Quantitative Yakking: Communication in Unconventional Monetary Policy

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Abstract

Federal Reserve (Fed) communication has changed significantly since the beginning of the financial crisis. This has been accompanied by increased public interest in monetary policy issues and Congressional concern with monetary policy. Using word counts of Fed communications from 1996-2011, I show that there is a structural break in the volume of communication at the end of 2007. By examining media articles and opinion polls concerning the Fed, I show that public interest in monetary policy has grown remarkably in recent years and that the general public opinion of the Fed has fallen. I also find theoretical evidence that shows that the crisis itself and the Fed's unconventional response exposed the bank to a credibility loss. Congress has responded by exploiting this loss and further discouraging support for the Fed. I show that by clearly communicating a time frame for its unconventional measures, the Fed could win back some of its public credibility. Finally, I propose that the Fed implement a more effective communication strategy that would make use of social media and local connections in order to regain public trust.

Acknowledgements

I would like to thank Professor Alessia Campolmi for her useful comments and insight concerning the argumentation and drafting of this thesis. This thesis would not have been possible without the help of Dr. Matthew Weinstein of Kent University who created the textual analysis application I used to gather data and was quick to respond to my requests for technical assistance. Finally, I would like to thank my wife for putting up with my arbitrary work schedule; she has been wonderfully supportive through this whole process.

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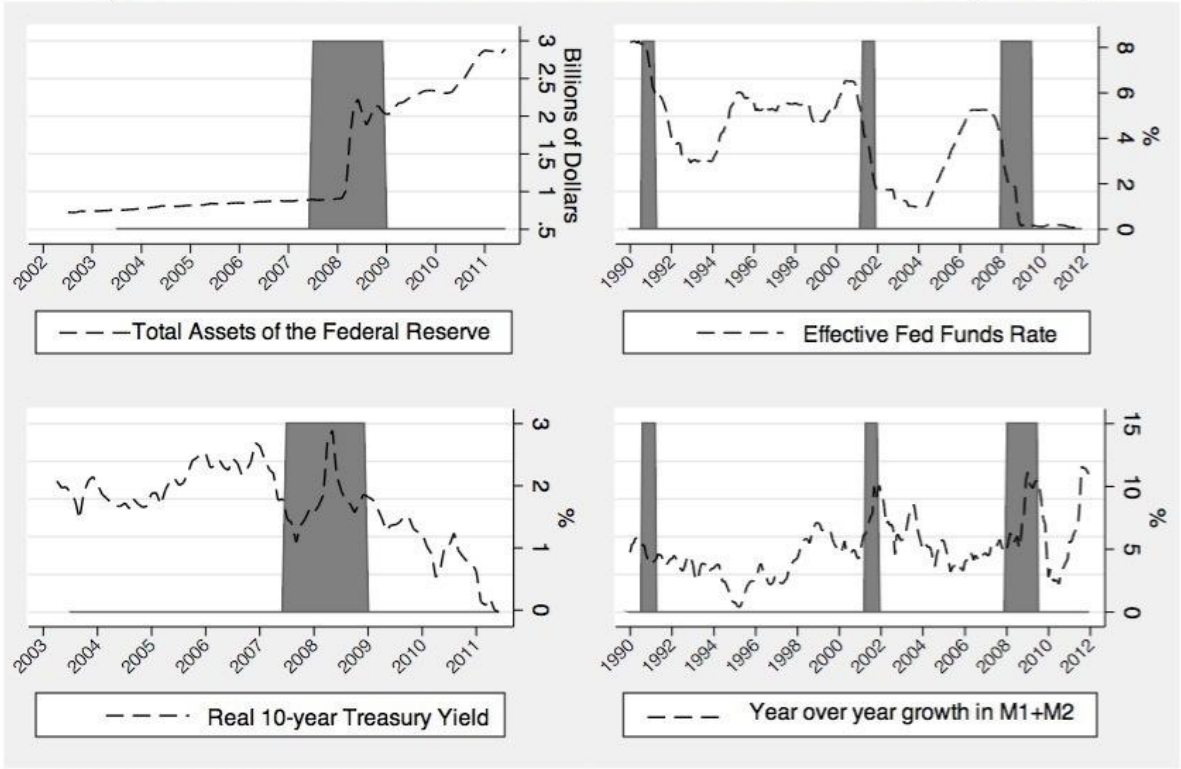
Chapter 1. Introduction

Since the financial crisis began in 2007, the Federal Reserve's (the Fed) response has been questioned and critiqued an inestimable number of times both in the media and in academic circles. Authors have covered multiple dimensions including the transparency, credibility, independence, discretionary stance and long-run stability of U.S. monetary policy (Farmer 2012, Williams 2011, Christiano 2011, Swanson 2011). The Fed's policy since the crisis has been generically labeled as "unconventional" because it has been operating for so long with near-zero interest rates (Cúrdia and Woodford 2009). Just as monetary policy is multi-dimensional under normal circumstances; unconventional monetary policy can be studied from many perspectives. Many of the recent academic studies of unconventional monetary policy focus on the uniqueness of monetary policy at the zero lower bound (Reis 2009), the potential long-term consequences of the expansion of the central bank balance sheets (Borio and Diyatat 2009), and the sort of exit strategy that should be pursued to return to conventional policy (see Rudebusch 2010 and Foerster 2011).

For the purpose of contextualization, Figure 1 displays four indicators of unconventional monetary policy. The upper left panel shows the extreme growth in the Fed's balance sheet in 2008 and its continuous growth even through 2010. These periods of growth coincide with the Fed's quantitative easing programs dubbed "QE1" and "QE2". The upper right panel shows that the Federal Funds rate is at historic lows and has been effectively zero since the middle of 2008. The Real 10-year Treasury Yield displayed in the lower left panel reveals that real yields are now at zero, having been driven lower by the Fed's balance sheet programs. The lower right panel shows that the growth in M1+M2 has been high recently, but not higher than the growth during 2001. The recent episode is unique in that the high growth of M1+M2 has lasted much longer than during the 2001-02 episode.

Figure 1:General Indicators of Unconventional Monetary Policy



Shaded Bars Denote Recessions

Having established that the Fed has been exercising unconventional measures in recent years, I want to highlight the fact that Fed communication has been unconventional as well. The parallel doctrines of transparency and communication in monetary policy run deep in the academic literature on monetary policy (see Blinder et al. 2008, Eijffinger and Geraats 2004, and Kohn and Sack 2003); an important subset in this literature zooms in on transparency in the context of unconventional monetary policy. Recent work by Yellen (2011) and Bernanke (2010) have been important in helping to understand the Fed's stance on communication and transparency since the financial crisis began in 2007. Older works by Bernanke and Reinhart (2004) and Bernanke, Reinhart and Sack (2004) provide pre-crisis analyses that highlight the importance of clear communication when a central bank implements unconventional measures.

The analysis in this paper is an extension of core analysis on unconventional monetary policy. For a model that describes the conditions which lead a central bank to take

unconventional measures see Gertler and Karadi (2011) or Mankiw and Weinzierl (2011). The pre-financial crisis literature that addresses the problems faced by central banks when interest rates are very low concentrates heavily on the importance of communication and expectations management (Bernanke and Reinhart 2004).

My research focuses on how Fed communication has changed since the crisis, how this is related to Congressional and media attention to monetary policy as well as the general public's opinion of the Fed. I use my findings to argue how the Fed should communicate with the public in the future. At least two things have occurred which have shifted the way the Fed communicates. The first is a loss of policy credibility which is the trust that financial markets have that the Fed is committed to and is able to achieve its policy goals. The second is a loss of public credibility which is the trust that the general public has in the Fed as the democratic solution for managing U.S. monetary policy.

The crisis and the Fed's dramatic response created a temporary loss of policy credibility among many players in the U.S. economy. This feeling was magnified by the media's focus on the Fed's unconventional policy and attacks against the Fed made by members of the U.S. Congress which has led to the loss of public credibility (see Bunn 2011 and McConnel et al. 2011). By changing its communication strategy and achieving some success at stabilizing the U.S. economy, the Fed effectively won back its policy credibility. However, the public credibility loss has not yet been fully remedied. I will argue that the Fed could use communication in an effort to gain back the public credibility it has lost.

The evidence I uncover shows that there has been a major shift in Fed communication that parallels its entry into unconventional monetary policy. I also find an increase in Congressional interest in monetary policy surrounding the passage of the Dodd-Frank Wall Street Reform and Consumer Protection Act. The recent change in media interest towards monetary policy that I expose and the public's opinion of the Fed support the claim that the

Fed's public credibility has been eroded.

Using a mathematical model, I show that the Fed should respond to Congressional criticism in order to protect its public credibility and that by communicating a time frame for unconventional policy the Fed could again improve its pubic credibility. Finally, in analyzing options for the Fed to do this I argue that a more locally connected communications strategy is necessary for Fed communication to effectively protect its credibility against Congressional communication which is a unique check against the Fed's independence.

These findings are my original contribution to the literature on unconventional monetary policy and the broader doctrine of communication in monetary policy. Central banks around the world should be reminded that they must protect both their policy and public credibility. Especially in a crisis situation when scapegoats are a commodity, clear communication can help to protect both types of credibility and keep central banks from being removed or handcuffed while still being able to achieve policy goals.

This paper is arranged in the following way. Chapter 2 establishes the context of this study within the academic literature on unconventional monetary policy and central bank transparency. Chapter 3 provides a general background of Federal Reserve transparency and communication as well as the recent history of Congressional concern with monetary policy. Chapter 4 describes the methodology I will use in answering my tripartite research question. Chapter 5 includes the presentation and analysis of my original data set on Fed communication and compares this data with data on Congressional communication about monetary policy issues as well as opinion poll data. Chapter 6 moves away from the data to a mathematical model that demonstrates the communication competition between a central bank and a legislative body before during and after a period of unconventional monetary policy. Chapter 7 evaluates policy options by appraising recent unique communication efforts by the Fed and argues for more efforts to establish a communication network with a broad

local reach. Chapter 8 concludes.

Chapter 2. Context and Literature Review

Though the communication efforts of the Federal Reserve since the start of the financial crisis have been unique, they are not without a solid context in the academic literature. There are three themes in the academic literature on monetary policy that are directly related to my question. The first theme is central bank credibility. The second is that of communication in monetary policy. The third theme is unconventional monetary policy or monetary policy in unusual circumstances.

Dornbusch (1991) develops a model in which a stabilization program is undertaken and the program has some ex ante probability of failure. This creates an imperfect credibility situation. Though Dornbush's main application is to exchange rate stabilization and disinflation, the general lesson is clear: the very need for a stabilization program creates a challenge to institutional credibility. So the actual need for the Fed to respond to the financial crisis made a weakening of credibility almost inevitable.

Moscarini (2007) argues that a reputation for competence in monetary policy implies credibility and transparency. He shows that the impact of this competence on communication strategy is actually two separate effects. First there is the power of words and second there is the credibility of likely announcements. One key finding that he uncovers fits perfectly with the case I am studying.

> "A more competent [central bank] is relatively less likely to observe and to announce the need for extreme policy measures. Thus it is less credible in the rare instances when extreme measures are in fact called for, but more credible in fine-tuning the frequent small deviations of the inflation target from its long-run mean" (Moscarini 2007).

So, by pairing the analysis of Dornbusch with Moscarini in the context of the Fed's response to the financial crisis, it becomes clear that the Fed's response automatically invited attacks on its credibility. This is before taking into account what the Fed actually planned to

do as part of its response. The need for policy action and the action itself created a credibility weakness.

Another aspect of credibility is whether or not the central bank is independent of the political process which is where the actions of the Congress are important. Jensen (1997) revisits Kydland and Prescott's (1977) proposed solution to the problem of dynamic inconsistencies in setting monetary policy. Jensen argues that the credibility of a delegated central banker depends on the process through which the banker is appointed. In fact, he shows that if reappointment has no costs, then a delegated central banker will not improve credibility. In the U.S. case, reappointment is not so cheap, but the costs are also not completely prohibitive to ensure perfect monetary policy credibility. If efforts are made by Congress to reduce the costs of reappointment (thus reducing Fed independence), this would bring another hit to Fed credibility. As Kydland and Prescott argued, exposure to the political process means exposure to dynamic inconsistencies and a lack of credibility. So when Congress asserts that it will change the working environment of the Fed or require it to be less independent, this is again an attack on the Fed's policy and public credibility.

A lesson for how policy credibility is created can be found in the 1980s. Hardouvelis and Barnhart (1989) look at the classic case of the Volcker disinflation to see how the Federal Reserve was able to achieve policy credibility. The empirical evidence they present shows that credibility was achieved over a period of time rather than immediately following the announcement to fight inflation in October 1979. They discover that "inflationary fears were present for at least one more year and that the Fed established credibility slowly over time, perhaps after markets began verifying that the new Fed policy was successful at reducing the rate of inflation." This highlights the two dynamics at work. First there is a learning curve where time allows markets to understand why the policy will work. Second, there is an establishment of trust that the Fed will maintain the new policy course as long as necessary.

> "Clear communication about the longer-run objectives of monetary policy is beneficial at all times but is particularly important in a time of low inflation and uncertain economic prospects such as the present. Improving the public's understanding of the central bank's policy strategy reduces economic and financial uncertainty and helps households and firms make more-informed decisions. Moreover, clarity about goals and strategies can help anchor the public's longer-term inflation expectations more firmly and thereby bolsters the central bank's ability to respond forcefully to adverse shocks" (Hardouvelis and Barnhart 1989).

Just as the literature on credibility has ramifications for my analysis, the literature on communication supports the claim that communication is vitally important to the operations of monetary policy. Kohn and Sack (2003) examine the effects of Fed communication and categorize Federal Open Market Committee (FOMC) communications into three categories for their analysis. The first includes FOMC statements, the second includes congressional testimony by Chairman Greenspan and the third category is major speeches by Chairman Greenspan. Using these categories, they examine the impact of Fed communication on financial market variables and find that statements "have had significant effects on the short- and intermediate-term portion of the yield curve and on futures rates at those horizons" (Kohn and Sack 2003). Congressional testimony by Chairman Greenspan has even larger effects for items with longer maturities. They conclude that these three forms of central bank communication provide key information to investors and private agents.

In further examining what communication is, Blinder et al. (2008) define central bank communication as "the provision of information by the central bank to the public regarding such matters as the objectives of monetary policy, the monetary policy strategy, the economic outlook, and the outlook for future policy decisions." They remind readers that communication can be used to influence market expectations of the future path of interest rates. In addition, they highlight that the process through which markets learn about central banking is a never-ending one. As an example they say, "while people are learning, an increase in inflation may lead the public to revise its estimate of long-run average inflation upward, which, in turn, raises actual inflation" (Blinder et al. 2008). They show that the

literature on central bank communication consistently prescribes a better communication strategy for such a learning problem.

The final theme in the literature that is directly relevant to my own analysis is that of unconventional monetary policy or conducting monetary policy in unusual circumstances. In an early attempt at modeling options for unconventional monetary policy Bernanke and Reinhart (2004) set out an expectations management strategy for when nominal interest rates are at or near zero. They argue that "additional stimulus can be imparted by offering some form of commitment to the public to keep the short rate low for a longer period than previously expected." In their analysis, they show that if such a commitment is credible, the term structure of interest rates should be lowered overall. They present two types of commitments: conditional and unconditional. Conditional commitments are tied to developments in the economy while an unconditional commitment would be tied to a date. As a caveat, Bernanke and Reinhart conclude that policymakers' inexperience with conducting monetary policy with near-zero interest rates creates a challenge in calibrating actions. Additionally, they assert, "the communication challenges would be considerable" (Bernanke and Reinhart 2004). These challenges have certainly been significant, but Bernanke himself has led the Fed to shift its communication strategy by historical standards in the midst of unconventional policy as I uncover below.

Along with Bernanke and Reinhart's (2004) strategy, the prescription of Hardouvelis and Barnhart (1989) concerning communication is almost precisely the one used by the Fed and reiterated in more recent years. This is where the themes of communication and unconventional policy overlap. Federal Reserve Board member Yellen (2011) follows Hardouvelis and Barnhart (1989) by arguing that the Federal Reserve's communication policy on forward guidance of interest rates has significantly changed the expectations of the markets. She highlights the fact that communication needs to be compared against

expectations and if market expectations of policy firming are not in line with the planned path of Fed policy, then the communication should be changed to shift expectations towards what the FOMC plans to do over the longer term. Yellen focuses on central bank communication with financial market players and seems to assume that this communication will feed out into the general public. Specifically she argues, "Good communications are a prerequisite if central banks are to maintain the democratic legitimacy and independence that are essential to sound monetary policy making" (Yellen 2011).

In his speech at a conference in 2007, Chairman Bernanke laid out four general arguments for greater transparency and communication.

> "First, improving the public's understanding of the central bank's objectives and policy strategies reduces economic and financial uncertainty and thereby allows businesses and households to make more-informed decisions. Second, if practitioners in financial markets gain a better understanding of how policy is likely to respond to incoming information, asset prices and bond yields will tend to respond to economic data in ways that further the central bank's policy objectives….Third, clarity about the central bank's policy objectives and strategy may help anchor the public's long-term inflation expectations, which can substantially improve the efficacy of policy and the overall functioning of the economy. Finally, open discussion of the central bank's analyses and forecasts invites valuable input and feedback from the public" (Bernanke 2007).

A more specific context is given in Bernanke et al. (2004). They argue that communication is important in keeping policy expectations of the public and the plans of the central bank in line. They point out that this importance is heightened when the policy rate is very close to zero. Communicating that the central bank is committed to keeping interest rates low for an extended period may drive real interest rates to the desired level even though the policy rate remains positive but close to zero. This has been put into practice by the Fed (led by Bernanke himself) in recent years. The following section describes how the idea of increased communication has been applied by the Fed in recent years.

So just as credibility, communication and unconventional policy have been analyzed. I will seek to apply these concepts to study the case of Fed communication since the financial

crisis. My own analysis builds upon previous research and adds key insight into how Fed communication has changed in recent years.

Chapter 3. Description of Fed Communications

Fed communications can be grouped into press releases, testimonies, monetary policy reports and speeches. The communications that get the most attention include those relating to FOMC meetings and the semiannual monetary policy report to the Congress. FOMC meetings are accompanied with a policy statement, the meeting minutes (released two weeks after the meeting), and since April 2011 a press conference following the April, June and November FOMC meetings. The semiannual report to the Congress is the longest type of document that the Fed releases and it includes a thorough analysis of Fed policy, current economic conditions in the U.S. as well as the global economy, and prospects for the future. The report is accompanied by a testimony given by the chairman of the FOMC to the House Financial Services Committee and the Senate Banking Committee.

Press releases can be related to a policy action, enforcement against a financial institution, new rules for the financial industry and many other items. Speeches are most often given at conferences that address a particular economic question that relates to monetary policy. Fed testimony before Congress occurs when Congress is investigating a certain part of the financial industry, the economy as a whole, or exploring a new regulation. Generally speeches and testimony occur at the invitation of the event planner, meaning the Fed may not be the initiator, although there is not a rule saying that the Fed cannot offer to give testimony, and the Fed is often the host of special events where speeches are given by members of the FOMC.

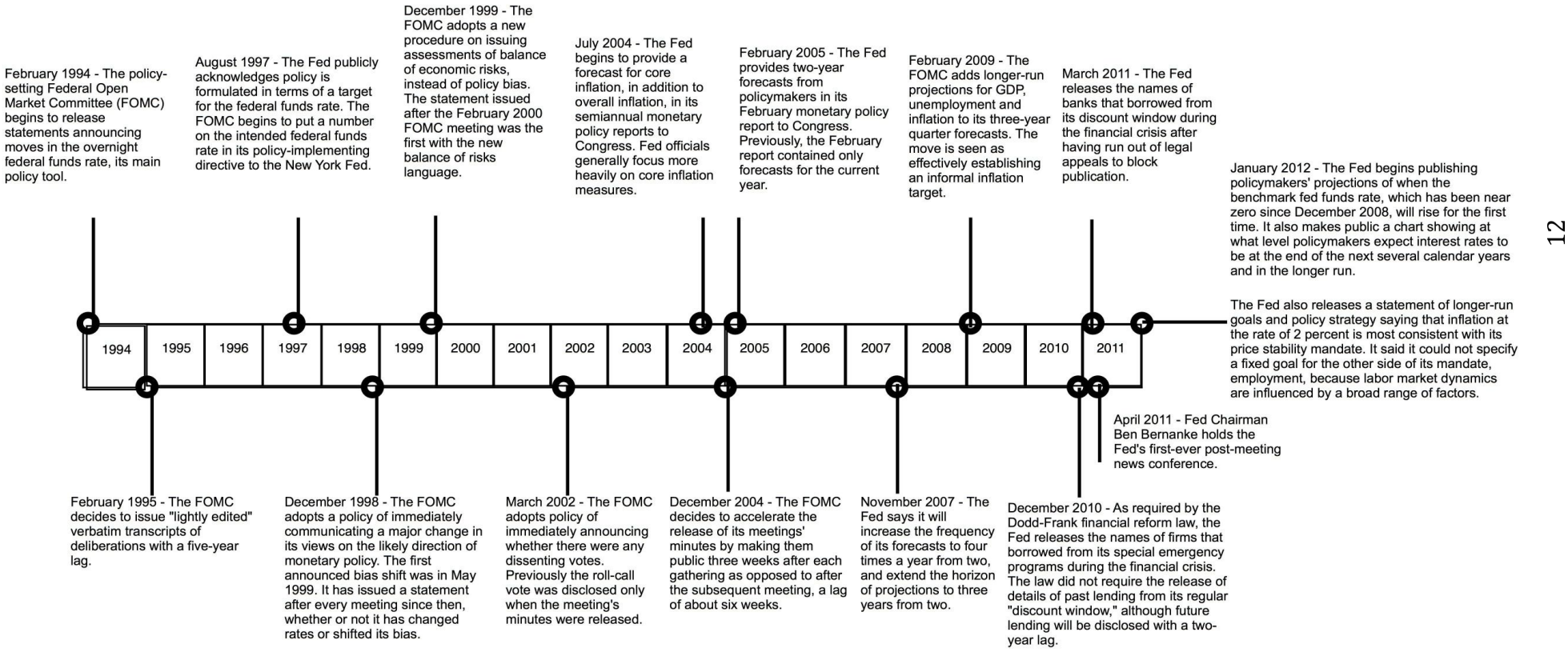
These communication techniques and their contents have evolved over time. The Fed has become increasingly transparent in its technical communication by providing more information on what it expects will happen in the economy and what it expects the appropriate

monetary policy response would be if certain events were to occur. Most recently, in January 2012, the Fed established that an inflation rate of 2 percent (as measured by the personal consumption expenditures index) is most consistent with its long run goals as well as the mandate placed upon it by Congress (Federal Reserve 2012a). For that occasion, Cross and Paschal (2012) wrote a short survey of Federal Reserve transparency events since 1994. The content of that survey is displayed in the timeline shown in Figure 2. The small technical changes have each had unique impacts on the amount of information that the markets have on Fed decision-making. By including new variables, clearer language and more information in general in its communications, the Fed has shifted from operating behind closed doors, to clarifying its intentions at almost every step of monetary policy. Prior to 2004 the transparency steps were spaced apart by more than a year, but the last five major steps have all taken place since the beginning of 2009.

The recent inflation target was accompanied with a completely new kind of communication. The Fed now publishes FOMC members' projections of when the policy rate will rise for the first time. This rate has been near zero since December 2008. The projections include the expected interest rate for the next three years as well as the longer-run (FOMC 2012). This type of information gives economic agents a horizon for the end of this episode of unconventional monetary policy, and in the language of Bernanke and Reinhart (2004) clarify the Fed's *conditional commitment* to keeping interest rates low.

With the context for increased transparency and communication set, I will now move to describing how I will analyze the communication shift during the recent crisis. By quantifying communication, I am able to show that recent Fed communication has been more than just technical information and actually a deluge of words.

Figure 2
Federal Reserve Transparency Steps



Based on Cross and Paschal 2012

Chapter 4. Methodology

The core analysis in this paper has three separate parts. Each part uses a separate methodology in order to answer the specific question posed in that section. The first part of the analysis in Section 5 uses text-based data analysis to uncover the recent history of monetary policy communication at the Fed and Congress in practice. Using several proxy variables, I look at the years 1996-2011 to examine trends and relationships between the variables. The difficulty with proxies is measurement error, so I avoid making strong conclusions and allow the data to speak for itself.

I also use survey data in Section 5 to show public opinions the Fed, Chairman Bernanke and certain policy measures. These opinion polls are useful in determining how much public credibility the Fed has. The polls are compared to the logic of Dornbusch (1991) and Moscarini (2007) to show that the Fed may have had no option but to take a credibility hit and respond dramatically to the financial crisis.

Section 6 provides the second part of the analysis and uses a simple mathematical model to analyze the incentives for Congress to communicate about monetary policy and for the Fed to respond to that communication. The model allows me to break away from the constraints of the rough proxy variables and evaluate different alternatives for Fed communication strategy. As with any model, each additional assumption weakens validity. The simplicity of my model allows the lessons for communication policy to be clear.

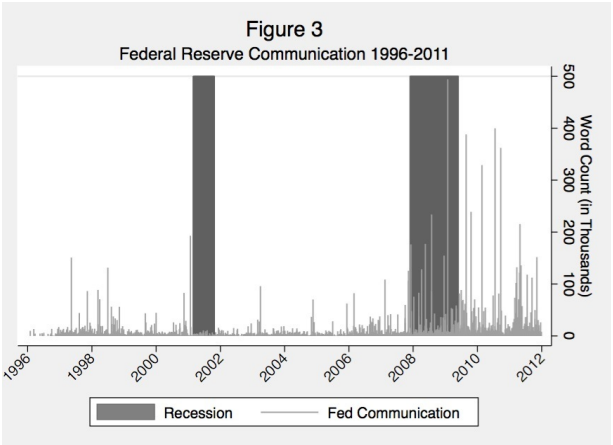
The final part of the analysis uses a synthesis of the literature on monetary policy communication, my findings from the data and the theoretical model to generate policy options for the Fed and Congress. The options are assessed against some ad hoc criteria such as political practicality, technical feasibility and potential impact. The options presented are certainly not an exclusive list, as the age of information and social networking is continually generating more options for communication.

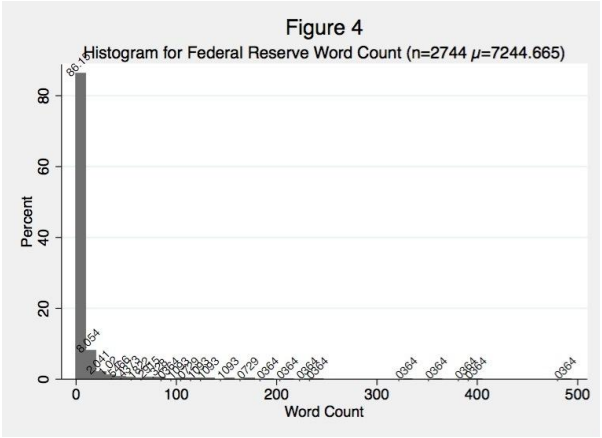
Chapter 5. Data Analysis

5.1 Federal Reserve Communication

The Fed's public website has press releases, testimonies, speeches and semiannual monetary policy reports publicly available for the years 1996-present (Federal Reserve 2012b). To get a general picture of how Fed communication has evolved over the last sixteen years I brought all of this communication into a single time series (See Appendix A.1 for details). Figure 3 displays the time series on Fed communication. This variable has 2,744 observations with a mean of 7,244.665, and a standard deviation of 2,3249.5. Figure 4 is a histogram showing how crowded the distribution is in the 0-10,000 words bin. More than 86% of the observations are days when the Fed released documents with words totaling 10,000 or less.

The largest spikes are from the semi-annual reports to Congress. As mentioned above, these are the longest documents that the Fed releases. Length-wise, speeches and testimonies are generally next in line, followed by press releases which tend to be shorter documents. Prior to the structural break at the end of 2007, it is easy to pick out the timing of the Fed's semi-annual reports.



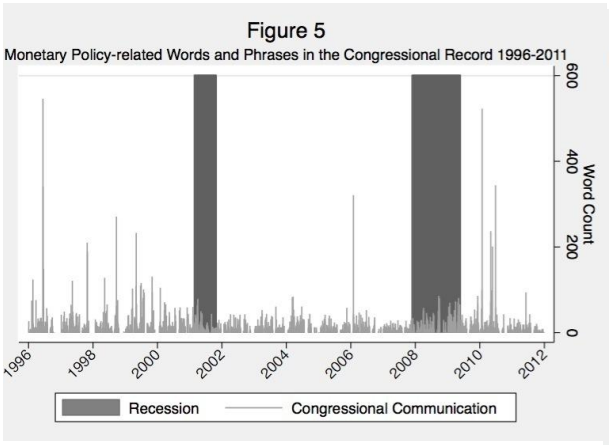


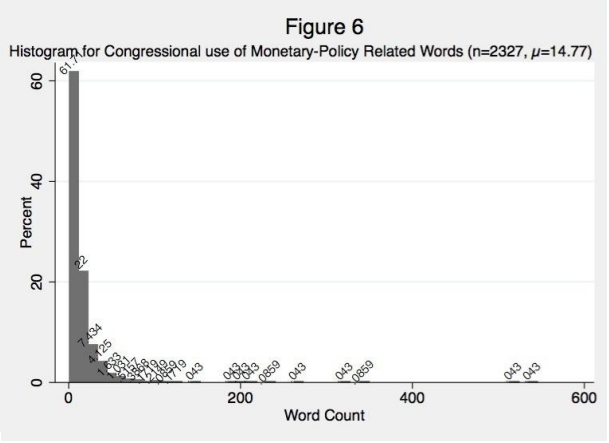
What is clear from Figure 3 is that there was a relatively consistent amount of communication from the Fed from 1996-2007, but at the end of 2007 this all changed. This

coincides perfectly with the beginnings of the financial crisis and the Fed's moves toward unconventional monetary policy. The darkest days of the crisis were matched with a significant jump in Fed communication. The mean of the variable prior to 2007 is 4,345.6, but the mean from 2007-2011 is 12,754.8. Following the arguments posed by Bernanke and Reinhart (2004) communication has been a very important part of the Fed's response to the crisis. This data shows that it was not just important to relay more technical information to the public (as shown above in Figure 2), but a larger volume of communication in general has been used by the Fed to counteract the effects of the financial crisis and stabilize inflation and policy expectations.

5.2 Congressional Communication

The other part of the story that I am trying to expose relies on the frequency of which the U.S. Congress mentions monetary policy terms in its debate. The reason for this is that if the Fed has lost credibility with the public due to its response to the financial crisis, change to the system will have to go through Congress. The data that addresses this issue comes from the Sunlight Foundation's Capitol Words website (Capitol Words 2012; see Appendix A.2 for details). Their data is taken from the Congressional Record which records all of the proceedings, debates and hearings in Congress for each day it is in session. I used the words *Greenspan, Bernanke, Federal Reserve, inflation, hyperinflation, inflationary, inflationism, monetary policy,* and *quantitative easing* to get a picture of Congressional concern with monetary policy. The time series is displayed in Figure 5. The variable has 2,327 observations, a mean of 14.77 and a standard deviation of 26.884. Figure 6 displays a histogram showing that more than 60% of the observations are days when the Congressional Record included between 1 and 12 mentions of the monetary policy-related words or phrases.

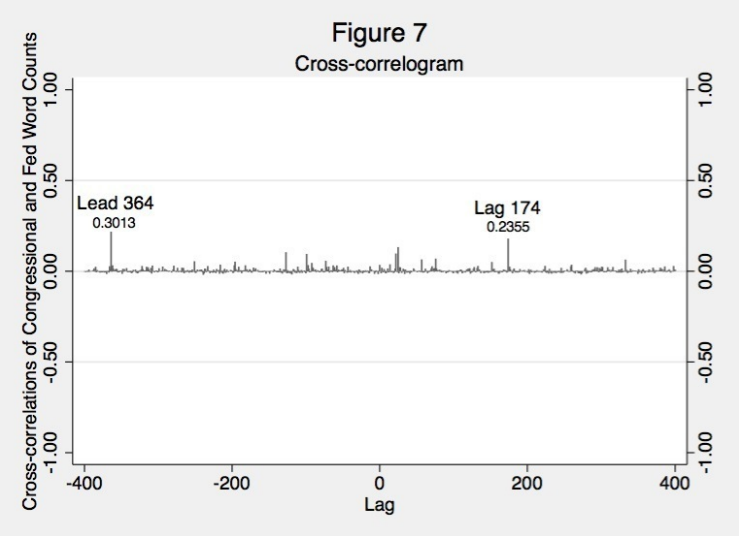




Unlike the data from the Federal Reserve, there is not a clear shift that coincides with the crisis. There is however a spike that comes in early 2010 that coincides with the reappointment of Chairman Bernanke and Congressional interest in bank regulation. The Dodd-Frank Wall Street Reform and Consumer Protection Act, which was signed into law on July 21, 2010, directly concerned the Federal Reserve (Dodd-Frank 2010). As shown in Figure 2 above in Section 3, the Federal Reserve released data in December 2010 as required by this financial reform law. This data included the names of the firms that borrowed from the Fed's emergency lending programs during the financial crisis. This information would not have been released if it were not for Congressional action. This is exactly the type of Congressional action that could lead to a complete change in the operating environment of the Fed in the future.

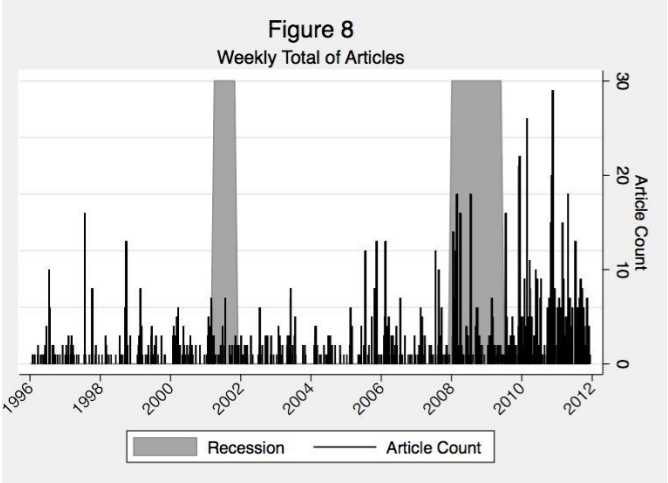
Other than the one group of spikes in 2010, there is no obvious connection between Congressional proceedings and the structural shift in Fed communication. There is almost zero correlation between these two variables as they are. One would not expect Congress to respond to the Fed immediately, though, or vice versa. The lag structure of the correlation relationship is displayed in Figure 7. It is interesting that at a 364 day lead and a 174 day lag, there is a significant correlation between the Congressional communication variable and the Fed communication variable. The interpretation of this is that the Congress variable changes in response to a change in the Fed variable with a 364 day lag on average. Also, the Fed variable changes in response to a change in the Congress variable with a 174 day lag on average. The correlations are significant, but not so strong and could be a simple anomaly in

the data. However it is interesting that the Congressional response to the Fed is a bit more than twice as delayed as a Fed response to Congress. I incorporate this information into the mathematical model I develop in Chapter 6.



5.3 Press Articles

In order to get a general picture of public interest in both the Federal Reserve and Congress I construct yet another proxy variable. The data is article counts from a LexisNexis search on articles referencing both Federal Reserve and Congressional topics (See Appendix A.3 for details). The data is displayed in Figure 8. This time series has 1,460 observations, a mean of 7.6 and a standard deviation of 6.8. The data is weekly totals of articles from the LexisNexis search. Similar to the data on Federal Reserve communication, there is a shift in volume of articles post-2007. The variable's mean prior to 2007 is 4.51, and the post-2007 mean is 10.21. The 2005-2006 group of spikes is related to the retirement of Chairman Greenspan and the appointment of Chairman Bernanke. Other spikes prior to 2000 are related to key speeches by Chairman Greenspan including the well-known "Greenspan put" episode when the Fed reduced interest rates following the collapse of Long-Term Capital Management (Investopedia 2012).



The surge in press covering the Fed and Congress shows that public attention has shifted in tandem with the Fed's response to the financial crisis. The spikes in early 2008 are related to the Fed's first round of quantitative easing, and the volume increases from there on out. What is interesting is that there is no sign of a drop-off in total volume going into 2012. The debt ceiling crisis in the summer of 2011 and the start of "Operation Twist" in September 2011 have kept the media focused on both Congress and the Federal Reserve. As the Fed programs continue, there is an increasing media trend of interest in the Fed and Congress.

5.4 Public Opinion Polls

The public opinion of the Fed is also an important concept in my analysis because it is what feeds the engine of monetary reform. If the Fed is to remain the democratic solution to U.S. monetary policy management, the American public must be willing to let it do its job. Opinion polls compiled by Selzer & Company for Bloomberg News provide a glimpse of the public's view of the Fed (Bloomberg Opinion Poll 2009a, 2009b, 2010a, 2010b, 2010c, 2010d, 2010e, 2011a, 2011b, 2011c, 2012). Figure 9 shows the responses to questions concerning Chairman Bernanke, the Fed as an institution and certain policies that were implemented in response to the financial crisis. Bernanke's approval rating (top left) has been consistently below 40% since the end of 2009, and his disapproval rating has been rising and is most recently above 30%. The two most recent surveys show Bernanke's favorability has fallen into a deficit of 6 and 4 percentage points respectively. In no survey have there been a

net favorable percentage of respondents of more than 50%. A majority of respondents to the seven surveys have either responded "not sure" or "unfavorable" to the question on Chairman Bernanke. The top right panel shows responses to a similar question concerning the Federal Reserve as an institution. The three surveys show that the approval rating has been consistently below 50% due both to "not sure" responses and "unfavorable" responses.

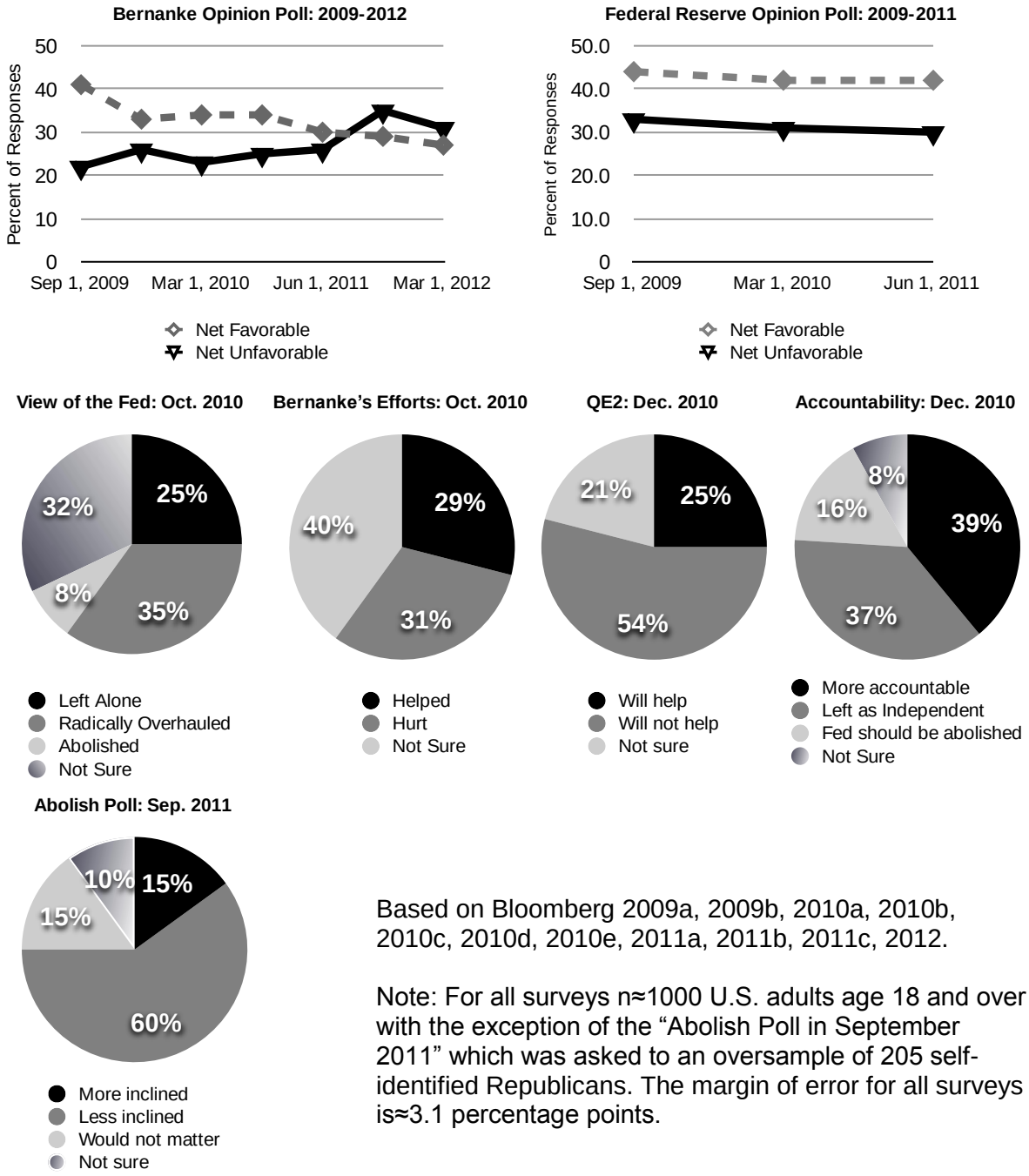
The answers to survey questions that have been asked on singular occasions are represented by the five pie charts. The figure labeled "View of the Fed" displays responses to the following question from an October 2010 survey:

> "Which of the following descriptions best reflects your view of the Federal Reserve, an independent authority that is responsible for interest rates, keeping the prices of goods stable, and encouraging maximum employment? If you do not know enough to answer, just say so."

Only 25% of respondents said that they thought the Fed should be left as it is, and 43% of respondents said the Fed should either be radically overhauled or abolished. Also in the October 2010 survey was a group of questions asking about several individuals who had a role in the response to the economic crisis. The figure labeled "Bernanke's Efforts" shows that respondents to the survey were split on whether or not Bernanke helped (29%) or hurt (31%) the recovery.

The pie chart labeled "QE2" shows the responses to the December 2010 question asking whether or not the respondent believed that the Federal Reserves plan to buy $600 Billion of Treasuries (QE2) would help the U.S. economy. The majority of respondents (54%) said they believe that QE2 would not help. The pie chart labeled "Accountability" displays responses to another question from December 2010 which asked the following: "Do you think the Federal Reserve should be more accountable to Congress or left as an independent body, or should it be abolished entirely?" The respondents are split between saying that the Fed should be more accountable (39%) and that it should be left as independent (37%).

Figure 9
Bloomberg Opinion Polls



Based on Bloomberg 2009a, 2009b, 2010a, 2010b, 2010c, 2010d, 2010e, 2011a, 2011b, 2011c, 2012.

Note: For all surveys n≈1000 U.S. adults age 18 and over with the exception of the "Abolish Poll in September 2011" which was asked to an oversample of 205 self-identified Republicans. The margin of error for all surveys is≈3.1 percentage points.

The final pie chart labeled "Abolish" shows responses to the following question posed in September 2011 to self-identified Republicans: "For each, please tell me if it would make you more inclined or less inclined to support the [Republican presidential nomination candidate] or if it would not matter." The clear majority (60% of respondents) said they would be less inclined to vote for the Candidate wanted to abolish the Federal Reserve.

Inference from such surveys is tricky. These survey results support a general argument

that the American public is dissatisfied with the Federal Reserve, but some of the results are contradictory. There is a contradiction between the responses to the survey asking about the Republican presidential nomination candidates ("Abolish") and the responses to the question about the views on the Fed ("View of the Fed"). However, that question only focuses on a subset of the survey sample (self-identified Republicans) and is therefore not generally comparable to other survey questions. The other questions show a general attitude of distrust towards the Fed or a lack of understanding concerning its purpose, structure or policies. This supports the story that was theorized by Dornbusch (1991) and Moscarini (2008) that the need to respond to the financial crisis and the size of the response caused the Fed to lose some of its public credibility Without data going back before the crisis, there is need for a more theoretical foundation upon which these arguments can be built. This leads me to develop the mathematical model in section 6.

Chapter 6. Mathematical Model

The variables presented above in section 5 all support my general thesis. I will develop a mathematical model to represent more clearly the logic of unconventional policy, communication, credibility loss and defense of credibility. The model is quite simple, yet instructive.

The story that the model attempts to capture is the following. When the Fed responded to the recent crisis with its quantitative easing programs, it also released hundreds of communications. Each of these communications had an individual purpose. It is not as though the Fed was talking just for the sake of talking. The increase in speeches, testimonies and press releases filters through to the general public through the media. Soon a good portion of the US knew that something was different. Congressional interest in monetary policy represents this general shift in interest. Why should the Fed care if the general public is aware

of its quantitative easing programs? The reason is this: the public through Congress has built the Fed as the institution that it is, and the public also has the power to remove or modify this institution if it does not like what it is doing. So, it is important for the Fed to protect its credibility vis a vis the public. This dimension of central banking is less commonly explored than the idea of credibility with the financial sector.

The public and Congress are rarely as interested in monetary policy as they have been over the last few years as shown by the media coverage data in figure 8 above. This may be a general result of the financial crisis, however, I believe it has a lot to do with the fact that the Fed has done things in response to this crisis that it has never done before which is similar to the logic of Mosarini (2008). When things are run normally, very few people care about monetary policy. However, when that changes as it did in this recent crisis, many people start wondering why the change took place. This happens with a lag because there are few incentives for the general public to pay close attention to the Fed's actions in real time. There is also a magnification effect on the public's concern with monetary policy. As the unconventional policy continues, increasingly people begin to be concerned if the Fed has become reckless. This erodes the public's trust in the Fed as an institution and leads to arguments for its abolishment or to rein it in from independence.

The first key variable in this situation is the Fed's communication that feeds through to the general public without much media interference. This establishes and maintains the Fed's relationship with the public. The second key variable is the communication by Congress that is aimed at reforming the Fed. This communication is purely reactionary, happens with a lag and describes Congressional concern with the Fed's unconventional measures. This communication effectively reaches the public because of Congress's local connections and their consistent media presence. The third key variable is the presence of the unconventional measure itself; this is the signal to the public that something is different. Even if the general

public doesn't understand what the monetary base is, they can easily tell that it is much larger than ever before and that the jump in 2008 was not normal behavior for this variable. The fourth variable of importance is the length of time that the unconventional policy is undertaken. The importance of this variable will be shown below.

Central bank communication in the model below will be defined as communication that feeds through to the general public without much media interference. This excludes statistical releases, policy specific press releases, inconsequential testimony before the legislature and speeches of no significance. This leaves very few types of standard central bank communications. The communication function for the central bank is as follows:

First, I assume that there exists a deterministic trend towards greater communication from the central bank:

(1) $\gamma_t = \gamma_{t-1} + \mu$

This is fed into the central bank's general communication function with a lag

(2) $C_t = (\gamma_{t-1})^a + \varrho \cdot C_{t-1} + \beta \cdot L_{t-1} + P_t$

Where $a = \frac{1}{2}$ to allow for decreasing returns to the deterministic trend's influence on actual communication.

C_t is the central bank communication at time t; ρ is the coefficient of autocorrelation and provides an AR(1) component to C_t. ß is the coefficient of response showing how much C_t depends on the communication of the Legislature on monetary policy issues.

The last term is just a dummy variable indicating if policy is unconventional. If policy is "normal" $P_t=0$; if policy is deemed unconventional it takes a value of one.

This completes the central bank's communication function.

The legislative communication function is represented by the following equation:

(3) $L_t = (C_{t-2} \cdot P_{t-2} \cdot \delta_{t-2}) + (\lambda \bullet \gamma_{t-2}) + \psi \bullet L_{t-1}$

The logic for the first term is the following. The local connections and large media

presence of the legislative body give it the flexibility to communicate at the same level as the central bank (C_{t-2}) in any period. The trigger for the communication is the policy change (P_{t-2}). The lags represent the time it takes for the public to learn about and respond to a change in monetary policy. The assumption that the learning lag is constant is not a simple one. Generally, a learning curve would be appropriate so that eventually the legislative would respond to the central bank in real time. However, as discussed briefly in section 5, there is some evidence for the legislative's communication lag to be twice as large as the central bank's communication lag.

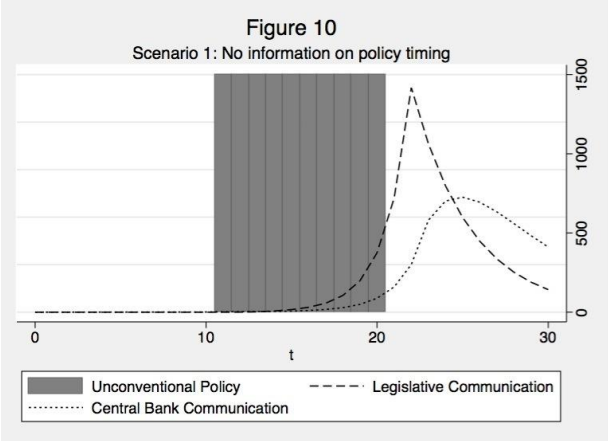
This is further increased by δ_t which is the magnification variable. In the case where the central bank asserts that a policy change will last a certain number of periods (e.g. 4), this variable will begin with a maximum (4) and fall by 1 each period until it reaches 0 and remains at that value. The other case is where the central bank undertakes an unconventional policy and is unable or unwilling to determine a specific ending point. In this case, δ_t will begin with a value of 1 and climb by 1 each period until policy returns to "normal."

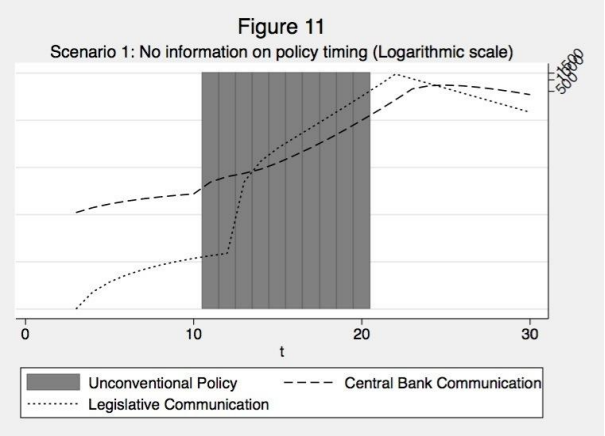
λ is the coefficient that shows how much legislative communication depends on the underlying trend toward transparency. In the final term ψ is the coefficient of autocorrelation and the AR(1) feature.

Using (1), (2) and (3) as well as the initial values specified in Table 1, I ran two simulations of the model as an example. The first case has the central bank unable or unwilling to communicate a specific end of the unconventional policy while the second case is just the opposite. Full results for all variables and parameters as well as their means and standard deviations are shown in Table A.1.

Table 1 Model variables, parameters, descriptions and initial values		
Endogenous Variables	Description	Value in Example
C_t	Central Bank Communication	t=0, Ct=0
L_t	Legislative Communication	t=0, Lt=0
Parameters		
γ_t	Indicator of the level of central bank transparency	t=0, *gamma_t*=0
μ	Amount transparency increases in each period	0.01
α	Decreasing returns to transparency level	0.5
ρ	Autocorrelation coefficient for central bank communication	0.75
$ß$	Dependence on legislative communication	0.25
P_t	Policy change dummy variable	t=0, 1, 2, …, 10, Pt=0; t=11, 12, …, 20, Pt=1, t=21, 22, …, 30, Pt=0
δ_t	Policy change magnification	1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and in reverse order
λ	Dependence on trend toward transparency	0.1
ψ	Autocorrelation coefficient for legislative communication	0.75

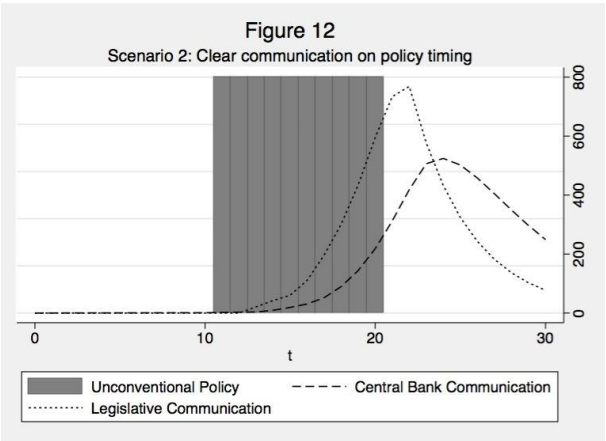
Figure 10 shows the first case simulation results for C_t and L_t on a linear scale. It is immediately apparent that the unconventional policy itself is not the main driver of communication volume towards the end of the policy and after it has returned to normal. The persistence of the legislative body to communicate its policy desires is worked into the model through the lags, but this feature is clearly presented here. The drop off in L_t occurs at t=23 and shows how quickly the model allows legislative attention to turn to other topics. Central bank communication quickly falls behind in the "yelling match" since it does not easily gain the attention of the public in its attempts at communication (i.e. not many people in the general public watch central bank press conferences).

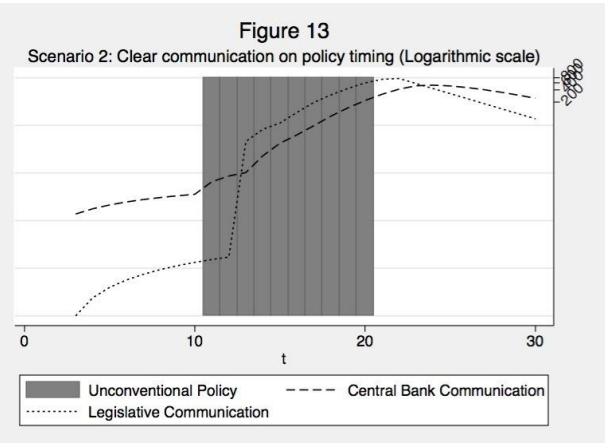




Switching the *y* scale to logarithmic allows closer observation of the dynamics at the beginning of the unconventional policy. Figure 11 displays this for both C_t and L_t. The initial jump in central bank communication is visible, but appears small relative to the growth in communication volume as the unconventional policy continues.

Figures 12 and 13 display Case 2's results of the model. These are analogous to Figure 10 and 11 but for the case when the central bank clearly communicates how long it will undertake the unconventional policy.





The difference in outcomes between simulation 1 and 2 can be examined by taking the difference between C_t (1) and L_t (1) and comparing it to the difference between C_t(2) and L_t (2). This is displayed in Figure 14. The Central Bank's communication deficit is much smaller in the case with clear communication on policy timing than in the case where there is no communication on policy timing. This is essentially the tradeoff that a Central Banker faces between a conditional commitment to keeping interest rates near zero and an unconditional

commitment to the same policy (Bernanke and Reinhart 2004).

In this specific case where legislative communication on monetary policy is interpreted an attack on rather than a defense of the central bank, the communication deficit translates into a public credibility loss. In a more general sense, legislative communication could either be in support of or against central bank policy. However, given the evidence discussed above in Chapter 5, I am restricting legislative communication to be in opposition of the central bank.

Figure 14
Communication Deficit in Scenario 1 and Scenario 2

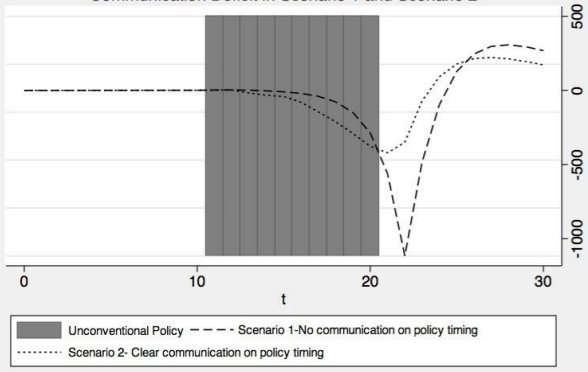


Figure 14 shows the difference in the communication deficits between scenarios 1 and 2. In order to protect its public credibility, the central bank should to minimize this deficit. Though the central bank may not be able to communicate as effectively and quickly as the legislative body to eliminate the deficit, it can improve its situation by clearly communicating its end game for the unconventional policy. Also, for the legislative body that is careful not to violate the policy independence of the central bank without public support, communication is a useful check against the central bank. However, since it would take a long time for legislative communication to affect monetary policy, it is better for the central bank to run unconventional policy for a short amount of time.

Another lesson is that the central bank should invest in its communications infrastructure to be able to quickly and consistently relate to the public its intentions and its reasoning for the unconventional policy. Though the central bank communication will most

likely continue to be dwarfed by that of the legislative, the situation will again be improved.

Chapter 7. Policy Options

The model above provides a simple comparison between two communication strategies during unconventional policy. It is clear that the strategy of expectations management works even for the issue of competing with a legislative body to protect central bank credibility. The question that this section focuses on is what are the practical communication options for the Fed?

The first option is one that the Fed has actually begun to use. Blogs are becoming central to discussion and policy evaluation in economics, and the Fed would do well to join in the discussions. Two of its blogs (*Macroblog* at the Atlanta Fed and *Liberty Street Economics* at the NY Fed) are already widely read and the cost of setting up more blogs is basically zero. However, the goal should be to have better blogs and not just more blogs that all mirror each other. The current Fed blogs could become more flexible in their content and engage with other economics bloggers more frequently in order to improve communication.

Thoma (2012) recently set out the case for better Fed blogs in a presentation to the St. Louis Fed. He presented a few key debates that have occurred in the economics blogosphere recently and argued that the Fed would do well to have more blogs to weigh in on the debates. He noted that stronger ties to the public, the press, policy makers, other economists and disciplines are all benefits of having a good blog. Blogs could allow the staff members of the regional Feds to become more connected to their regions and help the Fed communicate its message as a whole in order to avoid a misunderstanding of policy measures. While blogging is not the only answer, it is certainly a good option for the Fed to gain traction with the public when the media is having trouble interpreting the technical "Fedspeak" of FOMC minutes.

Another option for the Fed would be to allow the regional offices to create positions for

government liaisons. These individuals would connect consistently with local policymakers in order to answer questions about Fed policy and to teach them about how the Fed's actions are connected with its general mission. Just as Chairman Bernanke recently lectured at George Washington University, the regional liaisons could engage university students in the classroom (Federal Reserve 2012b). This would help the Fed's public image by opening it up to more opportunities to connect with the public. The feasibility of this option depends really on the willingness of the public to allow the liaisons opportunities to speak or connect with them. However, given the large interest in the Federal Reserve and Congress as discussed above in section 5, it would not be surprising if a person designated by the Fed to connect with the public had more than enough requests to give them a full-time job in that role.

In Washington, D.C., the Fed could set up more liaisons to build relationships with the policymakers there. An open relationship with Congress is necessary for a mutual understanding of policy. The independence of the Fed should not be threatened by more openness with policy makers on Capitol Hill. The goal would be to consistently connect with policymakers to be aware of their particular questions about Fed policy and their own plans for future economic policy.

Chapter 8. Conclusion

I have argued that along with its unconventional monetary policy of the past several years, the Fed has engaged in a program of intense communication with changes both to the content and volume of the communications. I have shown that, based on word counts, there was a structural break in the amount of Fed communication at the end of 2007. This wave of communication continues in tandem with the Fed's unconventional monetary programs. I also argued that because of the Fed's response to the crisis, the bank has exposed itself to a credibility loss. The U.S. Congress and the media have exploited this and they have

contributed to an erosion of public trust in the Fed and its policies.

Using this information I have designed a model that shows, in the case of unconventional policy, central bank communication can be dwarfed by legislative communication and this could create a public credibility problem for the central bank. The model shows that by communicating a clear time frame for unconventional policy, a central bank can shrink the size of the credibility loss. Thus communication is shown to be quite important not only for policy credibility but also for public credibility.

As the Fed continues to operate in an unconventional way, the advice my analysis has generated may be helpful to avoid further credibility losses or Congressional action to reform the Fed. With "Operation Twist" due to run out at the end of June 2012, and with expectations for interest rates to remain near zero until 2014, unconventional monetary policy will not be over in the U.S. any time soon. Criticism of the Fed's policy is almost constant nowadays (for a recent example see DeMint 2012), and anything it can do to improve its ability to communicate effectively with the public would be helpful. If the surge in communication I have uncovered is just the beginning of a new era for Fed communication, then improvements to the effectiveness of the communication strategy should be used going forward to defend both public and technical credibility.

Summary and Policy Conclusions

In tandem with its unconventional monetary policy since the beginning of 2008, the Federal Reserve (the Fed) has increased both the content and the volume of its communications. However, while this communication shift has allowed the Fed to stabilize markets and protect policy credibility, it has not protected the central bank from facing a loss of public credibility. The media and Congress have exploited this credibility and the general public has since lowered its general opinion of the Fed and the policies it has implemented since the crisis. Congress, in particular, has incentives to attack the credibility of the Fed as it continues its unconventional stance. Eventually a public credibility loss could lead to a change in the working environment of the Fed which may be less than optimal.

In order to defend against this, the Fed should recalibrate its communication to target the public in general. This would mean creating local connections and media relationships in order to channel more information to the public. The use of social media such as blogs could create a platform for such communication. However, the blogs should be administered in an interactive way by allowing comments, responding to comments, and engaging other key economics blogs. In fact, just one such blog could create stronger public relations.

Another important option would be to create Congressional and local liaisons who would consistently be available to policy-makers. These individuals could be used to make sure that Fed policy is not misunderstood by being available to answer questions from policy makers as well as media spots and local events. By building a locally connected and social media-based communication infrastructure, the Fed could seek to regain some of its public credibility and protect itself from future attacks as its unconventional policy continues into the future.

Technical Appendix

A 1. Federal Reserve Communication Data

The Fed's public website has press releases, testimonies, speeches and semiannual monetary policy reports publicly available for the years 1996-present (Federal Reserve 2012b). To get a general picture of how Fed communication has evolved over the last sixteen years I assembled computer commands that brought all of this communication into a single time series. First, the text from each file was downloaded to my computer. Second, a find function extracted the release date from the file and placed this text in a spreadsheet cell. Third, I used a textual analysis application to create a word count spreadsheet. This spreadsheet output included the total number of words in each file. I then paired the dates with the total number of words. Since more than one document may have been published on a single day, I created daily totals for words released by the Fed using a Stata command. After dropping recurring dates from the data set I was able to create Figure 3 in section 5.

The data is rather noisy, and somewhat imperfect. Not every file that was downloaded had a date that could be extracted. Although the layout of the Fed's website might make it appear simple to pair downloaded documents with the dates listed, this task was quite difficult. If a file did not have a date readily apparent to the "find dates" command, there would be no date extracted and the observation would consequently not appear in the data. After inspecting the process, I have concluded that such occurrences were random after the year 2000. Before that year, many documents were formatted in ways that the find function would not be able to identify a date on the file.

Another problem is that many pages included links to pdf files that had to be downloaded parsed and dated in a separate function. There were approximately 2000 unique pdf files that had to be processed in this way. The problem with the pdf's is that the word counts are generally higher on these files and many of the older files (mainly before 2000) did

not have text easily recognizable by either the parsing program or the date extraction function. Again this means that these observations do not show up in the sample. Overall, I did not find these problems significantly affecting the analysis in Section 5.

A 2. Congressional Communication Data from Capitol Words

The data I use to show Congressional communication on monetary policy comes from the Sunlight Foundation's Capitol Words website (Capitol Words 2012). Although the data is well displayed on the website, it is not very simple to download it. I used the website's API to download the number of times Congress used the words *Greenspan, Bernanke, Federal Reserve, inflation, hyperinflation, inflationary, inflationism, monetary policy,* and *quantitative easing*. These words were not selected through any clear scientific method other than their relationship to monetary policy issues. The assumption that any time these words were used they were used in the context of monetary policy is certainly a strong one. The use of the word *inflation*, for instance, is many times not in a context of monetary policy. However, a general interest in inflation could be used as a proxy for Congressional concern with monetary policy.

The data from the Capitol Words website is text data from the Congressional Record which is published for every day that Congress is in session. The document is imported to their database and parsed so that one is able to search for word usage over time. Using the API, I downloaded and imported the data for each of the words and phrases mentioned above. I then created a daily total of these words. The resulting time series data is displayed in figure 5 in Section 5.

A 3. Articles from Lexis-Nexis

The data I use to show media interest in Congress and monetary policy is weekly article counts from articles published by US media sources. The following Boolean search function

was used to retrieve articles with references to both Congressional terms and monetary policy terms:

> Source: News, All (English, Full Text)
> Terms: (((((Federal reserve) AND (monetary policy) AND (inflation) AND ((congressman) OR (senator) OR (representative)) AND NOT (reappointment) AND NOT (reappoint) AND NOT (reappoints) AND NOT (reappointed) AND NOT (appoint) AND NOT (appointed) AND NOT (appointment)) and ((#GC343#) AND (#STX001937#) AND (#N920000CC#) AND (#STX001970#)) and Date(geq(01/01/1996) and leq(12/31/2011)))

The search retrieved 2,458 articles. The reason so many terms avoiding the topic of appointment were included in the search is that there were huge spikes in media coverage surrounding Greenspan's reappointment and Bernanke's appointment. Since such attention to Congress and monetary policy are not relevant to my analysis, I designed the search function to avoid such articles.

Lexis-Nexis allows one to get a list of articles which includes publishing dates. Using a "find date" function, I extracted the dates the articles were published and gave each article a value of one. Then I created a weekly sum of articles in order to display the shift in interest towards the intersection of Congressional and monetary policy topics. The time series is displayed in Figure 8 in section 5.

A 4. Model Output

Using a spreadsheet and the values described in section whatever for the model, I ran two simulations of my model. The output from those simulations is used in figures 10-14 of section 6. The full output is in table A1.

Table A.1: Model Output

t	C_t (1)	L_t (1)	Ct (2)	L_t (2)	ɣ	μ	α	ρ	ß	P_t	δ_t (1)	δ_t (2)	λ	ψ
Mean	176.43	213.42	148.38	169.74	0.15	const.	const.	const.	const.	0.323	1.774	1.774	const.	const.
St. Dev.	265.75	358.332	191.51	236.07	0.091	const.	const.	const.	const.	0.475	3.095	3.095	const.	const.
0	0.00	0.00	0.00	0.00	0.00	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
1	0.10	0.00	0.10	0.00	0.01	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
2	0.22	0.00	0.22	0.00	0.02	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
3	0.34	0.00	0.34	0.00	0.03	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
4	0.45	0.00	0.45	0.00	0.04	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
5	0.56	0.01	0.56	0.01	0.05	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
6	0.67	0.01	0.67	0.01	0.06	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
7	0.77	0.01	0.77	0.01	0.07	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
8	0.86	0.01	0.86	0.01	0.08	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
9	0.95	0.02	0.95	0.02	0.09	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
10	1.03	0.02	1.03	0.02	0.10	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
11	2.11	0.02	2.11	0.02	0.11	0.01	0.50	0.75	0.25	1.00	1.00	10.00	0.10	0.75
12	2.94	0.03	2.94	0.03	0.12	0.01	0.50	0.75	0.25	1.00	2.00	9.00	0.10	0.75
13	3.57	2.14	3.57	21.15	0.13	0.01	0.50	0.75	0.25	1.00	3.00	8.00	0.10	0.75
14	4.59	7.49	9.34	42.30	0.14	0.01	0.50	0.75	0.25	1.00	4.00	7.00	0.10	0.75
15	6.70	16.34	18.97	60.30	0.15	0.01	0.50	0.75	0.25	1.00	5.00	6.00	0.10	0.75
16	10.51	30.62	30.70	110.61	0.16	0.01	0.50	0.75	0.25	1.00	6.00	5.00	0.10	0.75
17	16.95	56.49	52.09	196.77	0.17	0.01	0.50	0.75	0.25	1.00	7.00	4.00	0.10	0.75
18	28.26	105.45	89.68	301.09	0.18	0.01	0.50	0.75	0.25	1.00	8.00	3.00	0.10	0.75
19	48.99	197.77	143.97	434.20	0.19	0.01	0.50	0.75	0.25	1.00	9.00	2.00	0.10	0.75
20	87.63	374.42	217.98	594.72	0.20	0.01	0.50	0.75	0.25	1.00	10.00	1.00	0.10	0.75
21	159.79	721.78	312.62	734.00	0.21	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
22	300.75	1417.69	418.44	768.50	0.22	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
23	580.47	1063.29	506.43	576.40	0.23	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75

Table A.1: Model Output														
t	**C_t (1)**	**L_t (1)**	**Ct (2)**	**L_t (2)**	**ɣ**	**μ**	**α**	**ρ**	**ß**	**P_t**	**δ_t (1)**	**δ_t (2)**	**λ**	**ψ**
24	701.66	797.49	524.41	432.32	0.24	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
25	726.12	598.14	501.89	324.26	0.25	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
26	694.64	448.63	457.99	243.22	0.26	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
27	633.65	336.50	404.82	182.44	0.27	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
28	559.89	252.40	349.75	136.86	0.28	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
29	483.56	189.33	297.07	102.67	0.29	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75
30	410.55	142.0224	249.02	77.0299	0.30	0.01	0.50	0.75	0.25	0.00	0.00	0.00	0.10	0.75

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