FEDERAL RESERVE BANK OF KANSAS CITY

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Sentiment of the FOMC: Unscripted

By San Cannon

In 1994, the Federal Open Market Committee (FOMC) began publishing transcripts from past FOMC meetings with a five-year lag. Although the FOMC had released prepared statements and minutes to the public before 1994, the full transcripts paint a richer, more complete picture of the meetings. For example, the transcripts are the only meeting document that attributes comments to named speakers, making them ideal for text analysis. Even so, these transcripts have proved somewhat difficult to parse, as they contain a surfeit of disparate anecdotes, forecasts, and economic reports.

Cannon applies text-mining techniques to FOMC transcripts to identify patterns in participants' tone and diction over time, particularly as they relate to measures of economic activity. She finds significant differences in expression among Federal Reserve Governors, Presidents, and staff. Furthermore, she finds the tone of FOMC discussions changed measurably after the 1993 decision to release meeting transcripts to the public.

Estimating the Monetary Policy Rule Perceived by Forecasters

By Brent Bundick

When the Federal Open Market Committee (FOMC) communicates the expected future path of monetary policy to the public, it often outlines how economic conditions affect the stance of policy. In this way, the FOMC implicitly communicates a policy rule that guides its decisions. Professional forecasters, in turn, attempt to identify this implicit monetary policy rule as they set their forecasts for the short-term interest rate.

Bundick examines whether this forecaster-perceived policy rule has changed since December 2008, when the FOMC lowered the federal funds rate to its effective lower bound. After 2008, the FOMC turned to less conventional policy tools such as forward guidance to achieve its dual mandate of stable prices and maximum employment. Despite these changes, perceptions of the FOMC's policy rule remained relatively consistent before and during the zero lower bound period.

Competition in Local Agricultural Lending Markets: The Effect of the Farm Credit System

By Charles S. Morris, James Wilkinson, and Eric Hogue

When banks wish to merge, regulatory agencies must review and approve the proposed merger to ensure it will not result in an overly concentrated, anticompetitive market. As part of this approval process, agencies use screening measures based on banks' deposit shares to evaluate potential effects on competition. However, deposit-based measures do not explicitly account for competition from nondepository financial firms such as Farm Credit Associations. Farm Credit Associations have an especially large presence in agricultural loan markets, and screening measures that exclude them may consequently understate market competitiveness.

Morris, Wilkinson, and Hogue review the current methodology for assessing competition in banking markets and show that including Associations as a competitor in agricultural lending markets can significantly alter measures of market concentration. Moreover, the effect of including Associations in these measures tends to be larger in more concentrated markets and in markets that depend more heavily on the agricultural sector.

Sentiment of the FOMC: Unscripted

By San Cannon

The Federal Open Market Committee (FOMC) meets eight times each year to set monetary policy. During these meetings, a changing cast of participants engages in presentations and discussions, drawing on the perspectives of research staff and community and business leaders as they formulate their views on economic conditions and determine the stance of monetary policy.

Determining what the FOMC finds relevant to policy discussions and how these discussions might have changed over time can be challenging. Although the Committee releases carefully constructed statements and meeting minutes to the public, some marketwatchers have argued these pieces have only rendered proceedings more mysterious or opaque. The full transcripts offer a more complete picture of Committee meetings; however, these transcripts are only released to the public after five years. Furthermore, the transcripts can be somewhat difficult to parse: the texts contain a wealth of disparate information ranging from casual anecdotes to research findings to staff economic forecasts.

Nevertheless, meeting transcripts offer readers the unique opportunity to examine the original expressions of individual meeting participants prior to being distilled and summarized into the statement and minutes. Applying text-mining techniques to FOMC transcripts can help quantify this information to provide a rich analytical resource reflecting real-time economic and financial analysis. The words

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participants choose for particular topics allow text analysts to measure the tone of the overall discussion in a way not possible in statements or minutes. In addition, researchers can measure the tone of individual speakers. Unlike the minutes, which attribute general summary discussions to unidentified "Committee members," the transcripts identify speakers along with their contributions. This identification invites comparisons between individual speakers or classes of individuals such as Board members and Bank presidents.

In this article, I study the tone and diction, or word choice, of the meeting participants to better understand how the discussions are formed, how they related to the performance of the economy, and how they may have changed with movements toward greater transparency. Using some fairly simple language-processing tools, I measure the tone of FOMC deliberations, explore differences across speakers, and examine how the tone of the discussions relates to a measure of economic activity. I find first that the composition and tone of the discussions have changed over time. More specifically, the length of comments, the uniqueness of word choice, and the measure of the tone display distinct patterns from the late 1970s through 2009. Second, I find measurable differences in the diction and tone of different classes of speakers who participate in the discussions. The contributions of Board members, for example, have a different composition and tone than that of Reserve Bank presidents or Federal Reserve System staff. Finally, I find measures of the relationship between the tone of the discussions and economic activity also show differences across time and speaker.

Section I provides background information on the transcripts and the text-mining tools used to extract information. Section II calculates the tone measure for each discussion and explores how the role of individual speakers has changed over time. Section III examines the relationship between the tone measure and real economic activity and assesses what effect a move toward greater transparency in the Committee might have had.

I. Extracting Text from the Transcripts

Committee discussions generate an extensive amount of text. Although the Federal Reserve Act only mandates four FOMC meetings per year, the Committee met as often as monthly up until the

early 1980s and has met eight times each year since. Conference calls may also occur between scheduled meetings. In addition, the number of meeting attendees contributing to the deliberations can add significantly to the text. The Committee comprises all sitting members of the Federal Reserve Board of Governors—usually seven but at times as few as four—as well as five Reserve Bank Presidents who serve on the Committee on a rotating basis. Reserve Bank presidents who are not voting members of the Committee attend and participate in all meetings as do staff members from Reserve Banks and the Board. The meetings are closed to the public, but the Committee releases an official statement at the close of the meeting to convey its monetary policy decision. Minutes from the meeting are available several weeks later, and the Committee releases full transcripts of the discussion with a five-year lag.[1]

Not all of these communication pieces may be suitable for text analysis. The official statements, for example, are perhaps too carefully crafted, as the media and market participants vigilantly parse them. Indeed, *The Wall Street Journal* dedicates a column to outlining changes in the wording of FOMC statements from meeting to meeting. The transcripts, on the other hand, are ideal for text analysis, as they capture each part of the meeting from roll call to parliamentary procedures for policy votes. The transcripts include the entire discussion, indicating who was speaking and what was said with little editing except for the potential removal of "a very small amount of information received on a confidential basis from, or about, foreign officials, businesses, and persons that are identified or identifiable" (Board of Governors 2014). They show how Reserve Bank Presidents provide important regional context and information, how Governors voice opinions or ask questions, and how Board staff present information on economic output and other relevant topics. Such detail makes the text of the transcripts an excellent source of information to be mined.

Text mining

Text mining creates structured data out of unstructured data, allowing a quantitative analysis of qualitative information. Traditional methods of assessing relationships and patterns in data deal exclusively with structured data—numeric information generally well-formatted in tables or databases. However, much of the data created or captured

today is far less structured or in many cases unstructured, such as the text of tweets, blog posts, emails, or documents. Analyzing such inputs first requires transforming them from the raw data format to a format that can effectively use methods identical or analogous to those used to analyze structured numeric data.

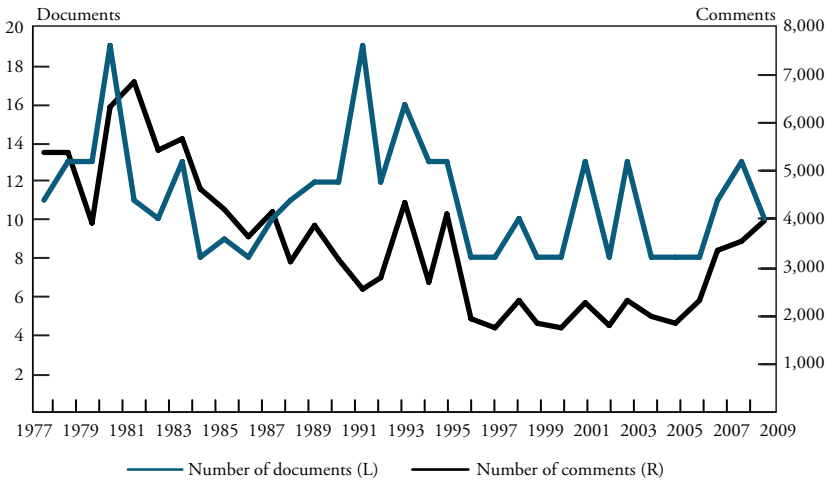
Researchers can mine text using different methods, each suitable for answering a different set of questions. More specifically, new research in this field applies a variety of methods to FOMC documents.[2] I focus here on the specific words FOMC participants choose during their discussions. Note that studying the words used is different than examining the topics discussed. The former is more closely aligned with expression, the latter with content.

As expression and word usage relate more to how ideas are conveyed than to the ideas themselves, they are a more appropriate way to address sentiment in a document like the FOMC transcripts. To assess how someone feels, examining their actual choice of words may be more instructive than attempting to attach a sentiment to a particular topic. Much of the current work on sentiment analysis focuses on consumer opinions expressed in tweets, online reviews, and other social media outlets. I apply similar techniques here with some changes to acknowledge the important differences between social media posts and monetary policy discussions.

Processing the transcripts

Some written records of the Committee's meetings are available from the Federal Reserve Board from as early as 1936. I start the sample with 1977, as this is the first year for which records are identified as transcripts. First, I extract the text from the digital file, parse it into words based on spaces and punctuation, and remove the preliminary Committee procedures (for example, roll call). I then group the text pieces into individual comments by speaker. For each named speaker, I collect the text of that person's comment until the next speaker is identified. For some entries, this text is as short or simple as "yes" or "thank you"; for others, a speaker giving a presentation or answering a question at length can have a single comment that runs for pages. I apply the extraction method to 362 complete transcripts and five partial transcripts over 33 years, yielding 114,912 individual comments.[3] I

Chart 1
Distribution of Transcripts over Time



Sources: FOMC and author's calculations.

remove numbers and punctuation from each comment, and convert all words to lower case to facilitate matching with words which may have different capitalization.

The number of transcripts and the number of comments extracted from the transcripts has varied drastically over the sample period. Chart 1 shows the distribution of the number of documents and the extracted comments over time. The FOMC convened as many as 19 times in 1980 (10 meetings and nine conference calls) and 1991 (eight meetings and 11 conference calls) and held the current standard number of meetings (eight) in 10 of the 33 years.

The next step in processing is to eliminate what are known as "stop words": common words such as articles ("the"), conjunctions ("and"), and helping verbs ("would," "are") unlikely to reveal any interesting information when examined thoroughly.

Even without these common words, the meeting participants had plenty to say. The parsed transcripts contain 4,746,165 words, after excluding 2,731,724 instances of 100 stop words. Figure 1 displays the most common 100 words from the 29,802 different words in the transcripts. Had I not removed the stop words, the top five most common words would be "the," "that," "and," "have," and "are," which don't

Figure 1
Distribution of Top 100 Words

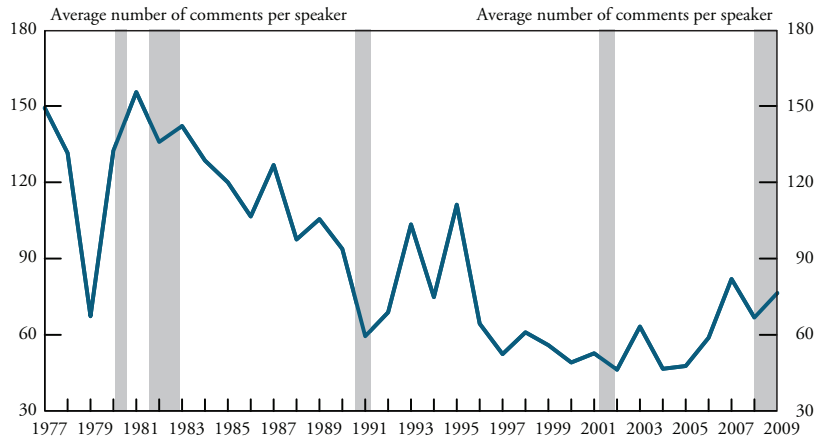
Note: Size of the word indicates the relative distribution of that word.
Sources: FOMC and author's calculations.

contribute much insight into the Committee's discussion. As Figure 1 shows, eliminating stop words does not eliminate neutral or uncommunicative words entirely. In addition to spoken words, the transcripts include some descriptors that the word count also captures. In 2,369 instances, the commentary was "unintelligible," and in 3,225 instances, "laughter" was documented.

Word frequency should not be strictly interpreted as indicating the importance or relevance of particular topics, as speakers may use synonyms and more detailed descriptors. Simple word counts are included here to give some insight into how Committee members most often express particular ideas and topics, which is part of the tone assessment discussion that follows. That said, Hansen, McMahon, and Prat apply a topic extraction method to the transcripts and show that for some topics, a single word or two clearly dominates all others in the discussion. In their analysis, the words "inflation" and "unemployment" are

Chart 2

Number of Comments per Speaker per Year



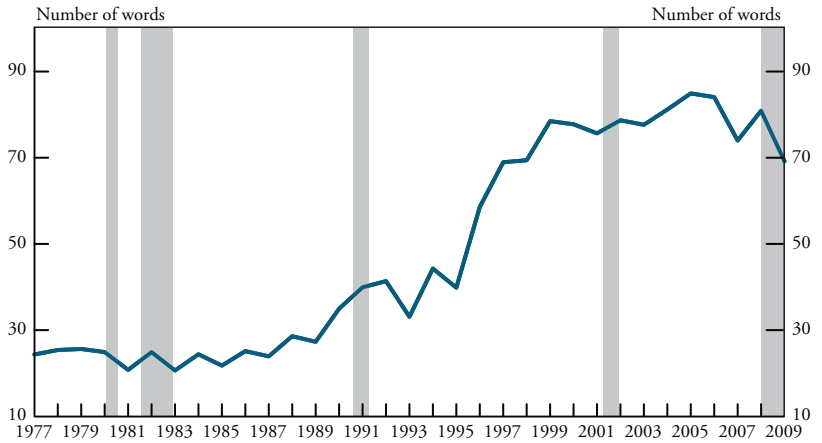
Note: Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

associated with the same topic or concept. Indeed, the two are inextricably linked for much of the FOMC's focus, as both are part of the Fed's "dual mandate" of maximum employment and price stability. But the word "inflation" overwhelmingly dominates all other words associated with what they label the "inflation" topic, including "measure," "core," and "percent."

While many pre-processing options are available in different text-mining applications, I choose to minimally pre-process the text. Removing stop words, for example, is helpful for exercises involving word counts or relative frequencies but may not be helpful for other analyses. In addition, I have chosen not to weight the words when calculating the sentiment measure. None of the commonly used weighting schemes is an obvious choice for this exercise, and though some evidence suggests weights can help decrease the noise in certain measures, it is not clear they would improve this analysis.

Simply counting the number of comments in the transcripts highlights changes in the nature of the FOMC's discussion over time. Chart 2 shows the average number of comments made by each speaker each year during the meetings or conference calls that occurred that year. The number of individual contributions per speaker has varied greatly over time with a distinct downward trend through about 2005 and a

Chart 3
Average Number of Words per Comment



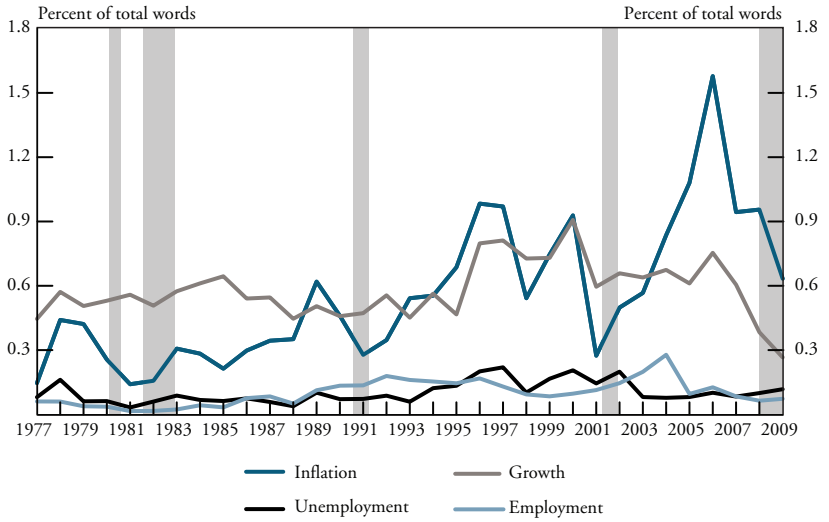
Note: Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

steady upward trend since then. There does not appear to be any clear cyclical pattern.

But fewer comments do not mean less discourse. Indeed, while the number of comments decreased, their average length increased. Chart 3 shows the number of words per comment appears to have increased significantly from 1993 to 2005. While the number of comments has decreased from its peak in 2005, it is still significantly higher than in the early years of the sample.

Although Committee members might use many words to discuss a certain concept, some words are core descriptors of monetary policy objectives and deserve individual attention. Chart 4 shows the distribution of particular words over time as a percentage of total words used. As other research has noted, the Committee uses the word "inflation" far more often than "unemployment" in its discussions. Members mention "growth" frequently as well, though they seem to rarely mention "employment." Hansen, McMahon, and Prat find "growth" and "employment" belong to two distinct topics separate from the "inflation" topic which encompasses the words "unemployment" and "inflation." The "growth" topic contains words such as "expansion" and "increase"; in contrast, the "employment" topic contains words such as "district"

Chart 4
Word Appearances per Comment



Note: Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

and "region," possibly indicating different focuses among sets of meeting participants. Members have used "inflation" much more in recent years: instances of the word peaked in 2006, when it made up more than one percent of all words in the Committee discussion.

II. Measuring Tone and Speaker Effects

Individual words can have a specific semantic orientation, meaning that they consistently convey a positive, negative, or neutral sentiment regardless of the topic with which they are affiliated. For example, "admirable" generally conveys a positive notion or idea. On the other hand, "lost" may more often have a negative connotation. Most words, though, have a neutral orientation: the word "word," for example, doesn't necessarily convey a positive or negative sentiment.

To measure the sentiment of FOMC discussions, I examine each comment, first evaluating the orientation of each word in the comment and then calculating a tone measure for the comment as a whole. Thus, the tone measure captures the net sentiment of the comment as either positive, negative, or neutral. For each month in which either a meeting

or conference call takes place, I use the tone measures for each comment to calculate an overall tone metric as an indicator of sentiment for that month.

Creating the tone measure

The tone of a comment is determined by the semantic orientation (positive, negative, or neutral) of the words in that comment. How researchers determine a word's semantic orientation depends on the word list or dictionary they use to evaluate it. Many researchers have created their own dictionaries to evaluate tone. One common approach is to start with a set of seed adjectives that carry a clear semantic orientation and then augment that list by attributing the tone of a seed adjective to its known synonyms. Another method is to consider word classifications that researchers have created in other domains, such as psychology, and edit them to fit a particular use case.

One wordlist constructed using the boosting-by-synonyms approach is that of Hu and Liu, who have worked on opinion mining and sentiment analysis of online customer reviews, social media posts, and other Internet venues. Hu and Liu start with 30 seed adjectives and, using their synonyms, create lists containing 2,006 words with a positive orientation and 4,783 words with a negative orientation. While Hu and Liu apply these word lists to consumer good evaluations, the lists are general enough to be suitable for a broader use. The list of positive words, for example, is quite extensive, ranging from "cozy," "swanky," and "twinkly," which one may not expect to find in a monetary policy discussion, to "outperform," "judicious," and "insightful," which may be more likely candidates. The range of negative words is equally large, from less formal words such as "anarchy," "stupidity," and "zombie," to the more reserved "worthless," "sluggish," and "inflationary." Although they may be less formal words, "anarchy," "stupidity," and "zombie" are all found in the FOMC transcripts. Because this dictionary was compiled to evaluate customer ratings of consumer goods, I refer to it as the "consumer" dictionary throughout the text.

While its broad range of words makes this dictionary appealing, the set of general words may not be a good fit for the specialized content of the transcripts. An alternative approach is to consider a dictionary tailored more specifically to financial and regulatory discussions.

Loughran and McDonald start with word classifications used in psychology and construct a dictionary more suitable to classifying financial text. Using text found in Securities and Exchange Commission (SEC) filings from 1994 to 2008, they build a dictionary of 85,131 words classified in multiple sentiment categories: positive, negative, uncertain, litigious, and constraining, among others. Of the larger list, 2,355 words are identified as negative, 354 as positive, and 297 as conveying uncertainty. And unlike other dictionaries, sentiment assignment is not mutually exclusive: in multiple instances, words appear simultaneously on two lists, usually uncertain and negative. For example, "anomaly," "doubt," and "deviate" are deemed to convey both negative and uncertain sentiment.

Loughran and McDonald's motivation for compiling this specialized dictionary is similar to a concern faced in this article: specifically, the context for words in technical documents like financial filings may be different than for other text domains. Indeed, Loughran and McDonald find only half of the words on their negative list appear on an alternative general-use sentiment list. Even when they do appear on a general-use list, the sentiment of these words may differ significantly in a technical context. For example, "liability" in a financial filing is often used in an accounting sense rather than as a pejorative term. However, this technical context may not make the Loughran and McDonald dictionary a better fit for the FOMC transcripts. In its focus on financial filings, their "finance dictionary" excludes some more common, relevant words from the consumer dictionary (such as the previously highlighted words "outperform," "insightful," and "sluggish").

Using both the finance and consumer dictionaries to score the tone of a comment can show why dictionary choice is so important. Take, for example, the following quotation from former Chairman Alan Greenspan: "It's an interesting question: When does this long-term trend we are all forecasting begin to affect the M2 data?"

After processing to remove punctuation, numbers, and capitalization, this comment appears in our calculations as: "its an interesting question when does this longterm trend we are all forecasting begin to affect the data." Once the number 2 is removed, the standalone "M" isn't recognized as a word or noted as an appropriate abbreviation and so is also dropped from the processed text.

I can then calculate a tone score (positive, negative, or neutral) for this comment based on each dictionary's assessment of the words it contains. The calculation for the tone label is that used in Fuksa and Sornette, and Sadique and others, and is applied for each of the dictionaries:

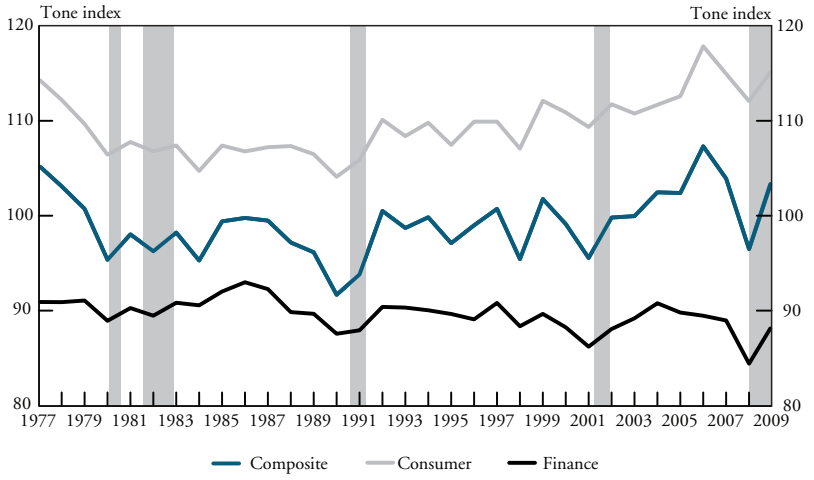
Tone = (#positive words – #negative words)/(#positive + #negative),
Tone > 0 indicates positive tone,
Tone < 0 indicates negative tone, and
Tone = 0 indicates neutral tone.

The consumer dictionary gives Greenspan's comment a positive tone label, while the finance dictionary gives it a negative tone label. The difference in labels comes from the different classifications of individual words. "Question" is the only word in Greenspan's comment that appears in the finance dictionary; it has a negative label, so the comment gets a negative label. The only word that appears in the consumer dictionary is "interesting," a positive word, so the comment gets a positive label.

The tone of a word can be changed by the words around it. When strictly scoring words with a dictionary entry, it is easy to miscast amplification—that is, words used to increase a sentiment such as "very," "deeply," or "extremely"—as well as negation, words used to change the sentiment of the word that follows such as "no," "not," or "never." While natural language processing has inspired a variety of techniques to account for negation and amplification, I opt for simplicity. For words associated with negation, I reverse the sign on the word that follows. This ensures the phrase "not helpful," for example, scores with a negative tone, preventing "helpful" from being counted as a positive word. For words associated with amplification, I add additional emphasis for the word that follows. The phrase "very admirable," for example, scores as two positive words. This approach is similar to that of Godbole, Srinivasaian, and Skiena.

Admittedly, this approach will miss amplification or negation in a more complex format. For example, the phrase "never been admirable" would generally be understood to have a negative tone. In this article's approach, the phrase would be classified as positive, because the word "admirable" is positive and "never" appears to negate the word "been,"

Chart 5
Tone Indexes Using Different Dictionaries



Notes: Index is (positive tone - negative tone) * 100 + 100 where 100 is neutral. Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

which has no semantic value. Nevertheless, this approach should accurately capture most instances in which the calculations are affected by amplification or negation.

Both the consumer and finance dictionaries have their strengths as well as their weaknesses, and neither is the obvious choice for this particular investigation. Sadique and others, for example, do not employ Loughran and McDonald's finance dictionary in their investigation of the Beige Book, asserting the text is sufficiently different from 10K filings for the dictionary to be useful.[4] A similar case could be made for the transcripts, as could a similar comparison of the transcripts to online product reviews. To try to achieve some balance in interpretation, I employ both dictionaries for this exercise and use a composite measure of tone that draws equally from them to label the comments. To do this, I score each comment twice and then use the resulting 229,824 labeled comments to calculate a composite tone measure.

The tone measures vary quite a bit across time and dictionaries. Chart 5 displays tone indexes for all three dictionaries. The consumer dictionary measures the tone of the transcripts as consistently positive over the entire period; the finance dictionary, on the other hand, classi-

fies the discussions as consistently negative. The composite measure sits reasonably between the other two measures and shows a similar cyclical pattern, with the tone of the policy discussion seeming to hit a trough just before a measured recession.

Diction and role of speaker

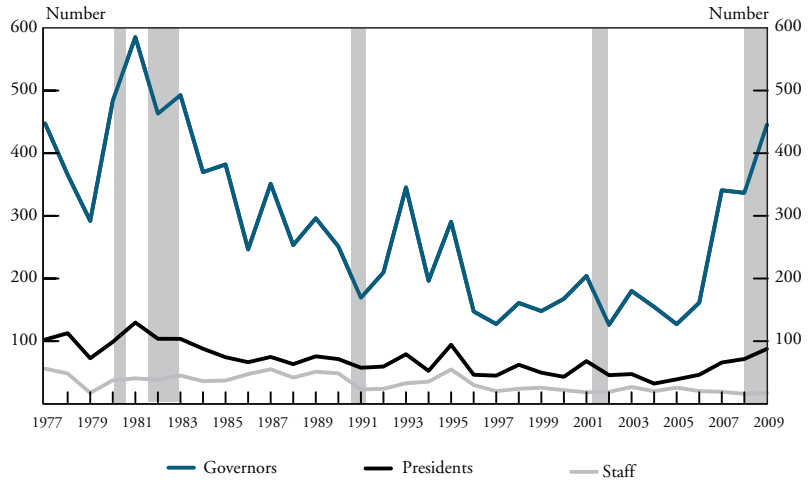
Unlike the FOMC meeting minutes and statements or the Beige Book, the transcripts identify a speaker for each comment. Using the speaker names, I classify each comment as belonging to a Governor, Reserve Bank President, or Federal Reserve staff member. I classify speakers by their respective role at the time of the comment. For example, comments Janet Yellen made from August 1994 to February 1997 contribute to the governor's tally, as she was on the Federal Reserve Board at the time; comments she made from June 2004 through the end of the currently published transcripts in December 2009, however, are counted in the Presidents' comments, as she was then President of the San Francisco Fed.[5]

The relative contribution of different classes of speaker has changed over time. Chart 6 shows the number of comments per speaker that each of the three different classes of participants made each year. Governors contributed the majority of the comments throughout the period, with their contributions peaking in the early 1980s, declining steadily until 2005, then climbing back toward the previous peak. Presidents consistently contributed more comments per speaker than the staff—however, this may not be surprising given the large number of rotating staff members who attend only occasionally.

The method of expression varies across speaker class both in the total number of words and the number of unique words used. Table 1 shows the Governors use a smaller variety of words per comment than either the Presidents or staff. Governors also have the shortest comments, likely due to a larger proportion of questions, which are usually short, instead of longer descriptions of current economic conditions in a district or a prepared presentation on a specific topic.

The measure of tone by speaker class shows a cyclical pattern, with the tone index generally rising during expansions and falling during contractions. Chart 7 shows marked cyclical variations for all

Chart 6
Distribution of Comments across Speaker Class



Note: Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

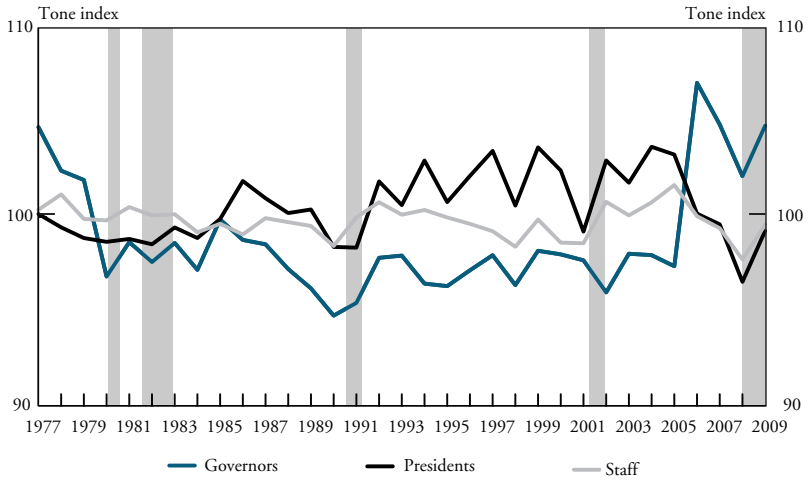
Table 1
Word Counts by Speaker Class

	Governors	Presidents	Staff
Average number of words per speaker	47,879	35,467	5,050
Average number of unique words per speaker	582	469	77
Average number of comments per speaker	1,652	601	93
Average number of words per comment	29	59	55
Average number of unique words per comment	0.35	0.78	0.83

Sources: FOMC and author's calculations.

classes but at different levels and different variances. The tone of Bank Presidents, for example, has been consistently more positive than that of the Governors and staff for most of the period. The staff tone has also been consistently more positive, with smaller variation, than the Governors until recent years. Other research has also noted differences in the focus or forecasts among the Governors, Presidents, and staff, and my results seem to align with those findings.[6]

Chart 7
Tone Indexes for Composite Measure across Speaker Class



Notes: Index is (positive tone - negative tone) * 100 + 100 where 100 is neutral. Gray bars represent NBER-defined recessions.
Sources: National Bureau of Economic Research, FOMC, and author's calculations.

III. Relationship Between Tone, Transparency, and Real Economic Activity

While the tone measure, both overall and by speaker classification, appears to move in tandem with the business cycle, it may also be related to specific measures of economic activity. To examine whether tone, speaker role, or comment variety are linked with indicators of economic growth or performance, I calculate correlations of the Chicago Fed National Activity Index (CFNAI) with several discussion descriptors and the tone index. The CFNAI is a weighted average of 85 activity indicators constructed to have a mean of 0. It is useful for this comparison because a positive number indicates growth above trend, whereas a negative number indicates growth below trend.

Effect of speaker class

The exercise reveals strong correlations between the tone of the discussions, diction of the participants, and economic activity. Table 2 shows the contemporaneous correlations between several aspects of the transcripts and economic activity as measured by the three-month moving average of the CFNAI. The overall correlation between

Table 2
Contemporaneous Correlations with CFNAI

Variable	Overall	Governors	Presidents	Staff
Total number of words per speaker	-0.56***	-0.64***	-0.43***	-0.05
Total number of unique words per speaker	-0.47***	-0.65***	-0.33*	0.25
Proportion of "inflation" mentions	0.02	0.08	0.0	-0.08
Proportion of "unemployment" mentions	-0.09	0.19	0.01	-0.01
Proportion of "growth" mentions	0.41**	0.38**	0.44***	0.17
Tone measure	0.26***	0.11*	0.28***	0.19***

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Sources: FOMC and author's calculations.

various features of the Committee discussions and activity is negative and significant: when growth is above trend, the discussions are shorter and contain fewer unique words. Conversely, when economic growth is below trend, the Committee discussions are wordier with more unique expressions. In addition, the relationship between FOMC tone and real economic activity is positive and significant—that is, positive tone in the FOMC discussions today is correlated with a high measure of economic activity.

These relationships hold somewhat when broken down by speaker class as well. The measured correlation for number of words used is lower for Presidents than for Governors, suggesting their contributions to the Committee discussions tend not to decrease as much with a decrease in real activity. Interestingly, the correlation between activity and the expression measures for the staff are not statistically significant. In addition, only one word correlation— "growth"—measures significantly and just for Presidents and Governors. Perhaps not surprisingly, they increase their discussion of economic growth when the economy is experiencing above trend growth. For all speaker classes, the correlation between tone and real activity is positive and highly significant, with the strongest relationship holding for the tone of the presidents.

Of course, correlation does not imply causation, so I cannot concretely determine if the FOMC discussions were positive because real activity was high. While the contemporaneous correlations are strong, both the FOMC discussion tone and the aggregate measures used for comparison may be reacting to the same current market conditions. This

does raise the question of whether correlations across time might reveal whether the FOMC discussions lead or lag real activity. Cross-correlation functions show the correlation of the composite tone measure with leads and lags of the economic activity variables up to 12 months.

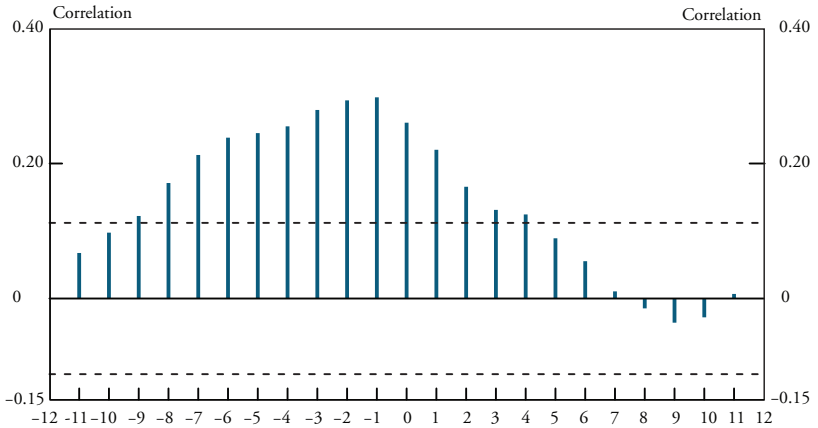
The correlation between the FOMC's tone and future (or past) economic activity indicates the extent to which the mood of the Committee discussion leads (or lags) real economic growth. Chart 8 shows the cross-correlation of the composite tone measure with the CFNAI for a span of two years: 12 months leading and 12 months lagging. The contemporaneous measure is represented by a lag equal to 0. As the correlation coefficients in Table 2 show, the tone is positively correlated with the CFNAI contemporaneously and in fact leads that index by as much as nine months: for example, a positive tone to the FOMC discussions in January through September is correlated with a positive measure for national activity in October. One interpretation for this long lead time is that FOMC participants have information, forecasts, or expectations that yield a positive tone to the discussion months before the economy experiences above-trend growth. The converse would then also be true: for example, a negative tone to Committee discussions would precede below-trend growth by several months.

As is the case with the tone level and different expression measures, the relationship between tone and activity differs across the speaker classes. The panels in Chart 9 show the cross-correlation of the tone measures with activity for the various speaker classifications. The Governors' tone is positively correlated with economic activity with just a one-month lead. The relationship between the Presidents' tone measure and the activity index is the strongest of all three speaker types and clearly leads the activity measure: a positive tone leads high measured activity by as much as a year. The correlation of the staff tone with activity is positive and significant for longer than the Governors' tone, but does not hold as long as for the Presidents.

The differences in the timing and duration of the effects are interesting in that they vary significantly across the speaker classes. As staff is likely to work more closely with the economic forecasts and other forward projections, it may have relevant information earlier than other speaker types and keep the focus on the periods ahead. Presidents' regional information and strong ties to local business and community

Chart 8

Cross-Correlation of Tone Measure with CFNAI



Note: Dashed lines represent 95 percent confidence intervals.
Sources: FOMC and author's calculations.

leaders could also give them earlier information than other classes of speakers, thus contributing to the timing of their tone in the discussion.

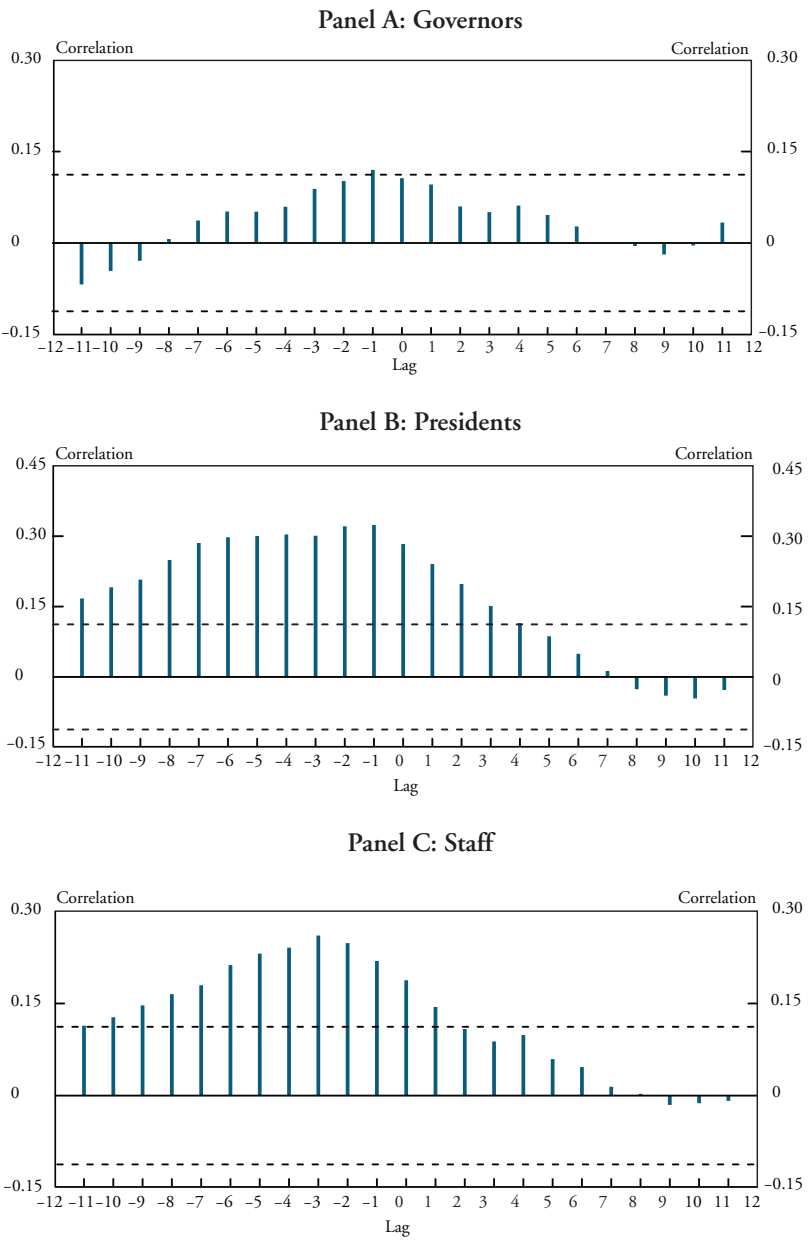
Effect of publication

Authors such as Meade and Acosta have posited that a fundamental change in the communication style of the FOMC occurred starting in late 1993. While the meetings were transcribed from recordings beginning in 1976 to compose the minutes, it is not clear FOMC participants were aware of these recordings—or that they expected the transcripts to be made public. In response to a congressional hearing in late 1993, the Federal Reserve Board decided to publish the transcripts from the historical and future recordings with a five-year lag. Meade and Stasavage note that "since 1993 there has been an increased tendency for Committee members to present … pre-prepared statements," which may result in changes in the distribution of words used as well as a change in the general tone measures. Following their work, the analysis here omits the 1993 observations due to possible confusion over who knew about the recordings at what point in the year. Thus, I break the sample into the pre-publication period of 1977–92 and the post-publication period of 1994–2009.

Several measures appear to have changed in the post-publication period. Table 3 shows the differences in the measures of expression

Chart 9

Cross-Correlation of Tone Measure by Speaker Class with CFNAI



Note: Dashed lines represent 95 percent confidence intervals.
Sources: FOMC and author's calculations.

Table 3
Word Counts by Publication Regime

	Pre-publication	Post-publication
Average number of words per meeting	12,731	13,102
Average number of unique words per meeting	162	115
Average number of comments per meeting	333	302
Average number of words per comment	38	43
Average number of unique words per comment	0.49	0.38

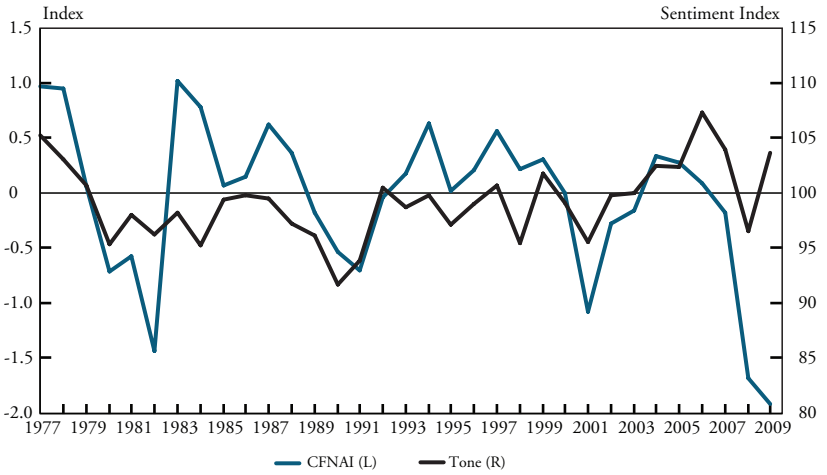
Sources: FOMC and author's calculations.

across the two time periods. The number of comments per meeting decreased, but the number of words used per comment increased—thus, the total number of words was higher post-publication. However, these words were less varied, as both the number of unique words per meeting and per comment declined in the post-publication period. One reason for the differences may be more carefully worded responses or scripted presentations with fewer common words than would be found in less constrained discourse—indeed, former Kansas City Fed President Thomas M. Hoenig said publication "has had some chilling effect on our discussions. I see a lot more people reading their statements. I think it is harder to be as candid as some of us might otherwise be" (Board of Governors 1995).

As before, these word counts should not be interpreted as indicating topic importance but do highlight a marked difference in the diction across the two periods. This result would support Meade and Stasavage's conclusion that discourse did change after the publication of the transcripts became a known and regular occurrence. The change in the form of expression may also support Acosta's finding that speakers had greater conformity—that is, the words they used were more similar—in the post-publication period than in the pre-publication period.

In addition to differences in the number and choice of words across the two periods, the relationship between tone and the CFNAI also differs. Chart 10 shows the relationship between the composite tone measure and the CFNAI across the entire sample period. The correlation appears to be quite close, as the static correlation measure would imply, but the nature of the relationship seems to have shifted over time: the sentiment measure appears to lag economic activity in the early and more recent periods and lead the index in the intervening years.

Chart 10
Tone and Activity Indexes



Sources: FOMC and author's calculations.

This change in the relationship from leading to lagging is more visible in the cross-correlation functions. Panels A and B of Chart 11 show that the strength and relationship between the tone of the discussions and real activity after publication lacks the consistent and positive relationship that exists prior to 1993. In fact, any leading relationship for the discussion tone and the CFNAI completely disappears in the post-publication period, and the timing becomes one of a lagging relationship.

A simple regression of the tone measure on CFNAI in each time period shows a measurable change in tone in the later time period.

Pre-publication:

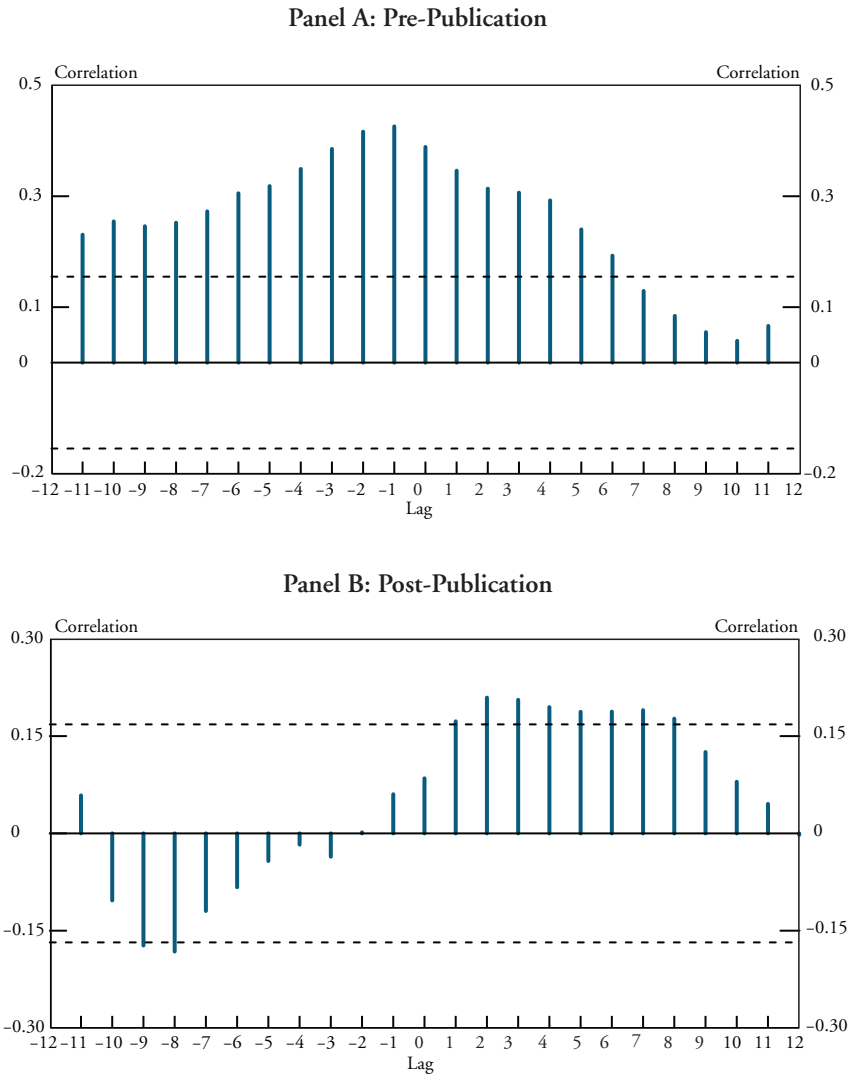
$$Tone = 99.17 + 1.02 * CFNAI$$
$$(0.15)\ (0.27)$$
$$R^2 = 0.07$$

Post-publication:

$$Tone = 100.11 + 0.4 * CFNAI$$
$$(0.18)\ (0.20)$$
$$R^2 = 0.01$$

The intercept implies that at trend growth (CFNAI = 0), the general tone was slightly higher in the latter period, but the correlation between activity and tone was much lower. The coefficient for CFNAI

Chart 11
Cross-Correlation of Tone Measure with CFNAI



Note: Dashed lines represent 95 percent confidence intervals.
Sources: FOMC and author's calculations.

shows a modulated or dampened effect on the tone of the Committee's discussion relative to the state of the economy after the publication of the transcripts: positive activity sparked a less positive tone in FOMC discussions post-publication than pre-publication.

To explore the differences across speaker class, I separate out the Bank Presidents' and staff members' tone from that of the Governors before and after the publication change.

Pre-publication:

Governor: $Tone = 98.23 + 2.17^{*} CFNAI$
$(0.37)\ (0.40)$
$R^2 = 0.16$

President: $Tone = 99.30 + 0.72^{*} CFNAI$
$(0.20)\ (0.21)$
$R^2 = 0.07$

Staff: $Tone = 99.97 + 0.15^{*} CFNAI$
$(0.15)\ (0.17)$
$R^2 = 0.01$

Post-publication:

Governor: $Tone = 98.75 - 1.26^{*} CFNAI$
$(0.36)\ (0.39)$
$R^2 = 0.07$

President: $Tone = 101.72 + 1.72^{*} CFNAI$
$(0.29)\ (0.31)$
$R^2 = 0.19$

Staff: $Tone = 99.86 + 0.75^{*} CFNAI$
$(0.2)\ \ (0.21)$
$R^2 = 0.08$

The relationship between tone and activity differs markedly from the pre-publication to post-publication periods across speaker class. Governors exhibit the most drastic change: the relationship between tone and

activity switches signs in the post-publication period, indicating that a positive tone correlated with above-trend growth changed to a negative tone correlated with above-trend growth. The Presidents' tone, on the other hand, remained positive in the post-publication period but had a larger coefficient than in the pre-publication period. This suggests Presidents' tended to use a more positive tone when the economy experienced above-trend growth in the post-publication period than they did before the transcripts were published. The staff tone differs across the periods as well: prior to publication, staff tone and activity had no statistically significant relationship, but the relationship became significant in the post-publication period.

IV. Conclusion

The FOMC meeting transcripts provide a unique record over time of monetary policy meetings, yet they have been studied far less intensively than FOMC press releases and meeting minutes. Even with a five-year publication lag, the transcripts are a rich source of detailed information about monetary policy deliberations from which much can be learned. The analysis in this article shows that the tone of the FOMC's discussion varies by speaker class, and that Bank Presidents contribute to the discussion in significantly different ways relative to Governors or Federal Reserve staff members. In addition, basic sentiment analysis shows the tone measure for the Committee discussions is strongly related to real economic activity, but that the relationship varies by speaker class. Finally, the analysis confirms the findings of other research that FOMC discourse shifted measurably after the decision to publish the transcripts in 1993 with both the tone and expression of the discussions changing measurably in the latter period.

These findings suggest that the Committee dynamics and the role of the participants in the meetings are fluid. Much research in this area has examined the transcripts as a single large corpus, without considering the variation over time and across speakers. Adding a time dimension to further text analysis, beyond examining the text before and after the 1993 publication decision, may give even more insight to how policy is formed.

Endnotes

[1]See Danker and Luecke for details of FOMC communications.

[2]See Boukus and Rosenberg; Acosta for examples using a methodology called Latent Semantic Analysis on the FOMC minutes and transcripts.

[3]The publicly available transcripts for one conference call and four meetings are missing pages: July 1979, March 1981, March 1984, November 1984, and August 1992. At the time of analysis, no transcript was available for the November 18, 1980 meeting.

[4]The Beige Book contains regional reports of conditions from the Federal Reserve districts and is an input to FOMC discussions but not an output from the Committee.

[5]I define the "staff" designation as non-Governor, non-President rather than matching comments to actual staff attendees. Therefore, in some instances, especially in the early transcripts, a comment may not be definitively attributable and may appear as "Speaker Y or Z." I classify those occurrences as staff observations unless there is clear indication they should be in one of the other two categories.

[6]For example, see Romer and Romer for a discussion of FOMC versus staff forecasts. For a discussion of Board versus Bank outlooks, see Meade; and Eijffinger, Mahieu, and Raes.

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Estimating the Monetary Policy Rule Perceived by Forecasters

By Brent Bundick

Communicating the expected future path of monetary policy to the public is inherently difficult. Policymakers often set a single policy instrument as a function of many different, and likely conflicting, macroeconomic indicators. In communicating their actions, central banks often explain how economic conditions affect the stance of monetary policy. By outlining how policy responds to economic conditions, the central bank implicitly communicates a policy rule that guides their decisionmaking process.

Professional forecasters, in turn, attempt to identify this implicit monetary policy rule. Many economists and financial market participants regularly produce forecasts for inflation, unemployment, output growth, and interest rates. The relationship between these variables shows how forecasters perceive the Federal Open Market Committee (FOMC) will set future policy as a function of future economic conditions. Ensuring the public correctly understands this reaction function is crucial for policymakers to implement sound monetary policy (Woodford).

In this article, I examine whether the policy rule perceived by forecasters has changed since the end of 2008, when the FOMC lowered its conventional policy tool, the federal funds rate, to its effective lower bound. Since December 2008, policymakers have used less conventional tools such as large-scale asset purchases and forward guidance

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about future policy actions to achieve their dual mandate of stable prices and maximum employment. Providing statements about likely future policy actions allows the FOMC to influence expectations about future interest rates even when they are constrained by the zero lower bound (Eggertsson and Woodford; Smith and Becker).

Has forward guidance changed perceptions of the FOMC's implicit policy rule? Statistical evidence suggests the forecaster-perceived policy rule remains relatively unchanged at the zero lower bound. Forecasters believe the FOMC responds significantly but gradually to changes in unemployment and inflation.

These findings suggest the FOMC's forward guidance is largely consistent with its behavior prior to hitting the zero lower bound. While unconventional policy may have changed some specifics of the FOMC's communication and conduct, the reaction function forecasters perceive is similar to the pre-zero lower bound period. These results suggest forecasters do not believe the FOMC's reaction function has changed simply because the economy hit the zero lower bound. More specifically, the statistical results suggest forecasters believe the FOMC's desired response to economic conditions remains intact even when current short-term rates are near zero.

I. Policy Rules as a Description of Monetary Policy

Policymakers consider a wide range of economic indicators when setting the appropriate path of monetary policy. For example, they may examine recent conditions in labor markets, household consumption, business investment, and changes in the overall prices of goods and services. However, determining the relevance of any single indicator in setting appropriate policy remains difficult.

To reduce the complexity of responding to "everything," policymakers often use simple rules to help guide their decisionmaking. Simple rules prescribe the stance of monetary policy as a function of a few key economic variables. Nevertheless, good policy sometimes requires flexibility and discretion, and central bankers cannot blindly follow an explicit rule (Yellen). Therefore, while the FOMC may use rules as a guide, it does not follow one explicit, publicly available policy rule.

Nevertheless, Taylor (1993, 1999), Kahn, and many others show that a simple policy rule can reasonably describe actual central bank

actions. While the exact rule varies across studies, a large body of statistical evidence suggests the FOMC has responded systematically to changes in real economic activity, labor market conditions, and the prices for goods and services. However, Clarida, Galí, and Gertler, among others, show that the simple rule that best describes monetary policy has not been constant over time.

The zero lower bound period, for example, may correspond with a change in the FOMC's implicit policy rule. The zero lower bound represents a significant constraint on policymakers, as their conventional policy tool for stabilizing the economy—the overnight federal funds rate—is no longer available as a tool for easing policy. As a result, the FOMC has had to rely on unconventional tools such as forward guidance and large-scale asset purchases. The Committee's relative inexperience with these new policy tools and the zero lower bound might suggest a change in how it responded to economic conditions.

To examine how professional forecasters interpreted unconventional actions during this period, I study their perceptions of the FOMC's implicit rule. Examining forecasters' perceived rule has two main benefits. First, professional forecasters have reputational incentives to use all available information to help predict future macroeconomic conditions and the stance of monetary policy. Thus, their forecasts about future interest rates reflect their best estimates of future FOMC behavior. Second, even when current nominal interest rates are stuck at zero, forecasts about the future stance of policy can reveal valuable information about the FOMC's implicit rule.

II. Modeling Monetary Policy

The conduct and communication of monetary policy after 2008 may have caused professional forecasters to change their perceptions about the FOMC's implicit policy rule. Evaluating whether the perceived rule changed first requires a model that can capture forecasters' beliefs about how the FOMC sets the stance of monetary policy. In the following empirical work, I assume forecasters believe the FOMC sets its short-term nominal rate using the rule:

$$r_t = \phi_r r_{t-1} + (1-\phi_r)[r + \phi_\pi(\pi_t - \pi) + \phi_u(u_t - u) + \phi_{\Delta y}(\Delta y_t - \Delta y)],$$

where r_t is the short-term policy rate set by the central bank (the federal funds rate), π_t denotes the percent change in the personal consumption expenditure (PCE) price index, u_t is the unemployment rate, and Δy_t is the growth in real gross domestic product. The central bank's inflation target is denoted by π, while u and Δy denote the long-run values for unemployment and output growth, respectively. Since forecasters don't announce their perceived rule, the assumed model includes many features that previous researchers have found helpful in describing actual FOMC behavior. The ϕ parameters denote the central bank's reaction to changes in inflation, unemployment, and output growth. The rule describes how forecasters expect policy rates to change if inflation, unemployment, and growth deviate from the FOMC's longer-run or target objectives. Current policy rates are also seen as a function of lagged policy rates, r_{t-1}, under forecasters' assumptions that policymakers smooth changes in interest rates over time. Smoothing changes in policy rates implies that the central bank responds gradually to changing economic conditions.

The interest rate rule assumes forecasters perceive policy is set as a function of past interest rates and current macroeconomic conditions. However, the rule can also be used to predict how future policy will be determined as a function of expected fundamentals. At a given point in time t, forecasts for the expected four-quarter-ahead policy rate, r^e_{t+4} can be determined using the following rule:

$$r^e_{t+4} = \phi_r r^e_{t+3} + (1-\phi_r)[r + \phi_\pi(\pi^e_{t+4} - \pi) + \phi_u(u^e_{t+4} - u) + \phi_{\Delta y}(\Delta y^e_{t+4} - \Delta y)].$$

After replacing the values of current inflation, unemployment, and output growth with their respective forecasts, the rule implies expected future short-term rates depend on expected future macroeconomic conditions. As with the earlier, contemporaneous policy rule, this simple forecast-based rule describes how policy rates are expected to change if inflation, unemployment, and growth are expected to deviate from their longer-run or target objectives.

The purpose of specifying these rules is to determine whether the coefficients in the forecaster-perceived policy rule changed after the economy hit the zero lower bound. A significant change in the ϕ coefficients of the perceived policy rule would imply that forecasters believe the FOMC's policy rule has indeed changed since the end of 2008.

In making this determination, I estimate the rule using monthly Blue Chip survey data from both the pre-zero lower bound period (January 1984–December 2008) and the zero lower bound period (January 2009–August 2015).[1]

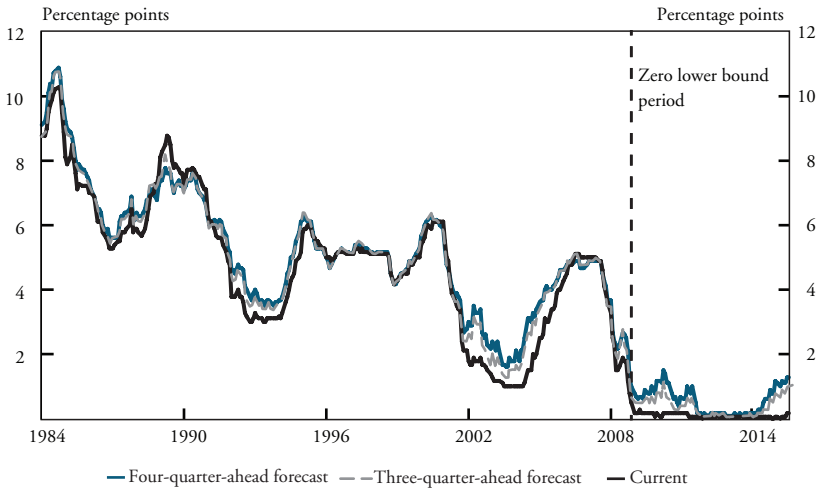
Blue Chip Economic Indicators conducts monthly surveys of various professional forecasters to measure expectations about future inflation, unemployment, output growth, and interest rates. To match the assumed model of monetary policy with the forecast variables available in the survey, I substitute forecasts of the federal funds rate with forecasts for the three-month Treasury bill rate. This assumption is common in previous research, as these two interest rates are highly correlated. In addition, I measure inflation using the consumer price index (CPI), rather than the PCE price index.

Forecast data provides a useful framework for examining the FOMC's implicit policy rule before and after the zero lower bound. Chart 1 plots the current and three-quarter and four-quarter-ahead forecasts of short-term nominal interest rates. Several key features of the data are noteworthy. First, short-term nominal rates fell to near zero in December 2008 and have remained there since. Without variation in the level of short-term interest rates since 2008, any estimation procedure will fail to uncover the parameters of the policy rule after 2008.[2] However, the four-quarter-ahead forecasts continue to vary over time, even when policy is constrained by the effective lower bound. Therefore, these forecasts can be used to estimate the perceived policy rule parameters at the zero lower bound.

One difficulty in estimating the perceived policy rule is that the long-run levels of unemployment and GDP growth are not observed. However, by taking the difference between the three-quarter and four-quarter-ahead forecasts, I can estimate the parameters without making assumptions or estimating the long-run or target objectives in the rule.[3] These parameters reveal the FOMC's reaction to changes in inflation, unemployment, or output growth. Chart 1 shows that the gap between the three-quarter and four-quarter-ahead forecasts fluctuates over time, including during the zero lower bound period. Further details on the statistical procedures are in the Appendix.

Chart 1

Forecasts of Short-Term Interest Rates



Note: Expectations about short-term interest rates are measured using the Blue Chip surveys for the three-month Treasury bill rate.
Sources: Blue Chip Economic Indicators and Board of Governors of the Federal Reserve System.

Before the Zero Lower Bound

Prior to 2008, forecasters appear to have believed that the FOMC responded significantly to changes in unemployment, inflation, and output growth. The second column of Table 1 shows estimated coefficients of the forecaster-perceived policy rule over the 1984–2008 sample period. The estimated parameters ϕ_π and ϕ_u indicate the central bank's reaction to deviations of inflation and unemployment, respectively, from their longer-run values. The large, negative coefficient on unemployment, -5.40, suggests forecasters believe the FOMC responded significantly to fluctuations in unemployment. The reaction coefficient on inflation (ϕ_π) is also large at 2.88 but is not estimated precisely. In addition, the perceived rule is characterized by a large estimated ϕ_r coefficient, which implies a high degree of interest rate smoothing. A high degree of smoothing suggests the central bank adjusts interest rates slowly over time in response to changing economic conditions.[4] Finally, the large coefficient on the $\phi_{\Delta y}$ parameter suggests forecasters also believed the FOMC responded significantly to fluctuations in output growth. The implied policy rule explains over 40 percent of the variation in the gap between the three-quarter and four-quarter interest rate forecasts.

Table 1
Parameter Estimates of the Policy Rule Perceived by Forecasters

Parameter	Pre-zero lower bound 1984–2008	Zero lower bound Post-2008
ϕ_r	0.93 (0.78, 1.07)	0.91 (0.83, 0.98)
ϕ_π	2.88 (-0.79, 6.56)	1.59 (0.64, 2.53)
ϕ_u	-5.40 (-9.43, -1.36)	-6.84 (-9.38, -4.30)
$\phi_{\Delta y}$	3.09 (1.65, 4.54)	0.31 (-0.59, 1.20)
Observations	292	80
R^2	0.44	0.69
P-value from overidentifying restrictions test	0.71	0.90

Note: Numbers in parentheses denote 95 percent confidence intervals.
Sources: Blue Chip Economic Indicators and author's calculations.

Over the 1984–2008 period, the estimated policy rule's predictions closely match forecasters' actual projections. Using the estimated policy rule, I compute the implied forecasts for the four-quarter-ahead interest rate.[5] Chart 2 plots these predicted values versus the actual four-quarter-ahead Blue Chip forecasts. The predicated rates from the estimated policy rule appear to closely track forecasters' actual projections.

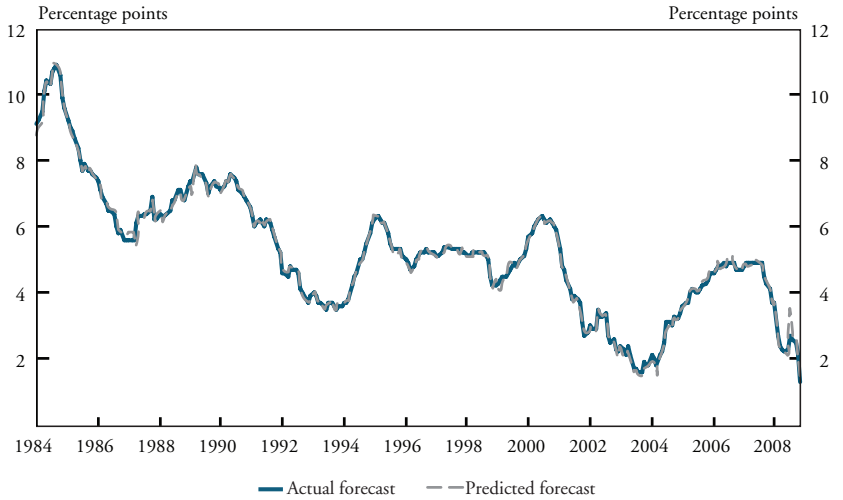
At the Zero Lower Bound

At the end of 2008, the FOMC lowered its nominal policy rate to its effective lower bound. Unable to lower rates further, the FOMC turned to unconventional policies such as forward guidance to help stabilize the economy. Smith and Becker discuss the FOMC's use of forward guidance over the last several years and find that unexpected changes in the FOMC's forward guidance have significant effects on economic activity and inflation. In this article, I instead examine how forecasters interpreted changes in the FOMC's guidance over this period. Did forecasters interpret the use of explicit forward guidance as a change in the central bank's implicit rule? Or did they interpret forward guidance as simply a communication device, with the bank's policy rule remaining unchanged?

To determine which of these views is supported by empirical evidence, I first examine how well the previously estimated rule from the

Chart 2

Actual and Predicted Four-Quarter-Ahead Interest Rates Prior to 2009

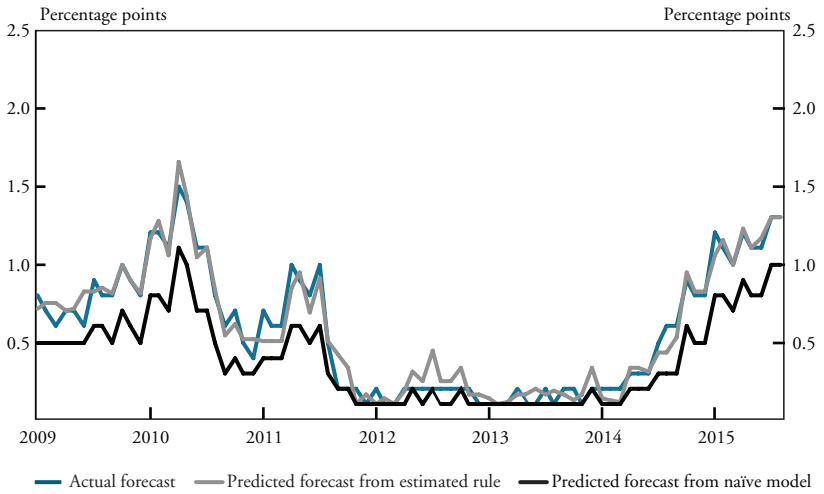


Sources: Blue Chip Economic Indicators and author's calculations.

pre-zero lower bound period predicts interest rate forecasts over the last few years. Using the policy rule estimated over the pre-2009 data, I generate the implied four-quarter-ahead interest rate forecasts for the zero lower bound period. Chart 3 plots these out-of-sample predictions against the actual four-quarter-ahead forecasts since 2009. The out-of-sample predictions of the pre-zero lower bound rule (gray line) are surprisingly consistent with forecasters' actual projections in the zero lower bound period (blue line). Like the actual forecasts, the estimated rule predicts a large decline in expected rates in the middle of 2010 and a gradual rising of interest rate expectations beginning in 2014. The close fit of these out-of-sample predictions to their actual forecasts suggests the forecaster-perceived rule has not changed dramatically since the end of 2008.

In addition, the predictions from the estimated policy rule fit the actual forecast data significantly better than a simple time series model. Chart 3 also plots the forecasts from a naïve random-walk model, where the forecast for the four-quarter-ahead interest rate simply equals the three-quarter-ahead forecast. The predictions from this simple model (black line) do not appear to closely track the actual forecasts well. The persistent differences between the random-walk model and the actual

Chart 3
Actual and Predicted Four-Quarter-Ahead Interest Rates



Sources: Blue Chip Economic Indicators and author's calculations.

forecasts suggest that forecasters' perceptions about future policy are not well captured by this naïve forecasting model.

To further test for a change in the forecaster-perceived rule, I re-estimate the rule over the January 2009–August 2015 sample period. Comparing the estimated coefficients across sample periods allows me to determine whether the perceived rule changed over time. The third column of Table 1 shows the parameter estimates over the zero lower bound period. The coefficients are similar to those in the pre-zero lower bound period, suggesting the policy rule perceived by forecasters is relatively unchanged since hitting the zero lower bound. For example, the coefficients on unemployment(ϕ_u) across both subsamples are about –6. The response coefficients on inflation(ϕ_π) are also similar across both subsamples, but the coefficient is more precisely estimated in the post-2008 period.[6] Forecasters continued to believe the FOMC responded significantly to fluctuations in unemployment with a large degree of interest rate smoothing. The coefficient on output growth is somewhat smaller in the zero lower pound period, suggesting forecasters believed the FOMC put less weight on output growth deviations in the last few years.[7] Even in the era of explicit forward guidance, the simple policy rule continues to explain much of the variation in the gap between the four-quarter and three-quarter-ahead forecasts. These subsample

estimation results suggest forecasters' perceived policy rule did not change dramatically over the zero lower bound period. [8]

III. Interpreting the August 2011 Period

The statistical results suggest forecasters believed the FOMC would respond to economic conditions in the zero lower bound period in the same way they did before the lower bound became a policy constraint. However, one notable change in forward guidance during this period challenges this interpretation. Before August 2011, the FOMC's forward guidance indicated "economic conditions … are likely to warrant exceptionally low levels of the federal funds rate for an extended period" (FOMC). One meeting later, however, the FOMC released a statement that indicating significant changes to its forward guidance regarding future rates. In its August 9, 2011 statement, the Committee replaced the "extended period" language with "at least through 2013." After this statement, forecasters significantly revised down their expectations of future short-term rates (Chart 3).

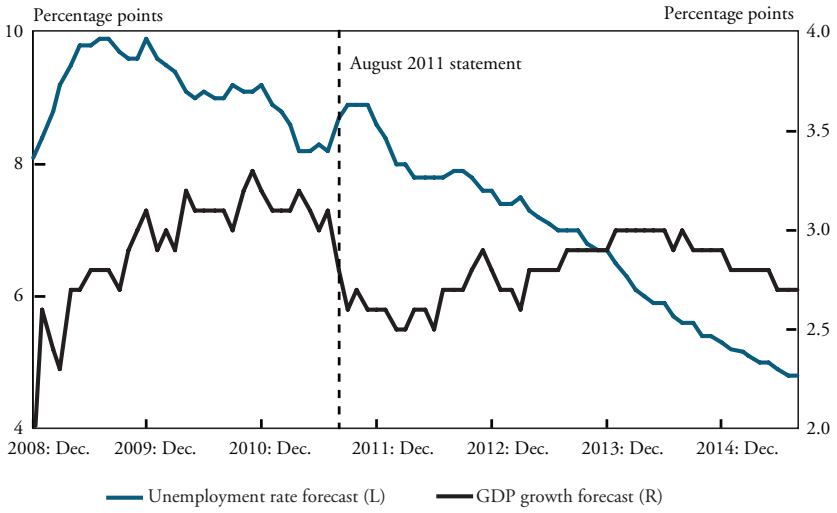
On the surface, this large change in guidance in the span of one meeting might have suggested a change in the FOMC's policy rule. However, private-sector forecasts show the economic outlook deteriorated rapidly in the middle of 2011. Chart 4 plots the four-quarter-ahead unemployment and real GDP growth forecasts during the zero lower bound period. In the summer of 2011, forecasters significantly revised down their projections for growth and unemployment. Growth expectations fell by 0.5 percentage point, and the unemployment rate was expected to reverse its downward trend. Many of these revisions occurred after releases of labor market data that painted a more pessimistic picture of the labor market than expected.[9]

Despite the large change in the FOMC's guidance, the pre-zero lower bound policy rule appears to accurately predict the change in interest rate forecasts.[10] Chart 3 shows that the predicted four-quarter-ahead interest rate forecasts also fell sharply around August 2011. These results suggest that the decline in interest rate forecasts was consistent with deterioration in the economic outlook rather than a change in the FOMC's underlying policy rule.[11]

The August 2011 statement and the FOMC participants' own forecasts around that time also suggest a deteriorating macroeconomic

Chart 4

Four-Quarter-Ahead Unemployment and Real GDP Growth Forecasts



Source: Blue Chip Economic Indicators.

Table 2

Central Tendencies from the Survey of Economic Projections

Variable	Forecast date	2011	2012	2013
Real GDP growth	June 2011	2.7–2.9	3.3–3.7	3.5–4.2
	November 2011	1.6–1.7	2.5–2.9	3.0–3.5
Unemployment rate	June 2011	8.6–8.9	7.8–8.2	7.0–7.5
	November 2011	9.0–9.1	8.5–8.7	7.8–8.2

Source: Board of Governors of the Federal Reserve System.

outlook in the middle of 2011. Table 2 shows central tendencies from the Survey of Economic Projections (SEP) for FOMC participants in June and November 2011.[12] The central tendencies of real GDP growth and employment fell significantly throughout the forecast period. Expectations for 2012 unemployment rose by over 0.5 percentage point from June to November 2011. The rapid change in the FOMC participants' forecasts suggests that the change in forward guidance was consistent with a rapid change in economic conditions.

IV. Conclusion

Despite the FOMC's unprecedented use of unconventional policy tools over the last few years, its implicit policy rule, as perceived by forecasters, appears to have remained relatively unchanged since hitting the zero lower bound. This suggests the Committee's communication strategies and forward guidance over the last few years were consistent with its previous behavior. Even when current short-term policy rates were constrained by the zero lower bound, forecasters believed the FOMC would respond similarly to developments in the economy as they did before the zero lower bound constrained policy.

However, a few significant caveats apply to the results and interpretation. The estimated policy rule does not account for the effects of large-scale asset purchases by the Federal Reserve. If these actions provided additional monetary accommodation, they are not captured by my analysis. However, Woodford and others argue that these large-scale asset purchases simply reflected a signaling channel of monetary policy. Under this view, the central bank supports its forward guidance by purchasing longer-term securities.

Despite this caveat, my estimation strategy helps identify the implicit policy rule forecasters believe the FOMC will follow *after* the economy lifts off from the zero lower bound. Forecasters could believe the FOMC has temporarily deviated from its established rule at the zero lower bound but will return to its previous rule when it begins raising interest rates. While my results cannot definitively address some of the more nuanced aspects of the FOMC's implicit policy rule at the zero lower bound, the statistical evidence suggests that the forecaster-perceived rule remains relatively constant.

Appendix
Data and Estimation Procedure

This Appendix provides additional details about the data and estimation procedure. Monthly Blue Chip Consensus surveys provide forecasts for quarterly variables. For example, the January, February, and March forecasts for the one-year-ahead inflation rate all pertain to the first quarter of the following year. Due to this overlapping forecast structure, I compute heteroskedastic and autocorrelated-corrected standard errors with two lags. I use the three-month Treasury bill interest rate forecasts, which are highly correlated with the federal funds rate, as the dependent variable.

I derive the primary equation used in the statistical analysis assuming forecasters believe the FOMC sets its short-term nominal rate using the following rule:

$$[r_t = \phi_r r_{t-1} + (1-\phi_r)r + \phi_\pi(\pi_t - \pi) + \phi_u(u_t - u) + \phi_{\Delta y}(\Delta y_t - \Delta y)]$$

where r_t is the short-term policy rate set by the central bank, π_t denotes the rate of inflation, u_t is the unemployment rate, and Δy_t is the growth in real gross domestic product. The central bank's inflation target is denoted by π, while u and Δy denote the long-run values for unemployment and output growth, respectively. Iterating this equation forward and taking expectations at time t, the three-quarter and four-quarter-ahead forecasts can be written as follows:

$$r^e_{t+3} = \phi_r r^e_{t+2} + (1-\phi_r)[r + \phi_\pi(\pi^e_{t+3} - \pi) + \phi_u(u^e_{t+3} - u) + \phi_{\Delta y}(\Delta y^e_{t+3} - \Delta y)]$$

$$r^e_{t+4} = \phi_r r^e_{t+3} + (1-\phi_r)[r + \phi_\pi(\pi^e_{t+4} - \pi) + \phi_u(u^e_{t+4} - u) + \phi_{\Delta y}(\Delta y^e_{t+4} - \Delta y)]$$

Since both equations hold for each forecast date , taking the difference of the two equations results in the following relationship between forecasts:

$$r^e_{t+4} - r^e_{t+3} = \phi_r(r^e_{t+3} - r^e_{t+2}) + (1-\phi_r)[\phi_\pi(\pi^e_{t+4} - \pi^e_{t+3}) + \phi_u(u^e_{t+4} - u^e_{t+3}) + \phi_{\Delta y}(\Delta y^e_{t+4} - \Delta y^e_{t+3})]$$

At a given date, the differences between the three-quarter and four-quarter-ahead forecasts can help identify the implicit policy rule perceived by forecasters. I estimate the policy rule parameters ϕ_r, ϕ_u,

Table A-1
Ordinary Least Squares Policy Rule Estimates

Parameter	Pre-zero lower bound 1984–2008	Zero lower bound Post-2008
ϕ_r	0.58 (0.38, 0.78)	0.85 (0.74, 0.95)
ϕ_π	0.31 (-0.06, 0.69)	0.74 (-0.08, 1.56)
ϕ_u	-1.31 (-1.92, -0.70)	-2.22 (-4.37, -0.07)
$\phi_{\Delta y}$	0.06 (-0.09, 0.22)	-0.03 (-0.62, 0.56)
Observations	300	80
R^2	0.58	0.71
P-value from exogeneity test	0.00	0.39

Note: Numbers in parentheses denote 95 percent confidence intervals.
Sources: Blue Chip Economic Indicators and author's calculations.

ϕ_π, and $\phi_{\Delta y}$. Note that this difference specification allows me to estimate the key policy parameters without making assumptions about the inflation target, π, or longer-run values for unemployment, u, or output growth, Δy . To compute the four-quarter-ahead policy rate implied by the estimated rule, I use the fitted values from the statistical model and add the value of the three-quarter-ahead policy rate to both sides of the estimating equation.

The estimation procedure uses generalized method of moments. The analogous ordinary least squares results appear in Table A-1. Statistical tests reject the exogeneity of the regressors at the 1 percent level for the pre-zero lower bound period. Thus, I use generalized method of moments for the baseline estimation, which is common in previous literature on estimating monetary policy rules. I estimate the model using the third through eighth lags of the right-hand-side variables. Due to the overlapping forecast structure, I find the first and second lags fail to satisfy weak instrument tests. The Hansen J-test fails to reject the overidentifying restrictions, which suggests the use of valid instruments. I implement the generalized method of moment estimation using the *ivreg2* package developed by Baum, Schaffer, and Stillman.

Constants are included in the statistical models but are not statistically significant from zero for the difference specification. I allow for estimation error in the statistical procedure by appending an uncorrelated shock to the estimating equation.

Endnotes

[1]I begin the analysis in 1984 to avoid any structural changes in the policy rule associated with the Volcker disinflation in the late 1970s and early 1980s. The December 2008 Blue Chip survey was conducted before the FOMC lowered the federal funds rate to its effective lower bound. Therefore, I include the December 2008 survey with the pre-zero lower bound sample.

[2]Kim and Pruitt show that at the zero lower bound, estimating policy rules with the level of the current short-term rates suffers from a censoring problem, which biases their coefficients toward zero. Hakkio and Kahn, instead, estimate policy rules using the Wu and Xia shadow rate. This shadow rate is not constrained by the zero lower bound and can be interpreted as the central bank's desired nominal policy rate.

[3]Estimating the model in first differences also allows the long-run or target objectives to differ across the two subsamples without affecting my estimation results. This feature is particularly important for inflation, because the FOMC explicitly sets a target for the PCE price index, rather than the CPI that is used in the statistical analysis.

[4]In a related work, Coibion and Gorodnichenko find significant evidence of interest rate smoothing in the FOMC's actual reaction function. In their baseline specification, they also find a reaction coefficient on inflation larger than 2. However, my article focuses on forecasters' perceptions of the FOMC's implicit policy rule.

[5]To determine the implied four-quarter-ahead policy rate, r^{e}_{t+4} , I use the fitted values from the statistical model and add the value of the three-quarter- ahead policy rate, r^{e}_{t+3} , to both sides of the estimating equation.

[6]While the estimated coefficients on inflation in Table 1 differ slightly across subsamples, the 95 percent confidence intervals show that the coefficient is imprecisely estimated in the pre-zero lower bound period. The estimated coefficient for the zero lower bound sample lies within the confidence interval for the 1984–2008 sample period.

[7]In related work, Hamilton, Pruitt, and Borger estimate the monetary policy rule perceived by financial market participants using high-frequency data on interest rate expectations. Their estimated rule suggests the FOMC's response to output fell after 2000.

[8]This work is similar to a recent paper by Kim and Pruitt. They also use forecast data to examine the FOMC's implicit policy rule before and after the onset of the zero lower bound. However, they find a decrease in the forecasters' perceived response to inflation in the zero lower bound period. In contrast, I find that the perceived inflation response was relatively unchanged across sample periods. These different conclusions occur for two reasons. First, my zero lower bound sample period extends through 2015, while Kim and Pruitt's analysis ends

in 2011. Second, I use a slightly different estimation procedure that uses generalized method of moments and an alternative empirical specification.

[9]Employment growth and unemployment rate releases were significantly worse than expected during the middle of 2011. In addition, past months' data were revised downward.

[10]Ideally, I would re-estimate the policy rule before and after the August 2011 FOMC statement. However, there are too few observations in the zero lower bound period to conduct meaningful statistical inference.

[11]A third explanation is also possible: forecasters may have believed that the FOMC chose to temporarily deviate from its established rule, but would follow its previous rule in the near future. In standard macroeconomic models, this interpretation could be modeled as an unexpected shock to the monetary policy rule that is uncorrelated with current economic conditions. However, Smith and Becker's empirical evidence suggests that such a shock would have to have been extremely large and highly unlikely by historical standards.

[12]SEP projections are only released every other FOMC meeting. Thus, the June and November projections are the closest available to the August meeting.

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Competition in Local Agricultural Lending Markets: The Effect of the Farm Credit System

By Charles S. Morris, James Wilkinson, and Eric Hogue

The goal of U.S. antitrust laws is to protect consumers and businesses from anticompetitive behavior. One area of antitrust law prohibits business mergers that substantially lessen competition or create a monopoly. In banking, insufficient competition can be harmful for consumers and businesses. For example, if a merger of two competing banks results in a combined bank with a substantial market share, bank customers may pay higher interest rates on loans, receive lower interest rates on deposits, or have less access to credit.

The federal banking regulatory agencies are responsible for approving bank mergers. As part of the approval process, they must ensure mergers comply with antitrust laws. The agencies initially assess the competitive effects of proposed mergers using screening measures based on the deposit shares of banks operating in the market. If proposed mergers do not pass the initial screening test, the banking agencies conduct further analysis of the mergers' potential effects on competition.

One shortcoming of deposit-based measures of competition is they do not explicitly account for competition from nondepository financial firms. For example, banks compete with finance companies for business and consumer loans and with money market mutual funds for deposit products. In rural markets where agriculture is a primary business activity, the Farm Credit System's retail lenders, known as Farm Credit Associations (Associations), are particularly important nonbank

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competitors. Despite Associations' large presence in agricultural loan markets, we are not aware of any studies that have assessed the effect of Associations on banking concentration measures—in particular, their implications for banking market competition and the evaluation of competitive conditions.

In this article, we estimate local market shares of agricultural loans to assess how Associations affect competition for these loans in rural markets where agriculture is an important industry. Our analysis suggests Associations often reduce measures of local market concentration, which implies excluding them from market structure analyses may understate the market's competitiveness.

Section I reviews U.S. antitrust laws and the underlying economic theory. Section II outlines the methodology for assessing competition in banking markets, with a focus on the Federal Reserve System's process. Section III shows how including Associations as a competitor in rural agricultural lending markets affects local market concentration measures.

I. The U.S. Antitrust Framework

In the United States, antitrust laws prohibit or restrict anticompetitive business conduct and practices and protect consumers and businesses from abuses of power that can occur when a firm or group of firms controls a substantial share of a market. In banking, the federal banking agencies—the Board of Governors of the Federal Reserve System (Board), the Office of the Comptroller of the Currency (OCC), and the Federal Deposit Insurance Corporation (FDIC)—are responsible for assessing the competitive effects of bank mergers and acquisitions (M&As) to ensure they comply with antitrust laws.[1] The agencies' merger approvals, however, are subject to review by the U.S. Department of Justice (DOJ).

The federal banking agencies and the DOJ use what is known as the Structure-Conduct-Performance (SCP) paradigm to assess whether an M&A may substantially lessen competition in banking. According to the SCP paradigm, market structure can affect firm and industry conduct, which in turn affects firm and industry performance. From an economic perspective, performance is maximized when firms set prices equal to their incremental production costs, which ensures industry resources are allocated to their most productive uses. This is the ultimate goal of antitrust policy.

Firm conduct determines the extent to which prices rise above incremental costs. Examples of such conduct include restricting product output, discriminating in the prices charged for different customer groups, and pursuing strategies that prevent new firms from entering the market.

Market structure, in turn, affects a firm's ability to engage in conduct that raises prices. Market structure can be described by factors such as the number and size distribution of firms and customers. In a product market with a single firm, the monopolist is able to maximize its profits by limiting its output, and therefore market output, to increase the market price above incremental cost. In a market with many firms, no single firm is able to influence the market price, so in equilibrium, price will equal incremental cost.

More generally, as a market's structure becomes more concentrated—for example, if the number of firms shrinks significantly or if one firm becomes much larger than others—conduct is more likely to approach that of a monopolist. For example, a small group of firms may agree (explicitly or implicitly) to collude to restrict their collective output and raise the market price above their incremental costs to increase their collective profit.

The SCP paradigm provides a practical methodology for assessing the potential competitive effects of proposed mergers. Conduct and performance are difficult to observe and measure. For example, measuring the difference between prices and incremental costs can be difficult in many industries. Abusive market practices and conduct are also often difficult to observe and prove. In contrast, structure is relatively easy to observe and measure. While a highly concentrated industry does not necessarily result in poor conduct and performance, it is more likely to do so than an unconcentrated industry. As a result, measuring industry concentration and the effect of mergers on concentration provides a good initial screening tool for assessing mergers' competitive effects.

II. The Federal Reserve's Implementation of the Structure-Conduct-Performance Paradigm

The DOJ and federal banking agencies all begin their competitive assessment of mergers by measuring pre- and post-merger concentration levels with the Herfindahl-Hirschman Index (HHI). The HHI

is the sum of the squared market shares of firms producing the same product in the same market. However, the DOJ's and banking agencies' processes differ slightly in how they measure the products and markets. This section focuses on the process used by the Federal Reserve.[2]

The HHI varies between 0 and 10,000 and increases as the number of firms falls or the distribution of firm sizes becomes skewed to large firms. For example, if five firms in an industry all had a 20 percent market share, the HHI would be 2,000. If two of the firms merged, the HHI would increase to 2,800.

The federal banking agencies' initial criteria for assessing the competitive effects of a merger or acquisition is whether it would (1) raise the HHI by 200 points or more to a level of 1,800 or higher in any local banking market in which both firms operate, or (2) increase the post-transaction market share for the acquiring firm to more than 35 percent in any of those markets. If the merger does not exceed these thresholds, it will generally be approved. If it exceeds one or both thresholds, the agencies conduct further analysis to determine whether the merger would be anticompetitive.

Before the banking agencies calculate an HHI, they must first define the relevant market for the antitrust analysis. Specifically, they must define the product and geographic dimensions of a market. In general, a product market includes all products and services that consumers consider to be close substitutes. The geographic area encompasses all banking service providers that customers would consider a viable alternative for meeting their banking needs. From a practical perspective, geographic markets should include any depository institution that a bank's customer would consider switching to when prices or service quality change.

Consistent with these principles, the criteria the agencies use to define banking product and geographic markets are largely based on U.S. Supreme Court antitrust cases.[3] The agencies define the product market for banking services as a "cluster" of commercial banking products and services. The cluster includes products and services that banks offer to most households and small businesses. As a result, competitors included in HHI calculations are depository institutions—commercial banks and thrift institutions—and sometimes credit unions.[4]

The geographic markets that the agencies use are generally local, economically integrated areas. Most markets are based on Metropolitan Statistical Areas (MSAs) or are rural counties, but some markets include multiple MSAs, counties, or parts of them.[5] Currently, the Federal Reserve recognizes more than 1,500 local banking markets in the United States and U.S. territories.

The agencies calculate market shares and the HHI for a local banking market using the deposits of all depository institutions with a presence in the market. Deposits are the only general and reasonable measure of overall banking activity available at the branch level. Indeed, the Board notes that deposits are a "reasonable indicator of the level of activity or output of a depository institution, because deposit accounts are widely held by consumers and small businesses and are held in combination with other commercial banking products. In addition, for smaller institutions, deposits may be considered a measure of a bank's lending capacity" (Board of Governors).

When a proposed merger or acquisition exceeds the initial HHI or market share threshold, the agencies generally conduct further analysis to determine whether the merger or acquisition may not be anticompetitive. The additional analysis evaluates "mitigating factors," which are other market characteristics or factors that might indicate the merger is less anticompetitive than the initial HHI analysis suggests. Examples of such mitigating factors are the attractiveness of the market to potential entrants, ease of entry into the market by existing out-of-market or new banks, the number of competitors, the number of competitors with significant market shares, the effects of a shrinking market, and whether the target bank is failing or experiencing severe financial difficulties (Board of Governors). In addition, the extended competitive analysis sometimes considers competition among banks in certain products, such as mortgages, credit cards, and small business loans, which could mitigate the merger's anticompetitive effects.

However, the current approach to competitive analysis does not include nondepository financial firms, many of which are important competitors in specific banking products. Examples include the Farm Credit System (FCS) in agricultural lending, specialty lenders in mortgages and credit cards, finance companies in commercial lending, factor companies in receivable financing, and money market mutual

funds for deposits. Including these firms could significantly affect the competitive analysis of proposed mergers.

III. How Does Farm Credit System Lending Affect Competition in Agricultural Lending Markets?

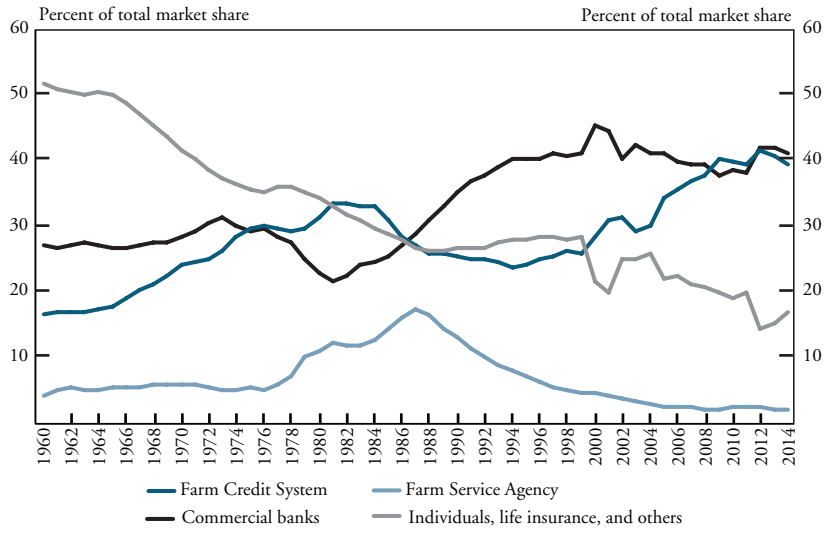
Rural areas are sparsely populated and consequently have less economic activity than metropolitan areas. As a result, most rural areas can support a limited number of banks, which often leads to high measures of banking market concentration. Agriculture is the dominant industry in many rural areas, and rural banks often specialize in lending to farmers and other agribusiness entities. However, nonbank agricultural lenders also compete with these banks, and none are explicitly included in the market shares and HHIs used in the initial competitive analyses of mergers. Along with commercial banks, the FCS is the largest lender to the agriculture sector. To see how the FCS affects local market competition in agricultural lending, we estimate bank and FCS agricultural loan market shares and HHIs in rural banking markets where agriculture is an important part of the local economy and compare the HHIs with and without Association loans.

The FCS's role in agricultural lending

While the FCS and commercial banks currently account for 80 percent of loans to agriculture, their combined dominance in the agricultural loan market is a relatively recent phenomenon (Chart 1). The FCS makes loans to their member borrowers through 76 Associations—74 Agricultural Credit Associations and two Federal Land Credit Associations (see Box for background on the FCS). As recently as the mid-1990s, the Associations' market share of agricultural loans was about 25 percent. The growth in their market share began accelerating in 2000, and by 2009, it overtook the banking industry's share for the first time since the mid-1980s. Since then, the market shares of both banks and Associations have been about 40 percent of all agriculture loans.[6]

Relative to banks, Associations have increased their share of real estate loans and production loans.[7] Panel A of Chart 2 shows that the Association share of agricultural real estate loans is larger than the bank share, and that the gap widened from 2005 to 2014. Specifically, the Association share rose from 52 percent in 2005 to 55 percent in 2014, increasing

Chart 1
Major Farm Credit Providers



Note: The data are aggregated farm sector balance sheet information.
Sources: U.S. Department of Agriculture, Economic Research Service, Farm Income and Wealth Statistics, and U.S. Farm Sector Financial Indicators.

the gap over the bank share from 4 to 10 percentage points. Panel B of Chart 2 shows the commercial bank share of production loans is larger than the Association share, but the gap narrowed after 2005. The Association share rose from 33 percentage points in 2005 to 40 percentage points in 2014, narrowing the gap between the Association and bank shares from 34 percentage points to 20 percentage points.

Estimating agricultural loan shares and HHIs in local markets

To calculate HHIs, we first need individual bank and Association shares of agricultural loans in local markets. Agricultural loan data, however, are available only at the bank and Association level, which may span more than one local market for banks with multiple branches and for all Associations. As a result, we must estimate agricultural loans in local markets for both banks and Associations. We estimate agricultural loans at the county level and then aggregate the estimates if the local market includes multiple counties. We then use the estimates of Association loans and bank loans in each market to calculate market shares for Associations and individual banks. Finally, we use these shares to calculate market HHIs.

Box

Farm Credit System Background

The Farm Credit System (FCS) was established as a government-sponsored enterprise in 1916 to provide affordable long-term financing to farmers.[8] The FCS has undergone several changes since then, but its general mission and structure have remained basically the same.

The current FCS structure was established by the Farm Credit Act of 1971. The Farm Credit Act provides several policy objectives for the FCS's lending programs to support its mission. One objective is improving "the income and well-being of American farmers and ranchers by furnishing sound, adequate, and constructive credit and closely related services to them, their cooperatives, and to selected farm-related businesses."[9] The Act also requires the FCS to "provide equitable and competitive interest rates to eligible borrowers" and specifies "that in no case is any borrower to be charged a rate of interest that is below competitive market rates for similar loans made by private lenders to borrowers of equivalent creditworthiness and access to alternative credit."[10]

The FCS organizational structure includes four regional wholesale banks that primarily provide funding to 76 Associations that make loans to their members. The wholesale banks include three Farm Credit Banks (AgriBank, AgFirst, and FCB of Texas) and one Agricultural Credit Bank (CoBank). These banks have specific regions, with some overlap, and lend only to Associations in their region. CoBank has a broader lending authority than the Farm Credit Banks—for example, CoBank can lend to public utility cooperatives, finance U.S. agricultural exports, and provide international banking services for farmer-owned cooperatives.

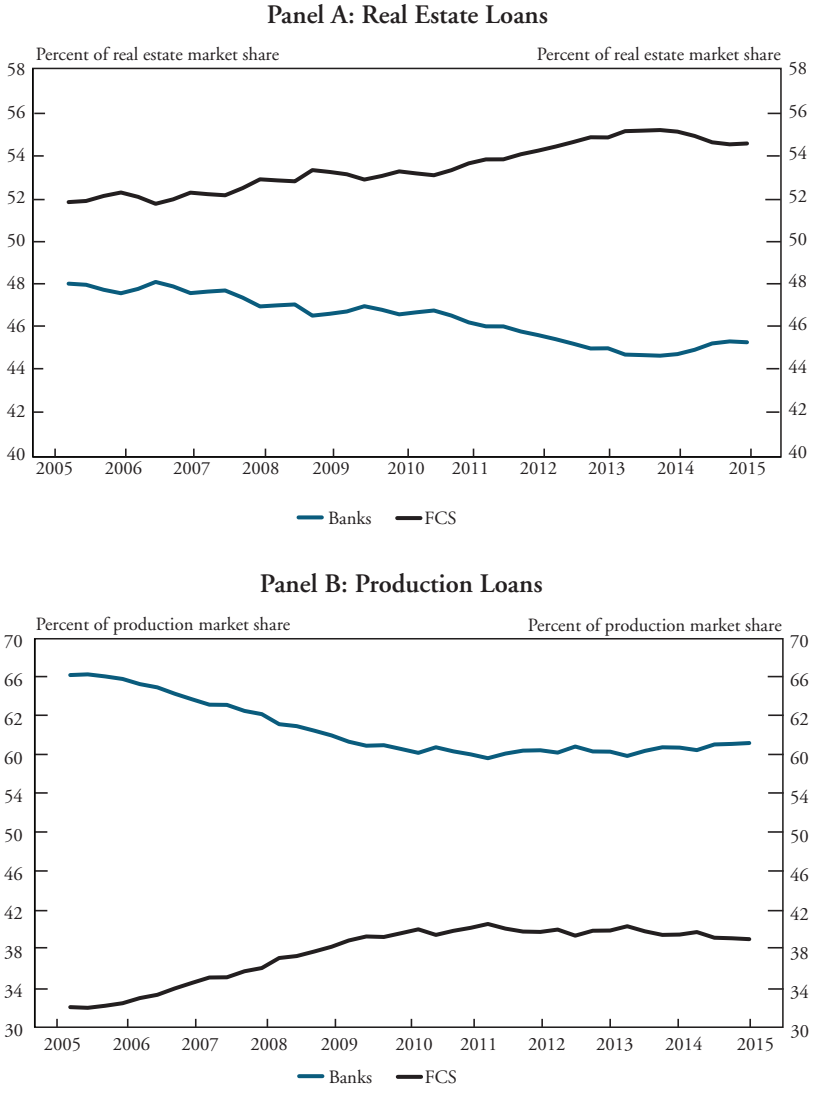
The four wholesale banks are funded by the Federal Farm Credit Banks Funding Corporation, a centralized funding corporation which raises funds in national debt markets.

The Farm Credit Insurance Corporation insures the FCS's funding. The Farm Credit Administration, a Federal agency created in1933, regulates and supervises the FCS.

The Associations include 74 Agricultural Credit Associations and two Federal Land Credit Associations. Agricultural Credit Associations make short-, intermediate-, and long-term loans, while Federal Land Credit Associations make only long-term land loans. The Associations are cooperatives owned by borrower-members, governed by a board of directors primarily elected from borrower-members, and pay dividends to their borrower-members. The Associations each have specific lending territories, although many of the territories overlap (Farm Credit Association). The sizes of the territories vary significantly. For example, Northwest Farm Credit Services' and Farm Credit Services of America's territories span multiple states in the Northwest and Midwest portions of the country, respectively, while Legacy Land Bank in eastern Texas spans just a few counties.

Chart 2

Agricultural Loan Market Shares



Sources: Farm Credit Administration for FCS loans and Reports of Condition and Income (Call Reports) for commercial banks.

Because banks report loans at their headquarters locations instead of at the branches where the loans are made, we must estimate local agricultural loans. Our general procedure is to allocate a bank's agricultural loans to counties based on the degree to which the counties are rural and on the level of the bank's activity in the county. Specifically, we obtain the percentage of each county that is rural from the Census Bureau, whose estimates are based on population densities for Census tracts. We measure a bank's activity in each county using its branch deposits in the county, and calculate a bank's "rural deposits" by multiplying its deposits in each county by the county's rural percentage. We then calculate the share of a bank's rural deposits for each county in which it operates and multiply the shares by its agricultural loans to estimate its county-level agricultural loans.[11] For multiple-county markets, we sum county loans up to the market level.

Associations also report all loans at their headquarters location. However, we do not have data on local office activities analogous to a bank's branch deposits. Thus, we allocate agricultural loans to individual counties based on the level of agricultural activity in each county. We measure agricultural activity using aggregate marketing proceeds from crops and livestock in the county. For each Association, we calculate each county's share of agricultural activity and allocate Association agricultural loans to each county in proportion to its share of agricultural activity. As with bank loans, we sum county loans for multiple-county markets.

Selecting agricultural loan markets

To determine market areas, we start with rural banking markets. Typically, these markets correspond with rural counties. However, Federal Reserve Bank staff may adjust market boundaries when appropriate to reflect local business patterns.

We consider several factors in selecting individual markets, including the importance of agricultural activity and the characteristics of the Association that serves the market area. Given our focus on agricultural lending, we include markets only if agricultural activity is economically important. The criteria we use to define whether agricultural activity is economically important are based on the USDA's definition of "farming-dependent" counties. The USDA defines a county as farming dependent if farm earnings are 15 percent or more of total county

earnings or if 15 percent or more of employed county residents work in farm occupations. The USDA includes the occupation option to account for farming-dependent economies that may not meet the earnings threshold, most often due to negative farm earnings for a given year.[12]

Following the USDA's general methodology, we calculate an index of agriculture importance using a three-year average of a county's maximum farm earnings and farm employment shares. We consider a market "agriculture-important" if the index is at least 5 percent and "agriculture-dependent" if the index meets or exceeds the USDA threshold of 15 percent. All markets in the analysis meet the agriculture-important threshold.

We also consider the characteristics of Associations in selecting markets. These characteristics are important because the allocation process assumes a proportional relationship between Association lending and agricultural activity measured by crop and livestock marketing proceeds. This assumption is less likely to hold for Associations that cover very large geographic areas, have non-contiguous territories, or are "overchartered"—that is, cover areas that are also included in another Association's territory. Thus, we select rural banking markets completely within smaller Associations with contiguous territories and in areas that are not overchartered.

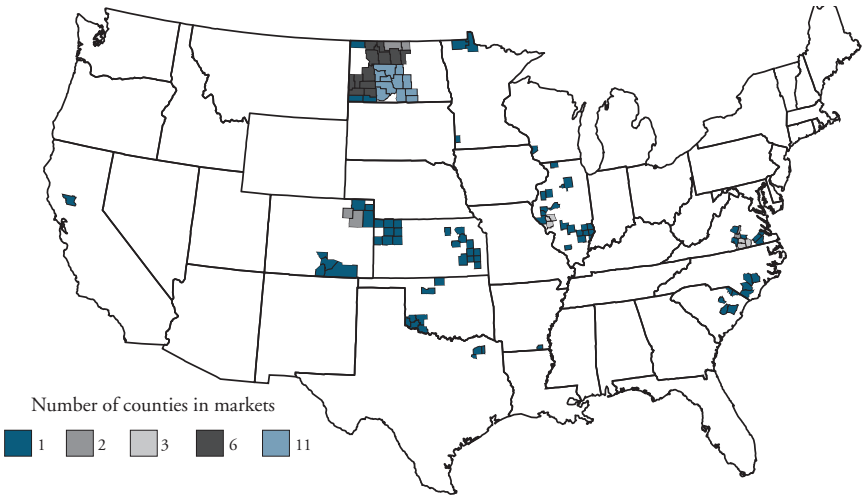
Using county earnings and employment data for 2011–13, we select 86 agriculture-important markets from the local banking markets the Federal Reserve uses for antitrust analysis (Map 1).[13] All but eight of the markets are single counties, and the largest market comprises 11 counties. Of the 86 markets, 48 meet the agriculture-dependent criteria.

The effect of Associations on competition in local agricultural lending markets

We assess the effect of Associations' lending on market competition by comparing HHIs calculated with and without Association loan shares. Whether adding a competitor to a market increases or decreases concentration is an empirical question. For example, if the additional competitor is large relative to other competitors, market concentration can increase.[14]

Table 1 shows summary statistics on banks, Associations, and market HHIs with and without Associations included for the agriculture-

Map 1
Agriculture-Important Banking Markets



Source: Authors' calculations. See Appendix for data sources.

important and agriculture-dependent markets, as well as a third type of market that we label "agricultural-bank" markets. Agricultural banks are banks with a ratio of agricultural loans to total loans of 25 percent or more. We define a market as an agricultural-bank market if 20 percent or more of the banks are agricultural banks. Agricultural activity is also likely to be important in rural markets that have a relatively large number of banks with highly concentrated agricultural loan portfolios. Thus, the agricultural-bank market is an alternative proxy for markets that are highly dependent on agriculture. Of the 86 agriculture-important markets, 56 (in 2005) and 62 (in 2014) are agricultural-bank markets.

Panel A of Table 1 summarizes trends in the number of banks and Associations in the markets. The median number of banks is essentially the same across all market groups—five banks in every year except for 2005, when agricultural-bank markets had six. The Associations' median share of agricultural loans increased from 2005 to 2014 in all three market groups, which is consistent with the national trends shown in Charts 1 and 2. Overall, Association loan shares decreased in relatively few markets from 2005 to 2014—among the 86 agriculture-important markets, their loan shares decreased in only 21 markets and decreased by more than 2 percentage points in only 12 markets.

Table 1

Local Banking Market Summary Statistics

Panel A: Market Composition

	Agriculture-important markets		Agriculture-dependent markets		Agricultural-bank markets	
	2005	2014	2005	2014	2005	2014
Number of markets	86	86	48	48	56	62
Number of banks (median)	5	5	5	5	6	5
Association agricultural loan market share (median)	37%	45%	39%	44%	34%	39%

Panel B: Market Competition Measures

	Agriculture-important markets		Agriculture-dependent markets		Agricultural-bank markets	
	2005	2014	2005	2014	2005	2014
HHI: deposits, banks (median)	3,064	3,037	3,135	3,124	2,478	2,950
Markets <1,800 (number / percent)	14 / 16%	11 / 13%	5 / 10%	5 / 10%	12 / 21%	10 / 16%
HHI: agricultural loans, banks (median)	3,457	3,690	3,549	3,807	2,833	3,534
ΔHHI: agricultural loans - deposits, banks (median)	372	600	229	590	173	523
Markets <1,800 (number / percent)	11 / 13%	7 / 8%	5 / 10%	2 / 4%	11 / 20%	7 / 11%
HHI: agricultural loans, banks and Associations (median)	3,343	3,688	3,343	3,634	2,684	3,082
ΔHHI: agricultural loans, banks and Associations - banks (median)	-413	-419	-554	-612	-413	-653
Markets <1,800 (number / percent)	9 / 10%	4 / 5%	3 / 6%	1 / 2%	9 / 16%	4 / 6%

Note: Agricultural banks are banks with a ratio of agricultural loans to total loans of 25 percent or more. An agricultural-bank market denotes a market in which 20 percent or more of the banks are agricultural banks.
Sources: Authors' calculations. See Appendix for data sources.

Panel B of Table 1 provides summary statistics for HHIs based on three measures of market activity and market participants—the traditional deposit measure for bank market shares, estimated agricultural loan market shares for banks only, and estimated agricultural loan market shares for banks and Associations. We use the deposit-based HHIs for banks as a benchmark for comparing bank agricultural-loan HHIs. We then compare the bank-and-Association HHIs to bank agricultural-loan HHIs to assess how Associations affect competition in agricultural lending markets. As expected, given the relatively few banks in all three market groups, the median HHIs for all market categories in 2005 and 2014 are very high.

The median deposit-based HHI is about 3,000 for agriculture-important and agriculture-dependent markets in both years and for agricultural-bank markets in 2014. The median HHI for agricultural-bank markets in 2005 is significantly lower at about 2,500. These results are consistent with the median number of banks shown in Panel A for all three market groups in each year. Few markets have HHIs below the 1,800 post-merger threshold that would allow a merger to be approved without an extended competitive analysis.

The middle section of Panel B shows statistics for HHIs calculated with agricultural loan shares assuming only banks are competing in the market. The median HHIs here are larger than the median deposit HHIs. For the agriculture-important and agriculture-dependent markets, the median HHIs are about 3,500 in 2005 and rise in 2014 to about 3,700 in agriculture-important markets and 3,800 in agriculture-dependent markets. For agricultural-bank markets, the median HHI is much lower, at about 2,800 in 2005, but increases to about 3,500 in 2014.

An alternative way to look at the difference between agricultural-loan and deposit HHIs is a market-by-market comparison of the differences between them. For all market groups, the median difference in the HHIs is positive, ranging from a low of 173 in agricultural-bank markets in 2005 to a high of 600 in agriculture-important markets in 2014. Finally, for every market group and in both years, the number of markets below the 1,800 threshold is less than or equal to the number of markets based on deposits, which is consistent with the larger agricultural-loan HHIs.

Panel B of Table 1 suggests markets are more competitive when Associations are included as market competitors with banks. Including

Associations reduces the median HHIs for the agriculture-dependent and agricultural-bank markets in both years and for the agriculture-important market in 2005. For the agriculture-important and agriculture-dependent markets, the median HHI is about 3,300 in 2005 and somewhat higher in 2014—about 3,700 for the agriculture-important markets and 3,600 for the agriculture-dependent markets. For the agricultural-bank market, the median HHI is much lower in both years at about 2,700 in 2005 and 3,100 in 2014. At the individual market level, the median difference between the bank-and-Association HHIs and the bank HHIs is negative and large. The differences range from -413 in agriculture-important and agricultural-bank markets in 2005 to -653 in agricultural-bank markets in 2014.

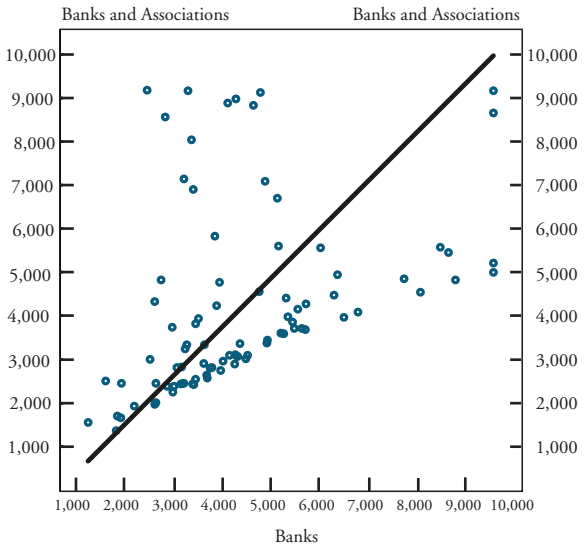
Overall, the summary statistics suggest including Associations in a market structure analysis tends to lower HHIs. Charts 3–5 provide a more detailed assessment of individual markets by plotting bank-and-Association HHIs against bank HHIs for each of the three market groups in 2014. Chart 3 shows that including Associations in agriculture-important markets lowers the HHI in 51 of 86 markets, or 59 percent. These markets are represented by the points below the 45 degree line. In addition, the HHI declines are relatively large—the index declines by 26 percentage points or more in 22 of the markets (25 percent) and by 13 percentage points or more in 43 of the markets (50 percent).

Interestingly, the relationship between the bank-and-Association HHI and bank HHI differs depending on whether including Associations causes the HHI to increase or decrease. For markets in which the HHI increases, the relationship is highly scattered, with a correlation of 63 percent. In seven markets, adding Associations increases the HHI from less than 5,000 to more than 8,500.[15] The increases in HHIs are due to very low bank lending in these markets—the average Association market share is 95 percent.

In contrast, for markets in which the HHI decreases when Associations are included, the declines are systematic. The correlation between the bank-and-Association HHI and bank HHI for declining markets is 88 percent. The estimated slope coefficient from a linear regression of the bank-and-Association HHI on the bank HHI is 0.57.[16] In other words, when including Associations reduces market concentration, the reduction rises with the size of the bank HHI.

Chart 3

Agricultural Loan HHIs: Banks and Associations versus Banks (Agriculture-Important Markets)



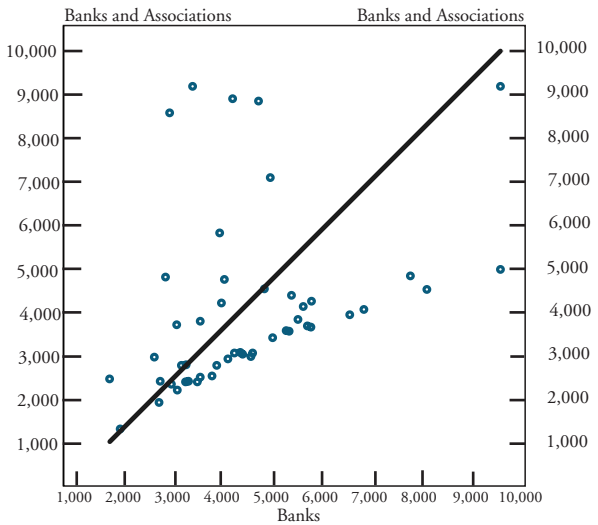
Source: Authors' calculations. See Appendix for data sources.

The results for the agriculture-dependent markets are similar (Chart 4). Including Associations increases HHIs in 17 of the 48 markets (35 percent). In these markets, the relationship between the HHIs is also scattered—the correlation is 64 percent and the HHI increases from less than 5,000 to more than 8,500 in four markets. Again, these are markets in which bank lending is relatively low and Associations market shares are high. The HHIs decline in 31 of the 48 markets, or 65 percent. The correlation coefficient (0.86) and regression slope coefficient (0.57) are essentially the same as in the agriculture-important results.[17] The distribution of declines is also similar to that of the agriculture-important markets—HHIs decline 28 percentage points or more in 12 markets (25 percent) and 15 percentage points or more in 24 markets (50 percent).

Finally, the results for the agricultural-bank markets provide the strongest support for the view that including Associations makes banking markets in agricultural areas appear more competitive (Chart 5). The relationship among increasing-HHI markets is much more systematic than in the other two market groups, with a correlation of 87 percent and no markets in the top-left quadrant.[18]

Chart 4

Agricultural Loan HHIs: Banks and Associations versus Banks (Agriculture-Dependent Markets)



Source: Authors' calculations. See Appendix for data sources.

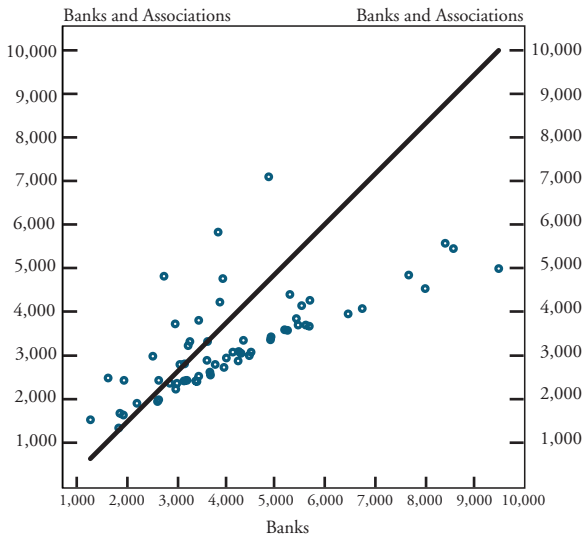
However, the percentage of agricultural-bank markets in which Associations reduce concentration is the highest among the three market groups—HHIs decline in 41of the 62 markets, or 66 percent. Moreover, they decline 28 percentage points or more in 16 of the markets (25 percent) and 19 percentage points or more in 31 of the markets (50 percent). The correlation among the markets with declining HHIs is 96 percent, and the regression-slope coefficient is 0.45.[19] These results indicate including Association lending reduces HHIs more in markets with higher initial concentration, and that this effect is stronger in agricultural-bank markets than in agriculture-dependent or agriculture-important markets. Overall, the results across all three market groups suggest the degree to which Associations increase market competitiveness increases with the importance of agriculture to the local economy.

The effect of Associations on competition when banks merge

To examine how including Associations affects competition when banks merge, we look at hypothetical mergers between the second- and third-largest banks in each market based on agricultural loan shares and compare the changes in HHIs calculated with and without Association loans.[20] Since this approach would be appropriate only for banks that

Chart 5

Agricultural Loan HHIs: Banks and Associations versus Banks (Agricultural-Bank Markets)



Notes: Agricultural banks are banks with a ratio of agricultural loans to total loans of 25 percent or more. An agricultural-bank market denotes a market in which 20 percent or more of the banks are agricultural banks.
Source: Authors' calculations. See Appendix for data sources.

are active agricultural lenders, we restrict our analysis to mergers in the 57 agricultural-bank markets that have at least three banks.

In-market mergers will always increase a market's HHI, because the number of banks declines and the share of the acquiring bank increases. Indeed, the HHI increase will be two times the product of the market shares of the merging banks. However, the change in the HHI will always shrink when Associations are included, because including Association loans reduces bank loan shares.

Table 2 shows that although the markets are more concentrated after a merger, including Associations can significantly decrease the number of markets in which the change in the HHI is greater than 200. The median post-merger bank HHI is 4,049, while the median post-merger bank-and-Association HHI is smaller—3,233—but still high. Only three markets (with Associations) or four markets (without Associations) have post-merger HHIs below the 1,800 threshold level used in an initial screening.

However, among these 57 markets, the median increase in the HHI is much smaller when Associations are included—the median increase in bank-and-Association HHIs is 181 compared with a median increase

Table 2
Effect of Mergers on HHIs in Agricultural Bank Markets

	Banks	Banks and Associations
HHI: pre-merger (median)	3,382	3,004
HHI: post-merger (median)	4,049	3,233
Markets <1,800	4	3
Change in HHI: post-merger (median)	591	181
Markets <200	8	32

Note: The table summarizes the effect of mergers between the second and third largest banks based on agricultural loan market shares in the 57 Agricultural-Bank markets with three or more banks.
Source: Authors' calculations. See Appendix for data sources.

of 591 in the bank HHIs. Importantly, in 32 markets, the change in bank-and-Association HHIs is below the initial screening threshold of 200, compared with eight markets when the HHI includes only banks. For example, the Pittsfield, Ill., market has nine banks. When Associations are not included in the HHI calculations, the agricultural market shares of the second- and third-largest banks are 14 percent and 13 percent. A hypothetical merger of these banks would increase the market's HHI by 345. When Associations are included, the market shares of these banks are 9 percent and 8 percent, and the increase in the HHI is only 144. Thus, these results suggest that when measures of competition consider Associations, mergers between banks are less likely to generate competitive concerns.

IV. Conclusion

The federal banking regulatory agencies are responsible for ensuring bank mergers are not anticompetitive. The initial competitive assessment of proposed mergers is based on the deposit shares of depository institutions operating in the market. One shortcoming of these deposit-based measures is they do not explicitly account for competition from nondepository financial firms. The FCS in particular is an important competitor for banks in rural markets that make agricultural loans.

This article uses data on bank and Association loans to estimate local market shares of agricultural loans in rural markets where agriculture is an important industry. We estimate agricultural loan-based market shares and HHIs and use these measures to assess how Associations affect local market competition. Our results show including Associations as competitors can significantly affect measures of market

concentration. In particular, when measuring market concentration using loan shares (instead of deposit shares), including Association lending can significantly reduce measures of concentration. In addition, the effect tends to be larger in more concentrated markets and as a market's economic dependence on agriculture increases.

We also show that including Associations not only reduces the change in the HHI after a merger but may reduce the change below the 200 point threshold. As a result, a merger that would otherwise increase the HHI by more than 200 points would be less of a competitive concern when accounting for competition from Associations.

These results imply excluding Associations from market structure analyses may understate market competitiveness in rural markets where agriculture is an important part of the local economy. They also suggest similar results may apply to other significant product lines for certain banks.

The results, of course, are dependent on the assumptions we use to disaggregate Association and bank agricultural loans to local market levels. Future research would greatly benefit from more granular, location-based agricultural loan data.

Appendix
Data Sources and Variable Construction

Data sources

Cash receipts from crop and livestock marketing: Bureau of Economic Analysis, Table CA45 (Line Code 10)

Commercial bank branch deposits: Federal Deposit Insurance Corporation, Summary of Deposits, Total Deposits (DEPSUMBR)

Commercial bank loans: Federal Financial Institutions Examination Council, Reports of Condition and Income (Call Reports)
- Agricultural Production Loans (RCFD1590)
- Farmland Loans (RCFD1420)
- Total Loans and Leases, Net of Unearned Income (RCFD2122)

Earnings: Bureau of Economic Analysis, Tables CA5, CA5N
- Farm Earnings (Line Code 81)
- Total Earnings: Wages and Salaries (Line Code 50) + Proprietors' Income (Line Code 70)

Employment: Bureau of Economic Analysis, Tables CA25, 25N
- Farm Employment (Line Code 70)
- Total Employment (Line Code 10)

Farm Credit Association agricultural production and real estate loans: Farm Credit Administration

Farm Credit Association mergers: Farm Credit Association websites

Farm credit providers: U.S. Department of Agriculture, Economic Research Service, Farm Income and Wealth Statistics, Farm Sector Balance Sheet and Selected Financial Ratios, available at http://www.ers.usda.gov/data-products/farm-income-and-wealth-statistics/balance-sheet.aspx

GeoFIPS codes (for merger adjustments): U.S. Census Bureau, 2010 FIPS Codes for Counties and County Equivalent Entities, available at https://www.census.gov/geo/reference/codes/cou.html

Local banking markets: Competitive Analysis and Structure Source Instrument for Depository Institutions (CASSIDI), available at https://cassidi.stlouisfed.org/

Rural population densities: U.S. Census Bureau Lists of Population, Land Area, and Percent Urban and Rural in 2010 table, available at https://www.census.gov/geo/reference/ua/urban-rural-2010.html

Farm Credit Association merger adjustments

We adjust the Association data for mergers that occurred from 2005 to 2014. For example, the current Texas Farm Credit Services (Texas FCS) was three separate entities in 2005: AgCredit of South Texas, Texas AgFinance, and AgriLand FCS. For this analysis, we combine the initial three institutions into a pro-forma Texas FCS when calculating total agriculture lending in 2005. In addition to adjusting Association loan volumes for mergers, we also adjust Association coverage areas.

Geographic market definitions and allocations

Geographic market areas are based on local banking markets used by the Federal Reserve. Information about these markets is available on the Federal Reserve's CASSIDI website. However, not all counties are in CASSIDI-defined markets. In these cases, we treat the counties as a market, which is the initial or default assumption in competitive analysis of banking mergers.

Our analysis uses data for 86 markets. Eight markets include more than one county, three of which include whole counties and portions of counties. We allocate bank deposits and loans based only on branches located within the market, and we identify branch locations using CASSIDI. Depending on the market characteristics, we assign Association loans to either the entire county, a portion of the county, or none at all. Once all counties in a market are allocated their appropriate Association agricultural loans, we aggregate county-level loans up to the market level, treating Association loans as coming from a single entity.

Minot market. The Minot market in North Dakota covers the entire counties of Burke, Mountrail, Pierce, Renville, and Ward, almost all of McHenry county, and approximately one-third of

Bottineau County. For purposes of assigning Association loans in the Minot market, all of McHenry County and one-third of Bottineau County were included in the market.

Bottineau market. The Bottineau market (adjacent to Minot) covers all of Rolette County, two-thirds of Bottineau County, and a very small portion of McHenry County. To assign Association loans in the Bottineau market, we include only two-thirds of Bottineau County.

Bismark/Mandan market. The Bismark/Mandan market in North Dakota encompasses the entire counties of Burleigh, Emmons, Grant, Kidder, Logan, McIntosh, McLean, Mercer, Oliver, and Sioux, but only half of Sheridan County. In addition, two Associations cover McLean and Sheridan—Farm Credit Services of Mandan (FCS Mandan) and Farm Credit Services of North Dakota (FCS North Dakota). Based on the Association coverage of these counties, we assign 25 percent of FCS Mandan's McLean County agricultural loans and 75 percent of FCS North Dakota's McLean County agricultural loans to the Bismark/Mandan market. In addition, we assign 80 percent of FCS Mandan's Sheridan County agricultural loans and 20 percent of FCS North Dakota's Sheridan County agricultural loans to this market. Because the Bismark/Mandan Market includes only half of Sheridan County, we include only half of the Sheridan County Association allocations in the final market calculations (bank loans in Sheridan County are included for those branches in the Bismark/Mandan half of the county.)

Deposit HHIs

We calculate deposit HHIs using bank and thrift branch deposit data with a 50 percent weight on thrift deposits. Standard practice assigns thrift deposits a 50 percent weight because thrifts typically do not provide the full cluster of banking services (Board of Governors of the Federal Reserve System). We aggregate the branch data for each bank and thrift up to the local market level. The deposit HHIs differ from the standard CASSIDI HHIs because we aggregate the deposit HHIs to the bank or thrift level instead of the holding company level. We use deposit market shares to calculate deposit HHIs.

Data adjustments

We make several adjustments to raw data to correct for irregularities and anomalies such as cities and counties with the same name (for example, the City of St. Louis and St. Louis County) which are not distinguished in the U.S. Census Bureau data. We also make adjustments for cities within counties that have separate GeoFips codes.

Endnotes

[1]Section 7 of the Clayton Act of 1914 (as amended in 1936 and 1950) prohibits M&As in which the effect "may be substantially to lessen competition, or to tend to create a monopoly" (15 U.S.C. §18). The Bank Merger Act, Home Owners' Loan Act, and Bank Holding Company Act give federal banking agencies specific authority to approve M&As of banks, thrifts, and holding companies they supervise (Bank Merger Act: 12 U.S.C. §1828(c)(5)(B); Bank Holding Company Act: 12 U.S.C. §1842(c)(1)(B); Home Owners' Loan Act, 12 U.S.C. 1467a(e)(2)(B)).

[2]Much of the general information in this section can be found in the Federal Reserve's "Frequently Asked Questions" document on the competitive analysis for mergers and acquisitions (Board of Governors of the Federal Reserve System).

[3]United States v. Philadelphia National Bank, 374 U.S. 321, 356 (1963). The DOJ, however, does not use the "cluster" definition. Instead, when the DOJ conducts its competitive review, it uses two product markets—retail banking products and services and small business banking products and services. Other relevant cases reaffirming the Philadelphia National Bank decision include United States v. Connecticut National Bank, 418 U.S. 656 (1974) and United States v. Phillipsburg National Bank & Trust Co., 399 U.S. 350 (1970).

[4]Although thrifts compete with banks in a variety of services such as deposits and home mortgage loans, they typically have not provided the full range of retail banking services. For example, thrifts historically have not been active in commercial lending due to legal restrictions.

[5]The information used to define geographic banking markets includes commuting and shopping patterns, interviews with local government and business leaders, and surveys of local households or small businesses. Geographic markets for some products, such as credit card or mortgage loans, may be regional or national in scope. Up-to-date geographic market definitions are available on the Federal Reserve's CASSIDI website, *https://cassidi.stlouisfed.org/.*

[6]Examples of other major lenders to the agricultural sector include the Farm Service Agency, life insurance companies, farm implement dealers, and individuals. The composition of the data used to measure debt owed to commercial banks changed in 2012. Specifically, farm sector debt owed to savings associations moved from the Individuals and Others category to the Commercial Bank category, resulting in an increase in the Commercial Bank share and a corresponding decrease in the Individuals and Others share. This compositional change does not affect the overall trends in Chart 1. While the commercial bank market share would have been slightly lower from 2012 to 2014, the FCS and bank market shares would still be roughly the same.

[7]The data are aggregated from individual Association and bank balance sheets and begin in 2005 because that is the first year for which individual

Association data are available. The Association agricultural real estate and production loan data are aggregated from Association balance sheets and were obtained from a Freedom of Information Act request to the Farm Credit Administration. The bank lending data are from the Reports of Condition and Income (Call Reports).

[8]See Monke for a more detailed overview of the Farm Credit System.

[9]12 U.S. Code §2001(a)

[10]12 U.S. Code §2001(c)

[11]For some bank merger applications submitted to the Federal Reserve, the staff conducting the competitive analysis may analyze competition for small business loans. Under certain circumstances, the estimate of market-level small business loans also relies on the assumption that local market loans are proportional to local market deposits.

[12]The USDA's most recent data for farm-dependent counties are for 2004, which are based on average earnings from 1998–2000 and farm employment in 2000.

[13]The earnings and employment data are from the U.S. Bureau of Economic Analysis. The most recent county-level earnings and employment data are from 2013, so the agriculture-importance index is calculated using data from 2011 to 2013. The index is used to determine the agriculture-important and agriculture-dependent counties for 2005 and 2014.

[14]For example, a market with five competitors that each makes $100 in loans would have an HHI of 2,000. Adding a new competitor that makes $500 in loans would increase the HHI to 3,000.

[15]These markets are in California, North Carolina (3), South Carolina (2), and Virginia.

[16]The estimated coefficient is statistically significant with a t-statistic of 12.9, and the regression's adjusted R^2 is 0.77.

[17]The estimated slope coefficient is statistically significant with a t-statistic of 9.2, and the regression's adjusted R^2 is 0.74.

[18]The estimated slope coefficient of the HHI regression is 1.22. The t-statistic is 7.5, and the adjusted R^2 is 0.74.

[19]The estimated coefficient is statistically significant with a t-statistic of 21.2, and the regression's adjusted R^2 is 0.92.

[20]These are the largest mergers that do not include the market's top bank as measured by agricultural loan share.

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