Chairs at congressional hearings on monetary policy, estimated using a latent Dirichlet allocation model

negative words and subsequently normalizing by the total number of words. In addition, we also use *sentometrics* to estimate a structural topic model. Such a model is methodologically similar to the LDA framework, with the main difference in the model initialization stage, that is, the starting values of the parameters.<sup>24</sup>

Figure 4 shows the results. As the figure makes clear, we can now also make an integral assessment of sentiment per topic. Comparing the LDA and the *sentometrics* approach, we would broadly identify similar topics, although this to some extent is dependent on our interpretation based on those words that have the strongest association with each topic. For the *sentometrics* approach, we find a strong positive correlation in sentiment for the six topics, pointing to a general tendency of positive or negative sentiment in a given statement. Sentiment on financial stability topics is clearly the most volatile of the six series, indicating that these concerns vary considerably over time. In particular, the negative

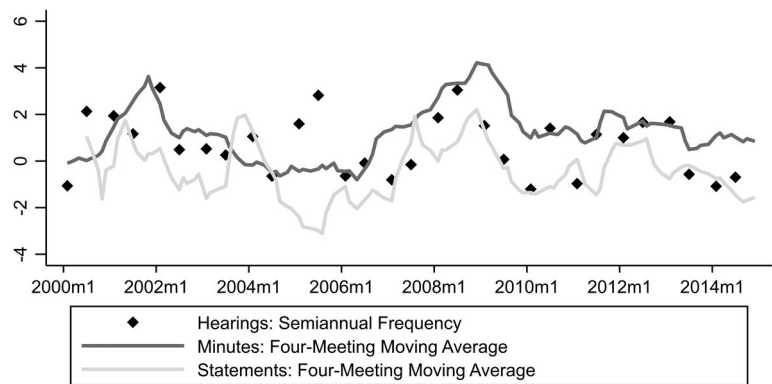


**FIGURE 4** Sentometrics topic modeling. This figure shows the sentiment associated with the topics in the opening statements by five Federal Reserve Chairs at Congressional hearings on monetary policy, estimated using the *sentometrics* approach developed by Ardia et al. (2020)

**TABLE 13** Robustness test with unsupervised sentiment indicators

	(1) HH	(2) GbK output	(3) GbK unemp	(4) CBO
FS sentiment	0.038 (0.153)	0.263** (0.120)	0.407*** (0.135)	0.214** (0.108)
Non-FS sentiment	0.115 (0.111)	0.004 (0.113)	-0.080 (0.120)	0.046 (0.104)

Notes: Table shows selected estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.



**FIGURE 5** Sentiment in hearings, statements, and minutes. This figure compares sentiment regarding financial stability (FSS) in congressional hearings, FOMC postmeeting statements (four-meeting moving average), and FOMC minutes (four-meeting moving average). The sentiment index is the number of negative words minus the number of positive words, scaled by the total number of words. The word connotations are determined according to the financial stability dictionary by Correa et al. (2020). The correlations of the FSS indicators are as follows: hearings versus minutes:  $\rho = 0.34$  ( $\rho = 0.60$  for the 2006–2014 subsample), hearings versus statements:  $\rho = 0.24$  ( $\rho = 0.50$ ), minutes versus statements:  $\rho = 0.57$  ( $\rho = 0.73$ )

sentiment associated with financial stability since July 2007 and during the early-1990s coincides with the relatively stronger prevalence of this topic around these times, as demonstrated in Figure 3. Combining these two findings indicates that when financial stability considerations become more prominent in monetary policy discussions, these considerations typically are of a negative sentiment. This finding is, once again, in line with the idea of a preference for a monetary policy that cleans ex post rather than leans ex ante.

As a further step in this particular robustness check, we use the *sentometrics* approach to create an additional indicator for sentiment that is unrelated to financial stability considerations. We use the first principal component of the five nonfinancial-stability subindexes from *sentometrics*, which explains 61.1% of the common variation in these topics.<sup>25</sup> We include this additional indicator for general sentiment alongside the financial-stability-sentiment indicator from Figure 4 in the augmented Taylor rules.<sup>26</sup> The idea is to check whether an alternative indicator of FSS based on an unsupervised machine learning technique leads to qualitatively similar results as compared to the indicator based on the Correa et al. (2020) dictionary. Put differently, we test once more if our results are specifically driven by financial-stability sentiment and not by sentiment in general. The results in Table 13 confirm this. The coefficient for the financial stability (FS) sentiment indicator from *sentometrics* is significant, while the coefficient for non-FS sentiment is insignificant.

In the 10th and last robustness check, we apply the Correa et al. (2020) methodology to two other main types of Fed communication, that is, FOMC statements and minutes. This is an intuitive way to check the idea that hearings may have offered additional insights. Figure 5 shows the evolution of FSS in the three types of Fed communications. One challenge in this analysis is that statements were relatively short for much of the 1990s and early-2000s. Therefore, the figure focuses on the post-2000 sample. Another complication is the difference in frequency, given that we have two observations per year for hearings and eight for the other two communication types. Figure 5, therefore, shows a moving average for statements and minutes. With these caveats in mind, Figure 5 presents two takeaways. First, a reassuring finding is that there is quite some similarity, as the sentiment in hearings is mostly in the range spanned by the other two communications. This broad similarity indicates the validity of applying the Correa et al. (2020) dictionary to the testimony texts. At the same time, there are also indications that the signals in the hearings can differ. For instance, sentiment in the two hearings right before the financial crisis was much more negative than in minutes and statements. Also, though the correlations between the three series are respectable, these are also far from perfect. Together, these two latter points confirm our argument that studying the congressional hearings can add value.

## 6 | CONCLUSIONS

This article analyzes introductory statements by five Federal Reserve Chairs at congressional hearings and finds that, already during more tranquil times, the Chairs have pointed to financial stability considerations when discussing the stance of US monetary policy. In particular, we find that negative FSS expressed during congressional hearings coincided with a more accommodative monetary policy stance than implied by standard Taylor-rule factors. This role of negative sentiment suggests a preference for reacting to episodes of financial instability rather than acting pre-emptively to a perceived build-up of risks, which would be in line with comments by several Fed officials (Bernanke, 2002; Greenspan, 2002).

This article's findings have broader relevance for ongoing discussions on the interactions between monetary and financial stability. Currently, there is a lively debate on the implications of the financial crisis for the conduct of monetary policy (Adrian & Liang, 2018; Smets, 2014; Svensson, 2017). A survey by Blinder et al. (2017) finds that academics and central bankers widely agree that macroprudential policy is an important addition to the macroeconomic-policy toolkit. In addition, a majority of central bank governors indicates having considered changing the monetary policy mandate, often by adding a financial stability objective. The evidence in our article does not address the question of whether adding such an objective would be welfare improving. We also do not address the issue of whether the Fed accounted sufficiently for financial stability in the run-up to the financial crisis. What our article does suggest, however, is that under a dual mandate such as that of the Federal Reserve, financial stability can, at least to some extent, already be factored into monetary policy deliberations.

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## ENDNOTES

- <sup>1</sup> Section 2.3 will provide further detail on the Humphrey–Hawkins testimonies. One practical point concerning the end-point of the sample is that some of our key explanatory variables are from the Fed's Greenbook, which is only available after a 5-year delay.
- <sup>2</sup> Section 2A of the Federal Reserve Act also lists moderate long-term interest rates, but that third objective usually receives less attention in policy and academic discussions. See Zhu (2013) for details on the 1977 Federal Reserve Reform Act.
- <sup>3</sup> See, for instance, the preamble of the Act (“... to furnish an elastic currency ...”) and Section 10 on emergency advances to member banks.
- <sup>4</sup> In a seminal analysis of FOMC transcripts, Cecchetti (2003) found that as equity prices boomed, FOMC members spoke more intensively about the stock market. He also finds evidence that the monetary policy stance was adjusted accordingly. In the paper, Cecchetti estimated various Taylor-rule models, but he did not include word counts for financial stability concerns as separate explanatory variables.
- <sup>5</sup> For details on the Federal Reserve Financial Stability Report, see <https://www.federalreserve.gov/publications/financial-stability-report.htm>. URL last accessed on 29 November 2018.
- <sup>6</sup> There is also some research on the European Central Bank (ECB) as Dybowski and Kempa (2020) show that financial stability considerations have an impact on the ECB's interest rate policy in the aftermath of the Global Financial Crisis, whereas the proportion of communication about financial stability in the President's introductory statements already grew over time before the crisis.
- <sup>7</sup> Appendix A lists the documents that were consulted for this background section.
- <sup>8</sup> Additional text data analysis tools that we use are *tm*, *qdap*, and *corpus*.
- <sup>9</sup> In some of our analyses, we tailor the stopword lists to the specific text-mining technique. For instance, when using *sentometrics* in Section 5 we need to ensure that words capturing shifts in the intensity of sentiment remain in the texts.
- <sup>10</sup> The dictionary can be downloaded at: <https://www.federalreserve.gov/econres/ifdp/files/ifdp1203-appendix.xlsx>. URL last accessed on 15 October 2020.
- <sup>11</sup> The number of Peek et al. (2016) dictionary-based keywords found in the texts is 564 as opposed to 9762 based on the list by Correa et al. (2020). In addition, only 21 texts contain 10 or more financial-stability related keywords.
- <sup>12</sup> We ran a keyword-in-context search for 20 forms of negation and then corrected for false positives if a negation term appeared within a three-word range before a positive word. This step identified 160 false positives in the sample.
- <sup>13</sup> Stemming is a common data preparation step in text-mining, where words are reduced to their roots. For example, “walking,” “walks,” and “walked” would all be measured as “walk.”
- <sup>14</sup> One dimension that we do not explore further here is the role of the different Chairs. However, Table B1 does provide some descriptives of the testimonies per Chair.
- <sup>15</sup> See, inter alia, Gerlach-Kristen (2004), Rudebusch (2006), or Consolo and Favero (2009) for a discussion of whether to include a partial adjustment mechanism and/or an autoregressive error term into the reaction function.
- <sup>16</sup> To facilitate the interpretation of the constant term as the equilibrium interest rate, we follow the recent literature (e.g., Bauer & Neuenkirch, 2017; Neuenkirch & Tillmann, 2014) and subtract 2% from expected inflation and from the GDP growth nowcast. Hence, we create proxies for the expected inflation gap and a nowcast of the output gap with a time-invariant target or trend.
- <sup>17</sup> Fed staff estimates of the (expected) output gap are available since August 1987. In addition, the real-time measure of the nonaccelerating inflation rate of unemployment goes back to 1989. Hence, employing one of these indicators would cause a loss of at least a quarter of the observations in the sample.
- <sup>18</sup> It has to be noted that the results of the augmented Taylor rules using the CBO output gap do not depend on the inclusion or exclusion of a persistent monetary policy shock term.
- <sup>19</sup> Note that the coefficient on negative sentiment is marginally insignificant in Table 2 with a *p*-value of .11.
- <sup>20</sup> Note that the coefficient on the FSS indicator is marginally insignificant in Tables 2 and 3 with *p*-values of .15 and .14, respectively.
- <sup>21</sup> Background information on the NFCI can be found at: <https://www.chicagofed.org/research/data/nfci/background>. URL last accessed on 15 October 2020.
- <sup>22</sup> There seems to be no standard approach for choosing the number of topics *K*. Our preference for *K* = 6 mainly reflects our prior (based on Schonhardt-Bailey, 2013) that setting *K* too low would not allow us to identify a separate financial stability topic. We are hesitant to set *K* much higher, as many document sets are found to be best characterized by relatively few and broadly-defined topics (for discussion and examples, see Blei et al., 2003; Maier et al., 2018; Sbalchiero & Eder, 2020; Istrefi et al., 2020).
- <sup>23</sup> Admittedly, the interpretation of a particular topic after an LDA analysis always remains subjective. To us, the fact that this topic gains so much in prominence after 2007 and also is associated with keywords such as “stability,” “funding,” and “credit” leads us to this particular financial stability interpretation.

- <sup>24</sup> The Gibbs Sampling algorithm is used in case of the LDA modeling. For structural topic modeling, the so-called Spectral algorithm is utilized (Roberts et al., 2019). As in the previous robustness check, we show results when setting the number of topics equal to six.
- <sup>25</sup> All other principal components have an Eigenvalue smaller than one. Hence, we only consider the first component in this robustness test.
- <sup>26</sup> It should be remembered that both sentiment indicators are standardized and that values larger than zero, in contrast to the Correa et al. (2020) FSS measure, now imply positive rather negative sentiment.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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## APPENDIX A. SOURCES CONSULTED

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## APPENDIX B. BACKGROUND ON FINANCIAL-STABILITY RELATED WORDS IN HEARINGS

TABLE B1. Average number of financial-stability related words in hearings

Chair	Total words	Total FS words	Positive FS words	Negative FS words	Negated positives	Example for FS in context
Miller	1,117.0	69.0	25.0	44.0	2.0	... key to a sound dollar and a <i>stabil</i> world <i>financi</i> system lie ultim in the resolut of some of our ...
Volcker	1,846.6	157.2	60.1	97.1	3.4	... the economi is depend on a sens of price and <i>financi stabil</i> and without it, we will undercut the growth ...
Greenspan	1,977.9	155.8	66.0	89.8	2.5	... we must ensur that the <i>stabil</i> of the <i>financi</i> system is protect as chang occur, for a sound ...
Bernanke	1,271.1	88.1	40.7	47.4	0.6	... the feder reserv is respond activ to <i>financi stabil</i> concern through substanti expand monitor of emerg risk ...
Yellen	729.5	45.5	26.0	19.5	0.0	... evalu possibl measur to address <i>financi stabil</i> risk associ with short-term wholesal funding ...
All chairs	1,733.1	135.6	56.8	78.8	2.2	

Notes: Table shows the average number of total and financial-stability related words per Fed Chair alongside an example in context.

## APPENDIX C. BASELINE TAYLOR RULES

TABLE C1. Baseline Taylor rule with Humphrey–Hawkins forecasts

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.665*** (0.058)	0.685*** (0.063)	0.604*** (0.088)	0.656*** (0.074)
Constant	0.575*** (0.191)	0.546** (0.215)	0.747*** (0.259)	0.645** (0.253)
Inflation 4Q forecast gap	0.768*** (0.136)		0.879*** (0.219)	
Inflation gap forecast CY		0.694*** (0.135)		0.735*** (0.168)
GDP CY forecast gap	0.346*** (0.074)	0.317*** (0.070)	0.381*** (0.109)	0.328*** (0.087)
Persistent MP shocks			0.378*** (0.146)	0.272** (0.113)
$\sigma$	0.828*** (0.081)	0.871*** (0.097)	0.774*** (0.082)	0.834*** (0.104)
AIC	187.14	194.39	179.55	190.33
Log likelihood	-88.571	-92.193	-83.777	-89.165

Notes: Table shows estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.  $\sigma$ : SE of regression. AIC: Akaike information criterion.

TABLE C2. Baseline Taylor rule with Greenbook forecasts (output)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.719*** (0.061)	0.836*** (0.050)	0.700*** (0.068)	0.834*** (0.057)
Constant	0.561*** (0.200)	0.264 (0.198)	0.626*** (0.228)	0.306 (0.221)
Inflation 2Q forecast gap	0.617*** (0.111)		0.643*** (0.123)	
Inflation nowcast gap		0.288*** (0.074)		0.269*** (0.084)
GDP nowcast gap	0.242*** (0.037)	0.142*** (0.054)	0.231*** (0.046)	0.120* (0.063)
Persistent MP shocks			0.201** (0.087)	0.211* (0.112)
$\sigma$	0.783*** (0.078)	0.885*** (0.084)	0.760*** (0.083)	0.867*** (0.088)
AIC	179.02	196.72	176.94	195.84
Log likelihood	-84.511	-93.362	-82.472	-91.922

Notes: Table shows estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.  $\sigma$ : SE of regression. AIC: Akaike information criterion.



**TABLE C3.** Baseline Taylor rule with Greenbook forecasts (unemployment)

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.690*** (0.060)	0.816*** (0.045)	0.658*** (0.068)	0.806*** (0.051)
Constant	0.727*** (0.200)	0.372** (0.171)	0.830*** (0.220)	0.435** (0.191)
Inflation 2Q forecast gap	0.614*** (0.124)		0.665*** (0.146)	
Inflation nowcast gap		0.290*** (0.071)		0.282*** (0.081)
Unemployment nowcast gap	-0.256*** (0.073)	-0.088 (0.067)	-0.274*** (0.087)	-0.081 (0.080)
Persistent MP shocks			0.229** (0.097)	0.275** (0.114)
$\sigma$	0.845*** (0.083)	0.927*** (0.082)	0.816*** (0.081)	0.891*** (0.079)
AIC	190.16	203.35	187.08	199.79
Log likelihood	-90.078	-96.673	-87.538	-93.895

Notes: Table shows estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.  $\sigma$ : SE of regression. AIC: Akaike information criterion.

**TABLE C4.** Baseline Taylor rule with Greenbook infl. forecast and CBO output gap

	(1)	(2)	(3)	(4)
Interest rate smoothing	0.694*** (0.044)	0.825*** (0.036)	0.694*** (0.041)	0.817*** (0.040)
Constant	1.220*** (0.171)	0.692*** (0.171)	1.221*** (0.164)	0.738*** (0.198)
Inflation 2Q forecast gap	0.594*** (0.113)		0.594*** (0.108)	
Inflation nowcast gap		0.270*** (0.070)		0.269*** (0.078)
GDP gap (CBO)	0.312*** (0.040)	0.213*** (0.050)	0.312*** (0.040)	0.216*** (0.060)
Persistent MP shocks			0.003 (0.116)	0.184 (0.137)
$\sigma$	0.707*** (0.072)	0.838*** (0.075)	0.707*** (0.072)	0.825*** (0.074)
AIC	164.46	188.93	166.46	188.58
Log likelihood	-77.229	-89.467	-77.229	-88.288

Notes: Table shows estimates of Equations (1) and (2) with robust SEs in parentheses. Number of observations: 72. \*\*\*/\*\*/\* indicate significance at the 1%/5%/10% level.  $\sigma$ : SE of regression. AIC: Akaike information criterion.