Title
Expectations and Uncertainty in the Macroeconomy

Author
Binder, Carola Conces

Publication Date
2015

Peer reviewed|Thesis/dissertation

Expectations and Uncertainty in the Macroeconomy

by

Carola Conces Binder

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

Economics

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Yuriy Gorodnichenko, Chair
Professor David H. Romer
Professor Shachar Kariv
Professor Edward Augenblick

Spring 2015

Expectations and Uncertainty in the Macroeconomy

Abstract

Expectations and Uncertainty in the Macroeconomy

by

Carola Conces Binder

Doctor of Philosophy in Economics

University of California, Berkeley

Professor Yuriy Gorodnichenko, Chair

This dissertation consists of three chapters with a common theme of expectations and beliefs in the macroeconomy. The first chapter introduces a micro-level measure of consumer inflation uncertainty. Literature on cognition and communication documents that people use round numbers as a communicative tool to convey uncertainty. I construct an uncertainty measure that exploits consumers' tendency to round their inflation forecasts to multiples of five on the Michigan Survey of Consumers. I document cross-sectional and time series properties of the measure and provide support for its validity. Mean inflation uncertainty is countercyclical and positively correlated with inflation disagreement, inflation volatility, and the Economic Policy Uncertainty Index. Inflation uncertainty varies more in the cross section than over time, so a major benefit of this new measure is its cross-sectional dimension which enables micro-level analysis of the relationship between uncertainty and consumption. More uncertain consumers are more reluctant to spend on durables, cars, and homes, and their spending attitudes are less sensitive to interest rates. The measure also has applications to inflation dynamics and monetary policy. For example, the expectations of more-certain consumers can be used to improve Phillips curve estimation.

The second chapter focuses on central bank communication with households. Transparent communication with the general public is a stated goal of the Federal Reserve. While most research has focused on central bank communication with financial markets, this paper evaluates the effectiveness of Federal Reserve communication with the public at large. While professional forecasters are attentive to Federal Reserve communications regarding the price stability objective, including the announcement of a 2% inflation target, many households are not. Consumers' inflation expectations are weakly-anchored, especially among less-educated, low-income, and female consumers. Anchoring has not improved notably since the late 1990s. News and media data reveal that Federal Reserve communications are not widely propagated through traditional or new media channels to the public and that that consumers do not proactively seek information on monetary policy. Evidence collected from dozens of surveys from the 1950s to 2014 exposes a lack of public awareness of the Federal Reserve and its objectives and a decline in public opinion of central bankers.

The third chapter studies expectations in an important episode of economic history. Competing interpretations of the Great Depression depend on the behavior of inflation expectations in the onset and recovery. A number of papers have examined whether the deflation of 1930-32 was anticipated and when positive inflationary expectations reappeared. I review and compare the various statistical, narrative, and market-based approaches that have been used to estimate inflation expectations in the Great Depression era and supplement these approaches with additional methods and narrative evidence. I introduce a new approach using Phillips curve estimation. Reconciling the disparate findings of the previous literature, I conclude that the deflation was mostly unanticipated until mid-1930 and that a regime change occurred at the start of Roosevelt's presidency, prior to monetary expansion.

To Joe and Ruby

Contents

List of Figures

List of Tables

Acknowledgments

I am truly grateful for all of the support, advice, and encouragement I have received leading up to the completion of this dissertation. The University of California, Berkeley and the Georgia Institute of Technology are two of the most vibrant intellectual communities in the world.

I thank Roe and Penny Stamps, who supported my undergraduate education at Georgia Tech through the Stamps Leadership Scholarship. They continually inspire me to do my best to make the world a better place. The National Science Foundation Graduate Research Fellowship Program provided generous financial support while I was at Berkeley. Patrick Allen and Victoria Lee keep the department running smoothly and were superhuman

My advisor, Yuriy Gorodnichenko, is truly the pride of the economics profession. Not only is he a prolific and innovative researcher, he also is a superb teacher and mentor. Every time I met with him, I left with new ideas about how to improve my research and with a renewed sense of motivation.

I also thank David Romer and Christina Romer for inspiring me to choose macroeconomics as my field through their superb teaching in my first years of graduate school. Their macroeconomic history elective is the best course I have ever taken and affirmed my desire to be an economist. Any one of their papers exemplifies the highest standards of research. They have consistently challenged me to ask important and clear research questions and built my confidence in my ability to do so.

Members of the Berkeley economic history group have been a wonderful source of research and teaching advice and encouragement. Marty Olney and Brad DeLong helped me set concrete goals and stay on track through regular history group meetings. Marty is incredibly generous in her formal and informal support of graduate students' overall well-being, helping us find balance and fulfillment in teaching, scholarship, and personal life. Barry Eichengreen is a patient and engaging teacher and the finest model of work ethic. The Berkeley Economic History Laboratory, which receives core funding from the Institute for New Economic Thinking, has allowed me to enjoy seminar presentations and discussions over coffee with dozens of great scholars. Many other faculty members at Berkeley have been supportive, including Raymond Hawkins, Ned Augenblick, and Schahar Kariv.

My classmates at Berkeley are the best. Participants in the Berkeley macroeconomics seminar and Graduate Economics Mini Symposium (GEMS) provided valuable feedback on the first and second chapters of this dissertation. More importantly, so many classmates have become friends and inspirations to me. My life is so much richer thanks to Maria Coelho, Daniel Gross, David Berger, and Gillian Brunet.

I thank the University of California San Diego Economics Department, and especially the macroeconomics group, for welcoming me into their community during my two years in San Diego. They provided me with many valuable opportunities to present my work in progress. I had terrific officemates, Andy Brownback, Larry Schmidt, and Leland Farmer.

Finally, I thank my family. This includes the Strawberry Canyon Track Club, especially Carl Rose, Linda Dix-Cooper, Nathan Leefer, and Sean McFarland. I also count the UCSD

Newman Center community, including Father Dominic, Father John Paul, the Young Adult Group, and my Small Church Community, as family. I cannot possibly overstate my love and gratitude to my parents, Phyllis and Guy Conces, and my brother, James Conces. I had the unbelievable blessing to meet and marry Joe while in graduate school. He is the most faithful, intelligent, and kind man I know. He shares those qualities with his parents, Mary Beth and Tom, and his siblings, Annie, Katie, and Peter. The blessing of my marriage to Joe is only rivaled by the birth of our daughter Ruby.

Chapter 1

Consumer Inflation Uncertainty

1.1 Introduction

The Great Recession has prompted a renewed effort to understand the causes and consequences of economic uncertainty, which may deepen and prolong economic distress and dampen the effects of macroeconomic policy. Households' uncertainty about inflation, the focus of this paper, has a variety of theoretical implications for consumer behavior and monetary policy. For instance, inflation uncertainty implies uncertainty about real income, which may reduce consumption through a precautionary savings channel. Inflation uncertainty also implies uncertainty about the real interest rate, which may result in a slow, "hump-shaped" response of consumption to monetary policy (Mackowiak and Wiederholt, 2011).

While there is no shortage of theories about why household inflation uncertainty matters for the macroeconomy, empirical studies on this topic have been hindered by a lack of household-level measures of inflation uncertainty (van der Klaauw et al., 2008). Uncertainty is a feature of individual agents' subjective beliefs, which we have a limited ability to observe. The first contribution of this paper is the introduction of a historical, micro-level proxy for household inflation uncertainty. The second is an analysis of key properties of household inflation uncertainty, its negative association with durable goods consumption, and its role in monetary policy and inflation dynamics.

Uncertainty refers to the spread of an individual agent's subjective probability distribution over an outcome. Uncertainty is conceptually distinct from disagreement, which measures the dispersion of beliefs *across* agents (Zarnowitz and Lambros, 1987). The New York Federal Reserve recently began conducting the Survey of Consumer Expectations (SCE), which elicits consumers' subjective probability distributions over future inflation, enabling direct computation of consumer inflation uncertainty (Armantier et al., 2013). Unfortunately, only a few months of survey data currently exist, so this data does not allow us to study inflation uncertainty over a long time sample. Historical consumer surveys, notably the Michigan Survey of Consumers (MSC), only provide consumers' point forecasts of inflation.

While de Bruin et al. (2009) claim that "Surveys asking individuals for point predictions

can at most convey some notion of the central tendency of their beliefs, and nothing about the uncertainty they feel when predicting outcomes," I posit that it is in fact possible to make inferences about the uncertainty associated with point forecasts. I combine insights from the fields of cognition, linguistics, and communication with a previously-unexplored feature of the Michigan Survey data: the high prevalence of "round number" responses. Linguistic theorists note that the use of a round number often signals more uncertainty than the use of a non-round number. This observation is named the *RNRI principle*, for "Round numbers suggest round interpretations" (Krifka, 2002).

After reviewing the multi-disciplinary literature on round numbers and the expression of uncertainty, I discuss how this literature can be applied to Michigan Survey data. Survey respondents must report their one-year-ahead inflation point forecasts as an integer. About half of these integer forecasts are multiples of five. The RNRI principle suggests that the multiple-of-five responses indicate more uncertainty, on average, than non-multiple-of-five responses. Intuitively, if a consumer reports that her inflation expectation is 5%, this potentially signals less precision than a response of 4% or 6%. A dummy variable that is positive if a respondent's forecast is a multiple of five could serve as a micro-level proxy for uncertainty. However, this rough proxy can be refined: the association between rounding and uncertainty may vary over time, and different round numbers may indicate different levels of uncertainty.

Hence, instead of a dummy variable, I construct an uncertainty proxy taking values between zero and one. I assume that consumers that are sufficiently uncertain about their inflation forecast round to a multiple of five when responding to the survey. Call these consumers "type h," for high uncertainty. Less uncertain consumers ("type l") report their forecast to the nearest integer, which may or may not be a multiple of five. If a consumer provides a multiple-of-five response, we do not know for sure whether she is type h or l. Responses in a given month come from a mixture of two distributions: one distribution of type-h responses whose support is multiples of five, and another of type-l responses whose support is integers. The mixture weight is the fraction of type-h consumers. For each month, I estimate the parameters of each distribution and the mixture weight via maximum likelihood. These estimates allow me to compute the *probability* that a consumer is type h given her response and the survey date. This probability is a proxy for her uncertainty.

I then document basic properties of the proxy and provide evidence in support of its validity. For example, more uncertain consumers make larger forecast errors and revisions. The proxy displays similar demographic patterns as found by the New York Fed's SCE in 2013. Namely, inflation uncertainty is lower for more educated, higher-income consumers. Uncertainty is also lower among people with investments in the stock market.

Mean inflation uncertainty is countercyclical and is positively correlated with alternative time-series proxies for uncertainty, including inflation disagreement, inflation volatility, and the Economic Policy Uncertainty Index of Baker et al. (2012). The major benefit of this new inflation uncertainty proxy in comparison to existing proxies is its *micro-level* dimension, which allows for cross-sectional as opposed to only time-series analysis. As Hsiao et al. (2005) and Mian and Sufi (2010) discuss, micro-level data and techniques enable more rigorous analysis of macroeconomic relationships compared to time series analysis. Uncertainty

varies extensively in the cross section, so microdata is particularly important for studying relationships between uncertainty and economic activity.

I use the micro-level proxy to study the link between inflation uncertainty and consumption. Even controlling for demographics, macroeconomic conditions, and other expectational variables, more uncertain consumers express less favorable attitudes toward spending on cars, homes, and other durables, consistent with a precautionary savings channel. Though statistically significant, the negative association between inflation uncertainty and spending attitudes is economically small. An aggregation exercise shows that even though inflation uncertainty reached historically high levels in the Great Recession but only accounts for about 2% of the decline in durables consumption during the recession. Aggregate inflation uncertainty is negatively correlated with aggregate expenditures on durables, but this is mostly because uncertainty rises and spending declines in recessions rather than because of a strong direct relationship between them.

Heterogeneity in consumers' inflation uncertainty also has implications for Phillips curve estimation. In the New Keynesian Phillips curve, inflation depends on the inflation expectations of the economy's price setters. Expectations of professional forecasters are typically used as a proxy for price setters' expectations. Coibion and Gorodnichenko (2013) argue that the mean expectations of consumers are in fact a better proxy. I show that the mean inflation expectations of type-l (less uncertain) consumers prove to be a more useful proxy than either the mean expectations of professional forecasters or of all consumers, enabling improved Phillips curve estimation. Consumers that are very uncertain about inflation may not play a role in the price-setting process, so their inflation expectations are less relevant to inflation dynamics. Phillips curve predictions of inflation dynamics since the Great Recession are most accurate when using the expectations of low-uncertainty consumers rather than of all consumers or of professional forecasters.

The MSC asks consumers not only about their one-year-ahead inflation expectations but also about their inflation expectations at the five- to ten-year horizon. I use this data to construct a long-horizon inflation uncertainty proxy analogous to the one-year-horizon proxy. Inflation uncertainty at longer horizons is a gauge of central bank credibility and communications effectiveness (Cukierman, 1992; Mishkin, 2008; van der Klaauw et al., 2008). If the public believes that the central bank is committed to price stability in the long run— in particular, if inflation expectations are firmly-anchored around a long-run target— then long-run inflation uncertainty should be low, and inflation uncertainty should decrease with forecast horizon (Beechey et al., 2011). Short- and long-horizon uncertainty were similar until the late 1980s. Since then, long-horizon inflation uncertainty has been lower than short-horizon uncertainty and has not returned to the high levels of the early 1980s. In the last two decades, however, long-horizon uncertainty displays no downward trend, despite monetary policymakers' efforts to enhance communication and transparency.

The paper is organized as follows. Section 1.2 discusses the association between round numbers and uncertainty, and documents the prevalence of round number responses in MSC inflation expectations data. Section 1.3 details the framework for constructing the new micro-level proxy for consumer inflation uncertainty. Section 1.4 describes summary statistics and

properties of the micro-level proxy and time series properties of mean inflation uncertainty. Section 1.5 explores the link between inflation uncertainty and consumption of cars, homes, and other durables. Section 1.6 discusses implications for Phillips curve estimation. Section 1.7 discusses longer-horizon inflation uncertainty as an indicator of effective monetary policy communication and expectations anchoring, and Section 1.8 concludes.

1.2 Round Numbers and the Expression of Uncertainty

To construct a measure of inflation uncertainty, I rely on a documented association between round numbers and uncertainty. First, I summarize the literature on round numbers and their link with uncertainty. Then I document the prevalence of round number responses in consumer survey data on inflation expectations and provide suggestive evidence that consumers who round are on average more uncertain than consumers who do not.

Round Numbers in Cognition and Communication

Round numbers play a prominent role in communication and cognition (Albers and Albers, 1983). In communication theory and theoretical linguistics, quantitative expressions can be interpreted as precise or imprecise. Round numbers—typically multiples of five in decimal system societies— are used especially frequently to communicate imprecise meaning (Sigurd, 1988; Dehaene and Mehler, 1992; Jansen and Pollmann, 2001; Krifka, 2002). One might say that "about 20" people attended a party if the exact number were unknown, but would not say that "about 19" attended. This is the intuition behind the *Round Numbers Suggest Round Interpretation* (RNRI) principle (Krifka, 2009).

Studies asking subjects to report estimated quantities find that round responses are associated with imprecise estimates, or "The rounder the number, the less is known about the subject matter" (Selten, 2002, p. 25). Baird et al. (1970) ask subjects to estimate the ratios of visually presented lengths or areas. Subjects use multiples of 5 and 10 most frequently, even though the true ratios do not favor round numbers. Huttenlocher et al. (1990) find that, when asked to estimate the days elapsed since an event occurred, subjects have a tendency to report round numbers, especially for events remembered with less precision.

In the finance literature, Harris (1991) finds that stock traders' bids and offers are clustered at round numbers, especially when market volatility is high, such as following the October 1987 crash. Similarly, Zhao et al. (2012) find that cognitive limitations lead to limit order clustering at round prices in the Taiwanese stock exchange. Investors who round have worse performance. Herrmann and Thomas (2005) find that analysts' forecasts of earnings per share disproportionately occur in nickel intervals, especially for less-informed forecasters. Shiller (2000) and Westerhoff (2003) claim that market participants with limited knowledge anchor on round numbers when estimating fundamental values. Dechow and You (2012) explain that financial analysts tend to round to the nearest nickel because "humans will

round a digit when they are uncertain or unconfident about the exact numerical value of that digit. In such cases rounding implicitly signals the lack of precision (p. 1)."

Rounding is documented in surveys of earnings, age, and other variables. Schweitzer and Severance-Lossin (1996) show that the systematic nature of rounding on reported earnings on the Current Population Survey affects commonly-calculated statistics such as median earnings and measures of earnings inequality. Pudney (2008) finds that households' reported energy expenditures are heaped at round responses. Economic historians and demographers have long known that self-reported ages in survey data exhibits heaping at multiples of five, particularly when respondents have low numeracy (Zelnick, 1961; A'Hearn and Baten, 2009). Self-reported body weight on the National Health and Nutrition Examination Survey is less accurate for adults who report round numbers than for those who do not (Rowland, 1990).

On the expectations module of the 2006 Health and Retirement Study, the majority of responses to questions about the subjective probability of a future event are multiples of five. Manski and Molinari (2010, p. 220) note that respondents "may perceive the future as partially ambiguous and, hence, not feel able to place precise probabilities on events. Thus, a response of '30 percent' could mean that a respondent believes that the percent chance of the event is in the range [25, 35] but feels incapable of providing finer resolution."

Rounding as an Indicator of Inflation Uncertainty

Round numbers are prevalent in the inflation expectations reported on the Michigan Survey of Consumers (MSC), a nationally-representative telephone survey. Each monthly sample of around 500 households consists of approximately 60% new respondents and 40% repeat respondents surveyed six months previously. Microdata is available since 1978. Respondents answer questions about their personal and financial characteristics and expectations, including, "By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?" Respondents may give any integer response or a "don't know" response (see Appendix A.1 for more details.)

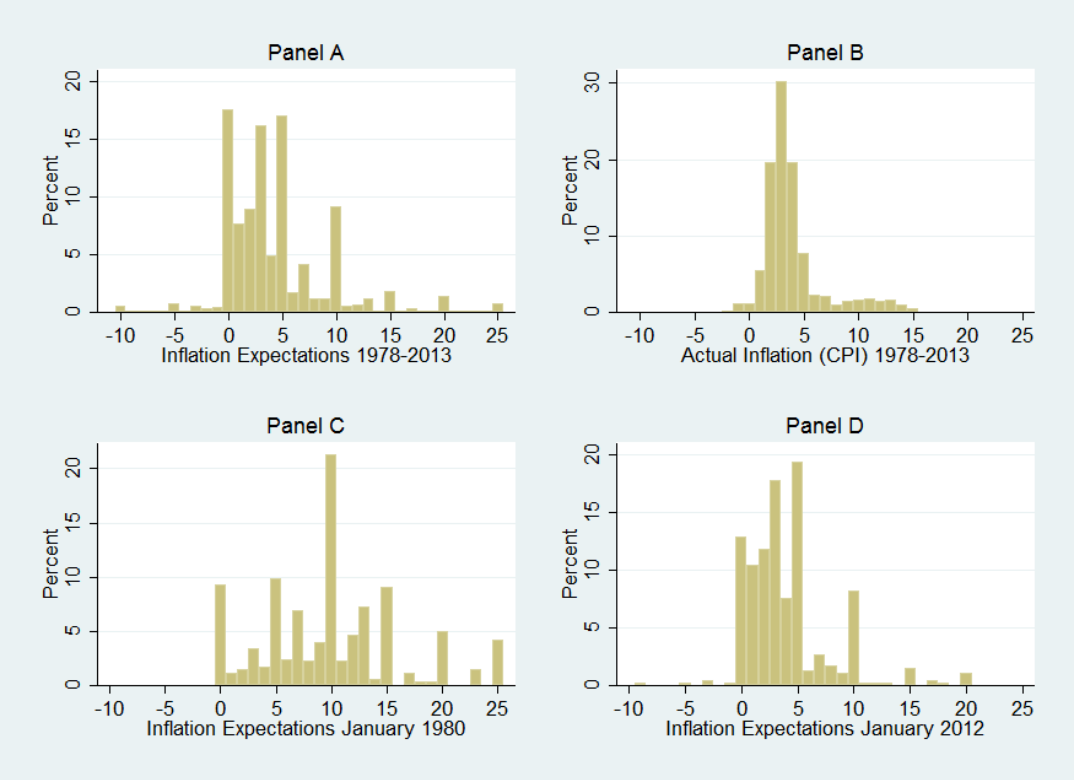
Histograms of consumers' inflation expectations show heaping at multiples of five.[1] Panel A of Figure 1.1 displays the distribution of 219,181 forecasts between -10% and 25% from January 1978 to December 2013.[2] Panel B shows that inflation realizations (year-over-year percent changes in the Consumer Price Index) do not clump around multiples of five. In an average month, 48% of numeric survey responses are a multiple of 5, although only 10% of inflation realizations are a multiple of 5. Quantitative tools for detecting digit preferences confirm that heaping occurs at multiples of five and not at other values (see Appendix A.2.)

Panels C and D show the distribution of forecasts in one high inflation month and one low inflation month. In January 1980, when the most accurate forecast would have been

[1]For professional forecasters, response heaping does not occur at multiples of 5%, but does occur at multiples of 0.05% (Engelberg et al., 2009).

[2]Less than 1.5% of respondents choose a value outside the range of -10% to 25%; these extreme value responses are recoded as "don't know" responses as they likely indicate that respondent did not understand the question or the concept of percent. Results are insensitive to choice of trimming procedure.

Figure 1.1: Histograms of inflation expectations and realized inflation.



Notes: Panel A shows Michigan Survey inflation expectations pooled across all months. Panel B shows monthly year-over-year CPI inflation, and Panels C and D show Michigan Survey responses in two particular months.

12%, the most common response was 10%. More consumers chose 5% and 15% than any nonround values. In January 2012, the most accurate forecast would have been 2%, but the most common response was 5%.

Based on the literature on rounding, I assume that round responses are more likely to indicate higher imprecision or uncertainty. Examination of forecast errors and revisions supports this assumption. More uncertain forecasts should be associated with larger ex-post errors and larger forecast revisions on average.[3]

Table 1.1 shows that indeed, round forecasts are associated with significantly larger ex-post errors and revisions. Moreover, comparing round number forecasts to nearest non-round number forecasts, so that magnitudes are similar, the multiple of five responses are less accurate than neighboring responses: 4% and 6% forecasts have smaller mean squared errors than 5% forecasts, etc. Multiples of five are unique in this regard; for example, 3%

[3]Bayes' Rule suggests that the magnitude of a forecast revision conditional on new information is inversely proportional to the precision of the prior.

Table 1.1: Forecast errors and revisions for round and non-round forecasts.

	Non-round	Round	t-statistic for difference
Mean absolute error (percentage pts)	2.4	4.6	54
Root mean squared error (percentage pts)	3.5	6.1	46
Mean absolute revision (percentage pts)	2.5	3.9	43
"Don't know" on second survey	4.0%	6.6%	15

Notes: Round forecasts are multiples of five while non-round forecasts are other integers. A respondent's forecast error is the difference between realized one-year-ahead CPI inflation and the respondent's inflation forecast. For a respondent who takes the Michigan Survey twice at a 6-month interval, the forecast revision is the difference between her second survey response and her first survey response. t-statistics computed using standard errors clustered by time period.

forecasts are not more inaccurate than 2% and 4% responses.

Survey respondents may give a "don't know" (DK) response, which is also indicative of uncertainty (Curtin, 2007; Blanchflower and Kelly, 2008). The final row of Table 1.1 shows that people who choose a round response the first time they take the survey are more likely than non-rounders to choose DK the second time. Similarly, of people who choose DK and a numerical response on the second survey, 60.0% choose a round number, compared to 45.9% of people who choose a numerical response on both surveys (t-stat 22.5, clustered by time). That rounding and providing DK responses are related behaviors provides further evidence of an association between rounding and uncertainty. These indications that round responses are associated with uncertainty are consistent with the literature in Subsection 1.2 and motivate the framework for constructing an uncertainty proxy in the next section.

1.3 Construction of Inflation Uncertainty Proxy

Michigan Survey of Consumers respondents provide integer forecasts for inflation. Respondents quite frequently choose responses that are a multiple of five (M5). As discussed in Section 1.2, these M5 responses are likely associated with higher uncertainty than non-M5 responses. A dummy variable taking value 1 for M5 responses and 0 for other integer responses could provide a simple proxy for inflation uncertainty. However, this proxy can be refined: not all M5 forecasts are always equally likely to indicate uncertainty.

Suppose that each consumer i has some subjective probability distribution over future inflation with mean f_{it} and variance v_{it}. Consumers with sufficiently high uncertainty—say, v_{it} above some threshold V—provide a survey response R_{it} that is the nearest multiple of five to f_{it}. Call these consumers type h, for high uncertainty. Consumers with lower uncertainty provide a response R_{it} that is the nearest integer to R_{it}, which may or may not be a multiple of five. Call these type l, for low uncertainty.

If we observe a non-M5 response, we know that $v_{it} < V$, and the respondent is type l. If

we observe an M5 response, we don't know whether the respondent is type l or type h. We can, however, estimate the probability that she is type h. This estimated probability, ζ_{it}, provides a proxy for consumer i's inflation uncertainty.

The probability ζ_{it} that i is type h can be estimated via maximum likelihood. Note that the cross-sectional distribution of survey responses R_{it} in a given month is a mixture of two probability mass functions (pmfs). One pmf is the responses R_{it} from the type-l consumers, whose support is integers. The other pmf is the responses R_{it} from the type-h consumers, whose support is multiples of five. The mixture weight is the share of type-h consumers. I obtain maximum likelihood estimates of the mixture weight and the parameters of the two pmfs, and use these estimates to compute the probability ζ_{it} that a respondent is type h.

Suppose that the cross section of forecasts f_{it} from the type-h consumers is distributed $N(\mu_{ht}, \sigma_{ht}^2)$ and from the type-l consumers $N(\mu_{lt}, \sigma_{lt}^2)$. Then the pmfs ϕ_t^h and ϕ_t^l of the cross section of responses for types h and l are discretized normal distributions:[4]

$$\phi_t^l = P(R_{it} = j | i \text{ is type } l) = \int_{j-.5}^{j+.5} \frac{1}{\sigma_{lt}\sqrt{2\pi}} e^{\frac{(x-\mu_{lt})^2}{2\sigma_{lt}^2}} dx, \; j = ... -1, 0, 1, ... \tag{1.1}$$

$$\phi_t^h = P(R_{it} = j | i \text{ is type } h) = \int_{j-2.5}^{j+2.5} \frac{1}{\sigma_{ht}\sqrt{2\pi}} e^{\frac{(x-\mu_{ht})^2}{2\sigma_{rt}^2}} dx, \; j = .. -5, 0, 5, ... \tag{1.2}$$

In each month t, survey responses come from a mixture of the two pmfs, $\phi_t = \lambda_t \phi_t^h + (1-\lambda_t)\phi_t^l$, where the mixture weight λ_t is the fraction of numerical responses from type-h consumers. Suppose there are N_t^τ consumers of each type τ. We observe the total number of numerical responses $N_t = N_t^h + N_t^l$, but N_t^l and N_t^l are unknown, since M5 responses may come from either type. Thus $\lambda_t = \frac{N_t^h}{N_t^h + N_t^l}$ is unknown. The five unknown parameters of ϕ_t are λ_t, μ_{lt}, μ_{ht}, σ_{lt}, and σ_{ht}. For responses $\{R_{it}\}_{i=1}^{N_t^l+N_t^h}$, the likelihood is:

$$L(\{R_{it}\}_{i=1}^{N_t^l+N_t^h} | \lambda_t, \mu_{lt}, \mu_{ht}, \sigma_{lt}, \sigma_{ht}) = \Pi_{j=1}^{N_t^l+N_t^h} \phi_t(R_{it} | \lambda_t, \mu_{lt}, \mu_{ht}, \sigma_{ht}, \sigma_{lt}). \tag{1.3}$$

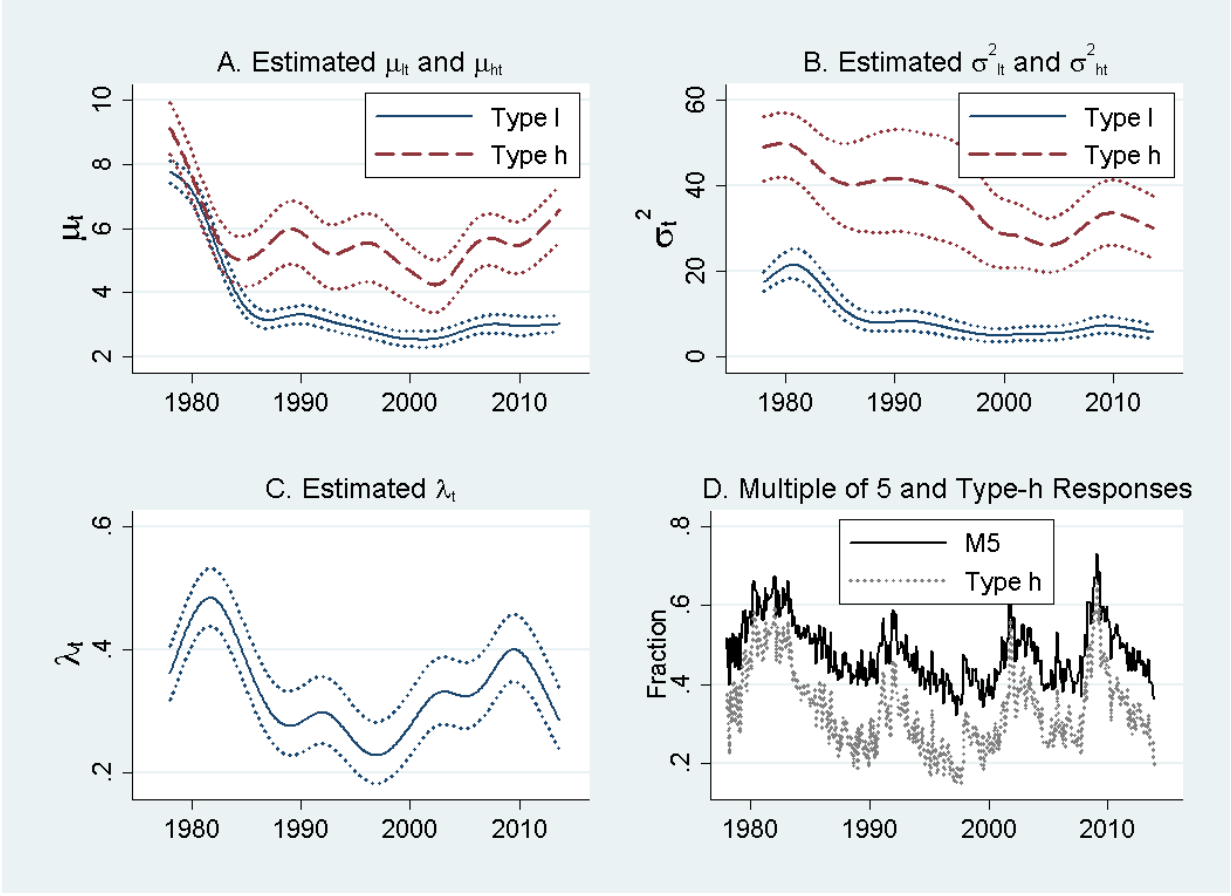
Figure 1.2 displays the maximum likelihood estimates with bootstrapped 95% confidence intervals. The likelihood ratio test confirms that the five-parameter mixture distribution fits the data significantly better than a two-parameter non-mixture distribution.[5] Panel D plots λ_t, the share of responses coming from type-h consumers, with the share of M5 responses. The two series have a correlation coefficient of 0.98, but λ_t is lower than the share of M5 responses, with a mean of 0.34 versus 0.48, since not all M5 responses indicate high uncertainty.

The probability ζ_{it} that consumer i is type h at time t depends on her response and the parameters $\lambda_t, \mu_t^l, \mu_t^h, \sigma_t^l,$, and σ_t^h. If R_{it} is not a multiple of five, then $\zeta_t(R_{it}) = 0$. If R_{it} is a

[4] As a robustness check, in Appendix A.1 I relax the normality assumption and instead use a distribution with fatter tails. Resulting uncertainty estimates are not highly sensitive to the normality assumption.

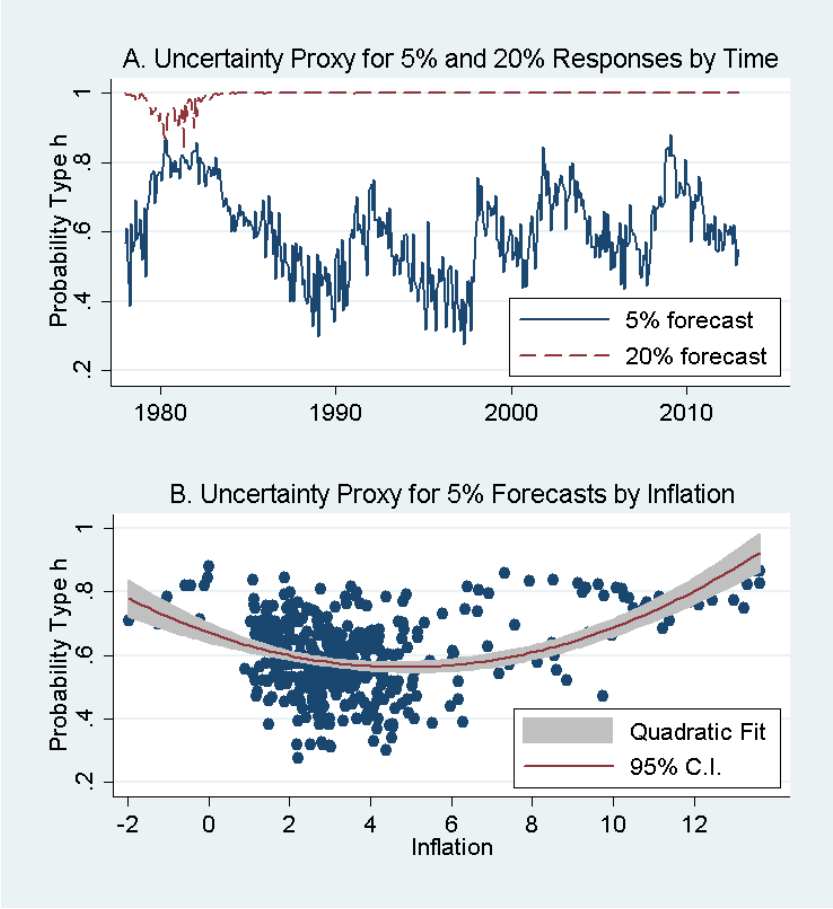
[5] The mean log likelihood for the mixture distribution is -1290 compared to -1468 for the two-parameter discretized normal distribution.

Figure 1.2: Maximum likelihood estimates of mixture distribution parameters



Notes: Panels A, B, and C show maximum likelihood estimates of $\mu_{lt}, \mu_{ht}, \sigma^2_{lt}, \sigma^2_{ht}$, and λ_t with bootstrapped 95% confidence intervals. See Equation (1.3). For visual clarity, estimates and confidence bands are HP-filtered with smoothing parameter 14,400 and the trends are shown. Panel D plots λ_t, the share of responses from type-h consumers, with the share of M5 responses.

Figure 1.3: Estimates of uncertainty proxy ζ_{it}



Notes: Panel A plots the inflation uncertainty proxy for 5% and 20% responses over time: $\zeta_t(5)$ is the probability that a consumer giving a 5% inflation forecast at time t is the highly uncertain type (type h), and $\zeta_t(20)$ is the probability that a consumer giving a 20% forecast is type h. Panel B plots $\zeta_t(5)$ against CPI inflation at time t, with quadratic fit and 95% confidence interval.

multiple of five, then ζ_{it} is some value between zero and one, given by Bayes' rule:

$$\zeta_{it} = \zeta_t(R_{it}) = P(\text{type } h|R_{it}) = \frac{P(\text{type } h)P(R_{it}|\text{type } h)}{P(R_{it})} = \frac{\lambda_t \phi_t^h(R_{it})}{\lambda_t \phi_t^h(R_{it}) + (1-\lambda_t)\phi_t^l(R_{it})}. \quad (1.4)$$

Figure 1.3 displays some of estimates of the uncertainty proxy ζ_{it}. In Panel A, values of ζ_{it} for responses $R_{it} = 5$ and $R_{it} = 20$ are plotted over time. Panel B plots $\zeta_t(5)$ against inflation π_t. When inflation is much higher or lower than 5%, $\zeta_t(5)$ tends to be higher, meaning that responses of 5% are more likely to come from the high-uncertainty type. A similar pattern appears for other values of R_{it}; $\zeta_t(10)$ is lower when inflation is near 10%, for example.

Note that construction of the proxy does not require any assumptions about V, the variance threshold above which agents round to a multiple of five. I estimate the probability that each agent is the highly uncertain type, without the need for arbitrary restrictions on the relative forecast variances of the high- and low-uncertainty types. In Appendix A.4, I show that under additional assumptions, the disagreement of each group can be used to estimate the mean uncertainty of each group following Lahiri and Sheng (2010). These estimates imply that the average forecast variance of type-h consumers is about four times greater than that of type-l consumers.

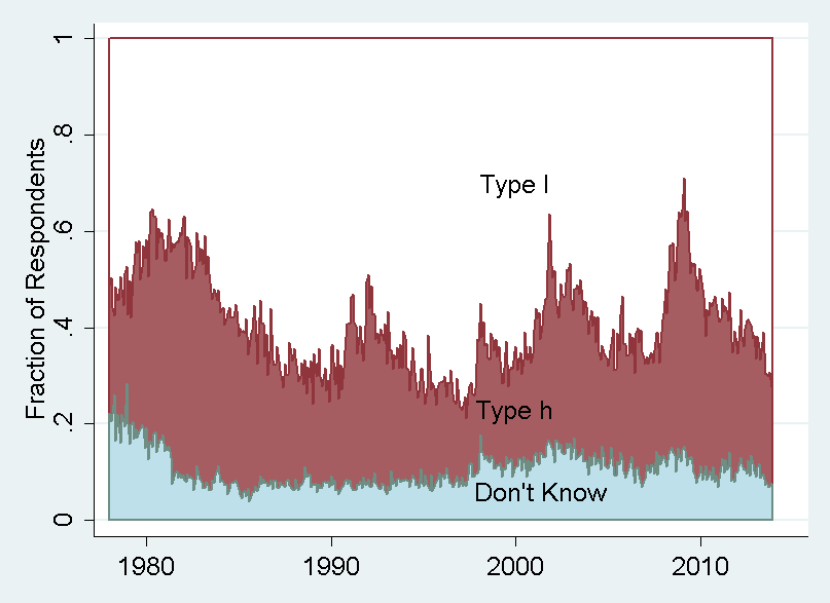
We have computed the uncertainty proxy ζ_{it} for consumers who provide a numerical response to the inflation expectations question. Some number N_t^{DK} of respondents decline to give a numerical response to the inflation expectations question, and instead say they don't know, which, similar to rounding, indicates a high degree of uncertainty (see Curtin (2007)). For these respondents, let $\zeta_{it} = 1$. Let DK_t be the share of don't know responses at time t, which has mean 10.5% and standard deviation 3.7%. Figure 1.4 plots DK_t and the share of numerical resposes coming from types h and l.

The mean of ζ_{it} at time t is the sum of the shares of "don't know" responses and type-h responses. Call this the *inflation uncertainty index* U_t:

$$U_t = \frac{1}{N_t^h + N_t^l + N_t^{DK}} \sum_{i=1}^{N_t} \zeta_{it} = (1 - DK_t)\lambda_t + DK_t. \tag{1.5}$$

The next section describes properties of both the micro-level uncertainty proxy ζ_{it} and the inflation uncertainty index U_t.

Figure 1.4: Inflation uncertainty index



Notes: The inflation uncertainty index is the estimated share of highly uncertain (type-h) consumers and consumers giving a "don't know" response. See Equation (1.5).

1.4 Properties and Validity of Uncertainty Proxy

This section describes summary statistics and properties of the inflation uncertainty proxy and provides support for its validity. Higher inflation uncertainty is associated with larger mean squared errors and larger forecast revisions. Demographic groups that tend to be more financially literate—high-income, highly-educated, males, and stock market investors—have lower average uncertainty, in line with findings from the New York Fed's Survey of Consumer Expectations. I also document time series properties of the inflation uncertainty proxy and trace its historical evolution. Aggregate inflation uncertainty is countercyclical and is positively correlated with other uncertainty proxies, including the Economic Policy Uncertainty index, inflation volatility, and inflation disagreement.

Micro-Level Summary Statistics and Demographic Patterns

The inflation uncertainty proxy (ζ_{it}) has mean 0.42 and standard deviation 0.41 over 245,946 observations. A regression of ζ_{it} on time fixed effects has an R^2 of just 0.06, indicating that time series variation accounts for a relatively small share of the overall variation in uncertainty. The majority of the variation comes from the cross section.

A valid proxy for uncertainty should exhibit several properties. More uncertain individuals should on average make larger forecast revisions and errors. Uncertainty should also

be persistent for individuals who take the survey twice, since individuals with better access to information or more precise models of the inflation process should continue to have lower uncertainty from one survey round to the next. Lahiri and Liu (2006) and van der Klaauw et al. (2008) document individual-level persistence in inflation uncertainty in other surveys. Table 1.2 verifies that ζ_{it} has these traits. The first two columns show that more uncertain consumers make significantly larger errors and revisions, while the third shows that uncertainty is persistent. When an individual takes the survey twice, her initial uncertainty is predictive of her uncertainty six months later.[6]

Table 1.2: Properties of inflation uncertainty proxy ζ_{it}

	(1) Sq. Error	(2) Abs. Revision	(3) $\zeta_{i,t+6}$
ζ_{it}	55.66***	3.18***	0.32***
	(1.19)	(0.06)	(0.00)
Constant	5.10***	2.10***	0.25***
	(0.55)	(0.04)	(0.00)
Observations	216381	75797	88553
R^2	0.15	0.09	0.10

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust, time-clustered standard errors in parentheses. Sq. error is the squared difference between realized CPI inflation and the respondent's inflation forecast R_{it}. Abs. revision is the absolute forecast revision of a respondent who takes the survey twice at a six-month interval, $|R_{i,t+6} - R_{it}|$.

Recent studies have elicited individual consumers' expectations about future inflation in the form of subjective probability distributions, or density forecasts. Density forecasts allow direct computation of each respondent's inflation uncertainty, typically defined as the interquartile range of the respondent's subjective probability distribution. Comparison of the properties of ζ_{it} with measures of uncertainty derived from density forecasts provides further support of the validity of ζ_{it}.

In particular, two projects at the New York Federal Reserve have collected consumers' density forecasts of inflation: the Household Inflation Expectations Project (HIEP) in 2007-2008, and the Survey of Consumer Expectations (SCE) since June 2013. Both the HIEP and the SCE compare uncertainty by demographic group and find that inflation uncertainty decrease with income and education (van der Klaauw et al., 2008; Armantier et al., 2013). HIEP results also show that uncertainty is higher for females than for males, higher for singles than for married people, lower for respondents who are responsible for their household's investments, and decreasing in financial literacy.

[6]With time fixed effects, the R^2 for columns (1) through (3) are 0.18, 0.10, and 0.14, and the coefficients on ζ_{it} are 54.0, 2.6, and 28.5.

Demographic patterns in uncertainty revealed by the HIEP and SCE are shared by ζ_{it}. Table 1.3 summarizes differences in inflation expectations, rounding behavior, and uncertainty across demographic groups from the MSC. The first two columns display the fraction of multiple of five responses and "don't know" (DK) responses by group. The third and fourth columns display the mean error and root mean squared error for each group, and the fifth is the mean of ζ_{it}, or the share of type-h and DK respondents. The mean of ζ_{it} is lower for people with higher income and educational attainment and for males. Uncertainty varies non-monotonically by age, with youngest and oldest respondents most uncertain. Though the MSC does not test financial literacy, questions about stock market investments and homeownership added to the survey in 1990 are correlated with financial literacy (van Rooij et al., 2011). Large-scale investors (in the top decile) are most certain, followed by smaller scale investors and non-investors. Uncertainty is also lower among homeowners.

To formally test for differences in ζ_{it} between demographic groups, in Table 1.4, ζ_{it} is regressed on demographic variables and time fixed effects. Income, education, gender, marital status, geographic region, and race are all statistically significant. Coefficients on income, education, gender, and marital status are of the sign suggested by HIEP and SCE findings. The positive coefficient on the female dummy variable is also in line with findings that women are less knowledgeable about inflation than men on average (Lusardi, 2008). Coefficients on the linear and quadratic age terms imply that uncertainty is minimized at age 42, near prime working age.

I also include a married*female interaction term in the regression. Married women are less likely than single women to be primary financial decision-makers in their households (**?**). The positive coefficient on the interaction term implies that while married men have lower inflation uncertainty than single men, married women have higher inflation uncertainty than single women, consistent with the HIEP finding that inflation uncertainty is lower for respondents who are primarily responsible for their household's investments.

The regression in Table 1.4 also includes a government opinion variable that takes values 1, 0, or -1 if the respondent's opinion of government policy is favorable, neutral, or negative. The negative coefficient on this variable implies that consumers with less trust in the government have higher inflation uncertainty, perhaps because they have less confidence in policymakers' ability or desire to stabilize inflation. Good news and bad news dummy variables that are positive if the respondent reports hearing good news or bad news about business conditions both have negative coefficients. Consumers who hear any news about business conditions may be more informed about the economy or more attentive to economic statistics, and hence less uncertain about inflation.

The results in Tables 1.3 and 1.4 also supplement a larger literature on how the inflation expectations formation process varies across demographic groups (Bryan and Venkatu, 2001; Souleles, 2004; de Bruin et al., 2010). The degree of access to information and the ability to process information varies with socioeconomic and demographic characteristics (Pfajfar and Santoro, 2008).

Table 1.3: Expectations and uncertainty by demographic group

	Mult. 5	DK	Error	RMSE	ζ	Observations
All	44%	11%	0.33	4.9	0.42	245,946
Bottom Income Tercile	46%	16%	1.19	5.5	0.49	56,975
Middle Income Tercile	45%	8%	0.77	4.8	0.39	69,812
Top Income Tercile	43%	5%	0.29	4.2	0.34	82,710
Non College Grad	45%	13%	0.31	5.3	0.45	85,139
College Grad	41%	6%	0.38	4.2	0.34	157,539
Male	40%	6%	-0.04	4.4	0.34	109,920
Female	46%	15%	0.66	5.4	0.48	135,355
Age 18-29	47%	8%	0.18	5.3	0.42	46,286
Age 30-64	43%	9%	0.38	4.8	0.39	151,704
Age 65-97	43%	19%	0.32	5.1	0.49	47,956
No Investments	43%	18%	1.57	4.9	0.49	38,891
Small or Medium Investor	42%	6%	0.98	4.2	0.35	41,800
Large Investor (Top Decile)	36%	4%	0.37	3.4	0.28	5,190
Non Homeowner	42%	14%	1.30	4.7	0.43	32,070
Homeowner	41%	10%	1.05	4.3	0.37	102,067

Notes: Mult. 5 and DK are the percent of respondents giving multiple of five or *don't know* responses, respectively. Error is the mean forecast error, RMSE the root mean squared forecast error, and ζ is the mean of the uncertainty proxy ζ_{it}.

Time Series Properties and Correlations

The inflation uncertainty index U_t has mean 0.41 and standard deviation 0.10 over 432 months of data. The autocorrelation coefficient is 0.91. Uncertainty was high in the recession of 1981-82, when inflation averaged 7.6% and the index averaged 0.57. Uncertainty declined during the Volcker disinflation, but rose again slightly during the early 1990s recession. Newspapers from that period describe inflation uncertainty caused by both the recession and the possible implications of the Gulf War on oil prices.[7] The index declined after the war. The minimum value, 0.21, occurred in May 1997, when both inflation and unemployment had been low and steady for months. Uncertainty rose sharply in the 2001 and 2007-2009 recessions, reaching highs of 0.64 in November 2001 and 0.71 in February 2009.

[7]The Wall Street Journal, for example, reported that "if the war is short and successful, there is likely to be a bounceback in the economy when the uncertainty ends. If the Fed in the meantime has tried to drown out the downturn with easy monetary policy, the central bank may face a new inflation threat." ("War or Recession, the Fed Won't Panic," January 23, 1991, p. A12.) A Washington Post article titled "How Long? How Deep?" captured the uncertainty surrounding how the war would unfold, its effects on oil prices and inflation, and how aggressively the Fed would respond. (January 27, 1981, p. H1.)

Table 1.4: Inflation uncertainty ζ_{it} regressed on demographic, opinion, and news variables

	(1) ζ_{it}	
log Real Income	-0.036***	(0.002)
Education	-0.013***	(0.000)
Female	0.096***	(0.003)
Married	-0.014***	(0.003)
Married Female	0.022***	(0.003)
Age	-0.004***	(0.0003)
Age Squared	0.00005***	(0.000003)
West Region	-0.009***	(0.003)
Northeast Region	0.020***	(0.002)
South Region	0.005**	(0.002)
White, non-Hispanic	-0.041***	(0.005)
African-American	-0.003	(0.006)
Hispanic	0.047***	(0.007)
Opinion of Government	-0.011***	(0.002)
Good News	-0.038***	(0.002)
Bad News	-0.011***	(0.002)
Observations	218066	
R^2	0.123	

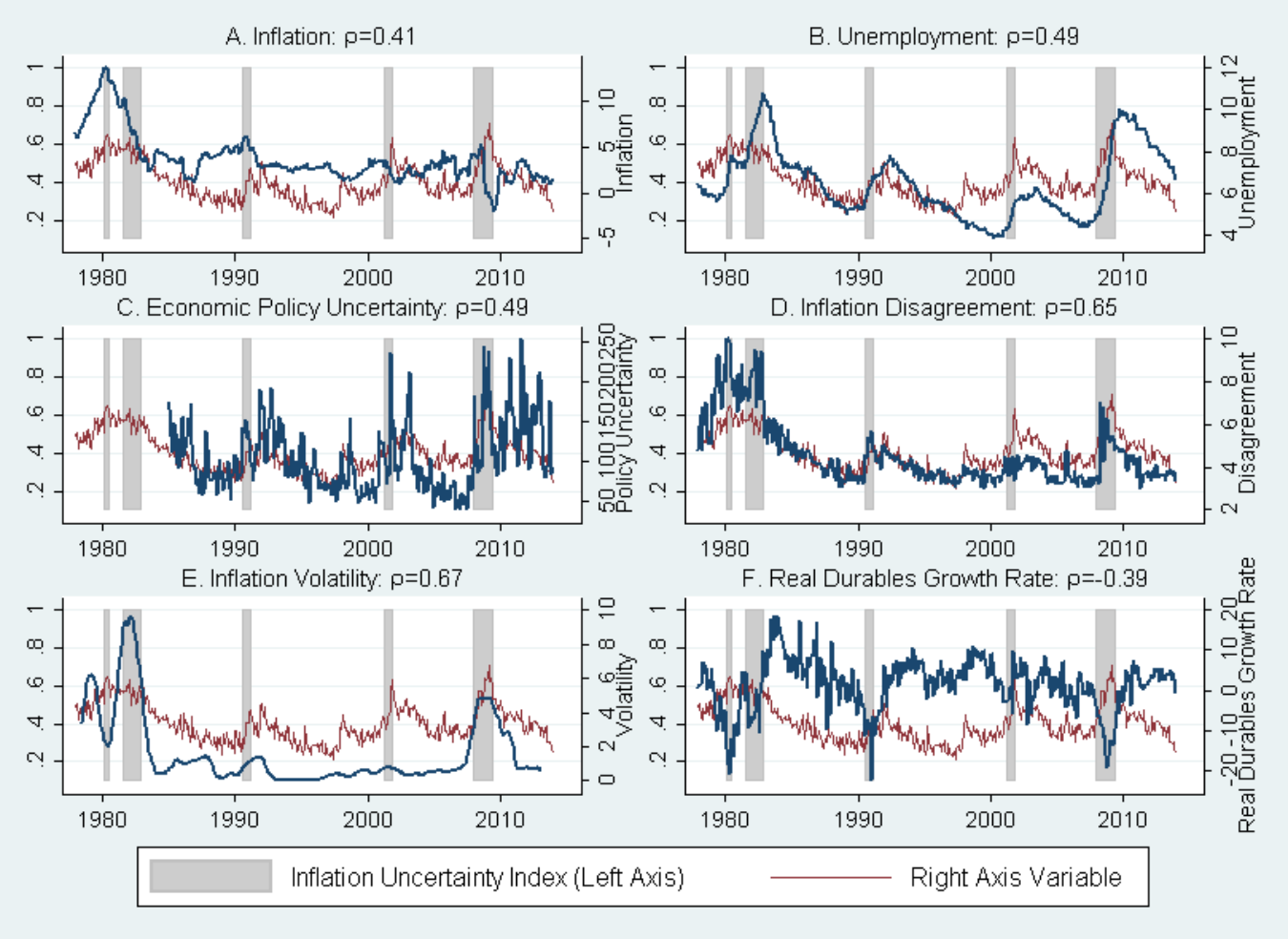
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust time-clustered standard errors in parentheses. Regression includes time fixed effects. Variable descriptions in Appendix Table A.2.

The convergent validity of a measure is the degree to which it is related to other measures to which theory suggests it should be related, and can be established using correlation coefficients (Campbell and Fiske, 1959). Figure 1.5 plots U_t with theoretically-related time series. Correlation coefficients are of the sign suggested by theory. First, Panel A plots the inflation uncertainty index along with the level of inflation. Ball (1992) hypothesizes that when inflation is low, the public knows that policymakers would like to keep it low, so inflation uncertainty is also low. When inflation is high, the public does not how willing policymakers will be to try to disinflate at the risk of causing a recession, thus uncertainty is high. Low inflation means maintaining the status quo, while high inflation means possible policy action. Inflation uncertainty and inflation were high in the late 1970s and early 1980s. The positive correlation between inflation uncertainty and inflation, with Granger-causality running from inflation to inflation uncertainty,[8] is in line with the Ball hypothesis.

Since the Great Moderation, the data suggest a modification of Ball's hypothesis. Very

[8] A bivariate vector autoregression with three lags of inflation and the inflation uncertainty index finds that inflation Granger causes inflation uncertainty ($p = 0.01$). Lag order was selected by the AIC.

Figure 1.5: Inflation uncertainty index with related time series



Notes: Correlation coefficients (ρ) in subtitles. Gray bars denote NBER recessions. Economic Policy Uncertainty Index from Baker et al. (2012). Disagreement is cross-sectional interquartile range of MSC inflation forecasts. Volatility is centered 3-year rolling variance of inflation.

low inflation is also associated with high uncertainty. Ball's basic reasoning still applies. Inflation that is too low can be just as undesirable as inflation that is too high. When inflation is very low, policymakers will likely act, but the timing, type, and size of the action are sources of uncertainty. Around 1990, the idea that the Federal Reserve had an implicit 2% inflation target came into discussion (Taylor, 1993). The Federal Reserve made this goal explicit in January 2012. Inflation uncertainty is more strongly correlated with $|\pi_t - 2|$, the absolute deviation of inflation from 2%, than with the level of inflation π_t. The correlation between $|\pi_t - 2|$ and U_t is 0.57, compared to 0.44 between π_t and U_t. Since 1990, the correlation between $|\pi_t - 2|$ and U_t is 0.20, compared to -0.27 between π_t and U_t. Deviations of inflation from its target level—either above *or* below—correspond to high uncertainty.

Panel B of Figure 1.5 plots the inflation uncertainty index with the unemployment rate. The positive correlation indicates that inflation uncertainty is countercyclical, in line with theory. Bachmann et al. (2012) hypothesize that recessions endogenously generate uncertainty by reducing the opportunity cost to firms of price mistakes, thus encouraging price experimentation. Price experimentation increases the dispersion and volatility of price changes, increasing uncertainty. The real options literature predicts countercyclical uncertainty with causation running in the reverse direction. With non-convex adjustment costs, high uncertainty discourages irreversible investment and hiring decisions (Bloom, 2009). Professional forecasters' uncertainty has been shown to be countercyclical (Rich et al., 2012).

The remaining panels plot the inflation uncertainty index U_t with commonly-used uncertainty proxies, beginning with the Economic Policy Uncertainty index (EPU) of Baker et al. (2012) (Panel C). The EPU is based on newspaper coverage of policy uncertainty, tax code provisions due to expire, and professional forecaster disagreement.[9] The EPU does not measure inflation uncertainty specifically, but does capture monetary policy-related uncertainty and forecaster inflation disagreement, so its positive correlation with U_t makes sense.

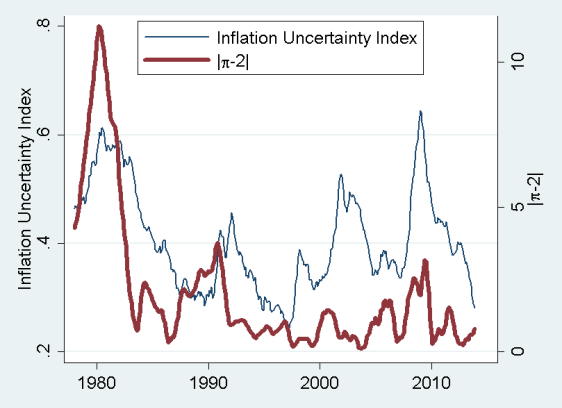
Panel D shows that the index is strongly correlated with inflation disagreement, the *cross sectional* interquartile range of consumers' point forecasts. Uncertainty and disagreement are theoretically related, but distinct (Lahiri and Sheng, 2010). It is possible, for example, for consumers to provide similar point forecasts, so that disagreement is low, even while consumers are very uncertain about their individual point forecasts. Disagreement is an aggregate measure only, while at any given time, uncertainty may vary across consumers.[10] Thus, measures of disagreement are limited to use in time series analysis, while measures of uncertainty can be used in micro-level analysis.

Researchers have used professional forecasters' density forecasts to study whether disagreement is a useful proxy for average uncertainty, with conflicting findings (Zarnowitz and Lambros, 1987; Lahiri and Liu, 2006; Boero et al., 2008; Rich and Tracy, 2010). Boero et al. (2014) find that for professional forecasters, disagreement is a useful proxy for average uncertainty in times of macroeconomic turbulence, when disagreement and uncertainty exhibit large fluctuations, but that low-level high-frequency movements in disagreement and average

[9]EPU data and documentation available at http://www.policyuncertainty.com/us_monthly.html.

[10]See Appendix A.4 for more on the relationship between uncertainty and disagreement.

Figure 1.6: Inflation uncertainty and the absolute deviation of inflation from 2%



Notes: Both series shown as centered seven-month moving average.

uncertainty are not strongly correlated. For consumers, similarly, inflation disagreement and mean uncertainty are positively correlated, but the correlation is weaker when disagreement is relatively low and stable. Before 1990, the correlation between the inflation uncertainty index and disagreement is 0.91, while from 1990 to 2007 it is just 0.51. From 2008 to 2013 the correlation is 0.77.

The volatility or conditional volatility of inflation is another common proxy for inflation uncertainty (Fountas and Karanasos, 2007). Orlik and Veldkamp (2012) explain that the variance of the innovations from a GARCH model woud be equivalent to uncertainty only if agents knew the true inflation process and its true parameters. Thus uncertainty and volatility are likely to be correlated, but are distinct concepts. The inflation uncertainty index is positively correlated with inflation volatility (Panel E).[11]

The countercyclicality of the inflation uncertainty index and its correlation with the EPU, inflation disagreement, and inflation volatility support the convergent validity of the proxy. A significant advantage of the rounding-based uncertainty proxy compared to existing proxies is its micro-level dimension which is useful for empirical analysis of the role of uncertainty in the economy. For example, Panel F shows a negative correlation between the inflation uncertainty index and real durables expenditures. The next section uses the micro-level uncertainty proxy to investigate the negative association between inflation uncertainty and consumption in more detail.

[11]In the figure, inflation volatility is defined as the three-year rolling variance of inflation, but positive correlations are also found for alternative definitions of volatility, including conditional volatility.

1.5 Inflation Uncertainty and Consumption

The links between inflation uncertainty and real economic activity are, in general, theoretically ambiguous (Cecchetti, 1993; Berument et al., 2005; Grier and Grier, 2006). Empirical studies, mostly relying on time series uncertainty proxies, typically find a negative association between inflation uncertainty and real activity (Jansen, 1989; Evans and Wachtel, 1993; Davis and Kanago, 1996; Grier and Perry, 2000; Elder, 2004). The empirical evidence is mixed, however, with some studies finding no relationship or a positive relationship between inflation uncertainty and real activity (McTaggart, 1992; Clark, 1997; Barro, 1998).

On the consumer side, inflation uncertainty may influence intertemporal decisions. Inflation uncertainty implies uncertainty about real income and about the real rate of return on saving, which have opposite effects on intertemporal allocation (Kantor, 1983). The precautionary savings literature predicts that higher uncertainty about future income increases buffer-stock saving and reduces consumption (Leland, 1968; Kimball, 1990; Lusardi, 1998; Carroll, 2004). In contrast, uncertainty about the real rate of return makes saving less attractive for risk averse consumers. A simple model in Appendix A.5 clarifies how the coefficient of relative risk aversion determines whether saving increases or decreases with inflation uncertainty. In a neoclassical growth model in which money is introduced with a cash-in-advance constraint, Dotsey and Sarte (2000) show that inflation uncertainty increases saving.

Durable consumption, in particular, likely depends on households' uncertainty (Bertola et al., 2005; Knotek and Khan, 2011). For example, Romer (1990) links uncertainty associated with the stock market crash to the decline of durable consumption in the Great Depression. Durable purchases are costly to reverse because of the lemons problem and transaction costs (Akerlof, 1970; Mishkin, 1976; Knotek and Khan, 2011). Uncertainty increases the real option value of waiting to make a decision that is costly to reverse (Bernanke, 1983; Dixit and Pindyck, 1993; Bloom et al., 2007; Baker et al., 2012; Leduc and Liu, 2012; Bloom et al., 2013). The effects of inflation uncertainty on housing are especially complex because of particular features of mortgage financing (Lessard and Modigliani, 1975; MacDonald and Winson-Geideman, 2012; Piazzesi and Schneider, 2012).

Greater understanding of the relationship between uncertainty and consumption of durables is important because durable consumption is volatile and procyclical, and large declines in durable consumption may prolong recessions (Petev and Pistaferri, 2012). Mankiw (1985, pg. 353) notes that "Understanding fluctuations in consumer purchases of durables is vital for understanding economic fluctuations generally." As we saw in Figure 1.5, the inflation uncertainty index is negatively correlated with expenditures on real durables. The index is also negatively correlated with purchases of cars and homes (Table 1.5). In the next subsection, the micro-level inflation uncertainty proxy is used to study of the theoretically ambiguous relationship between inflation uncertainty and consumer behavior. Next, the proxy is used to study the interest rate sensitivity of consumption under uncertainty.

Table 1.5: Correlation between consumer inflation uncertainty index U_t and aggregate spending series

	Correlation with U_t
Real Durables Growth Rate	-0.40
Car Sales	-0.52
Home Sales	-0.24

Notes: Monthly time series with 432 observations. Variable descriptions in Table A.1.

Inflation Uncertainty and Durable Spending Attitudes

Respondents to the Michigan Survey are asked, "About the big things people buy for their homes–such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or a bad time for people to buy major household items?" Questions about cars and homes are similar (see Appendix A.1). Dummy variables DUR_{it}, CAR_{it}, and HOM_{it} take value 1 if consumer i says it is a good time to buy durables, cars, or homes, respectively. All have means of about two-thirds (Table 1.6, Part A).

Bachmann et al. (2013) show that consumers' responses to these spending attitude questions are positively correlated with actual expenditures. They use probit models to investigate the relationship between inflation expectations and spending attitudes and find a small negative coefficient on expected inflation—discouraging for the prospect of policies designed to engineer higher inflation expectations to boost consumption. Since spending attitudes are theoretically related to not only the level of expected inflation, but also to inflation uncertainty, I include the inflation uncertainty proxy ζ_{it} in similar probit models.

First, to quantify the relationship between mean reported spending attitudes (DUR_t, CAR_t, and HOM_t) and actual aggregate spending on cars, home, and durables, I regress aggregate spending on mean spending attitudes and a time trend:

$$\ln(\text{Durables Spending}_t) = \alpha + \beta DUR_t + \gamma t, \tag{1.6}$$

and similarly for cars and homes (data descriptions in Appendix Table A.1). The estimated coefficients $\hat{\beta}$ are positive and highly statistically significant (Table 1.6, Part B).

Next, I run probit regressions of CAR_{it}, HOM_{it}, and DUR_{it} on inflation uncertainty ζ_{it}, inflation point forecasts π^e_{it}, and a vector X_{it} of controls.[12] Let Φ denote the cumulative distribution function of the standard normal distribution. The probit model takes the form:

$$Pr(DUR_{it} = 1|\zeta_{it}, \pi^e_{it}, X_{it}) = \Phi(\beta_0\zeta_{it} + \beta_1\pi^e_{it} + X'_{it}\beta_2) \tag{1.7}$$

In Bachmann et al.'s baseline specification, the vector of control variables X_{it} includes demographic variables, macroeconomic variables (such as inflation, unemployment, and a

[12]The regressions include generated regressors. Under the null hypothesis that the coefficient on a generated regressor is zero, standard errors do not need to be adjusted for generated regressors (Pagan, 1984).

zero lower bound dummy variable), and idiosyncratic expectations/attitude variables from Michigan Survey questions that ask consumers about their personal financial situation, income expectations, interest rate and unemployment expectations, and opinion of government policy. I use similar variables, listed in Appendix Table A.2, in my baseline specification. Estimation results are summarized in Table 1.6, Part C. Coefficients on both inflation uncertainty and expected inflation are negative and statistically significant. The reported marginal effects are the change in probability of having a favorable spending outlook for a one unit increase in inflation uncertainty or a one percentage point increase in expected inflation.

Using the coefficients β from the regression in Equation 1.6, the marginal effects of ζ_{it} on spending attitudes can be translated into back-of-the-envelop estimates of the decline in spending on cars, home, and durables associated with an increase in inflation uncertainty. If all agents were the low uncertainty type (type l), the mean of DUR would be 3.1 percentage points lower compared to if all agents were the high uncertainty type (type h). Correspondingly, real durable expenditures would be about 2.2% lower. Similarly, car sales and home sales would be about 2.0% and 4.8% lower, respectively. These figures, while non-negligible, are relatively small. For example, in January through Novemer 2007, prior to the start of the Great Recession, the mean of ζ was 0.38, and car sales averaged 16.1 million per year. During the recession, the mean of ζ was 0.63, and car sales averaged 12.0 million per year. In an accounting sense, the increase in inflation uncertainty accounts for roughly 2% of the decline in auto sales, and similarly small contributions to durables and home sales.

I conduct a variety of alternative specifications and robustness checks, detailed in Appendix A.6. Results are robust to restricting the time sample to exclude the early 1980s or the Great Recession, omitting all or some of the control variables in X_{it}, including gas price expectations as a control variable, omitting π^e_{it} from the regression, or using a linear probability model. These have minimal impact on the marginal effect of ζ_{it}, which remains negative and statistically significant. Following Bachmann et al., I also use a control function approach described by Wooldridge (2002) to address potential omitted variable bias and measurement error. Under the control function approach, the marginal effect of ζ is larger in magnitude, suggesting that measurement error biases the estimates toward zero in the baseline.

Respondents to the Michigan Survey provide a variety of reasons for their favorable or unfavorable spending attitudes. Some reasons are not closely related to inflation. For example, some respondents mention particular new features of cars or concerns with safety or pollution that explain their desire to buy. Other responses are directly related to inflation expectations. Respondents commonly report a desire to buy in advance of rising prices. Let DUR_BA_{it} be a dummy variable that takes value 1 if respondent i reports a favorable attitude toward spending on durables and cites a desire to buy in advance of rising prices. Define CAR_BA_{it} and HOM_BA_{it} analogously. About 22% of consumers report a desire to buy durables, cars, and/or homes in advance of rising prices. I modify the probit model of Equation (1.7) to use DUR_BA_{it} as the dependent variable:

$$Pr(DUR\_BA_{it} = 1|\zeta_{it}, \pi^e_{it}, X_{it}) = \Phi(\beta_0\zeta_{it} + \beta_1\pi^e_{it} + X'_{it}\beta_2) \tag{1.8}$$

Table 1.6: Spending attitudes, aggregate spending, and inflation uncertainty

	DUR	**CAR**	**HOM**
A. Mean spending attitudes			
Percent favorable responses	71%	64%	67%
B. Spending attitudes and aggregate spending: Equation (1.6)			
Coefficient $\hat{\beta}$	0.71***	1.01***	1.03***
	(0.03)	(0.07)	(0.12)
Observations	432	432	432
R^2	0.90	0.40	0.15
C. Spending attitudes, inflation uncertainty, and expected inflation: Equation (1.7)			
Marginal Effect of Inflation uncertainty	-3.1%***	-2.0%***	-4.7%***
	(0.37%)	(0.34%)	(0.37%)
Marginal Effect of Expected inflation	-0.02%	-0.29%***	-0.16%***
	(0.03%)	(0.03%)	(0.03%)
D. Buying in advance of rising prices: Equation (1.8)			
Marginal effect of inflation uncertainty	-2.8%***	-2.1%***	-1.5%***
	(0.23%)	(0.19%)	(0.20%)
Marginal effect of expected inflation	0.49%***	0.24%***	0.20%***
	(0.02%)	(0.02%)	(0.02%)

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust, time-clustered standard errors in parentheses. The marginal effect is the change in probability (in percentage points) of having a favorable spending outlook for a one unit increase in inflation uncertainty or a one percentage point expected inflation, with remaining variables set to their means. Complete regression output in Appendix A.6.

The marginal effects of ζ_{it} and π^e are shown in Table 1.6, Part D.[13] Note that the marginal effect of π^e is positive and statistically significant. The desire to buy in advance of rising prices *does* increase with expected inflation. This is more in line with the predictions of the theory motivating Bachmann et al.'s study. The desire to buy in advance of rising prices decreases with inflation uncertainty. A consumer who expects high inflation with high certainty is most likely to report a desire to buy in advance of rising prices.

Uncertainty and Interest Rate Sensitivity

Consumer spending on durables, cars, and especially homes is typically quite interest-rate sensitive (Bernanke, 1995; Erceg and Levin, 2002; Taylor, 2007). The sensitivity of consumer durables spending and and business investment to interest rates usually facilitates the ability of monetary policy to influence real activity, but in the recent recovery, reduced sensitivity

[13]For more details, see Appendix Tables A.9 and A.10.

to interest rates has weakened the effectiveness of the Federal Reserve's accommodative monetary policy stance (Zandweghe and Braxton, 2013).

Macroeconomic uncertainty has been posited as a reason for this diminished interest sensitivity. Bloom (2013) notes that the interest-elasticity of investment is smaller in times of high uncertainty, making monetary and fiscal stabilization tools less effective. Bloom (2009) also notes that in times of high uncertainty, firms require a large reduction in interest rates to leave their marginal investment decisions unchanged since uncertainty increases the value of postponing decisions that are costly to reverse. For consumers, similarly, since durables purchases are costly to reverse, a highly-uncertain consumer may be less rate-sensitive and require a larger reduction in interest rates in order to prompt a major purchase. Mackowiak and Wiederholt (2011) show that if consumers are more uncertain about the real interest rate, the response of consumption to monetary policy is slower. Since uncertainty about inflation implies uncertainty about the real interest rate, the response of consumption to monetary policy should be muted for consumers with high inflation uncertainty.

The uncertainty proxy allows me to study interest rate sensitivity under uncertainty empirically. The Michigan Survey asks consumers to state *why* they think it is a good or bad time to spend on homes, cars, and durables. They commonly mention interest rates, especially for the homebuying question. Of those who say it is a good time to buy a home, 53% cite low interest rates as a reason. Of those who say it is a bad time to buy a home, 41% cite high rates. Overall, 57% of consumers mention interest rates in response to at least one of the spending questions. If a consumer mentions interest rates as a reason for her spending attitudes, this indicates that rates are salient to her spending decisions.

Consumers' mentions of interest rates vary with inflation uncertainty ζ_{it}. Most relevant to the recent recovery, consumers with high inflation uncertainty are less likely to mention low rates as a reason for favorable spending attitudes. Since 2009, the Federal Reserve has maintained very low rates, and 48% of consumers mention low interest rates in their explanations of spending attitudes. For consumers with $\zeta_{it} \leq 0.5$, 54% mention low rates, while for consumers with $\zeta_{it} > 0.5$, only 42% mention low rates. Controlled probit regressions in Appendix A.6 find that compared to a low-uncertainty consumer ($\zeta_{it} = 0$), a highly uncertain consumer ($\zeta_{it} = 1$) is 6.8 percentage points less likely to mention interest rates.

Another way to guage consumers' interest rate sensitivity is to use the rotating panel to observe changes in interest rate mentions when the interest rate changes. Let R_{it} be the sum of consumer i's mentions of high interest rates minus the sum of her mentions of low interest rates. R_{it} ranges from -3 to 3. For example, if i mentions low interest rates for cars and homes but makes no mention of interest rates for other durables, then $R_{it} = -2$. Let rt_t be some measure of the interest rate at time t and consider a regression of the form:

$$\Delta R_{it} = \beta_0 + \beta_1 \Delta \text{rt}_t + \beta_2 \Delta \text{rt} * \zeta_{it} + \beta_3 \zeta_{it} \tag{1.9}$$

We expect β_1 to be positive: consumers should be more likely to mention high rates when rates increase and to mention low rates when rates decrease. If the coefficient β_2 on the interaction term is negative, then interest sensitivity is lower for more uncertain consumers.

Table 1.7: Inflation uncertainty and interest rate sensitivity

	(1) ΔR	(2) ΔR	(3) ΔR
ζ	0.004	-0.060***	-0.006
	(0.013)	(0.022)	(0.017)
Δ Fed funds rate	0.152***		
	(0.017)		
Δ Fed funds rate * ζ	-0.063***		
	(0.010)		
Δ Real rate		0.009***	
		(0.002)	
Δ Real rate * ζ		-0.011***	
		(0.002)	
MP Shock			0.199***
			(0.034)
MP Shock * ζ			-0.070***
			(0.027)
Observations	88553	75797	76763
R^2	0.024	0.001	0.007

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust time-clustered standard errors in parentheses. See Equation (1.9).

The regression output in Table 1.7 shows that this is indeed the case. I use three alternative interest rates for rt_t. In the first column, rt_t is the federal funds rate. In Column (2), rt_t is a measure of the real interest rate given by the federal funds rate minus expected inflation π^e_{it}. In Column (3), Δrt_t is a monetary policy shock (MP shock), defined as the sum of six lags of the Romer and Romer (2004) monetary policy shock.[14] In Column (1), β_2 is nearly half the size of β_1, which implies that type-h ($\zeta_{it} = 1$) consumers are about half as sensitive as type-l ($\zeta_{it} = 0$) consumers to changes in the federal funds rate. The magnitudes of the coefficients in Column (2) imply that unlike type-l consumers, type-h consumers are not sensitive to changes in real interest rates. Coefficients in Column (3) imply that type-h consumers are about two-thirds as sensitive to monetary policy shocks as type-l consumers.

These results indicate that interest rates are less salient for consumers who are very uncertain about inflation when they make spending decisions. Monetary policy, therefore, may be less effective when consumer inflation uncertainty is high. This finding is supportive of continued central bank efforts to improve communication, credibility, and well-anchored

[14]Romer and Romer identify exogenous monetary policy shocks as innovations to the federal funds rate that are uncorrelated with the Fed's Greenbook forecasts generated prior to each FOMC meeting. The shock series is updated in Coibion and Gorodnichenko (2012)

inflation expectations. To the extent that these efforts can reduce consumer uncertainty about inflation, they may help improve the ability of monetary policymakers to influence real activity through interest rate policy.

1.6 Inflation Uncertainty and the Phillips Curve

The Phillips curve describes a relationship between inflation, the real economy, and expected future inflation. The heterogeneity of agents' expectations of inflation led Federal Reserve Chairman Ben Bernanke (2007b) to ask, "On which measure or combination of measures should central bankers focus to assess inflation developments?"

In the micro-founded New Keynesian Phillips curve, inflation expectations of the economy's *price setters* are relevant to inflation dynamics. In the absence of direct quantitative surveys of US price setters' inflation expectations,[15] the expectations of professional forecasters are typically used for Phillips curve estimation. But as Coibion and Gorodnichenko (2013) note, "Given that many prices are set by small and medium-sized enterprises who do not have professional forecasters on staff (and who likely have little to gain from purchasing professional forecasting services), it seems a priori as likely for their inflation expectations to be well-proxied by household forecasts as by professional forecasts."

Coibion and Gorodnichenko estimate a nested Phillips curve augmented with the mean inflation expectations of consumers (μ_c) and SPF forecasters (μ_{SPF}). The coefficient on μ_c is near one and statistically significant, while the coefficient on μ_{SPF} is near zero. This implies that the inflation expectations of households indeed provide a better proxy for the expectations of price setters than do the expectations of professional forecasters.

Even among households, however, there is substantial heterogeneity of expectations, and the average household forecast may not be the best proxy. A price setter in a firm, even if less informed than a professional forecaster, is likely more informed about economic conditions than the average household. In Section 1.3, I estimated the mean inflation expectations of less-uncertain (type-l) and highly-uncertain (type-h) consumers. Since type-l consumers are relatively more informed about inflation, with greater forecast precision, it seems likely that price-setters' expectations are better-proxied by type-l forecasts than by the average household forecast. To test this hypothesis, similar to Coibion and Gorodnichenko, I estimate Phillips curves that include the mean inflation expectations of SPF forecasters, type-l consumers (μ_l), and type-h consumers (μ_h). In the first column of Table 1.8, the regression equation is:

$$\pi_t = \beta_l \mu_{lt} + \beta_h \mu_{ht} + \alpha \text{Unemployment}_t + \epsilon_t, \text{ with } \beta_l + \beta_h = 1. \tag{1.10}$$

The estimated coefficient β_l is not statistically different than one, indicating that type-l expectations provide a better proxy for firms' expectations than do type-h expectations. Column 2 indicates that μ_l is a better proxy for price setters' expectations than μ_{SPF},

[15] The Atlanta Fed conducts a survey of business inflation expectations, but the survey only includes businesses in the Sixth District and begins in 2011.

Table 1.8: Phillips Curve regressions with inflation expectations of different agent types

	(1)	(2)	(3)
μ_l	1.24***	0.57***	0.55***
	(0.23)	(0.19)	(0.18)
μ_h	-0.24		
	(0.23)		
μ_{SPF}		0.43**	0.40*
		(0.19)	(0.20)
π_{t-1}			0.05
			(0.07)
Unemployment	-0.25**	-0.19**	-0.18**
	(0.12)	(0.08)	(0.08)
Observations	144	130	130
R^2	0.37	0.10	0.48

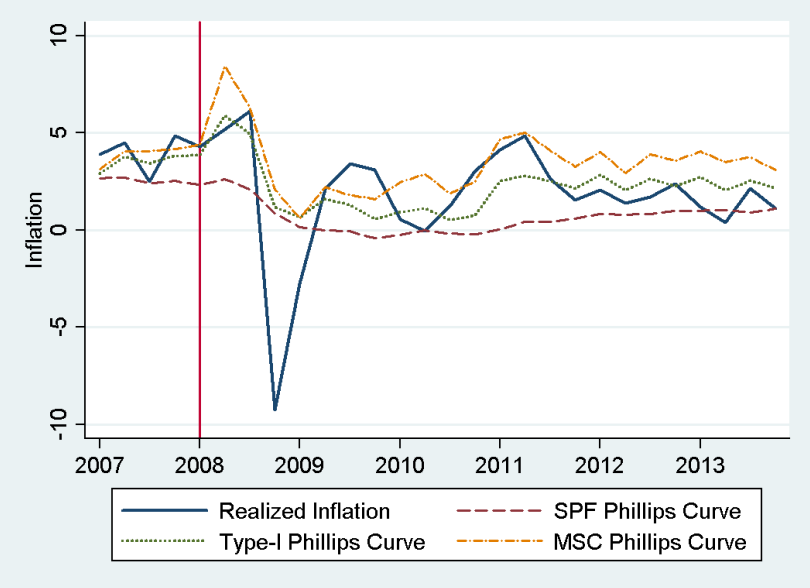
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey-West standard errors in parentheses. SPF data is quarterly, so MSC data is aggregated to quarterly frequency. Dependent variable π_t is annualized quarter-over-quarter percent change in the Consumer Price Index, and μ_l, μ_h, and μ_{SPF} are mean inflation forecasts of type-l and type-h consumers and SPF forecasters. See Equation (1.10).

although the coefficients on both types' forecasts are positive and statistically significant. Similarly, μ_l is a better proxy than the mean μ_c of all MSC respondents' forecasts (Appendix Table A.13). In Column 3, lagged inflation is included as a regressor, as in hybrid Phillips curves (Gali and Gertler, 1999). The sum of the coefficients on expected and lagged inflation is constrained to equal one. Lagged inflation is often included in the Phillips curve when a purely forward-looking model does not match the empirical persistence of inflation. However, when μ_l is used as the measure of inflation expectations, the coefficient on π_{t-1} is near zero.

Alternative specifications appear in Appendix A.7. Similar results arise if the regression coefficients on inflation expectations in Equation (1.10) are not constrained to sum to one, if the time sample is restricted, or if alternative indicators or real activity are used in place of unemployment. The coefficient on the real activity variable is of the expected sign. Regardless of specification, the coefficient on μ_l is always largest and statistically significant, indicating that μ_l is the best proxy for price setters' expectations. Price setters in firms are neither as sophisticated as the average professional forecaster nor as uninformed as the average consumer. They are most similar to the more informed (type-l) consumers.

Using μ_l as a proxy for price setters' inflation expectations helps explain puzzling inflation dynamics since the Great Recession. In the United States, the absence of more significant disinflation in the face of sustained high unemployment presented a challenge to the Phillips curve framework (Ball and Mazumder, 2011). I estimate Phillips curve regressions $\pi_t = \beta\mu_{\tau t} + \alpha\text{Unemployment}_t$ for $\tau \in \{l, c, SPF\}$ data from 1981Q3 to 2007Q4 and

Figure 1.7: Realized inflation and inflation predicted by Phillips curves



Notes: Phillips curves of the form $\pi_t = \beta\mu_{\tau t} + \alpha\text{Unemployment}_t$ are estimated with the expectations of professional forecasters, type-l consumers, or all consumers using data from 1981Q3 to 2007Q4. Estimated coefficients are used to predict inflation from 2008Q1 to 2013Q3.

use the estimates to predict inflation from 2008Q1 to 2013Q4 (Figure 1.7). Mean realized inflation from 2008Q1 to 2013Q4 is 1.8%. Mean inflation predicted by a Phillips curve with professionals' expectations is 0.7%, more stable and lower than realized inflation, giving the appearance of "missing disinflation." Mean inflation predicted by a Phillips curve with all consumers' expectations is 3.5%, higher than realized inflation. Using type-l consumers' expectations, mean predicted inflation is 2.2%, nearest to realized inflation.

A partial response to Bernanke's question, then, is that central bankers should focus on the inflation expectations of less-uncertain households to assess inflation dynamics. The mean expectations of these less-uncertain households can be estimated using the maximum likelihood framework of Section 1.3.

1.7 Long-Run Uncertainty and Expectations Anchoring

Household inflation uncertainty is an important indicator for monetary policymakers. A rise in uncertainty can warn of an erosion in credibility (van der Klaauw et al., 2008). Inflation uncertainty at longer horizons is especially relevant for monetary policy (Ball and Cecchetti, 1990; Wright, 2002; Erceg and Levin, 2002). A major goal of the Federal Reserve is to anchor

long-run inflation expectations. Well-anchored expectations are thought to promote short-run price stability and facilitate central bank efforts to achieve output stability (Orphanides and Williams, 2007). If expectations are firmly-anchored—if the public believes that the central bank is both committed to and capable of achieving its inflation target in the longer run— then long-horizon inflation uncertainty should be low.

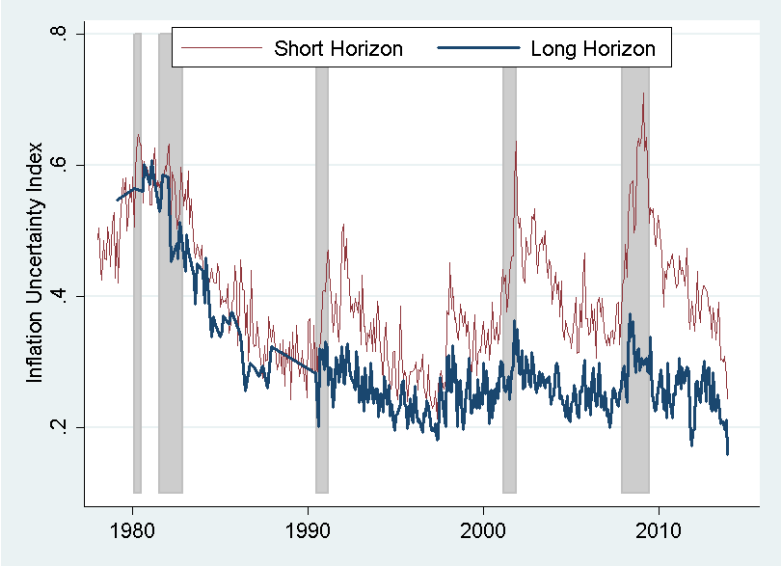
Respondents to the Michigan Survey are asked not only about their inflation expectations over the next year, but also over the next five- to ten-years. Rounding to a multiple of five is also common for responses to the longer-horizon question. Using the framework of Section 1.3, analogous long-horizon inflation uncertainty measures can be constructed. Figure 1.8 displays long- and short-horizon uncertainty indices. Until 1990, the long- and short-horizon indices were nearly identical, with means of 0.49 and 0.50, respectively, and a correlation coefficient of 0.91. Since 1990, the long-horizon index has mean 0.28, compared to 0.42 for the short-horizon index, and their correlation coefficient is 0.58.

The fact that inflation uncertainty is lower at the longer horizon than at the shorter horizon is a positive sign of monetary policy credibility. It is also positive that long-horizon uncertainty has never returned to the high levels of the early 1980s. It is discouraging, however, that long-horizon uncertainty has not continued to decline substantially in the past two decades. From the 1990s onward, uncertainty displays no downward trend, despite monetary policymakers' efforts to enhance communication and transparency. Low-income and low-education consumers, females, and non-investors have especially high inflation uncertainty at the long horizon just as they do at the short horizon. In another paper, I explore in detail the Federal Reserve's communication with the general public and the reasons for households' weakly-anchored inflation expectations (Binder, 2014).

One policy change that was intended to improve the anchoring of long-run inflation expectations was the announcement of an explicit numerical goal for long-run inflation. In January 2012, the Federal Open Market Committee announced that 2% inflation is most consistent over the longer-run with the Federal Reserve's statutory mandate.[16] Figure 1.9 displays the long-horizon inflation uncertainty index in a two-year window around the January 2012 announcement. There was no clear drop in uncertainty immediately following the announcement, but in December 2013, the long-horizon index reached its historical minimum of 0.17. It is still too early to tell whether or not long-horizon inflation uncertainty is beginning a lasting decline, but monetary policymakers should continue to monitor this indicator over the next few years.

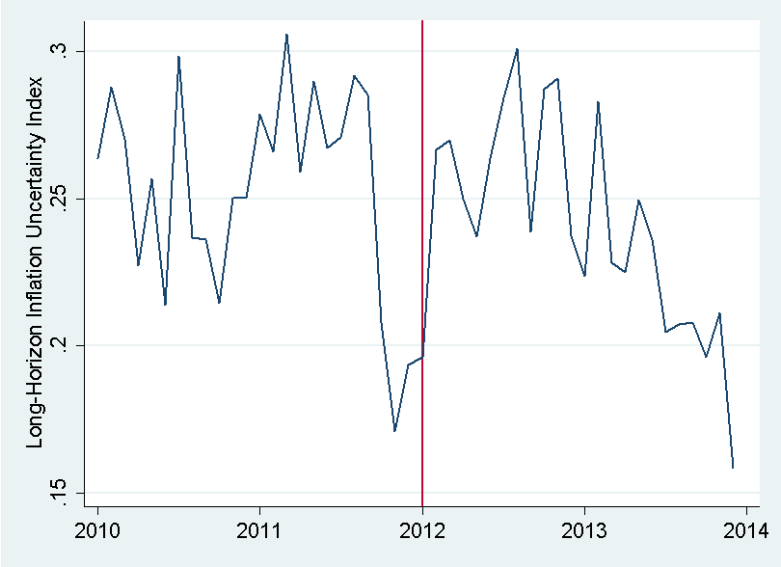
[16]Federal Reserve Press Release, January 25, 2012.

Figure 1.8: Inflation uncertainty index by horizon



Notes: Inflation uncertainty indices show the mean of the inflation uncertainty proxy ζ_{it} at the one-year and five- to ten-year horizons.

Figure 1.9: Long-horizon inflation uncertainty before and after explicit inflation target



Notes: Vertical line indicates announcement of 2% inflation target in January 2012.

1.8 Discussion and Conclusions

This paper has introduced a new measure of inflation uncertainty based on an association between rounding and uncertainty. The cognition and communication literature documents a human tendency to use round numbers when reporting quantitative expressions with high imprecision or uncertainty. This tendency, manifested in response heaping at multiples of five, enables construction of a micro-level uncertainty measure from inflation point forecasts. Since the measure uses pre-existing data from the Michigan Survey of Consumers (MSC), it allows historical analysis of inflation uncertainty since 1978, with 432 months of data and 245,946 observations. Construction of the measure uses a simple, flexible framework that could be used with other survey data to construct measures for uncertainty about other variables.

To construct the measure, I assume that consumers with sufficiently high uncertainty report their inflation forecast to the nearest multiple of five, while consumers with less uncertainty report their forecast to the nearest integer. In a given month, survey responses come from a mixture of two distributions, one of which is only positive at multiples of five, and the other at integers. I estimate the mixture weight by maximum likelihood. This allows me to compute the probability ζ_{it} that respondent i in month t is a highly-uncertain consumer; this probability is a measure of her inflation uncertainty.

Properties of the measure support its validity. Namely, higher values of ζ_{it} are associated with larger forecast errors and revisions, and ζ_{it} is persistent at the individual level. The New York Federal Reserve's new Survey of Consumer Expectations has collected probabilistic inflation forecasts from consumers since 2013, and documents certain demographic patterns in inflation uncertainty, which ζ_{it} also exhibits. Time series properties of the mean of the measure, which I call the inflation uncertainty index, also point to the measure's validity. The index is elevated when inflation is very high or very low, and is countercyclical, in line with other theoretical and empirical results about macroeconomic uncertainty in recessions. The index is positively correlated with other time-series proxies for uncertainty, including cross-sectional forecast disagreement, inflation volatility, and the Economic Policy Uncertainty Index. Compared to these other measures, however, the uncertainty measure constructed in this paper has the unique benefit of its micro-level dimension.

Uncertainty varies more in the cross section than over time, and this heterogeneity in uncertainty across consumers is key to understanding its role in the economy. While time series uncertainty measures are negatively correlated with time series measures of real economic activity, such aggregate relationships are fairly uniformative regarding causality and mechanisms. Time series analysis of macroeconomic relationships that neglects cross-sectional heterogeneity can be misleading (Hsiao et al., 2005). It is unsurprising, then, that a variety of time-series studies finds mixed evidence on the relationship between inflation uncertainty and real activity (see Elder (2004) and references therein). Microeconomic data and techniques allow more rigorous analysis of macroeconomic phenomena (Mian and Sufi, 2010).

In the case of household inflation uncertainty, the micro-level proxy is useful for studying its role in the consumption of durables. MSC respondents are asked whether they think it

is a good time to buy durables, cars, or homes. Probit regressions, controlling for individual characteristics, macroeconomic variables, and expectations of other economic conditions, find a small negative association between inflation uncertainty and attitudes toward spending. While the direct relationship between inflation uncertainty and durables spending attitudes appears small, uncertainty and spending attitudes are indirectly linked through interest rate sensitivity. The spending attitudes of more uncertain consumers are less sensitive to changes in interest rates and to monetary policy shocks.

Heterogeneity in inflation uncertainty across consumers also has important implications for studying inflation dynamics. In the Phillips curve framework, inflation depends on the expectations of the economy's price setters. No quantitative surveys of price setters' inflation expectations exist for the United States, so professional forecasters' expectations are commonly used as a proxy. Coibion and Gorodnichenko (2013) suggest that it is preferable to use the mean inflation forecast from the MSC in Phillips curve estimation. However, price setters may be more informed about inflation than the average consumer. The maximum likelihood framework that estimates the share of highly-uncertain consumers each month also estimates the mean inflation forecast of the highly-uncertain and less-uncertain consumers. The mean inflation forecast of less-uncertain consumers proves most useful for empirical estimation of the Phillips curve. Using the expectations of less-uncertain consumers in Phillips curve estimation can better replicate inflation dynamics since the Great Recession compared to average consumers' or professional forecasters' expectations.

I use the same maximum likelihood framework to construct a proxy for inflation uncertainty an the five- to ten-year horizon. Longer-horizon inflation uncertainty provides an indicator of the degree to which inflation expectations are anchored. Consumers' inflation expectations became better-anchored through the 1980s and 1990s, but the improvement did not continue after the late 1990s, despite changes to the Federal Reserve's communication strategy.

There are numerous other applications of the inflation uncertainty proxy to be explored in future research. For example, the proxy will be useful in testing implications of various models of information rigidities and expectations formation. The proxy and inflation uncertainty index will be available in the online appendix to this paper and should facilitate additional research into the causes and consequences of inflation uncertainty.

Chapter 2

Fed Speak on Main Street

2.1 Introduction

Ben Bernanke (2003) defines the central bank communication strategy as "regular procedures for communicating with the political authorities, the financial markets, and the general public." Communication with the public is a key, if understudied, component of monetary policy. In a survey of the literature on central bank communication, Blinder et al. (2008, p. 941) note that "virtually all the research to date has focused on central bank communication with the financial markets. It may be time to pay some attention to communication with the general public. Admittedly, studying communication with the general public will pose new challenges to researchers—not least because financial market prices will be less relevant. But the issues are at least as important. In the end, it is the general public that gives central banks their democratic legitimacy, and hence their independence."

This paper takes several first steps in studying Federal Reserve communication with the public, which Blinder et al. identify as important and underexplored. Effective communication with the public is distinct from effective communication with financial markets and a legitimate monetary policy goal.[1] According to Bernanke (2007a), "Improving the public's understanding of the central bank's objectives and policy strategy reduces economic and financial uncertainty and helps households and firms make more-informed decisions." In her confirmation hearing, Janet Yellen (2013b) professed that "monetary policy is most effective when the public understands what the Fed is trying to do and how it plans to do it."

How well, then, *does* the public understand what the Fed is trying to do and how it

[1] Carvalho and Nechio (2012) note that in a world with complete asset markets, so long as agents who participate in financial markets understand monetary policy, the general public's expectations about monetary policy may be irrelevant, but with incomplete markets, the general public's expectations regarding monetary policy and future economic variables matter. They add that the effort that the Federal Reserve devotes to public lectures and programs is evidence of the Fed's interest in promoting public understanding of monetary policy. Coibion and Gorodnichenko (2013) hypothesize that the weak anchoring of households' inflation expectations relative to those of professional forecasters plays a primary role in explaining the "missing disinflation" of the Great Recession.

plans to do it? The expectations of the general public differ, sometimes quite notably, from those of financial markets and professional forecasters (Carroll, 2003; Mankiw et al., 2004). Consumers vary in their ability and incentive to devote attention to Federal Reserve communications; financial literacy is often limited, and television and mass media are the dominant sources of consumers' economic information (Blinder and Krueger, 2004; Curtin, 2007; Lusardi, 2008). A communication strategy that effectively reaches financial markets may not effectively reach the general public. Only a small number of papers have indirectly addressed the public's reception and understanding of monetary policy communication. Carvalho and Nechio (2012) find that consumer understanding of monetary policy varies across income and demographic groups; high-income households appear to better understand Taylor rules. Drager et al. (2013) show that 50% of consumers' expectations are consistent with the Income Fisher equation and the Taylor rule, and 25% with the Phillips curve. Easaw et al. (2012) find that Italian households do not anchor their inflation expectations to the ECB's target, and tend to overreact as they update their expectations.

I consider a range of evidence concerning the general public's awareness, understanding, and opinions of the Fed since the early 1980s. Since, as Blinder et al. mention, financial market prices are a less relevant indicator of the effects of Federal Reserve communication with the general public, I make a comprehensive effort to collect and analyze more relevant indicators, including a variety of survey and multimedia data. Although the Fed's communication strategy aims to anchor the inflation expectations of economic agents, the data reveals that many consumers remain unaware of the Fed's longer-term inflation goal or unconvinced of its credibility. Fed communication is not widely propagated to the public through media channels. I document likely barriers to the propagation of Fed communication and compare the Fed's strategy to that of other central banks.

This paper begins with an overview of the history and theoretical underpinnings of central bank communication and the evolution of the Federal Reserve's interactions with the general public. The prevailing attitude among central bankers shifted dramatically in the 1990s and early 2000s, toward an understanding that greater openness could help monetary policymakers better manage the economy (Blinder, 1998). In January 2012, the Fed announced a 2% goal for long-run inflation, motivated by the theory that well-anchored expectations promote short-run price stability and facilitate efforts to achieve output stability (Orphanides and Williams, 2007). In addition to the literature on monetary policy communication, I review relevant literature from political communication theory on the determinants of public informedness, civic engagement, and the communicative links between citizens, the media, and the power holders of society.

As the Fed has introduced changes to its communication policy designed to enhance clarity and public understanding, inflation expectations in financial markets have become more anchored (Davis, 2012). I consider whether consumers' inflation expectations have likewise become better anchored. The median long-run inflation forecast on the Michigan Survey of Consumers (MSC) is very stable, rarely deviating far from 3%. This stability is sometimes cited as evidence of strong anchoring. I argue, however, that this measure of central tendency is not particularly informative; MSC microdata reveals weakly-anchored

expectations. A sizable portion of respondents say they don't know what inflation will be in five to ten years. Only half expect long-run inflation to be 1, 2, or 3%, and the uncertainty surrounding forecasts is high. Forecast revisions for long-run inflation are large and frequent, even among consumers who initially forecast 2% inflation. Highly-educated, high-income, male consumers and those who participate in the stock market tend to have the most strongly-anchored expectations. Two time trends stand out. First, anchoring improved steadily from the early 1980s through the late 1990s. Second, after the late 1990s, improvements stalled, though anchoring remains far from strong.

Why hasn't the Federal Reserve's communication strategy been more effective at anchoring the inflation expectations of the general public? Rational inattention theory is founded on the notion that people have limited attention to devote to seeking and processing macroeconomic information (Sims, 2003). Media coverage plays a significant role in directing consumers' limited attention (Lamla and Lein, 2006). Prominent media coverage of the Fed and inflation has been sparse in recent years. President Obama's economic policies dominated economic news coverage in the Great Recession. A new technology called "Meme-tracker"[2] analyzes 1.6 million articles daily to identify quotes that get widely propogated. Obama's quotes about the economy get the most attention by far; Bernanke only made a splash when he appeared on *Sixty Minutes* in March 2009. The Fed uses interactive media such as Twitter and Facebook but does not reach a very wide audience. Analysis of Google search trends and Youtube views shows that consumers are not proactively seeking out information about inflation or monetary policy. Low consumer inattention to monetary policy could reflect low perceived benefits and/or high perceived costs of paying attention.

To gain further insight into public perception of the Federal Reserve and (in)attention to monetary policy communications, I analyze a wide variety of less-utilized consumer surveys. Because of its long time sample and relatively high frequency, the MSC is the most studied source of information about consumers' inflation expectations. However, many other surveys over several decades have asked consumers about the Fed and inflation. Evidence gathered from these overlooked surveys presents a clearer picture of the Fed in the eyes of the public. The survey evidence speaks to two general questions. First, what does the public view as the costs and benefits of paying attention to the Fed and monetary policy? Second, how much confidence does the public have in the Fed, its policies, and its Chair?

The surveys reveal a persistent lack of basic awareness of the Fed and low recognition of the Fed's ability to influence the economy. This implies a high cost and low perceived benefit to consumers of paying attention to Fed communications. Consumers have relatively low confidence in and knowledge of Bernanke and Yellen relative to Volcker and Greenspan. In April 2014, confidence in the Fed Chair as an economic policymaker was much lower than confidence in the President, but higher than confidence in Congress. Opinions of Fed policies have been fairly unfavorable in recent years. Low confidence in the Fed Chair and lack of policy approval may indicate that the Fed has not effectively communicated its policy goals and rationales to the public or that poor credibility is a barrier to successful communication.

[2]See http://memetracker.org and http://cs.stanford.edu/people/jure/pubs/quotes-kdd09.pdf.

Other central banks face similar challenges in communicating with the general public but employ different approaches. The Swedish Riksbank and the European Central Bank merit particular attention for their explicit focus on households as a communication target. I consider how the Fed could adopt strategies used by these and several other banks.

The paper is organized as follows. Section 2.2 describes the history of Federal Reserve communication and transparency and provides an overview of political communication theory. Section 2.3 uses Michigan Survey data to study the anchoring of consumers' inflation expectations over time. Section 2.4 analyzes media coverage and search patterns related to the Federal Reserve and monetary policy, and includes a case study of how the message of a Federal Reserve President's speech was propagated to the public through various media channels. Section 2.5 gathers survey evidence on public attention to and opinion of the Federal Reserve, inflation, and monetary policy. Section 2.6 describes other central banks' philosophies and approaches to communicating with the general public, and Section 2.7 concludes.

2.2 History and Theory of Fed Communication

Over the course of the Federal Reserve's history, its policy objectives, tools, and communication strategy have evolved. The evolution of the Fed's interactions with the public reflects a shift in attitudes in favor of transparency. A growing literature on optimal monetary policy communication provides theoretical justification for the Fed's shift in communication strategy (Blinder et al., 2008). As the Fed strives to implement effective communication in practice, the literature on political communication theory also merits consideration. Political communication is the interdisciplinary study of "the strategic use of communication to influence public knowledge, beliefs, and action on political matters" (Swanson and Nimmo, 1990, p. 9). Many of its insights are relevant to monetary policy communication.

History of Fed Communication and Transparency

The Federal Reserve Act of 1913 did not envision a central bank that would interact actively with the general public. The Fed was intended to serve as a lender of last resort and provide an elastic currency, but not to pursue macroeconomic goals such as price stability or full employment. The early Fed interacted primarily with banks, pursuing its financial stability objective under the framework of the real bills doctrine.[3] When, in order to finance its operations, the Fed began purchasing government securities on the open market in the early 1920s, Fed officials realized that this affected bank lending to customers. Through open market operations, the Fed began interacting not only with banks but also with broader financial markets and the public (Wheelock, 1992; Bernanke, 2013).

[3]Under the real bills doctrine, the Fed increased liquidity to banks when business was expanding and decreased liquidity when business was contracting.

The Great Depression led to a belief that the federal government should do more to actively prevent recessions (Judd and Rudebusch, 1999), and prompted significant changes in the Fed's structure and operations. The Banking Act of 1935 expanded the powers of the Fed and removed the Treasury Secretary and the Comptroller of the Currency from its governing board. Nonetheless, the Treasury maintained significant de facto control over monetary policy. The 1951 Treasury Accord, which eliminated the obligation of the Fed to monetize the debt of the Treasury at a fixed rate, granted more independence to the Fed. The Fed could then focus on the price stability and employment objectives set out in the 1946 Employment Act, and maintained moderate inflation from the 1950s to the mid-1960s.

Prompted by high inflation, the Federal Reserve Reform Act of 1977 made price stability an explicit policy goal. The Full Employment and Balanced Growth Act of 1978, also known as the Humphrey-Hawkins Act, added a full employment goal and obligated the Fed Chair to make biannual reports to Congress, imposing more transparency and oversight on a fairly secretive institution. Federal Open Market Committee (FOMC) members feared that disclosing their views would prompt market response, impeding the Committee's ability to enact their plans (Moore, 1990).[4] Open communication countered the conventional wisdom of monetary policymaking.

The Fed, like most central banks at the time, kept communications rare and cryptic due to perceived benefits of keeping the markets guessing (Mishkin, 2004; Blinder et al., 2008). Brunner (1981, p. 5) describes that "The mystique thrives on a pervasive impression that Central Banking is an esoteric art...The esoteric nature of the art is moreover revealed by an inherent impossibility to articulate its insights in explicit and intelligible words and sentences. Communication with the uninitiated breaks down. The proper attitude to be cultivated by the latter is trust and confidence in the initiated group's comprehension of the esoteric knowledge."

When Paul Volcker became Chairman in 1979, the FOMC began to recognize the need to manage inflation expectations.[5] The Volcker regime, influenced by the rational expectations literature of the 1970s and early 1980s, "reflected an improved understanding of the importance of providing a firm anchor, secured by the credibility of the central bank, for the private sector's inflation expectations" (Bernanke, 2013). A number of reforms increased transparency with regard to the Fed's information and views. The FOMC began releasing semiannual economic projections in 1979, and in 1983 began publishing the Beige Book, which summarizes economic conditions in each Federal Reserve District. Nevertheless, expectations management did not take the form of clear, frequent public communications. To

[4]Governor Charles Partee, for example, worried that "the FOMCs ability to formulate effective policy by accurately predicting market reactions in response to actions taken under particular policies would be diminished" (Goodfriend, 1986, p. 74).

[5]For example, Volcker noted, "When I look at the past year or two I am impressed myself by an intangible: the degree to which inflationary psychology has really changed...I think that people are acting on that expectation [of high inflation] much more firmly than they used to... it does produce, potentially and actually, paradoxical reactions to policy" (FOMC transcript, 8-14-79, p. 21, cited in Goodfriend and King (2005).)

the contrary, Volcker's successor Alan Greenspan was notorious for his vague and obfuscatory remarks dubbed "Fed speak."

Attitudes toward communication shifted dramatically in the 1990s. An understanding that greater openness could help monetary policymakers better manage the economy spread widely (Blinder, 1998). By the early 21st century, academics and policymakers largely agreed on the wisdom of more extensive and clear communication (Blinder et al., 2008). A large literature developed to evaluate the macroeconomic consequences of central bank transparency and explicit communication of policy goals (Woodford, 2001; Kozicki and Tinsley, 2005; Melecký et al., 2009). Richard Lambert (2005, p. 63), as member of the Monetary Policy Committee of the Bank of England, remarked, "It's all very different from the time, not so long ago, when the stated objective of the Bank's press officer was to keep the Bank out of the press, and the press out of the Bank."

This new attitude was implemented in stages at the Fed. In 1994, the FOMC began to release postmeeting statements disclosing changes in monetary policy, albeit with scant explanation. Beginning in 2000, the postmeeting statements include a "balance of risks" assessment (Anderson, 2012). At its August 12, 2003 meeting, the FOMC announced that its low interest rate policy would be "maintained for a considerable period." Yellen (2013a) describes this as a landmark: "For the first time, the committee was using communication —mere words— as its primary monetary policy tool...The FOMC had journeyed from 'never explain' to a point where sometimes the explanation is the policy."

The desire for greater transparency and clarity was also reflected in the adoption of inflation targeting in some countries. The Bank of New Zealand adopted inflation targeting in 1990, and a number of other central banks followed suit over the subsequent decade, including those of Canada, Chile, England, Sweden, Australia, and Israel. Some FOMC members proposed that the Fed should adopt inflation targeting, but others were concerned that an inflation target would not give the Fed enough discretion to pursue the maximum employment component of the dual mandate. Bernanke (2003) describes that "the Federal Reserve, though rejecting the inflation-targeting label, has greatly increased its credibility for maintaining low and stable inflation, has become more proactive in heading off inflationary pressures, and has worked hard to improve the transparency of its policymaking process—all hallmarks of the inflation-targeting approach." He adds that inflation targeting must include "a strategy for communicating the context and rationale of these policy choices to the broader public... Although communication plays several important roles in inflation targeting, perhaps the most important is focusing and anchoring expectations."

The Fed's communication strategy evolved rapidly under Bernanke's chairmanship. The Fed expanded its use of forward guidance, or communication about the likely future evolution of policy. On March 24, 2011, the Fed announced that Bernanke would hold press conferences four times per year, intending to "enhance the clarity and timeliness of the Federal Reserve's monetary policy communication. The Federal Reserve will continue to review its communications practices in the interest of ensuring accountability and increasing public understanding."

The Bernanke Fed also announced a 2% goal for inflation. The January 2012 announce-

ment stated that "Communicating this inflation goal clearly to the public helps keep longer-term inflation expectations firmly anchored, thereby fostering price stability and moderate long-term interest rates and enhancing the Committee's ability to promote maximum employment in the face of significant economic disturbances."[6] The idea that the Fed had an implicit 2% inflation target came into discussion around 1990 (Taylor, 1993), but the announcement made the target explicit.

Federal Reserve Presidents and Governors have also emphasized communication with the public. Minneapolis Fed President Narayana Kocherlakota (2014) comments that "In order for the Fed to continue to be effective, it needs to communicate its policy decisions transparently to the public. Conversely, it also needs the public's input into how those policies are affecting them." Chicago Fed President Charles Evans (2014) explains that a successful communication strategy entails "expressing policy intentions clearly so that the public can understand the Federal Reserve's goals and how the Fed is committed to achieving these goals in a timely fashion."

Janet Yellen shares her predecessor's emphasis on communication with the public. In her speech "Communication in Monetary Policy," she refers 21 times to "the public." For example, Yellen (2013a) explains that "significant spending decisions–expanding a business, buying a house, or choosing how much to spend on consumer goods over the year—depend on expectations of income, employment, and other economic conditions over the longer term, as well as longer-term interest rates...What is important is the public's expectation of how the FOMC will use the federal funds rate to influence economic conditions over the next few years." Her first public speech as Chairwoman, Yellen (2014) emphasized, "Although we work through financial markets, our goal is to help Main Street, not Wall Street."

Political Communication Theory and the Fed

In addition to the economic literature on monetary policy communication and transparency, the political communication literature is relevant for Federal Reserve communication with the public. A key concept in political communication is the *public sphere*, which Dahlgren (2005, p. 148) describes as "a constellation of communicative spaces in society that permit the circulation of information, ideas, debates...These spaces, in which the mass media and now, more recently, the newer interactive media figure prominently, also serve to facilitate communicative links between citizens and the power holders of society." As a prominent power holder of society, the Fed communicates with citizens in the context of the public sphere and its rapidly changing media environment.

A highly functional public sphere is characterized by strong civic engagement and well-informed citizens. Iyengar and Curran (2009) emphasize that both demand- and supply-side factors determine engagement and informedness, noting that "informed opinion depends on the interplay between attentiveness to news on the one hand, and the supply of news on the other." For example, Americans' knowledge of world events is low relative to that of citizens

[6]Federal Reserve Press Release, January 25, 2012.

of European democracies, possibly because the higher cost of exposure to hard news in the United States, where there is less state-subsidized public broadcasting (Iyengar, 2010).

The effects of the Internet and related technologies on the public sphere are still being evaluated. Lee (2014) speculates that compared to the past, policymakers today may be more capable of sending messages directly to the public due to the rise of new media. The new media landscape brings about new challenges as well as new opportunities, however. Dahlgren (2005, p. 148) notes that observers of the Internet revolution in the 1990s hoped that new information and communication technologies would enhance civic engagement, but that often, "democratic deliberation is completely overshadowed by consumerism, entertainment, non-political networking and chat, and so forth." Significant changes in political communication in Western democracies in late modern society include increased sociocultural heterogeneity, massive growth in media outlets and channels, growing professionalization of political communication, the cacophony associated with media abundance, and growing disengagement and cynicism among citizens (Blumler and Gurevitch, 2000). All of these changes must be kept in mind by policymakers, including Federal Reserve officials, as they design strategies for communicating with the public.

Receptiveness to news varies across individuals, and many researchers have investigated disparities in informedness across segments of the population. A common finding is that high-income, high-education, white, male consumers have the highest levels of political knowledge (Carpini and Keeter, 1996). The *knowledge gap hypothesis* posits that higher socioeconomic status segments of the population tend to acquire information communicated through the mass media more rapidly than lower socioeconomic status segments, increasing the knowledge gap between groups (Tichenor et al., 1970; Gaziano, 1997; Hwang and Jeong, 2009). An implication of this hypothesis is that monetary policy communications that are transmitted through mass media may differentially reach different segments of the population. In Section 2.3 I show this to be the case.

2.3 Inflation Expectations Anchoring

The statutory mandate of the FOMC is to promote maximum employment, stable prices, and moderate long-term interest rates (Steelman, 2011, p. 2). The price stability component, in particular, is a major focus of FOMC communication. Bernanke (2003) explains, "public beliefs about how monetary policy will perform in the long run affect the effectiveness of monetary policy in the short run. Suppose, for example, that the central bank wants to stimulate a weak economy by cutting its policy interest rate. The effect on real activity will be strongest if the public is confident in the central bank's unshakable commitment to price stability, as that confidence will moderate any tendency of wages, prices, or long-term interest rates to rise today in anticipation of possible future inflationary pressures..."

Through its communications about price stability, the FOMC aims to *anchor* inflation expectations. Yellen (2013a) attributes the Great Inflation of the 1970s in part to unanchored inflation expectations. Bernanke suggests that anchoring has improved since the 1980s, but

remains imperfect, and poses the questions, "On which measure or combination of measures should central bankers focus to assess inflation developments and the degree to which expectations are anchored?" and "What factors affect the level of inflation expectations and the degree to which they are anchored?" (Bernanke, 2007b). In response to these questions, I consider a variety of measures that can be used to assess the degree to which inflation expectations are anchored, including a new measure of long-horizon inflation uncertainty. I compare the informativeness of the measures and document time trends in the anchoring of consumers' expectations. I detail differences in anchoring across demographic groups and compare consumers to professional forecasters.

Indicators of Anchoring

The Michigan Survey of Consumers (MSC), a nationally-representative monthly telephone survey of households' expectations, attitudes, and demographic characteristics, is an important source of information on the inflation expectations of the public. Respondents report integer values for their inflation expectations at the one-year and five- to ten-year horizons. They are also allowed to respond that they don't know. Approximately 500 people take the survey each month, and 40% of respondents take the survey a second time six months later.

Panel A of Figure 2.1 displays what is sometimes interpreted as evidence of well-anchored expectations. Median inflation expectations at the longer horizon are quite stable in recent years. In 97% of all months since 2000, the median long-run inflation forecast has been in the range of 2.7% to 3.3%, with mean 2.9% and standard deviation only 0.15%. Long-run inflation expectations are more stable than short-run expectations; the median short-run inflation forecast since 2000 has mean 3.0% and a larger standard deviation of 0.65%.

Several studies of expectations anchoring in financial markets are founded on the idea that if expectations are well-anchored, long-horizon inflation expectations should be stable in response to macroeconomic news, policy announcements, and changes in short-horizon inflation expectations (Clark and Nakata, 2008; Ball and Mazumder, 2011; Beechey et al., 2011). Long-run inflation expectations derived from financial data have become less responsive to shocks to current inflation, so Davis (2012) concludes that inflation expectations in financial markets have become more anchored over time. Policymakers emphasize this stability as well. Richmond Fed President Jeffrey Lacker has remarked, "I have been impressed by the stability of inflation expectations. People are pretty confident we're not going to let it get away from 2 percent. I like that."[7]

Median expectations do not tell the whole story, however. The remaining panels provide additional information on the degree to which consumers' expectations are anchored. Panel B displays the percentage of "don't know" (DK) responses by horizon. Consumers tend to choose the DK response if answering numerically poses a large cognitive burden (Curtin, 2007). The percentage of DK at the longer horizon is slightly greater after 2000 than before.

[7]Alister Bull, "Fed's Lacker says inflation expectations still well-anchored," Reuters, from CNBC interview, April 18, 2013.

If expectations were firmly anchored, we would expect more DK responses at the short than at the long horizon; even if consumers found it difficult to keep track of short-run fluctuations in inflation conditions, they would have an idea of what to expect in the longer run. In fact, the opposite is true. The percent of respondents who say they don't know about one-year-ahead inflation is 10.2%, compared to 12.4% for long-run inflation.[8] In 2012-13, 9.9% gave a DK response for one-year-ahead inflation compared to 11.1% for long-horizon inflation.

Panel C shows the percentage of respondents who choose a forecast of 1, 2, or 3% (within a percentage point of the FOMC's 2% target.) This is more common at the longer horizon. In the 1980s, only 21% of consumers chose a long-run forecast of 1, 2, or 3%. The number steadily increased to 54% in 1999, with no maintained improvement thereafter. Even though median long-run inflation expectations are reasonably close to the target, half of respondents choose forecasts that are far from the target.

Panels D and E consider forecast revisions. Bernanke (2007b) defines *anchored* as "relatively insensitive to incoming data;" hence large revisions of long-horizon expectations indicate weak anchoring. For a respondent who takes the survey twice with a six month gap, the revision is the change in her forecast. Drager and Lamla (2013) find that the strength of the comovement between long-horizon forecast revisions and short-horizon forecast revisions on the MSC is lower after 1996 than before. They interpret this as stronger anchoring after 1996. However, the downward trend in comovement between long- and short-horizon revisions does not continue throughout the 2000s; in fact, the comovement increases from 2002 to 2005 and from 2009 to 2012.

Drager and Lamla do not consider time trends in the frequency and magnitude of forecast revisions. Panel D shows the percent of consumers who revise their forecast in a six-month period. Revisions are frequent; in a six-month period, 75% of consumers revise their short-run expectations and 73% revise their long-run expectations, with no clear time trend. Panel E displays mean absolute forecast revisions by horizon. Consumers make substantial revisions in a six-month period. Most notably, the mean absolute short-horizon and long-horizon revisions in December 2008 were 6.8% and 3.0%, respectively (these are revision from previous forecasts made in June 2008). After the late 1990s, consumers make larger revisions to their short-horizon forecasts than to their long-horizon forecasts, but long-horizon revisions are still quite large, around 2.1% since 2000.[9] Even among consumers who initially forecast 1, 2, or 3% inflation, the mean absolute revision since 2000 is 1.4%. The stability of *median* inflation expectations in Panel A obscures this instability of *individuals'* expectations.

Panel F displays a new measure of uncertainty about inflation. Uncertainty is the variance of an individual's probability distribution over future inflation. Until very recently, United States consumers were not surveyed about their probability distributions over inflation. MSC respondents provide only their point forecasts for inflation. Binder (2014) develops a method of estimating uncertainty from point forecasts.[10] High uncertainty about

[8]Means exclude months in which long-run forecasts were not included in the survey.

[9]Median (rather than mean) absolute forecast revisions at the long horizon are consistently 1% or 2% since the mid 1980s, and range from 2% to 5% in the early 1980s.

[10]The estimation framework in Binder (2014) is based on a documented association between round num-

long-run inflation is indicative of poorly-anchored expectations. Federal Reserve Chair Janet Yellen (2013a) describes, for example, how "Starting in the mid-1960s, the Federal Reserve didn't act forcefully in the face of rising inflation, and the public grew less certain of the central bank's commitment to fighting inflation. This uncertainty led expectations of future inflation to become 'unanchored' and more likely to react to economic developments." Uncertainty can be high if agents are uninformed of the central bank's inflation target or unconvinced of its credibility, making it difficult for agents to distinguish transitory from permanent shocks to inflation (Erceg and Levin, 2003; Milani, 2007).

Time trends in mean inflation uncertainty are similar to trends in mean absolute forecast revisions, as Bayes' rule predicts.[11] Uncertainty at both horizons declined through most of the 1980s and 90s. Since the 1990s, uncertainty is higher at the shorter horizon (mean 16%) than at the longer horizon (mean 12%). In the Great Recession, short- and long-horizon inflation uncertainty averaged 25% and 14%, respectively, while in 2012-13 they averaged 14% and 9%. The long-horizon uncertainty measure gives no indication that anchoring has improved since as a result of new communication strategies in recent years. There is no downward time trend in long-horizon inflation uncertainty since 1996, and long-horizon uncertainty remains quite high. Even among consumers with long-run inflation expectations of 1, 2, or 3%, average uncertainty was 5% in the late 1990s and remains at 5% in 2012-13.

Figure 2.2 displays moving averages of don't know responses, 1-3% responses, mean uncertainty, and mean absolute forecast revisions for the longer horizon inflation forecasts. The overall picture indicates that anchoring improved through the late 1990s and has since neither improved nor deteriorated notably. While the stability of median inflation expectations at longer horizons gives the appearance of well-anchored expectations, alternative indicators reveal that anchoring among the public remains fairly weak and shows negligible improvement since the late 1990s.

The effectiveness of the communication strategy at improving expectations anchoring in the general public is difficult to detect. Despite efforts to improve households' expectations anchoring in recent years, improvements seem to have ended before 2000. One particular change in the communication strategy occured in January 2012, when the Fed announced that an inflation rate of 2% was most consistent with the statutory mandate. Yellen (2013b) remarked, "I believe this statement has sent a clear and powerful message about the FOMC's commitment to its goals and has helped anchor the public's expectations that inflation will remain low and stable in the future." Inflation targeting is linked to better-anchored inflation expectations in financial market (Gurkaynak et al., 2007). Consumers, however, seem unaware of the announcement or unconvinced of its credibility. In 2012 and 2013, just 14.8% of consumers report expectations of 2% inflation in the long run, compared to 15.7% of consumers in 2011. Even fewer consumers—less than 4% in 2012-13—report expectations of 2% both times that they take the survey.

bers and uncertainty. Michigan Survey data exhibits significant response heaping at multiples of five, which is exploited to estimate uncertainty quantitatively using a maximum likelihood estimation procedure.

[11] According to Bayes' rule, the magnitude of the revision of a prior in response to a signal is decreasing in the precision of the prior.

Demographic Patterns

The degree to which expectations are anchored varies across demographic groups. In Table 2.1, I regress indicators of anchoring on demographic variables and a stock investment variable that takes value 0 if the respondent has no investments, and values 1 through 5 for the lowest through highest investment quintiles.[12] Dependent variables are inflation uncertainty (column 1), absolute forecast revisions (column 2), and a dummy variable that takes value 1 if the respondent forecasts 1, 2, or 3% inflation (column 3), all at the long horizon. Columns 4 through 6 restrict the time sample to 2012-2013. All specifications find that higher income, higher education, working-age male consumers have more strongly-anchored expectations.

A large literature in political communication documents higher political informedness among these same demographics and predicts that these higher socioeconomic status segments of the population are more receptive to information communicated through the media (see Section 2.2). Tichenor et al. (1970) list several contributors to this knowledge gap. One has to do with education and stored information. People of higher socioeconomic status tend to have more formal education and previous exposure to relevant news topics, improving their reading and comprehension of information transmitted through the media. Other contributors include media target markets and selective exposure. Media outlets cater to particular segments of the population, and people choose to expose themselves to news topics that interest them.

To the extent that demographic differences in expectations anchoring reflect differences in absorption and comprehension of monetary policy communication, all of the above contributors are relevant. Regarding education and stored information, the groups with more strongly-anchored inflation expectations have been shown to have higher financial literacy (FINRA, 2013). Financial literacy and previous exposure to macroeconomic information should assist with comprehension of communications about price stability. Stock market participation is another correlate of financial literacy (van Rooij et al., 2011). Consumers who invest in the stock market also have more anchored expectations. Their long-run inflation uncertainty is significantly lower, they make smaller revisions, and they are significantly more likely to predict 1, 2, or 3% long-run inflation. In 2012 to 2013, only 41% of non-investors predict 1, 2, or 3% long-run inflation, compared to 60% of all investors and 69% of the top quintile of investors (Figure 2.3). Consumers who invest in the stock market form a media target market. Media outlets that cater to financially sophisticated consumers include more financial and economic news, and consumers with stock investments may choose to expose themselves to this news because of its relevance to their portfolios.

Comparison to Professional Forecasters

The demographic differences in the degree to which consumers' expectations are anchored appear to reflect heterogeneity in informedness and financial literacy. Professional forecasters

[12] Questions about stock market investments were added to the survey in 1990. About 60% of respondents participate in the stock market.

are presumably among the most informed and financially literate segments of the population, and paying attention to monetary policy communication is more central to their livelihood. Correspondingly, professional forecasters' inflation expectations are much more anchored than those of consumers.

Median long-run inflation forecasts from the Survey of Professional Forecasters (SPF) are slightly lower than those of consumers. Median ten-year CPI inflation forecasts declined through the 1980s and 90s and have remained between 2.2% and 2.5% since 1998. Professional forecasters have much lower disagreement and make much smaller revisions to their long-run forecasts than do consumers. In 2012-13, professional forecasters' disagreement averaged 0.3% and the mean absolute revision was 0.2%, an order of magnitude smaller than those of consumers.

Unlike the general public, professional forecasters are well-aware of the Fed's 2% inflation target. The SPF gave two special questionaires about inflation targeting, one before and one after the 2012 announcement.[13] Half of respondents to the 2007Q4 questionaire believed that the FOMC had a de facto long-run inflation target, but fewer than half of those thought that inflation over the next 10 years would be consistent with the target. Estimates of the target ranged from 1.5% to 2.25%, with a mean of 1.7%. On a questionaire in 2012Q2, SPF forecasters knew of the recently-announced 2% target, and three quarters found it credible.

The differences between the forecasts of households and professionals challenge some models of expectations formation. The sticky information model of Mankiw and Reis (2002) predicts that households update their information sets infrequently but fully. In a variant proposed by Carroll (2003), households use professional forecasts to periodically update their expectations. According to these models, revisions should be infrequent, but a consumer making a revision should make a "highly-informed" forecast. The fraction of households choosing forecasts near 2% should have gradually increased, since professional forecasters have consistently been making forecasts near 2%. Instead, consumers make frequent revisions, but rarely to a well-informed value.

Sims (2003) emphasizes that limited information processing capacity influences expectations formation. Consumers and professional forecasters face different costs and benefits of paying attention to monetary policy and forming inflation expectations. For instance, households are more reliant on the mass media for information about inflation than are professional forecasters (Doms and Morin, 2004; Lamla and Maag, 2012). The next section analyzes the role of media and consumer attention in the Fed's communication strategy.

2.4 The Role and Use of Media

The media plays an important part in shaping household expectations and opinions (Doms and Morin, 2004). For instance, the accuracy of households' inflation expectations increases

[13]Federal Reserve Bank of Philadelphia Survey of Professional Forecasters: special questions, fourth quarter 2007 and second quarter 2012. Accessed June 1, 2014 at http://www.phil.frb.org/research-and-data/real-time-center/survey-of-professional-forecasters.

with the amount of media reporting on inflation (Carroll, 2003). Household forecasts are sensitive to the tone of media stories, unlike professional forecasts (Lamla and Maag, 2012). Television, followed by newspapers, is the dominant source of the public's economic information (Blinder and Krueger, 2004). The media can propagate policymakers' communications to the public, and interactive new media also shape communications between citizens and power holders (Dahlgren, 2005).

While policymakers do not directly control media coverage, they can influence media attention. Lee (2014) examines the transmission of messages between the President, the media, and the public, and determines that direct transmission between the president and the public is weak. Instead, the public typically receives presidential messages indirectly, after the messages are modified and evaluated by the media. However, the President is able to influence what the media covers. The White House devotes substantial effort to shaping media coverage through press briefings and conferences, interviews, backgrounders, and press releases (Edwards, 2003). Through these efforts, the President impacts households' economic expectations and understanding of economic policy.

A vivid example is the media and communication strategy of President Franklin Delano Roosevelt beginning in 1933. When he took office, depression and deflation plagued the country. Roosevelt's effective communication with the public was an important component of the regime shift that helped restore positive inflation expectations and spur recovery (Temin and Wigmore, 1990; Romer, 2013). In his thirty evening radio addresses, or "fireside chats," Roosevelt clearly and accessibly explained his policies and objectives in a way that reached ordinary households and changed their expectations. His astute use of popular media and strong communication skills captured the attention of the public and strengthened their trust in him (Yu, 2005). He spoke frequently of prices and inflation, for instance in his October 22, 1933 chat, "On the Currency Situation":

> "I do not hesitate to say, in the simplest, clearest language of which I am capable, that although the prices of many products of the farm have gone up and although many farm families are better off than they were last year, I am not satisfied either with the amount or the extent of the rise, and that it is definitely a part of our policy to increase the rise and to extend it to those products which have as yet felt no benefit. If we cannot do this one way we will do it another. Do it, we will."

Roosevelt's pro-inflation message was also propagated by other channels. For instance, in June 1933, Metro-Goldwyn-Mayer released a 10-minute short film called "Inflation" that aired in movie theaters across the country and explained how Roosevelt's inflationary policies would help the economy (Hetzel, 2012). Since the Roosevelt administration, most Presidents have placed high priority on communicating with the public and have garnered extensive coverage in the mass media. The White House employs a Director of New Media, a Director of Online Engagement, and a Director of Progressive Media, and makes extensive use of new media.

The Federal Reserve's efforts to shape media attention and to use new media have not been evaluated. The Board of Governors and most of the Districts maintain online press centers or media centers where press releases and other content are posted. The Board and Districts also use new and interactive media, but to a much smaller extent than the White House.

Mass media coverage of inflation and the Federal Reserve has been scant in recent years. Figure 2.4 shows the number of New York Times front page headlines mentioning inflation, deflation, the Federal Reserve, prices rising, Greenspan, Volcker, Bernanke, or Yellen. In 1980 and 1981, these words appeared in 79 and 50 headlines, respectively, but in the 2000s, they appear only 8 times per year on average. A casual newspaper skimmer would rarely read about inflation or the Fed.

Researchers at the Pew Research Center Journalism Project tracked over 5,000 economic stories from January 1, 2007, through June 30, 2008 from 48 news outlets.[14] In 2008, economic news made up 6% of the newshole, up from about half that in 2007. Economic coverage was higher on "old media" (newspapers, broadcast television, and news radio) than on "new media" (talk radio and cable). On January 9, 2008, Goldman Sachs released a report predicting a recession; a week later, Bernanke publicly disagreed. These statements triggered a wave of press coverage. For the next three months, 44% of economic coverage focused on whether a recession was coming. Meanwhile, coverage of inflation was erratic, and did not clearly rise with inflation. Coverage of gas prices, on the other hand, was closely correlated with gas prices, which are "easier to see and touch consumers in more obvious ways" (Pew, 2008). In July 2008, 38% of Americans thought that energy prices were the most important economic problem facing the country, compared to 13% for unemployment and jobs, and 10% for housing (Pew, 2008).

A 2009 Pew study analyzing economic news stories from February 1 to July 3 found that an "Obama-centric approach to economic coverage came from following the president as he tried to sell his policies to the American public and quell political opposition." As the lead newsmaker in 14% of economic stories, the President was the most visible figure in economic news. Bernanke, lead newsmaker in 1% of economic news stories, was the fourth most visible, behind Obama, Bernard Madoff, and Treasury Secretary Timothy Geithner (Pew, 2009).

The Pew researchers collaborated with the developers of *Meme-tracker*, a technology that analyzes 1.6 million articles and posts per day from news and new media sites and blogs to identify "memes," or quotes and concepts that get widely propogated.[15] The top economic meme for February to July 2009 came from Obama on February 24: "we will rebuild, we will recover..." Of the top 20 economic memes, nine were quotes from the President. Two were from Bernanke, both from his Sixty Minutes interview on March 15. "We've seen some progress in the financial markets, absolutely," was ninth most-cited, with 2,425 citations. His

[14]The Pew Research Center bears no responsibility for analysis or interpretation of data presented here. The study tracked 1,955 hours of programming on the three major cable news channels, 1,369 hours on network morning and evening TV, 978 hours on radio, 469 editions of 21 different newspapers, and the five leading news websites.

[15]See http://memetracker.org and http://cs.stanford.edu/people/jure/pubs/quotes-kdd09.pdf.

other top-20 quote was, "slammed the phone more than a few times discussing AIG." Official FOMC announcements and speeches by Fed district presidents are not widely propogated.

The Pew Research Journalism Project also assembled a dataset of 20,447 stories from January to May 2012, of which 8% have to do with the economy or economics.[16] Bernanke is the lead newsmaker in only 2 stories and the second lead newsmaker in 24. For comparison, George Zimmerman is the lead and second lead newsmaker in 131 and 240 stories, respectively.

Consumers also do not actively seek information on Federal Reserve policy. Google Trends provides data on search volume for specific words or phrases since 2004. Figure 2.5 plots search volume for inflation, Federal Reserve, and interest rates. All three terms have similar search volumes which have slightly decreased over time, are regionally concentrated near Washington, D.C., New York, and Boston, and are far lower than searches for specific food items, sports, and celebrities. Google searches in the United States for "Ben Bernanke" during his time as Federal Reserve chair were less than half as common as searches for America's preferred Ben, of Ben and Jerry's.

The Federal Reserve also produces and propagates its own communications using online media. Facebook is the world's largest social networking site, with 1.23 billion active monthly users as of December 31, 2013 (Facebook, 2013). Mass adoption of online social networking—more than half of adults in the United States are Facebook users—has the potentially to drastically alter individuals' information exposure (Bakshy et al., 2012). Individuals and organizations share news and opinions on Facebook. Companies and agencies create Facebook pages that provide information, share photos, and link to news stories. Individual Facebook users interact by "liking" the page or by liking, sharing, or commenting on posted photos and links. The Federal Reserve branches maintain Facebook pages. San Francisco's is the most popular with almost five thousand "likes," which pales in comparison to over two million for the White House page.[17]

Twitter is a microblogging and social networking service that allows users to post short text messages ("tweets") and to follow other accounts. The Federal Reserve account has 149 thousand followers. The accounts of Federal Reserve districts have around 15 to 60 thousand followers each.[18] Again, these are orders of magnitude smaller than the White House and President Obama's follower numbers. The Federal Reserve tweets are aimed for a financially sophisticated audience.

Youtube is a popular free video website. Organizations and individuals create Youtube channels to which people may subscribe. The official channel of the Federal Reserve has about five thousand subscribers and its videos have been viewed 412 thousand times. The official channel of the White House has 432 thousand subscribers and 175 million views. Additional videos about the Fed have been posted by other Youtube users, and nearly all

[16]The dataset includes 1,977 newspaper stories, 3,242 online stories, 5,186 network television stories, 6,472 cable news stories, and 3,570 radio stories.

[17]Pages accessed July 16, 2014 at https://www.facebook.com/SFFedReserve and https://www.facebook.com/WhiteHouse.

[18]Twitter follower numbers and Youtube subscriber numbers and view counts as of May 29, 2014.

of the most-viewed videos are critical or inflammatory in nature.[19] The most-viewed more neutral video is a CBS News interview of Bernanke by Scott Pelley called "Fed Chairman Bernanke on the Economy," uploaded on December 5, 2010, with 75 thousand views and 865 comments.

A speech by San Francisco Federal Reserve President John Williams (2014) on June 30, 2014 provides a case study of how Fed communication is propagated. Williams clearly described the Federal Reserve's policy stance and his views and expectations of the inflationary situation:

> Those of us born before the 1970s reflexively worry about high inflation, but the problem for the past few years has actually been inflation that's persistently low. The inflation rate the Fed follows most closely—the personal consumption expenditures price index—has been running at about 1 and $\frac{3}{4}$ percent over the past year. This is below the Federal Open Market Committee's preferred 2 percent longer-run goal. This isn't all that surprising in light of the fact that the economy is still running below capacity and wage growth has remained modest. As the economy moves closer to full employment, I expect inflation to edge up gradually towards 2 percent.

The Media Relations Office of the Federal Reserve Bank of San Francisco wrote a press release the same day, omitting any quantitative discussion of inflation. The two most prominent media outlets to report on the speech are both geared toward relatively sophisticated audiences. The Wall Street Journal's "MarketWatch"[20] framed Williams in opposition to Stanford economist John Taylor, although Williams' speech made no mention of Taylor. The MarketWatch article was shared on Facebook by 19 people and tweeted by one. A Reuters article[21] about the speech was shared on Facebook by 91 people and tweeted by 27. Four readers commented directly on the MarketWatch article and two on the Reuters article, all with general criticism of the Fed. A representative example is, "Oh great ones you've stimulated the economy alright. Right into negative GDP for the 1st quarter 2014. Love to hear the explanations once double digit inflation hits and the lights go out."

The San Francisco Fed posted the MarketWatch article on its Facebook page on July 1 (Figure 2.6). Two Facebook users "liked" the post, one shared it, and none wrote comments. Articles posted by the White House page typically receive thousands or tens of thousands of "likes," shares, and comments. Overall, propagation of monetary policy communications to the general public through mass media and interactive media appears quite limited.

[19] Eight of the 20 most-viewed videos that appear in a search result for "Bernanke" have Ron Paul in the title.The video "Ron Paul 0wnz the Federal Reserve," uploaded February 19, 2007, has 898,610 views and 5,604 comments.

[20] "Fed's Williams hits back at critics like Stanford's Taylor," accessed July 14, 2014 at http://www.marketwatch.com/story/feds-williams-hits-back-at-critics-like-stanfords-taylor-2014-06-30

[21] Ann Saphir, "Fed's Williams sees no rate hike until after mid-2015," accessed July 16, 2014 at http://www.reuters.com/article/2014/06/30/us-usa-fed-williams-idUSKBN0F51UU20140630.

Atlanta Federal Reserve President Dennis Lockhart (2011) summarizes the challenges and opportunities that the Fed faces in the evolving media environment: "Communications media have been an arena for innovators and visionaries...with digital and social media aimed at engaging audiences in new ways. Central banks seem always to face formidable communications challenges, and certainly that is the case for the Federal Reserve in these times. In addition to conveying what is sometimes dense content on monetary policy and regulation, the Fed must adapt to both an evolving mix of media and the public's increasing expectation of transparency and accountability."

2.5 Other Survey Evidence

A plethora of surveys have asked the public about inflation and the Federal Reserve over the past few decades, though none with the frequency and regularity of the Michigan Survey. Some were one-time surveys and others were conducted a dozen or more times. Any one of these surveys on its own, is not particularly illuminating, but by gathering them all together, a clearer picture of the Fed in the eyes of the public emerges. The survey evidence helps answer two broad questions. First, what does the public view as the costs and benefits of paying attention to the Fed and monetary policy? Second, how much confidence does the public have in the Fed, its policies, and its Chair?

The first question is directly relevant to the efficacy of the Fed's communication policy. The Fed can only communicate with the public insofar as the public is willing to pay attention. Rational inattention theory implies that consumers have limited attention to devote to seeking and processing macroeconomic information (Sims, 2003) and will only pay attention to Fed communication if they believe the effort is worthwhile. Consumers lacking basic knowledge of the Fed and monetary policy might not perceive the benefits of paying attention to Fed communication, or might perceive the cost of doing so as insurmountably high. Consumers' understanding of inflation—what causes it, whether the government can control it, how it affects them personally—also affect the perceived benefits of attention. It also matters whether consumers view the Fed as a key player in the economy. If they perceive the Fed's influence as limited relative to, for example, the President's, then they may consider it more valuable focus attention on presidential policies and communications.

The second question is related to communication effectiveness and credibility. If the public shows low confidence or approval of Fed policy decisions, this may indicate that the Fed has not effectively communicated its policy goals and rationales. Low confidence in the Fed Chair signals poor credibility, a barrier to successful communication.

Costs and Benefits of Attention

The public's perception of the costs and benefits of paying attention to Fed communications depends on the public's understanding of the Fed, monetary policy, and inflation, and perception the Fed's influence. Survey evidence on these topics is summarized in several tables.

Table B.1 documents knowledge and awareness of the Fed and monetary policy. Many consumers lack even basic knowledge about the Fed and monetary policy. In the 1970s and 80s, most consumers rated their own understanding of the Fed and monetary policy as low, and only half could identify the Fed as responsible for setting monetary policy. The Fed's interest rate hikes in 1994 were noticed by two thirds of consumers; somewhat fewer noticed Fed policy in the first half of 2000. Many consumers are not aware of who is the chairman of the Federal Reserve. By 2000, 44% of adults could say who Alan Greenspan was without a list of options. Knowledge of Bernanke is even more limited. When asked to choose the Fed Chair from a list of three names, in 2007 and 2008 only about a third of respondents picked Bernanke—no better than guessing at random! Even after the financial crisis brought the Fed more into the news, Bernanke's name recognition was startlingly low.

Tables B.2 and B.3 trace consumers' understanding of the meaning, causes, and possibility of controlling inflation. While the FOMC believes that monetary policy is the primary determinant of long-run inflation (FOMC, 2012), not all consumers recognize so direct a link between monetary policy and inflation or understand how such a link should work. In the 1950s, most consumers thought that inflation meant devaluation of the dollar or rising prices, and thought that serious inflation would lower their standard of living or real wages. They understood that inflation could reduce the value of their savings and Social Security benefits, but most did not know ways to protect savings against inflation. Most thought that inflation was caused by people or the government spending too much. In the late 1960s and early 70s, many believed that cutting war spending or imposing price controls could help check inflation, but few thought that interest rates or the money supply had a role to play. Since the late 1970s, although most people believe that the government does have some ability to control inflation, fears that high inflation may return are quite prevalent. Even in 2013, confidence that inflation will remain moderate over the next ten years is low.

Table B.4 summarizes consumers' self-reported interest in news about monetary policy and beliefs about how it affects them personally. From 1957 to 1983, a growing share of households believed that inflation had hurt their family (Figure 2.7). Correspondingly, in the mid-80s over half of households thought Fed actions affected them personally, and in the 1990s, the general public did pay some attention to the Federal Reserve's interest rate policy. More recently, most people do not find it worthwhile to track economic statistics nor do they view inflation as a major concern. The attention they pay to Federal Reserve communications about monetary policy is correspondingly low. Public knowledge of the official inflation rate is far lower than knowledge of the official unemployment rate (Figure 2.8). When Shiller (1997) interviewed the public about inflation, he noted that "in spite of their convictions as to the importance of inflation, [most people] seemed not to have given really serious thought to it."

Table B.5 and B.6 summarize consumers' tendency to credit the Fed for favorable economic developments and blame the Fed for negative developments. In the 1970s and 80s, when inflation and disinflation were dramatic, the public was quite aware of the role of the Fed, and accorded it much of the blame and credit. Chairman Volcker was fairly widely recognized as one of the country's power players. Still, more people credited Reagan for

the recovery than the Fed. In the 1990s, the public preferred to blame the natural business cycle or private industry for economic problems, and credit the same for economic recovery. Only about 5% blamed the Fed for economic problems in the early 1990s, and just slightly more credited the Fed for the strong economy of the mid-to-late 1990s. Generally, when directly prodded, people give some credit to the Fed in good times and some blame to the Fed in bad times, but when asked who should get the *most* credit/blame, the Fed does not come to mind. Thus, the public may not think of communications from the Fed as the most obvious source to pay attention to when they are concerned about the state and future of the economy.

Confidence and Approval

Public opinion of the Fed, its policies, and its chair is informative of Fed credibility and communications effectiveness. Table B.7 summarizes the public's overall opinion about the Fed and its role in the economy, Table B.8 considers opinions of particular Fed policies, and Figures 2.9 and 2.10 plot measures of confidence. Public opinion of the Fed and its policies reached a high point in the mid-1980s around the Volcker disinflation. The majority of consumers—far more than in the years prior to the disinflation—approved of the Fed, its interest rate policy, and Volcker himself; the great majority favored central bank independence. Several years after the Volcker disinflation, public confidence in the Fed fell. By 1994, less than half of consumers approved of the Fed's policy of increasing interest rates to control inflation, and most opposed the idea of an independent Fed. The strong economy of the mid-2000s bolstered opinion of the Fed and Greenspan. In 2002-2005, nearly half of consumers approved of Fed interest rate policies, but almost as many had no opinion.

The financial crisis and Great Recession again weakened public opinion of the Fed. By October 2010, just 29% of consumers thought that Bernanke had helped the economy since the 2008 collapse. In 2009 only a third of consumers thought the Fed was doing a good or excellent job, and even by 2013 this opinion hadn't improved. When Bernanke left office, 40% approved of his job as Chairman, far lower than either Volcker or Greenspan.

Several questions about the Fed chair have been asked fairly consistently over the years. In 1989 and yearly since 2001, Gallup has asked: "Please tell me how much confidence you have in [Federal Reserve Chairman (Name)] to do or to recommend the right thing for the economy–a great deal, a fair amount, only a little, or almost none." Another Gallup/CNN/USA Today Poll[22] has asked occasionally since 1997, "As I read each name, please say if you have a favorable or unfavorable opinion of these people–or if you have never heard of them....[Federal Reserve Chairman]." From the first question, I compute a "confidence balance statistic": two times the percent of "great deal" responses plus one times the percent of "fair amount" responses minus the number of "only a little" or "almost none" responses. From the second question, I compute a "favorability balance statistic": the percent of favorable responses minus the percent of unfavorable responses.

[22]In 2009 and 2011, the poll was conducted by CNN/ORC International.

Panel A of Figure 2.9 plots the confidence balance statistic, the percent of "no opinion" responses from the Gallup Poll, and the favorability balance statistic. Greenspan, in 2001, had the highest confidence balance score, 87, but his score declined steadily to 42 by 2005. Bernanke began his chairmanship with a confidence balance score of 24 in 2006, when 34% of respondents had no opinion of him. By the next year, 25% had no opinion, and his score increased to 34. During and after the financial crisis and Great Recession, his score declined, reaching a low of -1 in 2012, when only 15% had no opinion of him. His score rose modestly to 11 in his last year. Yellen began 2014 with a confidence balance score of 3; 20% had no opinion of her. Greenspan's favorability balance statistic was much higher than Bernanke's.

Panel B of Figure 2.9 compares public opinions of Bernanke to opinions of President Obama and Republican and Democrat leaders in Congress in regards to doing or recommending the right thing for the economy, from an April 2014 Gallup Poll. The confidence balance statistic is by far the highest for Obama, second highest for Bernanke, and extremely low for Republican Congressional leaders. Only 1% of respondents have no opinion about Obama's ability to do or recommend the right thing for the economy, and only 3% have no opinion with respect to the Congressional leaders of either party, while 20% have no opinion with respect to Bernanke. The public is less familiar with the Federal Reserve and its economic policy than with economic policymaking by the executive and legislative branches.

Figure 2.10 compares Americans' confidence in the Fed to Britons' and Europeans' confidence in the Bank of England and the European Central Bank in 2008. The differences between countries are not drastic, though French confidence is somewhat higher and British confidence is somewhat lower. Few citizens in any of the countries were very confident, and most had lukewarm confidence.

2.6 Strategies in Other Countries

Central bank communication strategies vary across countries with no clear consensus on best practices (Blinder et al., 2008). Interactions with the general public also vary. Central banks in several countries have made explicit efforts to improve communications with the general public or have made note of the challenges they face in communicating with the public.

Swedish Riksbank

The Swedish Riksbank tops the list of most transparent central banks in Dincer and Eichengreen (2009). Target groups for the Riksbanks communication explicitly include members of the Riksdag, companies, households, banks and other participants in the financial markets, government agencies, organisations, media and employees of the Riksbank[23]. In at least one instance, the Riksbank has monitored the public's attention to its communication and modified its strategy based on what was learned. The Riksbank used to publish written questions and answers online following policy decisions. Riksbank Head of Communication

[23]Separate appendix to the Riksbank's communication policy, 2008.

Ann-Leena Mikiver recalls that "After a while when we monitored how many people read that, it was less than 20 people...We started to make films with [the governor] instead, and suddenly we had about 2,000 viewers - and it was exactly the same message. So it's choosing the right channels and mixing them in the right way." [24]

Riksbank video chats differ in several key ways from the Fed Chair's quarterly press conferences that began in 2011. Riksbank press conferences occur six times per year on the day after monetary policy meetings rather than quarterly. Levin (2014) says that there is a strong case for holding press conferences after every scheduled meeting, since a Q&A session provides a more comprehensive explanation of policy adjustments than a written statement.

Another difference is that questions come from the Swedish public rather than members of the press. This impacts the style of the questions, since many of the members of the press at the Fed's press conferences are highly informed about financial markets and write for a financially sophisticated audience. The questions from the press to the Fed Chair are more specific, lengthier, and of narrower interest than the questions posed by the Swedish public. The answers from the Fed Chair are correspondingly more specific, lengthier, and less accessible than the answers from the Riksbank Governor. To illustrate the differences, here is the first question and answer from Yellen's first press conference on March 19, 2014:

> **Marting Crutsinger**: Madam Chair, Marty Crutsinger with the Associated Press. Could you give us a little insight in how the decision was made on dropping the 6 and a half percent numerical target in the forward guidance? Was there any concern expressed that there's been criticism on forward guidance, that its confusing markets, not helping them in some ways? Was there concern expressed that perhaps it would have been better to go to just a lower target, say, 6 percent? And could you also address the concerns raised in the dissent that by dropping this, it lowers the commitment on fighting low inflation? Thank you.
> **Chair Yellen**: Thanks. Well, as I mentioned in my statement, the reason the Committee felt that the time had come to revise the forward guidance is not because we think it has not been effective. I believe the Committee does think its been effective. I think its had a very useful impact in helping markets understand our expectations and shaping their own. But it is becoming—as the unemployment rate gets closer and closer to 6 and a half percent, to breaching that threshold that seems like the one that is likely to be breached. The question is: Markets want to know, the public wants to understand, beyond that threshold, how will we decide what to do?...

Yellen's answer continues for another three paragraphs. The second question, posed by Jon Hilsenrath of the Wall Street Journal, is a detailed inquiry into the "slight upward drift in the expectations for rates going out to 2016" in the interest rate projections made by FOMC participants supplementing the FOMC statement. Yellen's four-paragraph response includes

[24] "Transparency award: Sveriges Riksbank." Central Banking Journal, 2014

references to dot plots. Compare these questions and answers to the chat with Riksbank Governor Stefan Ingves on December 17, 2013 and April 9, 2014 (translated from Swedish):

> **Racemouse**: Hi Stefan! Why have you lowered the interest rate? What do you actually wish to achieve?
> **Governor Ingves**: Inflation was lower than we expected, so we need to get inflation up as economic activity improves, and an interest rate cut will help with this. This will let us meet our inflation target of two per cent.

> **Anna**: Hi Stefan. What's the main reason for the low inflation? And if we had a zero interest rate, would it really boost inflation or would it only get households to borrow until Sweden's economy was in ruins?
> **Governor Ingves**: Inflation is low because demand has been weak in many parts of the world. At the same time, it's been difficult for Swedish companies to increase consumer prices. Both of these effects have led to low inflation. The low interest rates are making it easy to borrow and this effect is simultaneously pulling in the opposite direction. This is particularly the case now that economic activity is improving.

Swedish-style question and answer sessions with the general public could supplement, but not necessarily replace, the press conferences currently held by Yellen. The purpose and intended audience are different.

European Central Bank

The European Central Bank (ECB) has emphasized communication with the public and financial markets since its inception. The ECB provides a two-part rationale for communication: "Communication with the general public and with the financial markets is crucial for any central bank, for two reasons. First, effective communication can contribute to the efficiency of a central banks policies and help it attain its objectives. Second, communication can be regarded as part of a general requirement to be accountable to the public."[25]

ECB policymakers note that "transparency means more than simply releasing information, as this does not by itself translate into a better understanding of monetary policy. The potential problem of information overload contrasts with the need for clarity, which becomes even more important when information is to be communicated to different audiences across different environments. Proper interaction with the public requires that the central bank as 'sender' and the public as an active 'receiver' share a common framework and language — a common understanding — with which both are comfortable."[26]

The ECB President has held monthly press conferences since 1998. These press conferences, similar to those held by the Fed Chair, are best suited for communication with

[25] "The external communication of the European Central Bank," ECB Monthly Bulletin, February 2001, p. 59.

[26] "Transparency in the monetary policy of the ECB," ECB Monthly Bulletin, November 2002, p. 60.

financial markets. The ECB uses other methods to communicate with the general public. One approach is to target its communications to "multipliers" such as teachers and journalists (Kuhn, 2005). Approximately 10,000 people visit the ECB annually, and "it is assumed that there will be a strong 'multiplier effect', as the groups often consist of teachers, bankers, members of special interest groups and others who influence public opinion"[27] Another approach is to provide short educational videos on Youtube, such as "ECB and the Euro Explained in 3 Min." Section 2.4 discussed the Federal Reserve's Youtube channel, which has just over 400,000 video views. The official ECB Euro channel has over 6.3 million views.

The ECB works with the National Central Banks (NCBs) to serve a multilingual, multicultural public. The External Communications Committee, formed in September 1998, consists of communications experts from the ECB and the NCBs (**?**). Among the NCBs, the National Bank of Austria (OeNB) stands out for its comprehensive communication policy. The OeNB produces "Die aktuelle Zahl," in which OeNB statisticians highlight one particular statistical figure produced by the OeNB and explain it to the public in a few sentences. The OeNB Statistics Hotline takes around 1700 calls or emails per year from journalists and citizens. Since most of the general public does not read specialized financial media, the OeNB organizes seminars about economic statistics for journalists at nonspecialized media (Ittner and Schubert, 2010). The Federal Reserve also makes use of its decentralized structure to assist in outreach to a nonhomogeneous and geographically large public. Alan Greenspan (2001) notes that the Fed's regional structure also allows the 12 Banks and 25 branches to experiment with various techniques for reaching out to the public, citing the Visitors Center at the Chicago Fed as an example.

Bank of England

The Bank of England (BoE) website explains that "the monetary policy framework established in 1997 will be most effective if it is accompanied by wide public understanding and support, both for the objective of price stability and for the methods used to achieve it. The Monetary Policy Committee (MPC) uses a variety of methods to explain to the public its role of setting interest rates to meet the inflation target. These methods include the publication of the minutes of their monthly meetings; the quarterly Inflation Report; speeches and lectures; research papers; appearances before parliamentary committees; interviews with the media; visits throughout the UK and an education programme that includes the 'Target Two Point Zero' competition for schools and colleges."

Despite these efforts, the BoE faces substantial challenges in communicating with the public. The BoE uses a quarterly survey of inflation attitudes to monitor the impact of its communication efforts. One question asks, "Each month, a group of people meets to set Britain's basic interest rate level. Do you know what this group is?" Consistently around

[27] "The external communication of the European Central Bank," ECB Monthly Bulletin, February 2001, p. 59.

half of respondents say that they don't know, and around 40% identify the MPC or the BoE. When given a list of options (government ministers, civil servants, Bank of England, high street banks, or the European Central Bank), around two thirds choose the BoE. Reported satisfaction with "the way the Bank of England is doing its job to set interest rates in order to control inflation" varies more, and fell significantly during the Great Recession.

The BoE Youtube channel has 1,879 subscribers, twice as many as the Fed as a share of the country's Youtube users. Like the ECB, the BoE posts educational videos in the three to seven minute range that draw considerable interest. The video "Quantitative Easing—How it Works" has been viewed over 60,000 times. The videos "Money creation in the modern economy," "What is inflation?," and "History of inflation," are also among the most viewed.

Bank of Japan

According to its annual review, "To promote better understanding of the policies and business operations of the Bank [of Japan], not only in the eyes of financial professionals but also of the public as a whole, the Bank endeavors to make its publications and releases better suited to the diverse needs and interests of their users. The Bank also works to promote financial literacy among the public." [28] However, public understanding of Bank of Japan (BoJ) policies appears limited. Since 1993, the BoJ has conducted its Opinion Survey on the General Public's Views and Behavior. One section focuses on recognition and credibility of the Bank. About a third of consumers say they know that the Bank has a price stability mandate. In March 2014, 28% of consumer said they knew that the Bank had set the price stability target at 2%.

The survey includes occasional questions about the clarity of the Bank's explanations to the public. Over half of respondents say explanations are not clear enough. When asked to explain, most cite lack of basic knowledge about the bank, lack of opportunity to read or hear about the bank, and overly technical language in Bank communications. In December 2005, 68% of respondents said they "know almost nothing about the Banks policy and operations." On the same survey, 63% thought the BoJ should expand its television and radio communication, and 60% thought the BoJ should contribute materials to newspapers and magazines. Only a small minority wished for more Bank publications and speeches.

The BoJ Governor also holds press conferences, which are even less geared toward the general public and more toward financial markets compared to the Fed and ECB press conferences. Bank of Japan Governor Haruhiko Kuroda only began allowing media to broadcast his remarks in real time in March 2014; previously, remarks were embargoed until the end of the press conference. Kuroda's answers tend to exceed five minutes in length and even the questions can exceed a minute (Kuroda, 2014). BoJ press conferences are held monthly rather than quarterly.

[28] Bank of Japan 2012 Annual Review,p. 29

Common Challenges

The Fed, Riksbank, ECB, BoE, and BoJ are not alone in confronting the challenges of communicating with the general public. Many central banks around the world make a conscious effort to communicate with households and find that this target audience requires a different communication approach than other audiences. The Reserve Bank of South Africa commissioned a survey of the attitude of the public towards the Bank in 2011. Governor Gill Marcus (2014) describes that "The results of the survey were gratifying in that they indicated that the Bank had a high degree of credibility in the eyes of the markets. However, 45 per cent of South Africans were unaware of our very existence!" He adds that "communication is not just about our interaction with the markets. We have made a conscious effort to communicate with different stakeholder groups in the broader civil society through our outreach programme. We meet on a regular basis with political parties, trade unions and business associations from different sectors of the economy."

The Reserve Bank of India notes that "Communication is sensitive to the target audience — researchers, analysts, academics, media, regulated entities, other central banks, rating agencies, multilateral institutions, market participants, Government agencies and the common person including urban and rural population, women, senior citizens, defence personnel, school children — and therefore different types of communication instruments are used."[29]

Lack of financial and economic literacy is a shared obstacle to communication with the general public and has motivated education initiatives by many central banks. Outreach targeted to education professionals has the potential to impact a wide audience. Most precollege teachers in the United States have little to no formal training in economics, and teacher knowledge is a key predictor of student success in learning economics (Watts, 2005). Many of the Federal Reserve Banks have economics education initiatives, such as the San Francisco Fed's Education Advisory Group. The St. Louis Fed's Economic Education initiative, Econ Lowdown, provides free classroom resources for K-16 educators teaching about money and banking, economics, personal finance and the Federal Reserve. Econ Lowdown provides professional development events, videos, and other materials. Financial and economic literacy is not the sole responsibility of central banks. The Department of Education, other federal and state government agencies, colleges and universities, and employers all have a role to play. But since economic literacy is so complementary to the goals of the Federal Reserve, its efforts to improve economic literacy merit expansion and improvement. A rigorous impact evaluation of Fed education programs is much needed.

2.7 Discussion and Conclusions

Before the 1990s, the FOMC was shrouded in mystery. More recently, Federal Reserve officials believe that monetary policy is more effective when the public understands the Fed's

[29] "Communication Policy of the Reserve Bank of India," 2014

objectives and plans. The Fed therefore places significant emphasis on its communication strategy. While numerous papers have studied the impact of the Federal Reserve communication strategy on expectations in financial markets, this paper is among the first to focus instead on the general public.

Communications regarding the price stability mandate are not effectively transmitted to most of the public. Long-run inflation expectations are not firmly anchored around the 2% target. The stability of median expectations obscures the frequent, large forecast revisions made by individual consumers. The anchoring of consumers' inflation expectations improved during the 1980s and 1990s, but has not notably improved since then. Most consumers are either unaware of the 2% inflation target or do not believe it to be credible. Since the target was announced, just over half of consumers expect 1, 2, or 3% inflation at the 5- to 10-year horizon, and less than 15% expect 2% inflation. There are significant demographic disparities in the reach of Federal Reserve communication. Homeowners, stock market investors, and individuals with higher income and education have more strongly-anchored inflation expectations. Compared to professional forecasters, consumers are drastically more uncertain about inflation and less likely to believe that long-run inflation will be near the Federal Reserve's stated target.

The effectiveness of central bank communication in reaching the general public depends on propagation of monetary policymakers' messages through the media. Quantitative news analysis and Google search data reveal that consumers are neither passively exposed to information about inflation and the Federal Reserve by the mass media nor actively seeking this information. Though the Fed transparently provides information about its policies and long-run inflation goals, and this information is in theory easily accessible, it is not in practice widely transmitted. Policymakers can influence media coverage if they make an active effort to do so, but the Fed has so far taken a relatively passive approach to its interactions with the media. The Fed has begun to use interactive new media such as Facebook, Twitter, and YouTube, and its efforts to communicate via these media should continue to be evaluated. Television appears to be particularly effective at reaching a large audience; Chairman Bernanke's appearances on 60 Minutes and CBS News garnered far more public attention than his typical speeches.

A collection of various surveys fills in more of the picture of why the general public, in contrast to professional forecasters and financial market participants, is unreceptive to Federal Reserve communications. General knowledge and awareness of the Fed and its functions is limited. Many consumers can not identify the Federal Reserve chair or have no opinion of the chair's leadership. Public confidence in the Fed chair has been lower under Bernanke and Yellen than under Greenspan. Consumers are more likely to blame the President or Congress for economic troubles and credit them for economic improvements, rather than blaming or crediting the Fed, indicating a perception of limited efficacy or potency of monetary policy. Only a quarter of consumers in 2010 thought that QE2 would help the economy, for example. Consumers do not tend to rate inflation as a top economic issue, nor do they believe that economic statistics are particularly relevant to their lives. Consumer inattention is a greater reality than economists and policymakers might expect,

which may help explain why the communication strategy fails to reach large segments of the population, particularly less-educated and lower-income groups.

The apparent failure of recent Federal Reserve attempts to communicate its price stability objectives and policies to the public thus seems partly attributable to a general lack of attention, awareness, and financial literacy. In 2001, Alan Greenspan (2001) remarked that "we are most often communicating with colleagues and experts and thus do not confront the need to convey our observations in nontechnical, accessible, or entertaining formats." This insight remains relevant today, even as new media expand the possible communication formats at policymakers' disposal. Central banks across the world have begun to recognize the need to tailor communications to the needs of each target audience. Addressing this need will be an ongoing challenge of monetary policy research and practice.

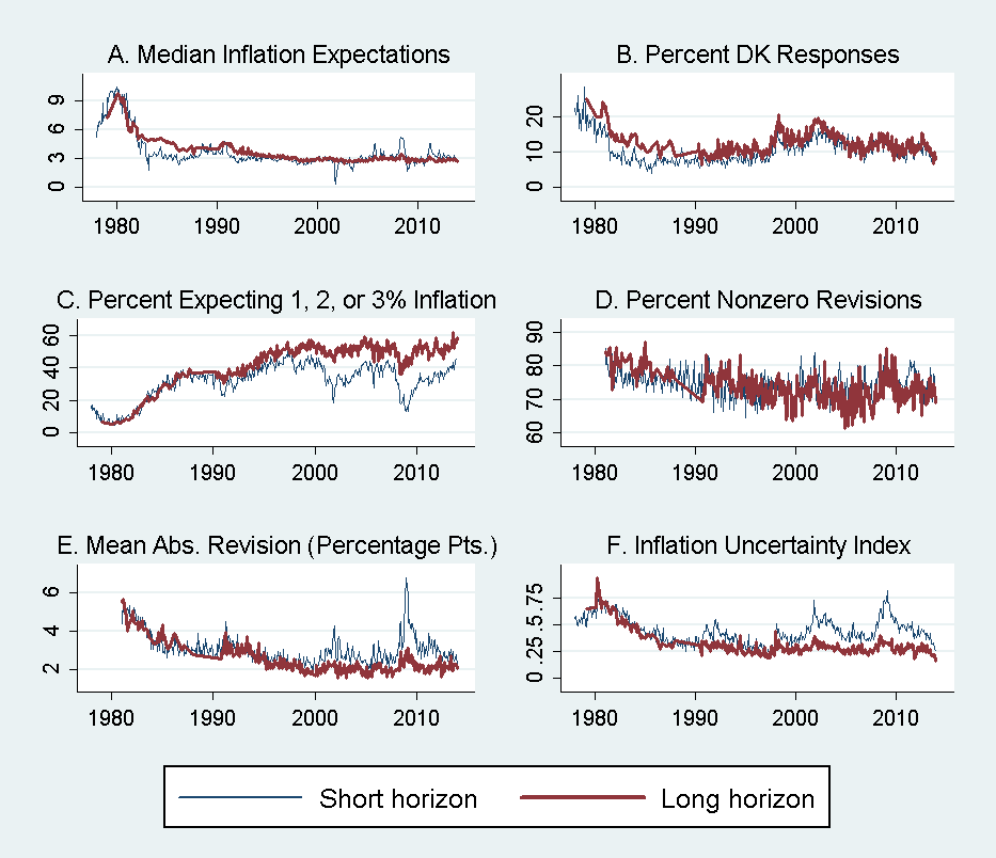
2.8 Tables and Figures

Table 2.1: Indicators of Expectations Anchoring Regressed on Demographic Variables.

	All Years			2012-2013		
	(1)	(2)	(3)	(4)	(5)	(6)
	Uncertainty	Abs. Rev.	1-3%	Uncertainty	Abs. Rev.	1-3%
log Real Inc.	-0.59***	-0.22***	0.14***	-0.59***	-0.18*	0.14***
	(0.05)	(0.03)	(0.01)	(0.15)	(0.09)	(0.02)
Educ.	-0.18***	-0.10***	0.04***	-0.16***	-0.11***	0.03***
	(0.02)	(0.01)	(0.00)	(0.04)	(0.03)	(0.01)
Female	1.25***	0.45***	-0.26***	1.06***	0.32***	-0.21***
	(0.07)	(0.03)	(0.01)	(0.17)	(0.09)	(0.03)
Married	0.08	0.01	0.03***	0.11	0.05	-0.01
	(0.05)	(0.04)	(0.01)	(0.18)	(0.12)	(0.03)
Age	-0.01	-0.02***	0.00***	-0.00	-0.03	-0.00
	(0.01)	(0.01)	(0.00)	(0.03)	(0.02)	(0.00)
Age Sq.	0.00	0.00***	-0.00***	0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
White	-0.31**	-0.26***	0.16***	-0.01	-0.16	0.03
	(0.14)	(0.08)	(0.02)	(0.27)	(0.15)	(0.06)
African-Amer.	0.29	0.34***	-0.02	-0.08	0.19	-0.07
	(0.18)	(0.12)	(0.03)	(0.28)	(0.28)	(0.07)
Hispanic	0.47***	0.16	-0.06*	0.13	-0.12	0.01
	(0.18)	(0.11)	(0.03)	(0.34)	(0.29)	(0.08)
Stock	-0.19***	-0.11***	0.06***	-0.21***	-0.15***	0.08***
	(0.02)	(0.01)	(0.00)	(0.04)	(0.03)	(0.01)
N	67767	27000	77409	8986	3369	9952
R^2	0.04	0.06		0.04	0.05	

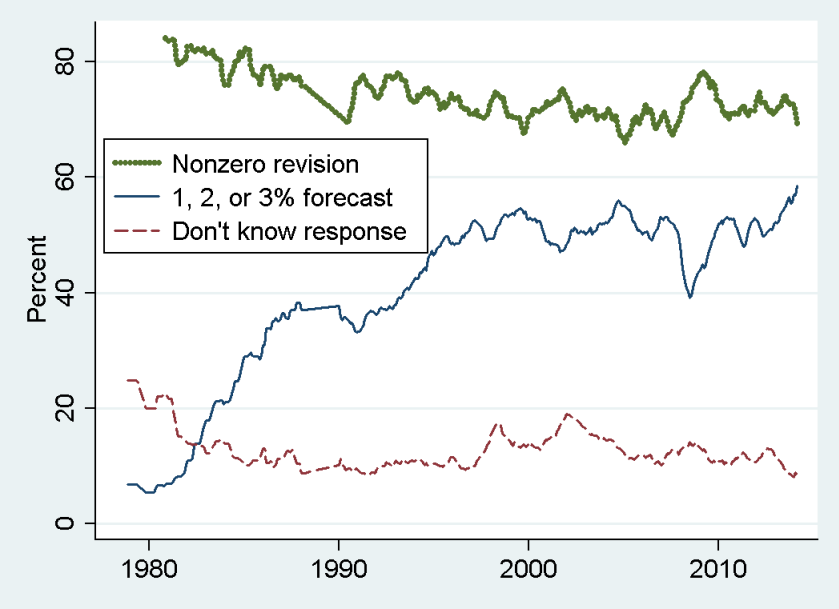
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors clustered by time in parentheses. Data from Michigan Survey of Consumers. Dependent variables derived from consumers' long-run inflation expectations. Columns (3) and (6) are probit regressions. Log real inc. is log of real income, educ. is highest grade of schooling completed, and stock is the stock market investment quintile, taking values from 0 (no stock investments) to 5 (highest investment quintile).

Figure 2.1: The anchoring of consumer inflation expectations



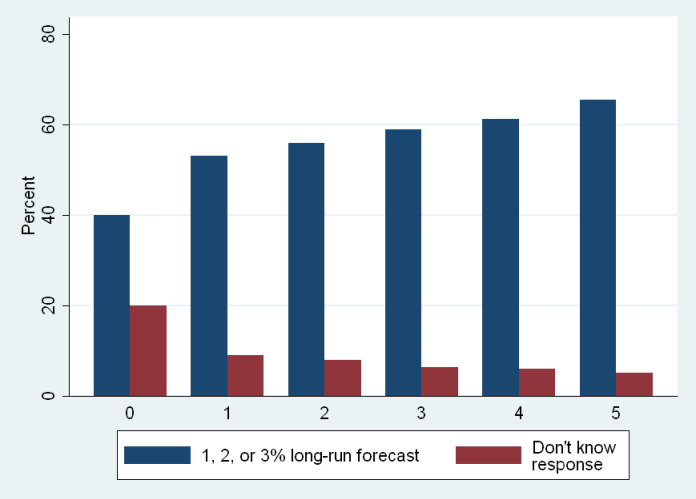
Notes: Data from Michigan Survey of Consumers. The short and long horizons refer to one-year-ahead and five- to ten-year-ahead inflation expectations, respectively. Forecast revisions are the difference in expectations made by respondents who take survey twice at six-month interval.

Figure 2.2: Indicators of expectations anchoring over time



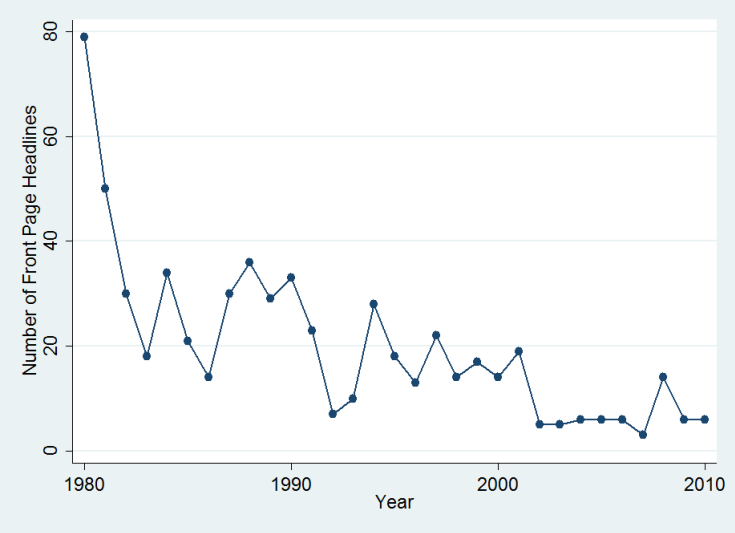
Notes: All measures are derived from Michigan Survey of Consumers long-run inflation expectations microdata. Centered 7-month moving average.

Figure 2.3: Characteristics of inflation forecasts by investment quintile



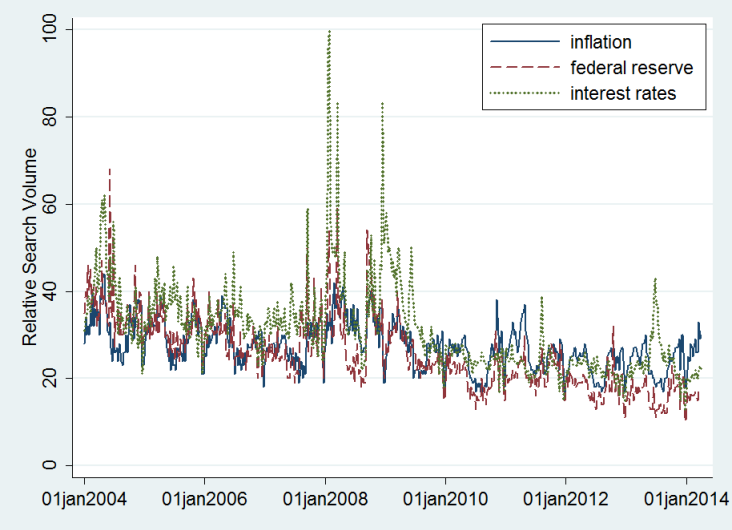
Notes: Percent of respondents with 1, 2, or 3% inflation forecast or giving "don't know" response, by investment quintile, where 0 denotes no stock market investments and 5 denotes highest quintile.

Figure 2.4: Newspaper Coverage of Inflation and the Federal Reserve



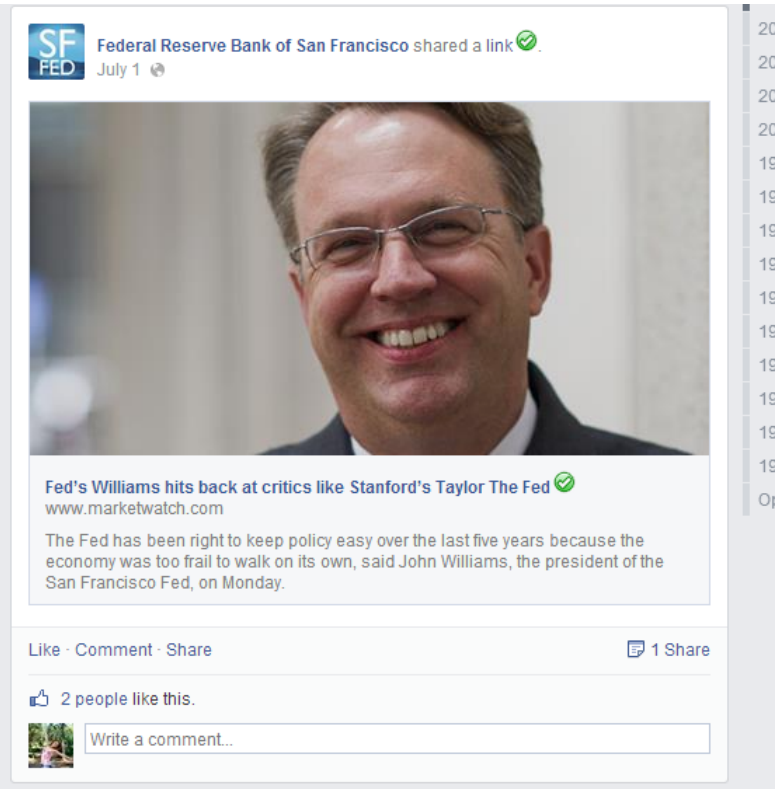
Notes: Number of New York Times front page headlines per year mentioning inflation, deflation, Federal Reserve, prices rising, Greenspan, Volcker, Bernanke, or Yellen.

Figure 2.5: Google search volume for inflation, Federal Reserve, and interest rates



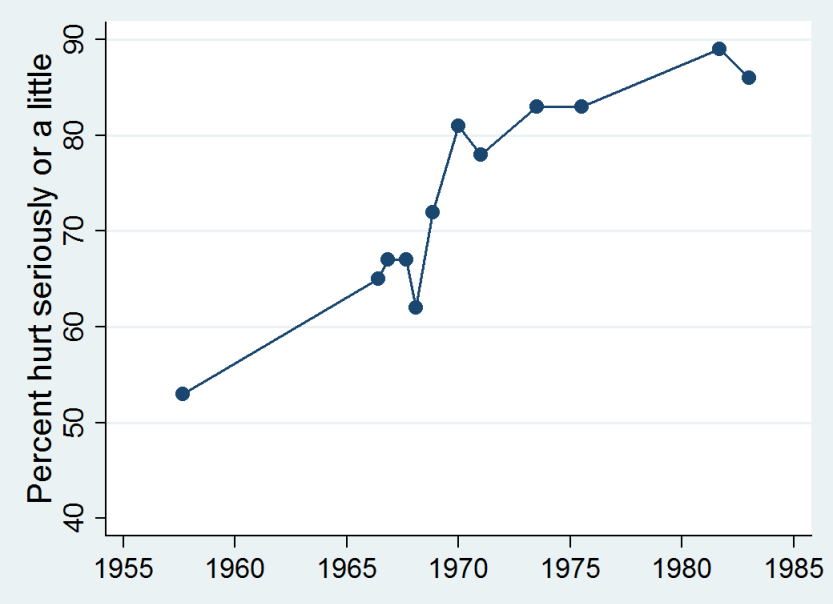
Notes: Data on search volume in the United States is from Google Trends. Data is only available normalized; the highest search volume week for "interest rates" is normalized to 100.

Figure 2.6: Facebook post by the San Francisco Federal Reserve



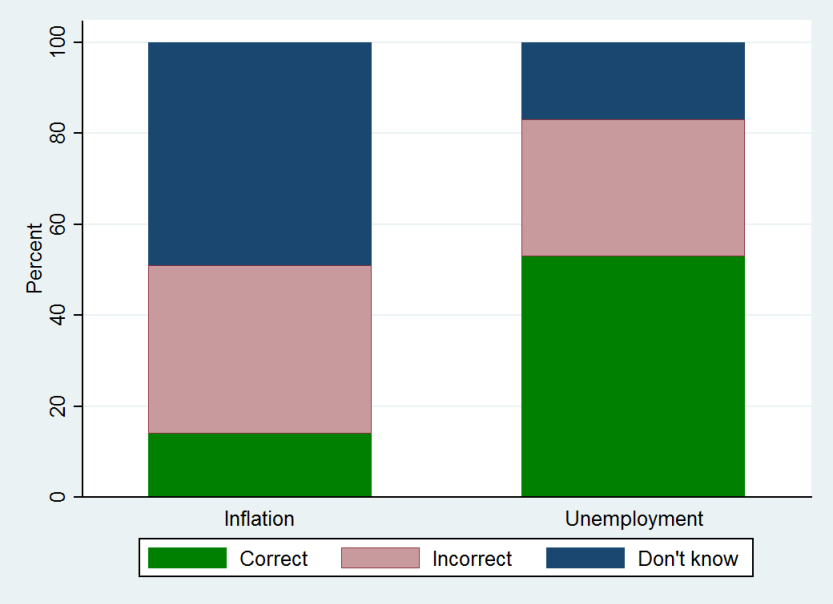
Notes: This screenshot from the San Francisco Fed's Facebook page was captured on July 14, 2014. The SF Fed posted an article from the Wall Street Journal's "MarketWatch" site on July 1, 2014. Two Facebook users "liked" the post, one shared it, and zero commented on it.

Figure 2.7: Percent of consumers hurt by inflation



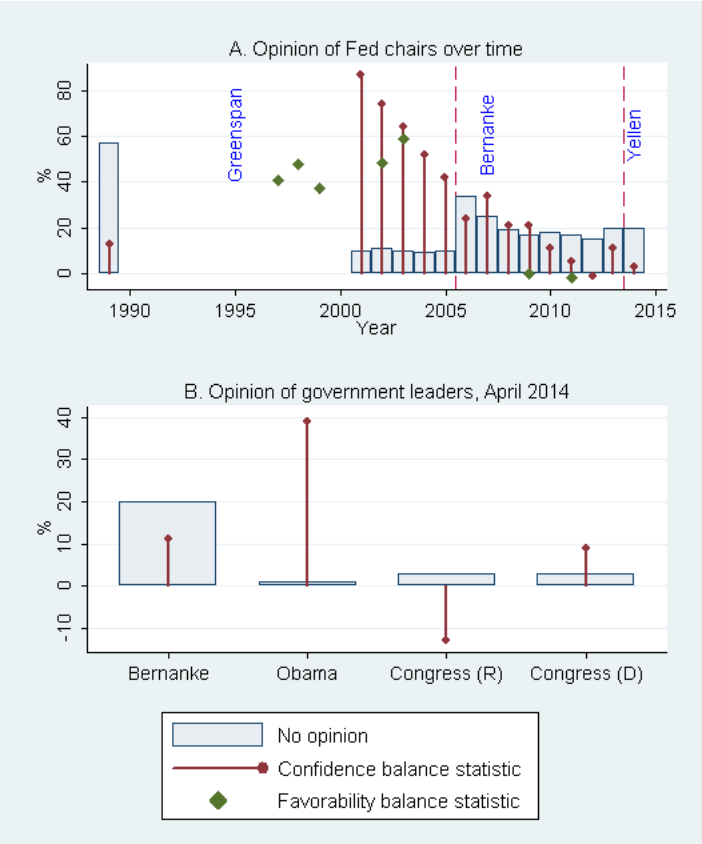
Notes: Responses to ORC Public Opinion Index question, "Speaking of yourself or your family, has inflation so far hurt you seriously, hurt a little, or hasn't it hurt you at all?"

Figure 2.8: Knowledge of official inflation and unemployment rates



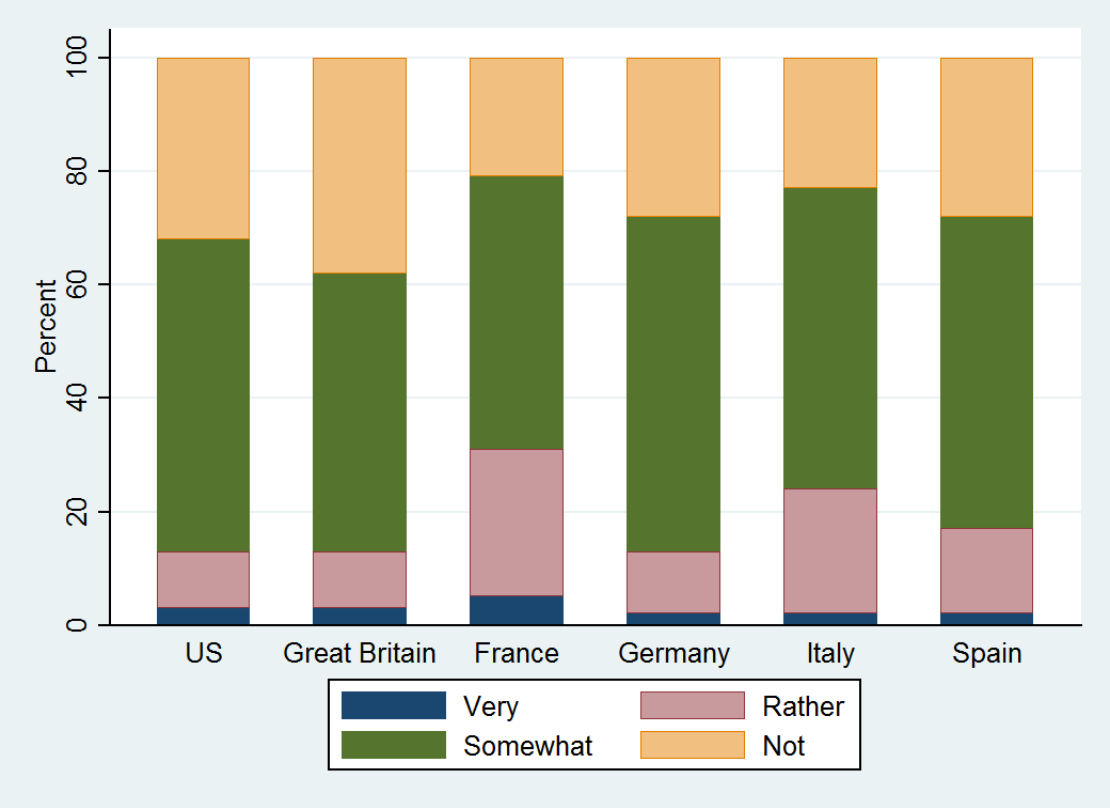
Notes: The Pew Research Center for People and the Press in December, 2010, asked 1,001 adults,"Do you happen to know if the national [inflation, unemployment] rate reported by the government is closer to 1%, 5%, 10%, or 20%?"

Figure 2.9: PublicoOpinion of federal reserve chairs



Notes: Confidence balance statistic, and favorability balance statistic, and percent of respondents having no opinion of Federal Reserve Chairs and other government leaders. Higher balance scores indicate greater confidence or favorability. No opinion and confidence balance statistics from Gallup Polls. Favorability balance statistics from Gallup/CNN/USA Today Polls.

Figure 2.10: Confidence in central banks



Notes: The Financial Times/Harris Survey on April 16, 2008, asked approximately 1,000 adults per country,"How confident are you that the [European Central Bank, Bank of England, Federal Reserve] can set interest rates at an appropriate rate to manage the current credit crisis: very confident, rather confident, somewhat confident, or not confident at all?"

Chapter 3

Inflation Expectations in the Great Depression

3.1 Introduction

The Great Depression is one of the most dramatic episodes in economic history. Ben Bernanke (1995) calls it the "Holy Grail of macroeconomics." Interpretations of its onset, severity, and recovery depend on the behavior of inflation expectations from before the Depression through the recovery period. Theories of the contraction depend on when, whether, and why the deflation of 1930-32 was anticipated (Romer and Romer, 2013). Theories of the recovery depend on when and why positive inflation expectations reappeared, and in particular on whether a "regime change" under Roosevelt generated inflationary expectations (Temin and Wigmore, 1990; Eggertsson, 2008).

This paper examines the behavior and role of expectations in the Great Depression in more detail. Economists have used a variety of approaches to estimate inflation expectations in the Depression era. Some have focused on the onset and others on the recovery. In this paper I describe, compare, and supplement the numerous approaches that have been used and account for differences in results. Approaches fall into three categories: "market-based," statistical, and narrative.

"Market-based" approaches use asset prices or other market data to make inferences about inflation expectations. Temin and Wigmore (1990) use the behavior of stock prices to make qualitative inferences about inflation expectations, and I quantify their strategy. Other market-based approaches include the commodities future prices approach of Hamilton (1992) and the analysis of nominal debt issuance by Fackler and Parker (2005). I introduce a Phillips curve approach that exploits the role of inflation expectations in inflation dynamics.

Statistical approaches use univariate or multivariate time series methods to estimate inflation expectations. Univariate statistical approaches are used by Cecchetti (1992) and Dorval and Smith (2013), who construct ARMA forecasts of inflation to estimate inflation expectations. Multivariate methods include the interest rate approach introduced by Mishkin

(1981) and used by Cecchetti (1992) and Romer (1992), and vector autoregressions used by Dominguez et al. (1988). I conduct similar estimates using alternative specifications and data. A general problem with these approaches is that they are, by construction, unable to detect a regime shift in expectations, and depend on strong assumptions about the models and information sets used by contemporaries to form inflation expectations.

The narrative approach provides more insights into how agents in the Depression era actually formed their inflation expectations. Dominguez et al. (1988) present narrative evidence from the records of the Harvard and Yale forecasting services in 1929. Nelson (1991) and Romer and Romer (2013) present evidence from the contemporary business and financial press for the onset of the Depression, and Jalil and Rua (2013) do so for 1933. I supplement these authors' evidence with evidence from professional forecasting services, economic reports, and major newspapers that previous researchers haven't explored.

After comparing the estimates obtained by each approach and accounting for differences in estimates, I conclude that deflation was mostly unanticipated until mid-1930. Thus it is possible that debt deflation, as described by Fisher (1933) and Bernanke (1983), was operative in the downturn. I also conclude that a regime change occured at the start of Roosevelt's presidency, and that inflation expectations turned positive before monetary expansion. These conclusions do not negate Friedman and Schwartz' (1963) monetary theory, but do suggest that nonmonetary forces played a major role in the contraction and recovery.

Section 3.2 outlines the role of inflation expectations in competing theories of the Depression. Section 3.3 discusses market-based approaches, Section 3.4 statistical approaches, and Section 3.5 narrative approaches. Section 3.6 summarizes the approaches and concludes.

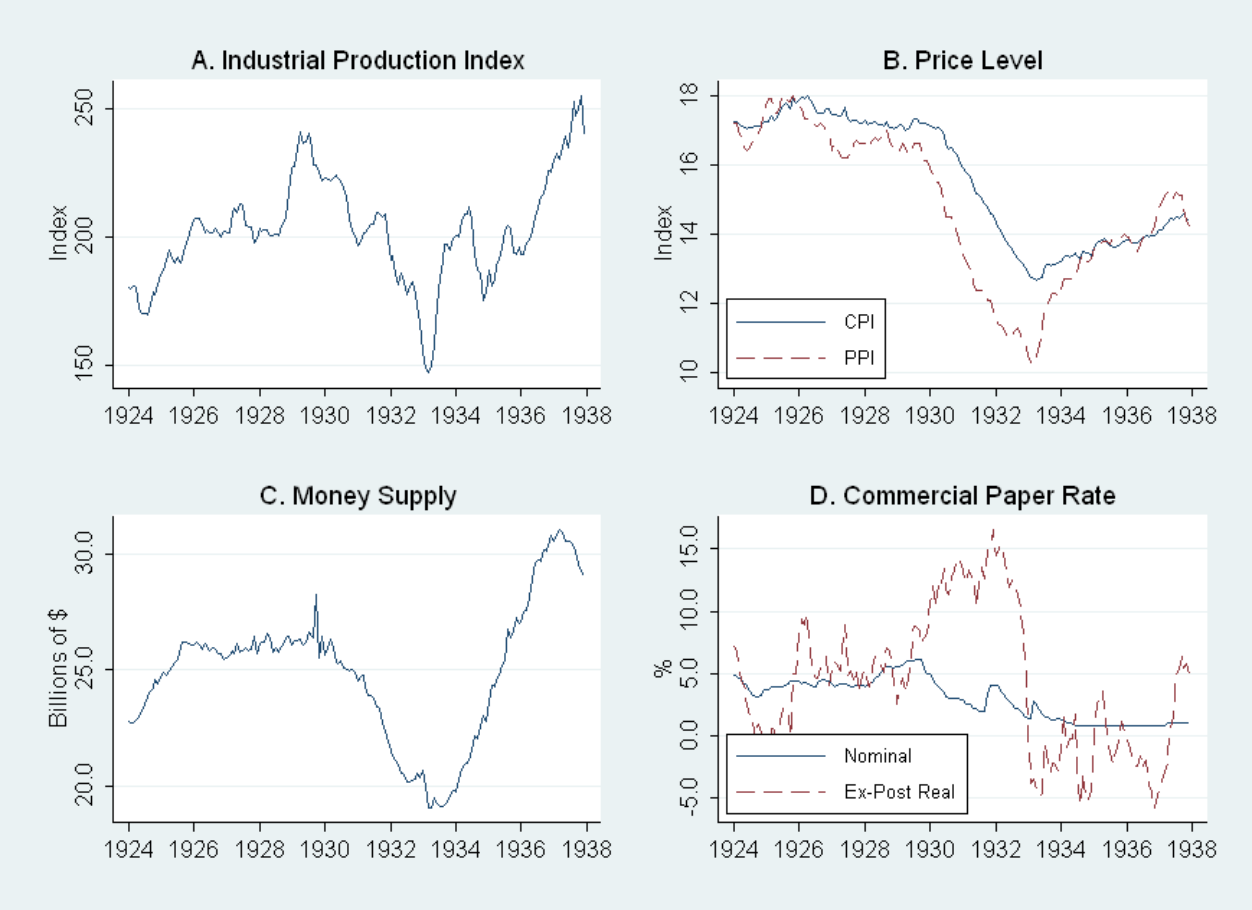
3.2 Inflation Expectations in Theories of the Depression

Macroeconomic time series exhibit striking behavior during the Great Depression. Figure 3.1 displays graphs of industrial production, the price level, the money supply, and real and nominal interest rates from 1924 to 1938.[1] After relative stability in the mid-1920s, the Consumer Price Index (CPI) and Producer Price Index (PPI) declined an average of 8% and 12% per year, respectively, from 1930 to 1932. Meanwhile, the money supply and industrial production contracted. Recovery began in 1933 as these trends reversed.

Panel D shows the 4-6 month nominal commercial paper rate in New York and the *ex post* real interest rate (the commercial paper rate minus CPI inflation from month t to $t+6$, annualized.) Nominal interest rates generally declined through the Great Depression, approaching the zero lower bound. While Panel D displays *ex post* real interest rates, without a measure of inflation expectations we do not know the behavior of *ex ante* real interest rates. This unknown plays a critical role in theories of both the contraction and the recovery.

[1] See Appendix C.1 for data descriptions.

Figure 3.1: Macroeconomic time series 1925-38



Notes: Industrial production is the adjusted Miron-Romer index from Romer (1994). The money supply, in millions of $, seasonally adjusted, is series Cb64 from Friedman and Schwartz' "A Monetary History of the United States." Commercial paper rate is the FRED series M13002US35620M156NNBR.

Expectations and the Contraction

According to the *monetary hypothesis* of Friedman and Schwartz (1963), monetary contraction is largely to blame for the economic collapse of 1929-33, and more accomodative monetary policy could have dramatically reduced its severity. Friedman and Schwarz identify episodes from 1867 to 1960 when the money supply moved for reasons exogenous to current or expected macroeconomic conditions. They find that output and prices moved in the same direction as the money supply following these "monetary shocks."

They identify several contractionary monetary shocks from 1928 to 1933. First was deliberate monetary tightening from Spring 1928 until the October 1929 stock market crash in response to Federal Reserve concern about speculation on Wall Street. Benjamin Strong, Governor of the Federal Reserve Bank of New York, was opposed to the use of monetary policy to try to slow the stock market boom. When Strong died of tuberculosis in 1928, he could no longer restrain the Fed from anti-speculative tightening. Another example of a shock came in October 1931, when the Fed raised the discount rate by 200 basis points following Britain's departure from the gold standard. This tightening was not an endogenous reaction to declining output, but rather was motivated by a desire to defend the gold standard.

Friedman and Schwartz's reading of almost a century of the historic record and reduced form estimates of the response of output to monetary shocks is some of the strongest evidence that changes in the money supply have real effects. In the 1930s, however, monetary forces may not be the most important explanation of developments in the real economy. Friedman and Schwartz provide little discussion of the transmission mechanism from monetary shocks to output, but most scholars assume that Friedman and Schwartz had a conventional interest rate channel in mind (Romer and Romer, 2013). In the textbook IS-LM model, an exogenous reduction in money supply shifts the LM curve back, raising real and nominal interest rates. Indeed, nominal interest rate rise following most of Friedman and Schwartz' contractionary shocks. But the decline in nominal interest rates from 1929-33 is a glaring exception.

Because of the anomolous behavior of nominal interest rates, some authors have sought alternatives to the monetary hypothesis. Temin (1976), contending that nominal interest in the Depression rates present no indication of monetary stringency, points instead to an autonomous and unexplained decline in consumption[2] and a decline in exports resulting from worldwide agricultural depression. He argues that declines in consumption and exports reduced U.S. income, and, in turn, the demand for money; this, rather than contractionary monetary policy actions, explains the reduction in the money supply. In the IS-LM framework, Temin's spending hypothesis implies that the IS curve shifted back more than the LM curve, explaining the behavior of nominal interest rates.

Another non-monetary hypothesis that implicitly describes a backward-shifting IS curve is the *debt deflation hypothesis* put forth by Fisher (1933). Small borrowers greatly increased their nominal debts during the 1920s (Fackler and Parker, 2005). According to the debt deflation hypothesis, when debt is nominal, unanticipated deflation increases the real burden

[2]Romer (1990) attributes the initial decline in consumption to the uncertainty associated with the stock market crash, while Olney (1999) attributes part of the decline to features of household bankruptcy law.

on debtors, leading to insolvency and a reduction in aggregate demand. The reduction in aggregate demand leads to further declines in the price level, creating a terrible spiral. Bernanke (1983) formalizes and extends the debt deflation hypothesis by focusing on feedback between the financial and real sectors. Bank liabilities are also denominated in nominal terms. When large deflationary shocks result in debtor bankruptcies, the nominal values of assets forfeited by debtors to the banks also decline, bringing banks closer to insolvency and raising the cost of credit intermediation. Banks may fail or may reallocate assets from loans to safer government securities. The resulting higher cost and reduced availability of credit further depress aggregate demand, exacerbating the deflationary spiral.

The viability of the debt deflation hypothesis depends on *unanticipated* deflation. Alternatively, *anticipated* deflation could reconcile declining nominal interest rates with the monetary hypothesis. If anticipated deflation were a direct result of monetary contraction, then monetary forces would be responsible for rising *real* rates (Romer and Romer, 2013). Schwartz (1987) hints that she has this mechanism in mind when she criticizes Temin for neglecting the distinction between real and nominal interest rates. The behavior of *ex post* real interest rates makes this explanation plausible, but to verify it requires knowledge of inflation expectations and *ex ante* real rates, which are not directly observable.

Monetary and nonmonetary forces could certainly have both played a part in the economic contraction. Determining the extent and timing of deflation expectations is key to understanding their respective roles. The debt deflation hypothesis depends on deflation being unanticipated at the time when nominal debts were being accrued. The monetary hypothesis depends on contractionary monetary shocks giving rise to anticipation of deflation.

Expectations and the Recovery

Friedman and Schwartz identify an expansionary monetary shock beginning in April 1932, when Congress began pressuring the Fed to ease monetary policy. Initially reluctant, the Board authorized substantial open-market purchases of securities between April and June. The Glass-Steagall Act of February 1932 made this possible by allowing the Fed's holdings of government securities to be used as collateral for Federal Reserve notes. This freed up large amounts of gold to back increases in the money supply (Hsieh and Romer, 2006). But the trough of the business cycle did not occur until the spring of 1933. Friedman and Schwartz classify January 1933 to the March 1933 bank holiday as a contractionary monetary shock because, in the long gap between the November 1932 election and March 1933 inauguration of President Franklin Roosevelt, speculation arose that Roosevelt might devalue the dollar or break the link with gold. To avoid potential capital losses, domestic and foreign investors converted dollars to gold, resulting in bank failures and defensive measures against gold drain by the Fed that reduced the money stock.

The deflation episode ended and recovery began in the second quarter of 1933 under President Roosevelt, whose famous "first one hundred days" included the abandonment of the gold standard on April 19, 1933 and the enactment of the National Investment and

Recovery Act (NIRA) in June. Output growth from 1933 to 1937 was the highest of any four-year peacetime period in United States history (Eggertsson, 2008).

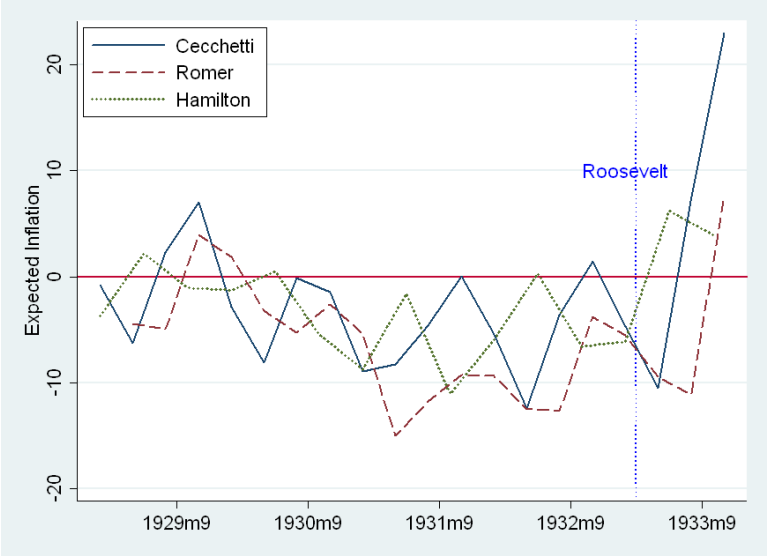
Friedman and Schwartz (1963) attribute the recovery of output from 1933 to 1937 to monetary expansion. Rapid growth of the money stock from June 1933 to June 1936, they write, "was in no way a consequence of the contemporaneous business expansion." The monetary base grew primarily through increases in the stock of gold, as the deteriorating political situation in Europe caused flows from Europe to the United States (Steindl, 2008). Romer (1992) finds that monetary expansion was a larger contributer to recovery than fiscal policy. She notes that since nominal interest rates were near the zero lower bound in early 1933, for monetary expansion to explain the recovery through aggregate demand stimulus, money growth must have lowered real interest rates by generating expectations of inflation. While money growth may explain some of the output growth from 1933 to 1937, it has difficulty explaining the turning point. Industrial production increased from the first to the second quarter of 1933, while the money supply was still declining. Friedman and Schwartz do not provide a complete explanation of the turning point, but suggest that production rose partly in anticipation of higher prices and costs under the (not-yet-passed) NIRA.

Temin and Wigmore (1990) view this explanation of the turning point as unsatisfactory, and provide an alternative explanation. They argue that Roosevelt brought about a *regime change* that shifted inflation expectations upward, stimulating the economy. The use the regime change framework of Sargent (1983), in which a sharp change in expectations enables stabilization. Temin and Wigmore explain, "It is not necessary for this transition that economic decision makers in 1933 understood modern open-economy macroeconomics...It was sufficient for them to have comprehended that gold standard rules dictated deflation in times of trouble. Roosevelt abandoned the rules that Hoover repeatedly articulated for directing the economy... Euphoria—that is, a dramatic shift in expectations—was the initial response. People anticipated that prices, incomes, or both were about to rise" (p. 486). The model of Eggertsson (2008) formalizes this regime change hypothesis, which depends on a sharp shift in inflation expectations in the second quarter of 1933.

In February 1933, a run on the dollar followed President-elect Roosevelt's discussions of the possibility of devaluation to raise commodity prices. The Bank Holiday in March was "the denouement of the Depression and gave Roosevelt unprecedented Presidential power to change policies" (Temin and Wigmore, 1990, p. 488). On April 18, 1933, Roosevelt announced his support for the Thomas Amendment to the Emergency Farm Mortgage Act of 1933, which would allow him to devalue the dollar. Devaluation was "the single biggest signal that the deflationary policies implied by adherence to the gold standard had been abandoned...It sent a general message to all industries because it marked a change in direction for government policies and for prices in general" (Temin and Wigmore, 1990, p. 485).

Temin and Wigmore take care to distinguish this regime change explanation of the turning point from the description of recovery in Europe by Eichengreen and Sachs (1985), who show that in ten European countries, departure from the gold standard preceded and enabled recovery by permitting monetary expansion. In the United States, where there was no market pressure to devalue, departure from the gold standard facilitated recovery by

Figure 3.2: Expected inflation estimates in the literature



Notes: AR(1) time series estimates from Cecchetti (1992), multivariate time series estimates from Romer (1990), and estimates derived from commodities futures prices from Hamilton (1992).

signalling the establishment of a new policy regime. The consistently aggressive, interventionist, expansionary policy approach pursued by Roosevelt in subsequent months was in stark contrast to Hoover's passive, deflationary approach.

There are several channels by which increased inflation expectations may raise economic activity. First, raising inflation expectations lowers real interest rates, boosting interest-sensitive components of aggregate demand. Second, increased inflation expectations mean higher expected wealth for debtors. If debtors have higher propensities to spend out of wealth than creditors, then this channel also implies a positive relationship between inflation expectations and aggregate spending. Third, raising inflation expectations may either raise or lower consumer and business confidence, depending on the circumstances. If deflation has long been associated with recession and economic distress—as was probably the case in the Great Depression—then a rise in expected inflation could boost general economic optimism. Bachmann et al. (2013) find no evidence that consumers with higher inflation expectations are more willing to spend on consumer durables *in recent decades*, but a rise in inflation expectations in 1933 seems more likely to be expansionary given the context and the likely more dramatic nature of the shift in expectations.

Figure 3.2 plots three estimates of expected inflation from 1928-34 found in the literature. Other authors provide qualitative estimates of when inflation expectations were positive or negative. The various estimates, discussed in the following sections, differ in the extent to which deflation was anticipated as well as in the timing of the resumption of positive inflation expectations. Reconciling the differences is crucial for understanding the Great Depression.

3.3 Market-Based Approaches

One approach to estimating inflation expectations in the Great Depression era entails seeking information implicit in certain prices or quantities. In recent times, the wide availability of inflation-linked assets such as Treasury Inflation-Protected Securities enables relatively straightforward calculation of implied inflation expectations. These assets were not available in the 1920s and 30s; however, other assets allow less direct inferences to be made about expected inflation. Stock prices, commodities futures prices, and the quantity of nominal debt issuance at various maturities have previously been used to make indirect inferences about inflation expectations. The New Keynesian Phillips curve implies that inflation itself can also be used to make indirect inferences about inflation expectations.

The following notation will be used in this and subsequent sections. Let p_t be a price index with monthly frequency. Let $\pi_t = 1200 \ln(p_t/p_{t-1})$ be contemporaneous annualized inflation. Denote mean realized inflation from period t to $t+j$ by $\pi_{t,j} = \frac{1200}{j} \ln(p_{t+j}/p_t)$. For example, one-year-ahead realized inflation is $\pi_{t,12} = \frac{1200}{12} \ln(p_{t+12}/p_t) = 100 \ln(p_{t+12}/p_t)$.

Let Ω_t be agents' information set at time t and $\pi^e_{t,j}$ be expected average inflation from period t to $t+j$, $\pi^e_{t,j} = E[\frac{100}{j} \ln(p_{t+j}/p_t)|\Omega_t] = \frac{1}{j} E[\pi_{t+1} + \pi_{t+2} + ... + \pi_{t+j}|\Omega_t]$.

If p_t has quarterly frequency, then contemporaneous annualized inflation is $\pi_t = 400 \ln(p_t/p_{t-1})$ and mean realized inflation from t to $t+j$ is $\pi_{t,j} = \frac{400}{j} \ln(p_{t+j}/p_t)$. The market-based approaches share an assumption of rational expectations:

$$\pi^e_{t,j} = \pi_{t,j} + \nu_{t,j}, \text{ where } E[\nu_{t,j}|\Omega_t] = 0. \tag{3.1}$$

Stock Market Approach

Temin and Wigmore (1990) use stock market data to investigate the return of inflationary expectations in the recovery from the Depression. Stocks were at a trough in March 1933, and rose sharply until July. From March to July, industrial stocks doubled in price. Temin and Wigmore explain that when deflation is expected, people hold cash for the real return it provides. When expectations of deflation are replaced by expectations of inflation, people shift out of cash and into assets whose value rises with inflation, such as stocks. The rise in stock prices from March to July, they argue, reflects the portfolio shift driven by a regime change in inflation expectations. Their analysis is qualitative.

I use monthly data on S&P500 stock prices and CPI inflation to verify that the posited relationship between stock prices and inflation expectations is reasonable and to quantify Temin and Wigmore's analysis. While they focus on the recovery period, I also use stock prices to estimate expectations during the onset of the Depression. Let stock price growth S_t be the year-over-year percent change in the monthly S&P 500 index. Suppose S_t depends on inflation and expected future inflation:

$$S_t = \beta_0 + \beta_1 \pi_{t-12,12} + \beta_2 \pi^e_{t,12} + \epsilon_t. \tag{3.2}$$

Using Equation (3.1), we can write Equation (3.2) as:

$$S_t = \beta_0 + \beta_1 \pi_{t-12,12} + \beta_2 \pi_{t,12} + \beta_2 \nu_{t,12} + \epsilon_t, \text{ where } E_t[\beta_2 \nu_{t,12} + \epsilon_t] = 0. \tag{3.3}$$

We can use estimates $\hat{\beta}_0$, $\hat{\beta}_1$, and $\hat{\beta}_2$ to compute approximate inflation expectations:

$$\frac{S_t - \hat{\beta}_0 - \hat{\beta}_1 \pi_t}{\hat{\beta}_2} = \pi_{t,12} + \nu_{t,12} + \epsilon_t / \hat{\beta}_2 \approx \pi_{t,12} + \nu_{t,12} = \pi^e_{t,12}. \tag{3.4}$$

I estimate Equation (3.3) using monthly data from 1924-1938 (Table 3.1). The main specification is in column (1). Column (2) includes a number of control variables (see variable descriptions in Appendix C.1). In both specifications, the coefficient $\hat{\beta}_2$ is positive and statistically significant, consistent with Temin and Wigmore's hypothesis.

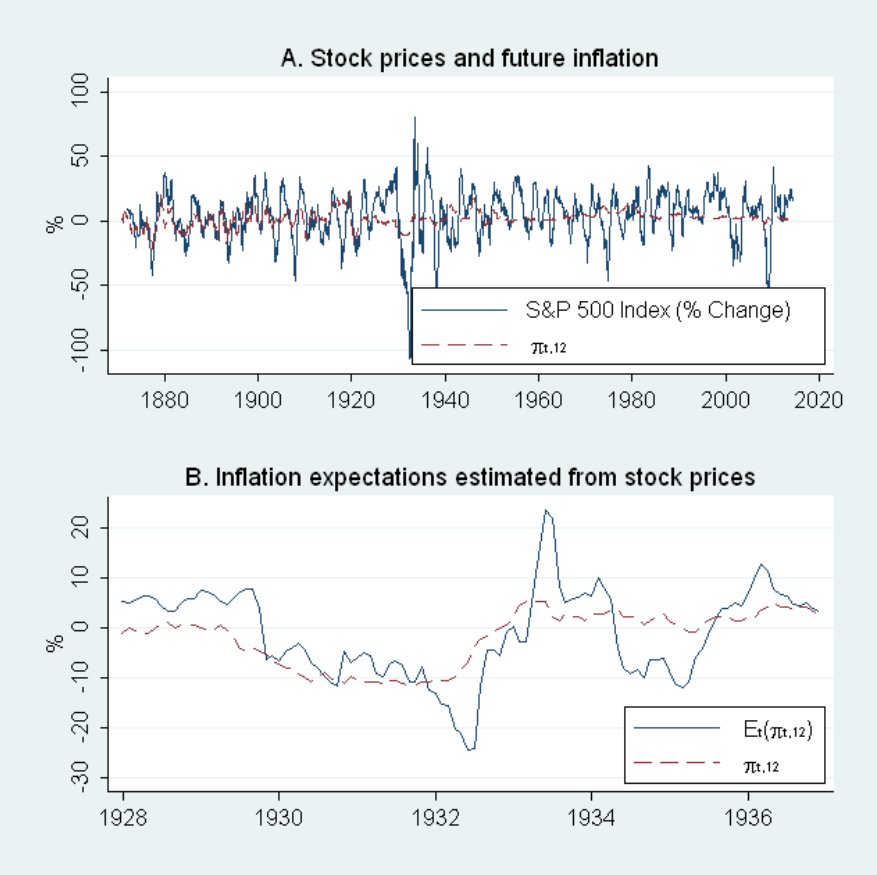
Table 3.1: Stock price approach regressions, 1924-1938. See Equation (3.3).

	(1) S_t	(2) S_t
$\pi_{t-12,12}$	2.68***	1.97***
	(0.87)	(0.69)
$\pi_{t,12}$	3.62***	3.06***
	(0.68)	(0.61)
Industrial Production		0.38***
		(0.10)
10-Yr Treasury Constant Maturity Rate		-21.32***
		(7.66)
Commercial Paper Rate		9.79***
		(1.81)
Sensitive Industrial Raw Commodities		0.25***
		(0.09)
Observations	180	180
R^2	0.51	0.75

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey West standard errors in parentheses. Dependent variable is year-over-year percent change in monthly S&P 500 index.

Panel A of Figure 3.3 plots the percent change in the S&P 500 index and one-year-ahead inflation from 1871 to 2014. The series have a correlation coefficient of 0.28. Panel B shows estimates of inflation expectations at the one-year horizon for the onset through the recovery

Figure 3.3: Stock prices and one-year-ahead CPI inflation



Notes: Stock prices are the year-over-year percent change in the S&P 500 index.

computed from Equation (3.4). By these estimates, inflation expectations turned negative in November 1929; from 1928 until late 1931, expectations were consistently higher than realizations. Inflation expectations were at their lowest in the third quarter of 1932 then began to rise, turning positive in April 1933.

Futures Prices Approach

Hamilton (1992) uses commodities futures prices to calculate expected commodity price changes in the Depression. For most of the Depression, futures prices were above spot prices for most commodities, indicating that declines in agricultural prices caught people by surprise. Hamilton shows that commodity futures prices can be used to infer aggregate price changes by estimating historical correlations between commodity prices and consumer prices. His results indicate that the deflation of the early 1930s was largely unanticipated

and that positive inflation expectations resumed in the second trimester of 1933.[3]

Let $S_{j,t}$ be the time t spot price of commodity j and $F_{j,t}$ the price of a one-period-ahead forward contract. Let $s_{j,t+1} = \log S_{j,t+1} \sim N(\mu_{j,t}, \sigma_j^2)$. Then $f_{j,t} = \log F_{j,t} = E_t[s_{j,t+1}] + \sigma_j^2/2$. With risk neutral investors, $F_{j,t} = E_t[S_{j,t+1}]$. If investors are not risk-neutral, let κ be a constant risk premium and $k_j = -\sigma_j^2/2 - \kappa$. Then:

$$f_{j,t} = E_t s_{j,t+1} - k_j. \tag{3.5}$$

Hamilton's approach relies on an assumption that there is a strong and stable relationship between commodity price changes and aggregate price level changes. One potential concern is that this relationship may not hold in deflationary episodes. Mishkin (1990) argues that the relationship between commodity price changes and aggregate price level changes is very noisy. He thus claims that futures market data can be used to construct own-commodity real interest rates but that these do not contain much information about the aggregate real interest rate. A time-varying risk premium would add additional noise to the estimates.

Cecchetti (1992) notes that physical stocks of commodities are assets whose risk-adjusted nominal return must equal that of other assets, and that physical stocks of commodities were high during the Great Depression. Since the nominal interest rate on bonds cannot be negative, he argues that the price of stored commodities cannot be expected to fall. Cecchetti also points to government intervention in commodities futures markets as part of a policy goal of preventing agricultural commodities from falling, contending that this could contaminate Hamilton's results.

Hamilton counters both of Cecchetti's critiques. He notes that "commodity inventories facilitate milling, processing, and distribution, and these often dominate the capital-gains motive for holding inventories" (p. 162). The difference between spot and futures prices ($f_{j,t} - s_{j,t}$) ranges from very positive to very negative values in the data. Indeed, Hamilton estimates that inflation expectations were negative from mid-1930 to mid-1933. It is thus both theoretically and empirically possible for the price of stored commodities to be expected to fall. To the second concern, he responds that commodities were so openly traded on world markets that the U.S. government's ability to control their price is questionable, and that government intervention does not alter the validity of equation (3.5).

Nominal Debt Issuance

Fackler and Parker (2005) claim that the behavior of nominal debt issuance in the years prior to the Great Depression is not consistent with the deflation being anticipated. Anticipated deflation should cause some borrowers to defer borrowing or choose longer-term rather than short-term debt to minimize repayment in deflated dollars. The data shows no evidence of this occuring. The private debt to income ratio, already high in 1920, grew rapidly prior to the Depression, and the volume of corporate debt offerings did not fall substantially until

[3]Voth (1999) uses a similar approach to estimate inflation expectations in Germany during the Depression, and finds that fear of inflation was prominent in 1931-31.

1932. Moreover, the relative shares of long-term and short-term debt did not change until after the deflation began. Household indebtedness more than doubled from 15% of GDP in 1920 to 32% in 1929 (Gärtner, 2013). That so many borrowers became delinquent or defaulted also implies that the growing real debt burden was unexpected (Bernanke, 1983)

The increase in nominal debt from 1922-29 was noteworthy to contemporary observers. Persons (1930, p. 94) documented high growth in borrowing by households during the 1920s, particularly an increase in mortgage debt, and attributed the depression to this "great wave of credit expansion." The debt service to national income ratio rose from 9% in 1929 to 19.8% in 1932-33 (Clark, 1933).

Phillips Curve Approach

A new approach to estimating inflation expectations comes from the role of inflation expectations in inflation dynamics. Phelps (1968) proposed an expectations-augmented Phillips curve in which inflation depends on expected future inflation and unemployment. The central insight of the New Keynesian Phillips curve (NKPC) is that inflation is a forward-looking process, as opposed to being driven by past shocks (Mavroeidis et al., 2014):

$$\pi_t = \alpha \pi_t^e + \beta x_t + \epsilon_t, \tag{3.6}$$

where x_t is a measure of real activity, ϵ_t may be interpreted as a supply shock and measurement error with $E_t[\epsilon_t] = 0$, and π_t and π_t^e are inflation and expected future inflation. I use monthly data and let $\pi_t = \pi_{t-3,3} = 400 * \ln(p_t/p_{t-3})$ be the annualized quarter-over-quarter percent change in p_t. Let $\pi_t^e = \pi_{t,12}^e$ be expected annual inflation over the next year.

The relationship between current and expected inflation can be used to estimate expected inflation. Using the rational expectations assumption of Equation (3.1), Equation (3.6) becomes:

$$\pi_{t-3,3} = \alpha(\pi_{t,12} + \nu_{t,12}) + \beta x_t + \epsilon_t = \alpha \pi_{t,12} + \beta x_t + \underbrace{\alpha \nu_{t,12} + \epsilon_t}_{u_t}, \text{ where } E_t[u_t] = 0. \tag{3.7}$$

Estimates $\hat{\alpha}$ and $\hat{\beta}$ can be used to compute:

$$\frac{\pi_t - \hat{\beta} x_t}{\hat{\alpha}} = \pi_{t,12} + \nu_{t,12} + \epsilon_t/\hat{\alpha} = \pi_{t,12}^e + \epsilon_t/\hat{\alpha} \approx \pi_{t,12}^e. \tag{3.8}$$

These estimates of inflation expectations are contaminated by $\epsilon_t/\hat{\alpha}$, a multiple of the supply shock. To improve the estimates, suppose we have some variables V_t correlated with ϵ_t, so that $\epsilon_t = \gamma V_t + \zeta_t$, where ζ_t is mean zero and uncorrelated with $\nu_{t,12}$. Equation (3.7) becomes:

$$\pi_t = \alpha \pi_{t,12} + \beta x_t + \alpha \nu_{t,12} + \gamma V_t + \zeta_t, \tag{3.9}$$

and a closer approximation to $\pi_{t,12}^e$ is given by $\pi_{t,12}^e \approx (\pi_t - \hat{\beta} x_t - \hat{\gamma} V_t)/\hat{\alpha}$.

To estimate Equation (3.9), using data from 1924-38, I let p_t be the CPI and x_t be the annualized quarter-over-quarter percent change in the Adjusted Miron-Romer Index of Industrial Production. The supply shock variable V_t includes coal prices.[4] Table 3.2 displays regression results with and without supply shock variables, and Figure 3.4 plots implied one-year-ahead inflation expectations and inflation realizations using the results of column (2).

Table 3.2: Phillips curve regressions, 1924-1938.

	(1)	(2)
	$\pi_{t-3,3}$	$\pi_{t-3,3}$
$\pi_{t,12}$	0.54***	0.39***
	(0.13)	(0.09)
Industrial Production	0.09***	0.10***
	(0.03)	(0.02)
Coal Price		7.45***
		(1.90)
Observations	180	180
R^2	0.37	0.47

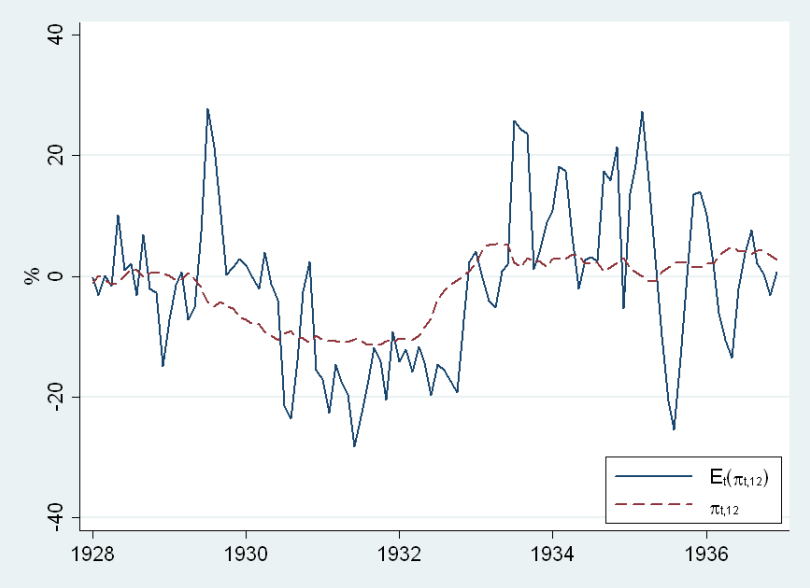
Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey West standard errors in parentheses. Dependent variable is the annualized quarter-over-quarter percent change in the CPI. Independent variables are one-year-ahead inflation, the percent change in the Miron-Romer industrial price index, and coal prices. See Equation (3.7).

In Appendix C.2, I use Monte Carlo methods to repeatedly simulate a basic three-equation New Keynesian model. In the simulations, I know the true values of π_t^e, and use the simulated π_t and x_t to estimate Equation (3.7) and compute $\hat{\pi}_t^e$ by Equation (3.8). The correlation coefficient between the true and estimated values of π_t^e is 0.8, indicating that this estimation procedure is indeed informative of true inflation expectations.

All of the market-based approaches posit a dependence of some market price or quantity on inflation expectations and other variables, and use the relationship to make inferences about inflation expectations. Noisiness arises from omitted variables, measurement error, and potential nonstationarity of the relationship between expected inflation and the market price or quantity. For example, inflation dynamics may depend on unobserved supply shocks, stock prices and nominal debt issuance may depend on variables other than inflation expectations that were not included in the analysis, and the relationship between expected commodity price changes and expected aggregate price level changes may be noisy.

[4] I experiment with alternative choices of V_t, such as petroleum prices, but only coal prices are statistically significant. Results are not sensitive to the inclusion of alternative choices of V_t.

Figure 3.4: Expected inflation estimated from Phillips curve and realized inflation



Notes: Inflation is the year-over-year percent change in the CPI. Estimates computed using Equation (3.8).

Despite the noisiness of the market-based estimates of inflation expectations, the different market-based approaches make qualitatively similar findings about inflation expectations in the onset and recovery periods. First, the deflation was mostly unanticipated. Second, positive inflation expectations returned by mid-1933 or slightly earlier.

3.4 Statistical Approaches

An alternative to the narrative approach of Section 3.5 is a class of statistical approaches. Statistical approaches to estimating inflation expectations involve modeling the stochastic process governing inflation dynamics and using forecasts as a measure of inflation expectations. The limitation of the statistical approach is the reliance on strong assumptions about the models and information sets contemporary observers used to form their expectations.

The general idea of the statistical approach is as follows. Suppose agents form inflation expectations $\pi^e_{t,j}$ according to:

$$\pi^e_{t,j} = f(\Omega_t). \tag{3.10}$$

The econometrician does not know agents' information set Ω_t or model $f(\Omega_t)$ of the inflation process, but assumes that the information set is $\tilde{\Omega}_t$ and that agents make forecasts using $\tilde{f}(\tilde{\Omega})$. Using data $(\tilde{\Omega}_t, \{\pi_t\}_{t=1}^T)$, the econometrician estimates:

$$\pi_{t,j} = \tilde{f}(\tilde{\Omega}_t) + \epsilon_{t,j}. \tag{3.11}$$

Using the estimate $\hat{\tilde{f}}$ of $\tilde{f}$, her estimate of agents' inflation expectations is $\hat{\pi}^e_{t,j} = \hat{\tilde{f}}(\tilde{\Omega}_t)$. The error in this approach is the difference between estimated and true inflation expectations:

$$\hat{\pi}^e_{t,j} - \pi^e_{t,j} = \hat{\tilde{f}}(\tilde{\Omega}_t) - f(\Omega_t) = (\hat{\tilde{f}}(\tilde{\Omega}_t) - \tilde{f}(\tilde{\Omega}_t)) + (\tilde{f}(\tilde{\Omega}_t) - f(\Omega_t)). \tag{3.12}$$

The first term is estimation error from Equation (3.11). The second error term arises because the econometrician does not know what information set agents used or how agents used their information to form expectations. The various statistical approaches used in the literature differ in choice of $\tilde{\Omega}$ and $\tilde{f}(\tilde{\Omega})$. The univariate forecasts in Subsection 3.4 include only lags of inflation in $\tilde{\Omega}$, while the multivariate forecasts in Subsection 3.3 include lags of inflation and additional variables in $\tilde{\Omega}$. Most approaches assume that $\tilde{f}$ is a linear function of the elements of $\tilde{\Omega}$, so that Equation (3.11) can be estimated easily by ordinary least squares or other standard methods.

Univariate Forecasts

In the univariate statistical approach, the econometrician models inflation as depending only on its own lags, so $\tilde{\Omega}_t = \{\pi_{t-s}\}_{s=0}^{L}$. Cecchetti (1992) uses univariate time series techniques to forecast inflation. Using quarterly data from 1919 to 1928, he estimates ARMA(p,q) models up to order (2,2) and uses the Schwarz and Akaike criteria to select the best fitting model. Both criteria select the MA(2) model. Repeating this process with data from 1919 to 1940, the AR(1) model is selected, so he constructs both MA(2) and AR(1) forecasts. The MA(2) model is used to construct out-of-sample forecasts while the AR(1) model is used to construct in-sample forecasts. In the AR(1) model, for example, $\tilde{\Omega}_t = \{\pi_t\}$ and $\tilde{f}(\tilde{\Omega}) = \tilde{f}(\pi_t) = \alpha_0 + \alpha_1\pi_t$. His AR(1) estimates, with standard errors in parentheses, are:

$$\begin{gathered}\pi_{t,1} = -0.28 + 0.52\pi_t + \epsilon_{t,1} \\ (0.84) \quad (0.06)\end{gathered} \tag{3.13}$$

These estimates imply that the unconditional mean of the series is -0.6 and that $\pi^e_{t,1} < 0$ if and only if $-0.284 + 0.516\pi_t < 0$. Hence, whenever *actual* inflation is negative or small and positive, Cecchetti concludes that deflation is anticipated. Since the persistence parameter is fairly large ($\hat{\alpha}_1 = 0.52$), when deflation is realized it is expected to persist. The AR(1) and MA(2) models imply that moderate deflation was anticipated by the end of 1929, and by the start of 1930, price declines were expected to persist. These results arise because actual inflation was negative in the fourth quarter of 1929. Since actual inflation turns moderately positive in the second quarter of 1933 and strongly positive in the third, expected inflation turns moderately positive in the third quarter and strongly positive in the fourth.

Dorval and Smith (2013) use a similar approach and find considerable cross-country variation across countries in the degree to which the deflation was anticipated. Using quarterly data from 1922 to 1939, they recursively estimate a first-order autoregression of inflation for each of 26 countries. In the United States, where inflation persistence is relatively high, after deflation begins, further deflation is quickly incorporated into expectations. In countries

like France, where persistence is smaller, deflation less statistically forecastable inflation. A more sophisticated univariate approach is used by (Fackler and Parker, 2005), who estimate a Markov switching model of the price process during the interwar period. They assume that there are two states— a deflationary state and a stable prices state—and estimate the filtered probability that the economy is in the deflationary state in each period. Only after mid-1930 did the filtered probability rise from near zero to near one. Thus they conclude that agents would not have had reason to anticipate deflation in the 1920s when nominal debt was issued in great volume.

Since Cecchetti uses quarterly data, his estimates of $\pi^e_{t,1}$ are estimates of three-month-ahead expectations. As Fackler and Parker (2005) note, inflation expectations over longer horizons are more relevant to the debt deflation hypothesis, which depends on deflation being unanticipated *when the debt was being issued*. Computing longer-horizon forecasts with the AR(1) model is straightforward; $\pi^e_{t+1,1} = \alpha_0 + \alpha_1 \pi^e_{t,1} = \alpha_0(1+\alpha_1) + \alpha_1^2 \pi_t$, and by recursion,

$$\pi^e_{t+h,1} = \alpha_0 \frac{1-\alpha_1^h}{1-\alpha_1} + \alpha_1^{h+1} \pi_t \tag{3.14}$$

Expected mean inflation over a one-year horizon, for example, is given by:

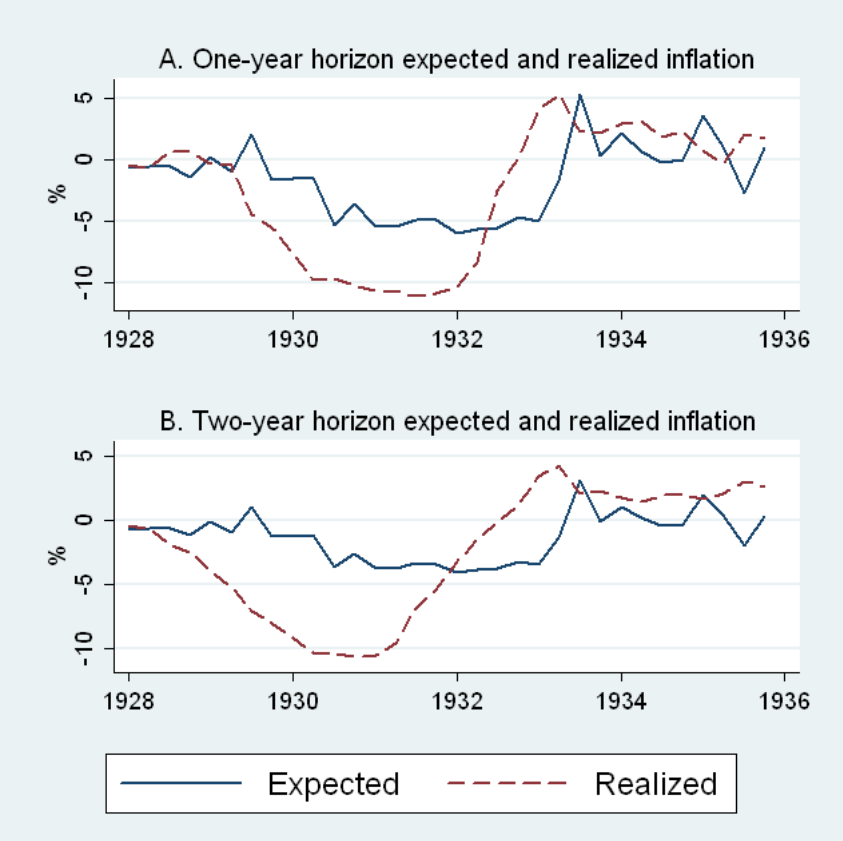
$$\pi^e_{t,4} = \frac{1}{4}[\pi^e_{t,1} + \pi^e_{t+1,1} + \pi^e_{t+2,1} + \pi^e_{t+3,1}] = \frac{1}{4}[\alpha_0 \frac{4-\alpha_1^4-\alpha_1^3-\alpha_1^2-\alpha_1^1}{1-\alpha_1} + (\alpha_1^4+\alpha_1^3+\alpha_1^2+\alpha_1^1)\pi_t]$$

Figure 3.5 plots estimates of expected inflation at one-year and two-year horizons estimated by an AR(1) model with quarterly CPI inflation data. Expected inflation is plotted with realized inflation at the same horizon. The gap between expected and realized inflation (both of which are annualized) indicates unanticipated deflation. For example, in the first quarter of 1929, expected inflation over a 2-year horizon (i.e. from 1929 to 1931) was -0.2% but realized inflation from 1929 to 1931 was -5.2%. A borrower taking out a two-year loan in 1929Q1 would have faced 0.2% per year anticipated and 5% per year unanticipated deflation over the course of the loan. Inflation expectations begin rising after the first quarter of 1933 and turn positive in the third quarter.

Cecchetti's approach is not suitable for detecting a regime change of the sort hypothesized by Temin and Wigmore (1990). The idea of the regime change is that agents initially believed that inflation was following a particular process, then their beliefs suddenly changed. The AR(1) model, for example, will only find positive inflation expectations once actual inflation has turned positive. If, in the midst of deflation, Roosevelt convinced the public that inflation would resume, this change in expectations would not be detected.

For a simple illustration how this approach could err, suppose that a regime change occurs in period T. Before T, agents use an AR(1) model of the inflation process to form their expectations: $\pi_{t,1} = \mu + \rho\pi_t + \epsilon_{t,1}$. Imagine that the econometrician also uses an AR(1) model and obtains accurate estimates of μ and ρ. Beginning in period T, unbeknownst to the econometrician, agents believe that inflation will follow a different process under the new regime, with higher mean but the same persistence: $\pi_{t,1} = \mu_1 + \rho\pi_t + \epsilon_{t,1}$, $t \geq T$, with $\mu_1 > \mu$.

Figure 3.5: Expected inflation estimated by AR(1) model



Notes: Inflation refers to the percent change in the consumer price index.

Let $D_t = 1$ if $t \geq T$ and 0 if $t < T$. Then $\Omega_t = \{\pi_t, D_t\}$ and agents' perception of the inflation process can be written $f(\Omega_t) = \mu + (\mu_1 - \mu)D_t + \rho\pi_t$. Inflation expectations at time T are $\pi^e_{T,1} = \mu_1 + \rho_2\pi_T$. The econometrician, using $\hat{f}(\hat{\Omega}_t) = \mu + \rho\pi_t$, estimates that $\hat{\pi}^e_{T,1} = \mu + \rho\pi_T < \mu_1 + \rho\pi_T = \pi^e_{T,1}$. In short, the econometrician underestimates expected inflation at the time of the regime change because her model of agents' expectation formation does not incorporate the regime change. Even a Markov switching model similar like that of Fackler and Parker (2005) can only detect a change in the statistical inflation process, rather than a change in agents' perception of the inflation process, a potentially critical distinction.

Multivariate Forecasts

Estimates of expected inflation constructed with the univariate statistical approach may differ from true inflation expectations if contemporary agents used other models and/or information sets to forecast inflation. One possibility is that they may have incorporated additional economic variables into their forecasts. In multivariate statistical approaches, $\tilde{\Omega}_t$

includes not only lags of inflation, but also contemporaneous and/or lagged values of additional variables. If contemporary agents incorporated similar variables into their forecasts, then the multivariate statistical approach will provide a closer approximation to agents' true inflation expectations. However, if the econometrician includes information in $\tilde{\Omega}_t$ than is quite different than the information in Ω_t, then the multivariate approach can provide a worse approximation to agents' true inflation expectations than the univariate approach.

Mishkin (1981) describes a multivariate statistical technique for estimating expected inflation, and later authors refer to this approach as the Mishkin approach. Though Mishkin formulates his approach in terms of ex post and ex ante real interest rates, it is exactly equivalent to estimating Equation (3.11) under the assumption that $\tilde{f}$ is a linear function. The econometrician estimates:

$$\pi_{t,j} = \tilde{\Omega}_t'\beta + \nu_{t,j}, \tag{3.15}$$

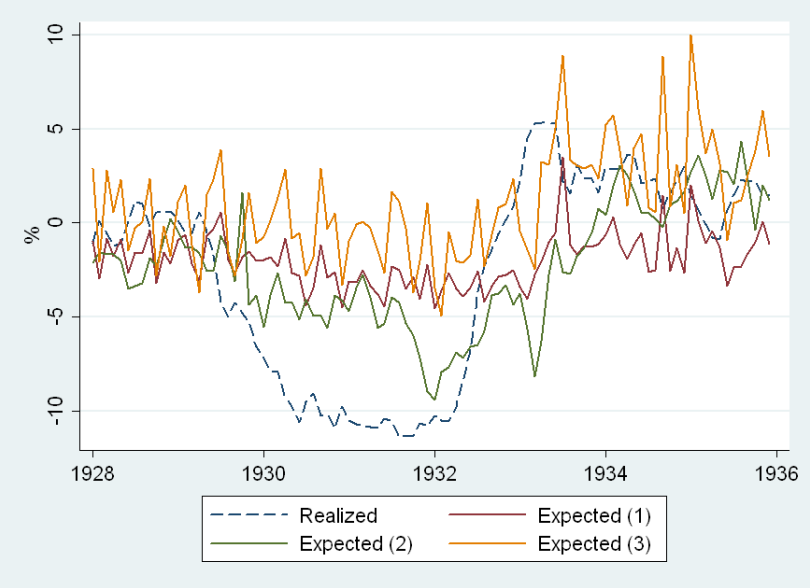
and the fitted values are estimates of expected inflation.

Dominguez et al. (1988), Cecchetti (1992), and Romer (1992) use this approach to estimate expected inflation. They differ in the inflation series they use and in the other variables included in $\tilde{\Omega}_t$. Cecchetti considers the nominal interest rate, the monetary base, M1, M2, and industrial production for potential inclusion in $\tilde{\Omega}_t$. For each variable x, he defines $\Delta x_t = \log(x_t/x_{t-12})$ and includes Δx_{t-1}, Δx_{t-13} and Δx_{t-25} as regressors. For each x, a Wald test for the null hypothesis that the coefficient on all three lag Δx terms is conducted, and the variable is dropped if the null is not rejected. The monetary base and M2 remain in $\tilde{\Omega}_t$. He finds that mild deflation was anticipated in 1929 and 1930, and that inflationary expectations turned sharply positive in the first quarter of 1933.

Romer estimates ex ante real interest rates and expected inflation over 1929-1942 using quarterly data from 1923Q1 to 1942Q2, where $\tilde{\Omega}_t$ includes the current value and four quarterly lags of PPI inflation, change in industrial production, the nominal commercial paper rate, and the deviation of the annual growth rate of M1 from its average annual growth rate between 1923 and 1927. She finds that inflation expectations were negative from 1929 to late 1933, turning positive in 1933Q4. Ex ante real commercial paper rates dropped from values often over 15% in the early 1930s to values between -5% and -10% from the beginning of the monetary expansion until the contraction of 1937-38.

Dominguez et al. construct estimates of inflation expectations in the early 1930s using several vector autoregressions (VARs) differing in the time sample and data series used. Some of the VARs use data that would have been available to agents in real time, and others use data that was not available until more recently. Forecasts are quite sensitive to the choice of time sample; certain specifications with recently-available data through the fall of 1929 rather accurately predict the deflation, but when data through December 1929 or June 1930 is included, the forecasts do not nearly predict the full extent of the deflation. In general, using either real time or modern data, neither the severity of the Depression nor the severity of the deflation were forecastable. Dominguez et al. declare that "an econometrician endowed with modern time-series methods and data would be justified in appearing optimistic about the economy on the eve of and in the months following the Crash" (p. 605).

Figure 3.6: Expected inflation estimated by multivariate approach



Notes: Inflation refers to the percent change in the consumer price index.

Whereas Cecchetti and Romer use quarterly data in the Mishkin approach, I use monthly CPI inflation data and alternative choices for $\tilde{\Omega}_t$ and the sample period. I estimate Equation (3.15) under a variety of specifications with different variables and numbers of lags in $\tilde{\Omega}_t$. Fitted values are estimates of $\pi^e_{t,12}$, one-year-ahead expected inflation. Figure 3.6 shows estimates of $\pi^e_{t,12}$ from three different specifications, along with realized one-year-ahead inflation. Specification (1) uses 1920-1939 data and $\tilde{\Omega}_t = \pi_t$. Specification (2) uses 1920-1939 data and $\tilde{\Omega}_t$ includes π_t, current and six lags of money growth, and current and six lags of industrial production growth. Specification (3) uses a wider sample period, 1914-1950, and $\tilde{\Omega}_t$ includes π_t, current and six lags of the nominal commercial paper rate, and a gold standard dummy. Regression output is in Table 3.3. The general result is that the full extent of the deflation was not anticipated.

How Did Contemporaries Forecast?

The most obvious concern with estimates of inflation expectations derived from statistical forecasts is that we cannot know for sure how people in the 1920s and 30s formed their inflation expectations. If they used different forecasting methods and information sets than the time series techniques used in the literature, then true inflation expectations will differ from estimated inflation expectations. It seems highly unlikely that they would have used some of the more sophisticated and computationally-intensive forecasting methods that have

Table 3.3: Multivariate statistical approach regressions

	(1)		(2)		(3)	
	$\pi_{t,12}$		$\pi_{t,12}$		$\pi_{t,12}$	
π	0.17**	(0.07)	0.02	(0.07)	0.34***	(0.05)
Money Growth			0.06***	(0.02)		
L.Money Growth			0.06***	(0.02)		
L2.Money Growth			0.05***	(0.02)		
L3.Money Growth			0.03**	(0.02)		
L4.Money Growth			0.03*	(0.02)		
L5.Money Growth			0.02	(0.02)		
L6.Money Growth			0.00	(0.02)		
IP			0.03*	(0.02)		
L.IP			0.00	(0.01)		
L2.IP			0.01	(0.01)		
L3.IP			-0.02	(0.02)		
L4.IP			0.01	(0.01)		
L5.IP			0.00	(0.01)		
L6.IP			0.00	(0.01)		
Commercial Paper Rate					-2.74	(1.72)
L.Commercial Paper Rate					3.62*	(1.93)
L2.Commercial Paper Rate					-1.88	(1.88)
L3.Commercial Paper Rate					1.01	(1.97)
L4.Commercial Paper Rate					-3.00	(2.01)
L5.Commercial Paper Rate					2.68	(1.91)
L6.Commercial Paper Rate					-0.58	(1.63)
Gold Standard					1.54	(2.81)
Constant	-1.54***	(0.57)	-2.39***	(0.57)	3.41***	(0.95)
Observations	240		240		444	
	(1920-1939)		(1920-1939)		(1914-1950)	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. See Equation (3.15). IP is annualized month-over-month percent change in industrial production.

been introduced in more recent decades.[5] Even simple univariate forecasting models, such as the AR(1) model, seem unlikely to have been popular.

The business of economic forecasting got its start in the early 20th century (Favero, 2007; Friedman, 2014). Roger Babson began the first weekly forecasting service in the United States in 1907. John Moody's weekly forecasting newsletter began in 1909, and James Brookmire's leading-indicator model was created in 1910. Professional economists who ventured into economic forecasting include Warren Persons of the Harvard Economic Service, and Irving Fisher, whose *Business Page* appeared in newspapers across the country. How did these forecasting services make their economic forecasts? Would their forecasts have been similar to those constructed by the time series methods in this section? The next section uses the narrative record to seek evidence on this issue. While at least some of the forecasters used historical trends in the formation of their forecasts, they did not use the time series techniques that are popular today.

3.5 Narrative Approaches

Several authors employ a narrative approach to estimate inflation expectations in the onset or recovery from the Great Depression. The narrative approach entails careful examination of contemporary news articles or other documents to gather information that may not be available from quantitative data series. This approach has the benefit of providing contextual and explanatory information that may otherwise not be apparent. The narrative approach has been used in a variety of contexts, notably by Ramey and Shapiro (1998) to identify military spending shocks and by Romer and Romer (2004) to identify exogenous monetary policy shocks. This approach is particularly suited to questions of what people understood and expected about the circumstances of their time.

The statistical approaches to estimating inflation expectations, discussed in Section 3.4, rely on strong assumptions about the information sets and models that contemporary forecasters would have used to form their inflation expectations. Cecchetti (1992), for example, estimates the expectations that agents would have formed had they used an AR(1) model to forecast inflation. The narrative record provides indications of the information and reasoning used by forecasters and the public to form their expectations.

Subsection 3.5 describes the literature on narrative evidence of inflation expectations in the Great Depression era. The records of the Harvard and Yale forecasting services in 1929 are analyzed by Dominguez et al. (1988), and evidence from the contemporary business and financial press is presented by Nelson (1991), Romer and Romer (2013), and Jalil and Rua (2013). In Subsection 3.5, I supplement these authors' findings with additional narrative evidence from major newspapers, professional forecasting services, and economic reports.

[5]See Wright and Faust (2012) for a review of current methods of inflation forecasting.

Narrative Evidence in the Literature

Dominguez et al. (1988) examine whether the Great Depression was anticipated by analyzing the pronouncements made by Harvard and Yale forecasters in 1929-30. The Harvard Economic Service (HES), led by Warren Persons, was a subscription service offered to businesses. The HES constructed an Index of General Business Conditions based on their theorized relationship between three curves representing speculation (New York bank clearings and industrial stock prices), business (outside bank debits and commodity prices), and money (commercial paper rates), called the A, B, and C curves, respectively. Irving Fisher of Yale published a weekly, nationwide syndicated newspaper column on economic affairs. Fisher began publishing a Commodity Price Index and its inverse, the Purchasing Power of the Dollar Index, in his newspaper column in January 1923.

Neither group predicted the occurence or severity of the Great Depression. Through the summer of 1929, HES noted signs of recession, and Fisher was bullish about the economy. In late 1929, HES also grew optimistic, expressing confidence in the ability of the reserve system to ease the money market and prevent depression. This optimism continued into 1930. HES wrote, on August 20, 1930, that "our monetary and credit structure is not only sound but unusually strong, commercial credits are liquid...there is every prospect that the recovery which we have been expecting will not be long delayed." Fisher's optimism equaled or surpassed that of the HES. The fact that neither forecasting service anticipated the depression itself suggests that they also did not anticipate the deflation.

Nelson (1991) examines articles in the business and financial press to study inflation expectations from June 1929 to December 1930. In 1929 and 1930, some analysts expected declines in the price level, but most underestimated the extent of future deflation. Only by the middle of 1930 was the severity of the crisis recognized. In late 1930, some business analysts expected prices to return to pre-World War I levels.

Romer and Romer (2013) also use the narrative approach to study expectations of the deflation in the early 1930s. They note that *Business Week* viewed money and credit contraction as the primary cause of deflation. In the early 1930s, *Business Week* changed its expectations of price movements fairly frequently, based on anticipated changes in money and credit conditions. In the first half of 1930, *Business Week* did not consistently expect much deflation, predicting on January 1 that "Prices, wages and employment will be somewhat, but not much, lower in 1930 than in 1929." On February 26, the magazine wrote that "the unexpected commodity price deflation since the market crash has apparently given a second and more serious shock to business itself," implying that the deflation of late 1929 and early 1930 was unanticipated.

On June 9, 1930, after the Federal Reserve lowered the discount rate, *Business Week* proclaimed that "either price levels or the volume of business activity is bound to rise—or both." This lowering of the discount rate was not followed by additional monetary expansion, leading *Business Week* writers to be pessimistic that the Fed would act to counteract deflation. Nonetheless, a sentiment that prices could not fall below prewar levels prevailed as late as September 1930.

The narrative record from 1929-30 tells us that the univariate time series models of inflation, such as the MA(2) and AR(1) models in Cecchetti (1992), do not provide accurate estimates of agents' inflation expectations. Money and credit conditions were part of forecasters' information sets, and it is not clear that inflation was thought to depend on its own lags. Some agents held the view that the *price level* was mean-reverting, which is not consistent with a persistent inflation process.

Hsieh and Romer (2006) analyze the *Economist* and the *Commercial and Financial Chronicle* from 1932 to see whether the $1 billion expansionary open market operation led investors to believe that the United States would devalue. They find no evidence of such sentiment. The passage of the Glass-Steagall Act in February and the acceleration of open market purchases in April featured in several news articles, and were interpreted as easy monetary policy with the potential to end deflation.

For the recovery period, Jalil and Rua (2013) read *Business Week* and the *Economist* to study inflation expectations from October 1932 to July 1933. They find that, prior to Roosevelt's election, and between election and inauguration, very little was known about his likely economic policies and whether or not he was committed to a new inflationary movement gaining public attention. Roosevelt's relative silence on the topic of inflation, they claim, helped to moderate inflationary expectations in early 1933. Expectations shifted dramatically in the second quarter of 1933 as a result of Roosevelt's new inflationary regime. In March, when Roosevelt declared a banking holiday and the suspension of exports and private hoarding of gold, *Business Week* wrote that Roosevelt's banking emergency plan contained some deflationary measures but on the whole was more likely inflationary.[6] *Business Week* also reported that 141 professional economists petitioned Roosevelt to pursue inflationary measures to promote economic recovery.[7]

When the gold standard was abandoned, *Business Week* proclaimed that "the long debate as to whether we are or are not going to attempt inflation is over—the Administration is committed."[8] Inflation expectations increased dramatically and remained high until July. While the abandonment of the gold standard was the primary event that raised inflation expectations, Roosevelt's communication strategy and newly-acquired control over the currency also contributed to expectations of inflation. Jalil and Rua find that the fireside chats, the Thomas Inflation Amendment in the Farm Relief Bill, parts of the National Industrial Recovery Act, and the World Economic Conference were all interpreted by the press as powerful signals of an inflationary regime.

Most of the statistical estimates of inflation expectations find a later return of positive inflation expectations. The narrative record shows that new policies and communications from policymakers were part of agents' information sets, which the statistical approaches leave out.

[6]March 15, 1933, "New Deal, New Money, New Banks, p. 3.

[7]March 22, 1933, "Inflation, Please," p. 6.

[8]April 19, 1933, "Recovery: The Next Effort," p. 1.

New Narrative Evidence

None of the literature using the narrative approach has examined major newspapers. I use the ProQuest Historical Newspapers Database to examine the New York Times (NYT), Washington Post (WP), Wall Street Journal (WSJ), Los Angeles (LA) Times, and Chicago Tribune for evidence of how contemporary observers thought about the causes of price changes and how they formed forecasts. I also present new narrative evidence from professional forecasters and economic reports, including from the Review of Economic Statistics (RES). The RES published a discussion of the HES Index of General Business in its quarterly (or sometimes monthly) issues until the discontinuation of the index in 1935.

Expectations and Forecasting Before 1929

The validity of the debt deflation hypothesis depends on whether deflation was anticipated at the time that nominal debt was being incurred. While previous literature has examined narrative evidence beginning in 1929, it also matters whether the possibility of future deflation was recognized before 1929. In 1928, there was no hint of deflation on the horizon.

In January 1928, the LA Times reported that "the return of Europe to gold, now virtually made, should remove the chief pressure against world prices in the last few years. With hard money restored, commodity prices will be able with great ease to rise."[9] That May, the LA Times noted that the Federal Reserve Bank of New York's weekly index of sensitive commodity prices was up, and that this index had previously been an accurate predictor of movements in the Bureau of Labor Statistics' weighted commodity price index. "It pretty plainly indicates that the long decline in commodity prices not only has been checked, but that, for the moment at least, a definite upward movement is in progress."[10]

At the time of World War I, there were only ten professional forecasting agencies in the United States, but by 1925, there were about 80 (Friedman, 2014). In the 1920s there was quite a bit of controversy regarding the methods used for economic forecasting, the proper role for probability theory in forecasting, and the limits of forecasters' predictive powers. In 1923, in his presidential address at the 85th annual meeting of the American Statistical Association, Warren Persons of the Harvard Economic Service remarked that "Given as he [the statistician] must, that the consecutive items of a statistical series are, in fact, related, he admits that the mathematical theory of probability is inapplicable," and one must rather forecast "by the application of the usual methods of inductive argument."

At the annual outlook meeting of the Bureau of Agricultural Economics, Stein (1928) explained that "A price forecast is an indication of probable future prices based upon present conditions, experience, and knowledge of what makes prices. Many people shy at the word 'forecast' or the idea of predicting prices. They think that it can **not** be done unless the forecaster be endowed with some supernatural power. We have been told by some that no one person knows anything more about prices than any other person...We know that prices

[9]Paul Willard Gabbet, Los Angeles Times, 17 January 1928, "Price Trend Disappoints."
[10]Paul Willard Gabbet, Los Angeles Times, 4 May 1928, "Commodity Price Index Up," p. 10.

are the result of economic forces which are subject to economic laws, and that by studying these forces and laws we can interpret supply and demand in terms of prices."

Expectations and Uncertainty in 1929-31

In 1929, economic analysts were highly impressed by the seven years of price stability the economy had experienced. The Committee on Recent Economic Changes of the President's Conference on Unemployment[11] published a report called *Recent Economic Changes in the United States* that focused on the years 1922-29. Decreasing variability in prices was viewed as "one of the most significant factors disclosed by the survey":

> "The increasing tendency toward price stability, both as between classes of commodities and in the price experience of individual commodities, was a characteristic of the period... Price fluctuations seem to have been held within narrow limits during this period by a combination of factors; a more complete background of statistical information making possible better judgment regarding supply and demand on the part both of producers and consumers; prudence on the part of management; cost reductions by technicians, skill on the part of bankers, an enlightened attitude on the part of labor, and the expansion of foreign markets...Whether the price relationships of recent years prove to be transitory or permanent, they represent to-day a huge gain which is reflected in all parts of the economic organism." (Committee on Recent Economic Changes, 1929, p. xiii).

These analysts were uncertain whether this price stability reflected a permanent new reality or whether the price volatility of earlier years would return, but they foresaw no particular signs of impending deflation. On October 21, 1929, the Conference of Statisticians in Industry of the National Industrial Conference Board determined that business activity was higher than the previous year, but that "conservatism on the part of buyers" had "obviated the danger of commodity price inflation."[12]

Other observers also took note of the price stability in the mid 1920s. Analysts at the Chicago Daily Tribune noted that "The upward swing of price levels on the stock exchanges had no appreciable effect on commodity prices from 1925 to 1929. While stocks climbed to the heights the general price levels of usable goods remained stationary or dropped slightly."[13] The implication was that commodity prices were not sensitive to stock market fluctuations, so the stock market crash seemed unlikely to provoke a fall in commodity prices. This is consistent with Hamilton's finding that futures markets revealed no expectation of declining commodities prices in the third trimester of 1929.

Considerable uncertainty surrounded expectations of price changes in particular industries. For example, in November 1929, the WSJ wrote that "What the price of wheat will

[11]The President's Conference on Unemployment was originally convened by then Commerce Secretary Herbert Hoover to investigate rising unemployment during the recession of 1920-21.

[12]NYT, 21 October 1929, "Finds Gain in Business," p. 54.

[13]Chicago Daily Tribute, 14 November 1929, "Good Business is Seen Due to Orderly Marketing," p. 23.

be for the remainder of this crop season The Wall Street Journal will not attempt to say," and very tentatively predicted that "so far as supply and probable demand are concerned, the situation favors the wheat market of the near future."[14] In November and December of 1929, the WSJ also reported on uncertainty about price trends in the rubber industry.[15] Uncertainty about rubber prices continued at least through December 1930.[16] This uncertainty continued in 1930 in many industries. The NYT reported in April that the copper market was "so uncertain that even the keenest followers of the market refuse to hazard an opinion as to the course of prices."[17] A WSJ headline proclaimed "Price of Steel More Uncertain."[18]

By mid 1930 it became more apparent that the deflation trend would continue. For example, the July 22, 1930 WSJ reported that an economist of the wool industry found "little likelihood that there will be any marked upturn in prices this year." For cigar tobacco, "the price outlook still is uncertain," but "lower prices than those of a year ago seem probable."[19] Articles like "Deflation Helps Lenders"[20] stated the main idea of the debt deflation hypothesis quite clearly.

Though neither the Yale nor the Harvard forecasters anticipated the severity of the depression, another well-known forecaster, Roger Babson, quite famously predicted the stock market crash and was also more pessimistic about business conditions and prices. In November 1929, the NYT[21] quoted Ralph B. Wilson, vice president of the Babson Statistical Organization, as saying, "In regard to general business, commodity prices and the labor outlook, we are not so optimistic...Declining tendencies in business which have been under way since July seem likely to continue during the coming months...Commodity prices may also show some downward tendencies. Prices of industrial products presumably will be the most prominent in the decline." Babson was in the minority.

Why did the Harvard forecasters not foresee the Great Depression? According to Bullock and Crum (1932), having "seen the intervention of the federal reserve authorities prove effective in averting serious situations in the fall of 1927 and the fall of 1928," the HES "counted upon similar action in 1929 if, as seemed likely, it should become necessary."

In the midst of the deflation, contemporaries lookede back to the previous deflation of 1920-22. By the start of 1931, deflation had continued for approximately the duration of the previous deflation, leading to an impression that the end of deflation was due. The NYT reported, "Low level of the 'deflation' which began in 1920 was reached in January, 1922. Between then and the year-end, commodity prices had risen 13 per cent."[22]

[14] "Upturn in Grain Prices," WSJ, 11 Nov. 1929: 1.

[15] "Rubber Schemes Held Uncertain" WSJ, 25 Nov. 1929: 17. "Trend in Rubber Still Uncertain" WSJ, 31 Dec. 1929: 6."

[16] "Use of Rubber Off Sharply in Year. Price Outlook Uncertain," NYT, 31 Dec. 1930: 23.

[17] "Future Unsettled for Copper Prices," NYT, 20 Apr. 1930: 35.

[18] WSJ, 1 May 1930: 3.

[19] "Cigar Tobacco Price," WSJ, 11 Dec. 1930: 3.

[20] "Deflation Helps Lenders," Washington Post, March 17, 1930, p. 10.

[21] NYT, 17 Nov. 1929, "Babson Officer Lays Crash to Business Ebb; Also Blames Disregard of Mathematics," p. 2.

[22] "After the Other 'Deflation,' NYT, January 1, 1931, p. 48.

From Election to Devaluation

I search the Proquest Historical Newspapers database for the term "reflation" from 1928 to 1945. It appears in only six total articles from 1928 to 1931. Then it appears in 53 articles in 1932, 170 in 1933, 64 in 1934, and around 30 per year until World War II, when usage drops sharply. In 1932, most discussion of reflation came in April, when the Fed greatly expanded its open market operations. January 1933 saw the most discussion of reflation of any month, followed by April, May, and June 1933. I also search for "currency inflation," the usage of which spiked in 1933 (3539 articles). More articles mentioned currency inflation in April 1933 than in any other month in the interwar period.

Evidence from major newspapers aligns with Jalil and Rua's (2013) finding and Temin and Whigmore's (1990) assertion that prior to Roosevelt's inauguration, his attitude toward inflation was uncertain. On December 2, 1932, the New York Times reported on President-elect Roosevelt's support for legislation to increase the price of tobacco. The article noted that Roosevelt "during his campaign pledged himself to do his utmost to increase the prices of all staple crops to their previous levels." But neither plans nor intentions for general reflation were yet evident.

Talk of reflation in January 1933 was partly prompted by a speech by King Gustav of Sweden, who advocated reflation as an antidote to depression and announced a comprehensive public works scheme and unemployment insurance in Sweden. There was also reporting on a speech by British economist Arthur Salter in which he urged worldwide reflation. Other articles that month described the support for reflation by Senator-elect McAdoo and Senator Borah. "Currency inflation is becoming a dominant theme in Congress," reported the WSJ.[23] This talk was noted in international markets; the S.S. Aquitania, S.S. Champlain, and S.S. Europa, which planned to ship a combined $12 to $14 million worth of gold from France to New York, delayed their journeys because of a "revival of talk of inflation in the United States" which made gold exports no longer profitable on an exchange basis.[24]

Professional economists and statisticians noted the surge of inflationary proposals but could not pinpoint the likelihood of inflation. The RES January 1933 supplement emphasized the impossibility of "scientific forecast" regarding inflationary proposals: "The possibility of monetary disturbance now lies chiefly in action regarding the federal deficit and in the recrudescence of inflationary proposals - political factors about which scientific forecast is impossible."

The January suppplement also noted that "British commodity prices have moved approximately sidewise since the suspension of the gold standard in September 1931," so if forecasters were looking to the British experience for evidence of the potential effects of going off of the gold standard, they would not have seen an obvious link between leaving gold and restoration of inflation (RES, 1933b, p. 2).

After January, talk of reflation died down until April, when discussions and debates about reflation and currency inflation became prominent in the newspapers. Even before devalu-

[23] "Many Ways to Do It," WSJ, January 21, 1933.

[24] "Talk of Inflation Stems Gold Flow," WSJ, January 5, 1933.

ation, "it is made clear that the administration also recognizes the need for 'reflation,' or a mild inflation," reported the NYT, adding, "The coming conferences with world statesmen, the public works program, railroad, farm and mortgage relief and other undertakings of the government point in the direction of inflation, but the sounder steps that way have already been taken or are under way."[25] The WSJ noted "insistent harping on the possibilities of inflation."[26]

Devaluation was immediately interpreted as inflationary. The famous forecaster Roger Babson wrote, "this action reverses the vicious trend of deflation, replacing it with a trend of rising values... The administration intends to adopt such measures as will effectually raise commodity prices. Moreover, it intends to do this without letting inflationary measures get out of hand...The President may be depended upon so to regulate and control the use of these powers that our currency shall not go the way of Germany's or other European countries who have tried inflation with disastrous results."[27] Roosevelt was expected to gain wider powers over the currency. The WSJ reported, "Decision of the Administration to control gold exports puts the country, technically at least, off a gold basis again. The President, acording to reliable information from Washington, is going to ask wide powers over the handling of the curency."[28]

Reflation was perceived as imminent in April, but there was debate about how high prices would or should rise. An LA Times article gives the impression that people had a price level targeting model in mind, but disagreed about the most "fair" target. It was thought fair to restore prices to their level when the majority of debt was incurred—which lends support to the debt deflation hypothesis.

> "If it is assumed that inflation is subject to control, the quarrel between two groups of economists on the price level at which the bulk of debts was contracted is a controversy of significance. If, on the other hand, inflation is only governed by human emotions, the profound deliberations of the economists represent just another futile outburst from the sidelines. Devaluation of the gold dollar is advocated by the Committee for the Nation, representing an important body of business opinion and economic thought, on the reasoning that price levels must be restored to the 1926 level. The bulk of the American debt, this group states, was created at 1926 prices. Now comes Moody's Investors Service, another reputable group of economists, with the statement that the present outstanding corporate debt was built on the average price level of 1930."[29]

[25] C.F. Hughes, "The Merchant's Point of View, NYT, April 9, 1933, p. N15.

[26] Reflation Hint Spur to Buying. Markets Strengthen as Uneasiness over Administration Program is Dispelled," WSJ, April 10, 1933, p. 6.

[27] Washington Post, 23 April 1933, "U.S. Money Stand Praised by Babson," p. R6.

[28] "Abreast of the Market," WSJ, April 20, 1933, p. 2.

[29] "Price Level Ideas Differ," LA Times, April 30, 1933, p. 25.

From Devaluation to Recovery

The newspapers and Review of Economic Statistics reinforce Jalil and Rua's finding that expectations of inflation brought about increased business confidence and spending. Of course, inflation was not instantly and uniformly perceived as beneficial. Several articles expressed sentiments like the following:

> "Inflation may bring a temporary wave of buying because of fear that the value of money is to be debased, but every business man knows that such a flurry in the markets does not mean permanent improvement in economic conditions....Business and industry will resist all increases in their operating expenses until a basis of stability is again reached upon which they can calculate future prices and demands. This set of circumstances will make the advance of wages under an inflation policy extremely slow, even though the cost of living rises."[30]

> "...in the common acceptation of the term 'inflation,' as arbitrary and artificial increase of the currency by Government edict, no country has ever emerged from a depression as a result of it. Depreciation of the currency, through such a process, has raised prices and, at the outset, stimulated business for that reason; but the subsequent reaction in legitimate industry was proportionately violent. All history testifies that the gainers from a forced-inflation period were the speculators."[31]

Professional economists were unsure, at first, about the effects of devaluation other than inflation. The May 1933 RES reports, "The flow of money is still back toward the banks, and only a moderate amount of the recent emergency currency has been called for. Expansion of bank credit has hardly begun; and nothing has happened except that it has rather suddenly become evident that some sort of inflation is to come" RES (1933a, p. 61). But by the June RES issue, the restoration of inflationary expectations is explicitly linked to renewed business confidence and an increase in business activity:

> "The developments of the month, therefore, leave no reasonable doubt of the intention of the Administration to resort to distinctly inflationary measures; and this has evidently been the interpretation placed upon them by commodity and security markets... Another important development of the month has been a great improvement of business sentiment, which seems to be very general and to admit of no possible doubt. Such a restoration of confidence in the business future accompanies the early stages of recovery from a severe depression; but probably no one will question that the improvement has been greater than could result in two months time from the operation of natural causes. Without much doubt the prospect of inflation is now a definite factor in determining business

[30] Washington Post, April 23, 1933.

[31] "Inflation and Depression," letter to the editor, NYT, April 25, 1933, p. 16.

> sentiment; and in this way it has been an important influence making for increase of general business activity. The first effects of stimulants are usually agreeable" (RES, 1933c, p. 98).

3.6 Consensus and Conclusions

This paper provides the first detailed comparison of the wide literature estimating inflation expectations in the Great Depression era. Table 3.4 summarizes the approaches and findings. While none of the existing estimation methods are perfect, looking at the spectrum of estimates and understanding possible noise and systematic errors in each can bring about a clearer picture of true inflation expectations. By scrutinizing and supplementing the different estimation approaches to reconcile differences in findings, I arrive at a consensus view of the general behavior of inflation expectations in that era.

The majority of the studies find that the deflation of the 1930s was not fully anticipated. In the mid- to late-1920s, when large quantities of nominal debt were issued, deflation was not anticipated. The price stability that characterized this period was widely noted and lauded and showed no sign of ending. Even in most of 1929, positive, stable, or very mildly negative inflation expectations are found by all authors. Asset prices, the behavior of nominal debt issuance, and inflation dynamics are consistent with unanticipated deflation at the start of the Depression. Time series statistical approaches to estimating inflation expectations, such as those used by Cecchetti (1992) and (Romer, 1992), tend to find that once deflation began in late 1929, agents expected it to continue. This finding arises because the inflation process itself is persistent, so if agents used something akin to an AR(1) method to form their expectations, they would necessarily expect deflation to persist.

However, forecasters in the 1920s and 30s did not use the time series methods that are popular today. Nor did they have access to all of the data series that are currently available. Narrative evidence from the press, economic journals, and written materials of economic forecasting services reveals that agents' forecasts were not consistent with modern-day time-series econometrics techniques and that the deflation was largely unanticipated.

Unanticipated deflation prior to the onset of the Depression is consistent with the debt deflation hypothesis. When borrowers accrued nominal debt during the 1920s, they did not foresee how greatly its real value would rise. The resulting insolvency and debt overhang severely reduced aggregate demand, consistent with the interpretation of contemporary observers of the Depression, Persons (1930) and Fisher (1933). Unexpectedly high real household debt burdens would also explain the collapse in consumption in the spending hypothesis of Temin (1976). The finding that deflation was unanticipated also lends support to Bernanke's explanation of the Depression, which relies on unexpected deflation setting off a debt crisis characterized by mass insolvencies that then raises the cost of credit intermediation and weakens the banking system.

A regime change in inflation expectations occurred shortly after Roosevelt's inauguration. Statistical approaches tend to find a later return of positive inflationary expectations. By

Table 3.4: Summary of estimated Great Depression era inflation expectations

	Approach	Price Index	1928	1929	1930	Q1-2 1933	Q3-4 1933
Market-Based							
Hamilton 1992	Commodities futures	CPI	-3	-0.9	-2.0	-3	7.1
Temin and Wigmore 1990	Stock prices	...	...	...	...	Pos.	Pos.
Binder 2015	Stock prices	CPI	5.2	4.4	-6.8	7	9.1
Binder 2015	Phillips curve	CPI	-0.6	4.4	-6.3	-0.4	14.7
Statistical							
Cecchetti 1992	MA(2)	CPI	...	0	-3.1	-7.6	15
Cecchetti 1992	AR(1)	CPI	...	0.5	-3.1	-9.1	10.1
Cecchetti 1992	Multivariate	CPI	...	-3.2	-4.1	17.2	0.2
Romer 1992	Multivariate	PPI	...	-1.8	-2.3	-7.5	-2
Fackler and Parker 2005	Markov Switching	CPI				...	...
Dorval and Smith 2013	AR(1)	Retail	Stable	Stable	...	...	...
Binder 2015	AR(1)	CPI	-0.8	-0.1	-3.0	-3.4	2.8
Narrative							
Dominguez et al. 1988	Forecasters	...	...	Stable	Stable	...	...
Nelson 1991	Press	...	...	Mild neg.	Mild neg.	...	...
Romer and Romer 2013	Press	...	...	...	Pos.	...	...
Jalil and Rua 2013	Press	...	...	...	...	Pos.	Pos.
Binder 2015	Newspapers, forecasters	...	Pos.	Stable/ uncertain		Pos.	Pos.

Notes: This table summarizes the existing literature on inflation expectations in the Great Depression and results from this paper.

construction, these methods cannot detect a regime change in inflation expectations. Market-based and narrative approaches can and do detect an earlier return of positive inflation expectations. Commodities futures prices reveal positive inflation expectations in the second trimester of 1933, while stock prices and inflation dynamics similarly estimate a return of positive inflation expectations in April or May. The narrative evidence is perhaps the most conclusive in detecting a regime change around April 1933.

The evidence on inflation expectations in 1933 strongly supports the regime change hypothesis of Temin and Wigmore (1990) and Eggertsson (2008). Roosevelt's policies were a sharp and noted break from those of Hoover. The devaluation of the dollar signalled the start of the inflationary regime, and subsequent communication and policies reinforced it. The dramatic shift in expectations sparked a recovery in business confidence and economic activity that preceded monetary expansion. Irving Fisher summarized the nature of the regime change when he wrote, "Only one thing can save us—reflation. Fortunately, we have a President who sees this and is willing to break with any tradition in order to preserve our national existence."[32] The behavior of Depression-era inflation expectations does not negate the role of monetary forces in the contraction and recovery, but does suggest that nonmonetary forces—"shifts in the IS curve," so to speak— played a large role.

Roosevelt's success in enacting a regime change holds lessons for current policy. Policymakers increasingly recognize the power of shaping expectations and make big promises of change. In July 2012, for example, European Central Bank President Mario Draghi pledged to do "whatever it takes" to save the euro from collapse. In Japan, a two-decade long stagnation began in the early 1990s. In early 2013, Prime Minister Shinzo Abe attempted to enact regime change through monetary and fiscal policy and structural reforms aimed at raising long-run inflation expectations and ending deflation (Hausman and Wieland, 2014). Great Depression history teaches that a regime change can be remarkably successful, but requires bold promises backed and made credible by expedient actions.

[32]Irving Fisher, "Inflation," NYT, May 1, 1933, p. 14.

Bibliography

A'Hearn, Brian and Jrg Baten, "Quantifying Quantitative Literacy: Age Heaping and the History of Human Capital," *C*entre for Economic Policy Research Discussion Paper, April 2009, *7*277.

Akerlof, George, "The Market for 'Lemons': Quality Uncertainty and the Market Mechanism," *Q*uarterly Journal of Economics, 1970, *8*4 (3), 488–500.

Albers, Wulf and Gisela Albers, *D*ecisionmaking Under Uncertainty, Elsevier,

Anderson, Richard, "The FOMC: Transparency Achieved?," *E*conomic Synopses, 2012, (9).

Armantier, Olivier, Giorgio Topa, Wilbert van der Klaauw, and Basit Zafar, "Introducing the FRBNY Survey of Consumer Expectations: Measuring Price Inflation Expectations," *F*ederal Reserve Bank of New York Liberty Street Economics, 2013.

Bachmann, Rudiger, Steffen Elstner, and Eric Sims, "Uncertainty and Economic Activity: Evidence from Business Survey Data," *N*A, 2012, *N*A, 1–47.

_ , Tim Berg, and Eric Sims, "Inflation Expectations and Readiness to Spend: Cross-Sectional Evidence," Technical Report, Working Paper 2013.

Baird, John, Charles Lewis, and Daniel Romer, "Relative Frequency of Numerical Responses in Ratio Estimation," *P*erception and Psychophysics, 1970, *8* (5B), 358–362.

Baker, Scott, Nicholas Bloom, and Steven Davis, "Measuring Economic Policy Uncertainty," *S*tanford Mimeo, 2012.

Bakshy, Eytan, Itamar Rosenn, Cameron Marlow, and Lada Adamic, "The Role of Social Networks in Information Diffusion," *P*roceedings of the 21st international conference on World Wide Web, 2012, pp. 519–523.

Ball, Laurence, "Why Does High Inflation Raise Inflation Uncertainty?," *J*ournal of Monetary Economics, 1992, *2*9 (3), 371–388.

_ and Sandeep Mazumder, "Inflation Dynamics and the Great Recession," *B*rookings Papers on Economic Activity, 2011, pp. 337–405.

_ and Stephen Cecchetti, "Infation and Uncertainty at Short and Long Horizons," *B*rookings Papers on Economic Activity, 1990, *1*, 215–254.

Barro, Robert, *D*eterminants of Economic Growth: A Cross-Country Empirical Study, Vol. 1, MIT Press, December 1998.

Beechey, Meredith, Benjamin Johannsen, and Andrew Levin, "Are Long-Run Inflation Expectations Anchored More Firmly in the Euro Area Than in the United States?," *A*merican Economic Journal: Macroeconomics, April 2011, *3* (2), 104–129.

Bernanke, Ben, "Irreversibility, Uncertainty, and Cyclical Investment," *Q*uarterly Journal of Economics, 1983, *9*7 (1), 85–106.

_ , "The Macroeconomics of the Great Depression: A Comparative Approach," *J*ournal of Money, Credit, and Banking, 1995, *2*7, 1–28.

_ , "A Perspective on Inflation Targeting," *A*nnual Washington Policy Conference of the National Association of Business Economists, Washington, D.C., March 2003.

_ , "Federal Reserve Communications," *C*ato Institute 25th Annual Monetary Conference, Washington, D.C., 2007.

_ , "Inflation Expectations and Inflation Forecasting," in "Monetary Economics Workshop of the National Bureau of Economic Research Summer Institute" 2007.

_ , "A Century of U.S. Central Banking: Goals, Frameworks, Accountability," *T*he First 100 Years of the Federal Reserve: The Policy Record, Lessons Learned, and Prospects for the Future, 2013.

Bertola, Giuseppe, Luigi Guiso, and Luigi Pistaferri, "Uncertainty and Consumer Durables Adjustment," *R*eview of Economic Studies, 2005, *7*2, 9731007.

Berument, Hakan, Zubeyir Kilinc, and Umit Ozlalew, "The Missing Link between Inflation Uncertainty and Interest Rates," *S*cottish Journal of Political Economy, May 2005, *5*2 (2), 222–241.

Binder, Carola, "Fed Speak on Main Street," *W*orking Paper, 2014.

Blanchflower, David and Roger Kelly, "Macroeconomic literacy, numeracy and the implications for monetary policy," *B*ank of England Working Paper, 2008.

Blinder, Alan, *C*entral Banking in Theory and Practice, Cambridge and London: MIT Press, 1998.

_ and Alan Krueger, "What Does the Public Know about Economic Policy, and How Does It Know It?," *B*rookings Papers on Economic Activity, 2004, *1*, 327–397.

_ , Michael Ehrmann, Marcel Fratzscher, Jakob de Haan, and David-Jan Jansen, "Central Bank Communication and Monetary Policy: A Survey of Theory and Evidence," *J*ournal of Economic Literature, December 2008, *4*6 (4), 910–945.

Bloom, Nicholas, "The Impact of Uncertainty Shocks," *E*conometrica, 2009, *7*7 (3), 623–685.

_ , "Fluctuations in Uncertainty," *J*ournal of Economic Perspectives, 2013, *2*8 (2), 153–176.

_ , Max Floetotto, Nir Jaimovich, Itay Saporta-Eksten, and Stephen Terry, "Really Uncertain Business Cycles," *C*EP Discussion Papers, 2013, *1*195, 1–39.

Bloom, Nick, Stephen Bond, and John Van Reenen, "Uncertainty and Investment Dynamics," *R*eview of Economic Studies, 2007, *7*4 (2), 391–415.

Blumler, Jay and Michael Gurevitch, *M*ass Media and Society, Arnold,

Boero, Gianna, Jeremy Smith, and Kenneth Wallis, "Uncertainty and disagreement in economic prediction: the Bank of England Survey of External Forecasters," *E*conomic Journal, 2008, *1*18 (530), 1107–1127.

_ , _ , and _ , "The Measurement and Characteristics of Professional Forecasters' Uncertainty," *J*ournal of Applied Econometrics, 2014.

Brunner, Karl, "Epilogue: Understanding the Great Depression," in Karl Brunner, ed., *T*he Great Depression Revisited, Rochester Studies in Economics and Policy Issues, 1981.

Bryan, Michael and Guhan Venkatu, "The Demographics of Inflation Opinion Surveys," *F*ederal Reserve Bank of Cleveland Economic Commentary, 2001, *O*ctober.

Bullock, C. and W. Crum, "The Harvard index of economic conditions: interpretation and performance, 1919-31," *R*eview of Economic Statistics, 1932, *1*4, 132–148.

Campbell, Donald and Donald Fiske, "Convergent and discriminant validation by the multitrait-multimethod matrix," *P*sychological Bulletin, March 1959, *5*6 (2), 81–105.

Carpini, Michael Delli and Scott Keeter, *W*hat Americans Know about Politics and Why It Matters, Yale University Press, 1996.

Carroll, Christopher, "Macroeconomic Expectations of Households and Professional Forecasters," *Q*uarterly Journal of Economics, 2003, *1*18 (1), 269–298.

_ , "Theoretical Foundations of Buffer Stock Saving," *N*BER Working Paper, 2004, *1*0867.

Carvalho, Carlos and Fernanda Nechio, "Do People Understand Monetary Policy?," *F*ederal Reserve Bank of San Francisco Working Paper, 2012, *0*1, 1–49.

Cecchetti, Stephen, "Prices During the Great Depression: Was the Deflation of 1930-1932 Really Unanticipated?," *A*merican Economic Review, March 1992, *8*2 (1), 141–156.

_ , "Inflation Uncertainty, Relative Price Uncertainty and Investment in U.S Manufacturing: Comment," *J*ournal of Money, Credit and Banking, August 1993, *2*5, 550–556.

Clark, Evans, *T*he Internal Debts of the United States, New York: MacMillan Co., 1933.

Clark, Todd, "Cross-country evidence on long-run growth and inflation," *E*conomic Inquiry, 1997, *3*5, 70–81.

_ and Taisuke Nakata, "Has the Behavior of Inflation and Long-Term Inflation Expectations Changed?," *F*ederal Reserve Bank of Kansas City Economic Review, 2008, pp. 17–50.

Cohen, Alma and Liran Einav, "Estimating Risk Preferences from Deductible Choice," *A*merican Economic Review, June 2007, *9*7 (3), 745–788.

Coibion, Olivier and Yuriy Gorodnichenko, "What can survey forecasts tell us about information rigidities?," *J*ournal of Political Economy, 2012, *1*20 (1), 116–159.

_ and _ , "Is the Phillips Curve Alive and Well After All? Inflation Expectations and the Missing Disinflation," *W*orking Paper, 2013.

Committee on Recent Economic Changes, "Recent Economic Changes in the United States," *P*resident's Conference on Unemployment, 1929, *1*-2.

Cukierman, Alex, *C*entral Bank Strategy, Credibility, and Independence: Theory and Evidence, Massachusetts Institute of Technology, 1992.

Curtin, Richard, "What U.S. Consumers Know About Economic Conditions," Technical Report, University of Michigan 2007.

Dahlgren, Peter, "The Internet, Public Spheres, and Political Communication: Dispersion and Deliberation," *P*olitical Communication, 2005, *2*2, 147–162.

Davis, George and Bruce Kanago, "On Measuring the Effect of Inflation Uncertainty on Real GNP Growth," *O*xford Economic Papers, 1996, *4*8, 163–175.

Davis, J. Scott, "Inflation Expectations Have Become More Anchored Over Time," *D*allas Fed Economic Letters, 2012, *7* (13), 1–4.

de Bruin, Wandi Bruine, Charles F. Manski, Giorgio Topa, and Wilbert van der Klaauw, "Measuring Consumer Uncertainty about Future Inflation," *F*ederal Reserve Bank of New York Staff Report, 2009, *4*15.

_ , Wilbert van der Klaauw, Julie Downs, Baruch Fischhoff, Giorgio Topa, and Olivier Armantier, "Expectations of Inflation: The Role of Demographic Variables, Expectation Formation, and Financial Literacy," *T*he Journal of Consumer Affairs, 2010, *4*4 (2), 381–402.

Dechow, Patricia and Haifeng You, "Analysts Motives for Rounding EPS Forecasts," *A*ccounting Review, 2012.

Dehaene, Stanislas and Jacques Mehler, "Cross-linguistic regularities in the frequency of number words," *C*ognition, 1992, *4*3 (1), 1–29.

Dincer, Nergiz and Barry Eichengreen, "Central Bank Transparency: Causes, Consequences and Updates," *N*BER Working Paper, 2009, *1*4791.

Dixit, Avinash and Robert Pindyck, *I*nvestment under Uncertainty, Princeton, NJ: Princeton University Press, 1993.

Dominguez, Kathryn, Ray Fair, and Matthew D. Shapiro, "Forecasting the Depression: Harvard Versus Yale," *A*merican Economic Review, 1988, *7*8, 595612.

Doms, Mark and Norman Morin, "Consumer Sentiment, the Economy, and the News Media," *F*ederal Reserve Bank of San Francisco Working Paper, 2004, *9*.

Dorval, Bill and Gregor Smith, "Interwar Deflation and Depression," *Q*ueens Economics Department Working Paper, 2013, (1310).

Dotsey, Michael and Pierre Daniel Sarte, "Inflation Uncertainty and Growth in a Cash-in-Advance Economy," *J*ournal of Monetary Economics, June 2000, *4*5 (3), 631–655.

Drager, Lena and Michael Lamla, "Imperfect Information and Inflation Expectations: Evidence from Microdata," *D*EP (Socioeconomics) Discussion Papers Macroeconomics and Finance Series, 2013, *1*, 1–38.

_ , _ , and Damjan Pfajfar, "Are Consumer Expectations Theory Dependent? The Role of Macroeconomic Determinants and Central Bank Communication," *K*OF Working Papers, 2013, *3*45.

Easaw, Joshy, Roberto Golinelli, and Marco Malgarini, "Do Households Anchor their Inflation Expectations? Theory and Evidence from a Household Survey," *Q*uaderni DSE Working Paper, 2012, (842).

Edwards, George, *O*n Deaf Ears: The Limits of the Bully Pulpit, Yale University Press, 2003.

Eggertsson, Gauti B., "Great Expectations and the End of the Depression," *A*merican Economic Review, 2008, *9*8 (4), 1476–1516.

Eichengreen, Barry and Jeffrey Sachs, "Exchange Rates and Economic Recovery in the 1930s," *J*ournal of Economic History, 1985, *4*5, 925–946.

Elder, John, "Another Perspective on the Effects of Inflation Uncertainty," *J*ournal of Money, Credit and Banking, 2004, *3*6 (5).

Engelberg, Joseph, Charles Manski, and Jared Williams, "Comparing the Point Predictions and Subjective Probability Distributions of Professional Forecasters," *J*ournal of Business and Economic Statistics, 1 2009, *2*7, 30–41.

Erceg, Christopher and Andrew Levin, "Optimal Monetary Policy with Durable and Non-Durable Goods," *E*CB Working Paper, 2002, *1*79.

_ and _ , "Imperfect Credibility and Inflation Persistence," *J*ournal of Monetary Economics, 2003, *5*0 (4), 915–944.

Evans, Charles, "Like It or Not, 90 Percent of a 'Successful Fed Communications' Strategy Comes from Simply Pursuing a Goal-oriented Monetary Policy Strategy," *U*.S. Monetary Policy Forum, New York, NY, 2014.

Evans, Martin and Paul Wachtel, "Inflation Regimes and the Sources of Inflation Uncertainty," *J*ournal of Money, Credit and Banking, 1993, *2*5 (3), 475–511.

Facebook, "Fourth Quarter and Full Year Financial Summary," 2013.

Fackler, James and Randall Parker, "Was Debt Deflation Operative During the Great Depression?," *E*conomic Inquiry, 2005, *4*3 (1), 67–78.

Favero, Giovanni, "Weather Forecast or Rain-Dance? On Inter-War Business Barometers," *W*orking Paper, Department of Economics Ca Foscari University of Venice, 2007, (14).

FINRA, "Financial Capability in the United States," *R*eport of Findings from the 2012 National Financial Capability Study, May 2013.

Fisher, Irving, "The Debt Deflation Theory of Great Depressions," *E*conometrica, October 1933, *1* (4), 337–357.

FOMC, "Press Release," January 25 2012.

Fountas, Stilianos and Menelaos Karanasos, "Inflation, output growth, and nominal and real uncertainty: Empirical evidence for the G7," *J*ournal of International Money and Finance, 2007, *2*6, 229–250.

Friedman, Milton and Anna Schwartz, *A* Monetary History of the United States, 1867-1960, Princeton: Princeton University Press, 1963.

Friedman, Walter, *F*ortune Tellers: The Story of Americas First Economic Forecasters, Princeton University Press, 2014.

Gali, Jordi and Mark Gertler, "Inflation dynamics: A structural econometric analysis," *J*ournal of Monetary Economics, 1999, *4*4, 195–222.

Gärtner, Katharina, "Household Debt and Economic Recovery: Evidence from the U.S. Great Depression," *E*uropean Historical Economics Society Working Paper, March 2013, (36).

Gaziano, Cecilie, "Forecast 2000: Widening knowledge gaps," *J*ournalism and Mass Communication, 1997, *7*4 (2).

Gertner, Robert, "Game Shows and Economic Behavior: Risk-Taking on 'Card Sharks'," *Q*uarterly Journal of Economics, 1993, *1*08 (2), 507–521.

Goodfriend, Marvin, "Monetary Mystique: Secrecy and Central Banking," *J*ournal of Monetary Economics, 1986, *1*7 (1), 63–92.

_ and Robert King, "The Incredible Volcker Disinflation," *J*ournal of Monetary Economics, July 2005, *5*2 (5), 981–1015.

Greenspan, Alan, "The value of public outreach by the Federal Reserve," *R*emarks at the dedication of the Visitors Center at the Federal Reserve Bank of Chicago, 2001.

Grier, Kevin and Mark Perry, "The Effects of Real and Nominal Uncertainty on Inflation and Output Growth: Some GARCH-M Evidence," *J*ournal of Applied Econometrics, 2000, *1*5, 45–58.

Grier, Robin and Kevin Grier, "On the real effects of inflation and inflation uncertainty in Mexico," *J*ournal of Development Economics, 2006, *8*0, 478–500.

Gurkaynak, Refet, Andrew Levin, Andrew Marder, and Eric Swanson, "Inflation Targeting and the Anchoring of Inflation Expectations in the Western Hemisphere," *F*ederal Reserve Bank of San Francisco Economic Review, 2007, pp. 25–47.

Hamilton, James, "Was the Deflation During the Great Depression Anticipated? Evidence from the Commodity Futures Market," *A*merican Economic Review, March 1992, *8*2 (1), 157–178.

Harris, Lawrence, "Stock Price Clustering and Discreteness," *R*eview of Financial Studies, 1991, *4* (3), 389–415.

Hausman, Joshua and Johannes Wieland, "Abenomics Preliminary Analysis and Outlook," *B*rookings Papers on Economic Activity, 2014.

Herrmann, Don and Wayne Thomas, "Rounding of Analyst Forecasts," *A*ccounting Review, 2005, *8*0, 805–823.

Hetzel, Robert, *T*he Great Recession: Market Failure Or Policy Failure?, Cambridge University Press, 2012.

Hsiao, Cheng, Yan Shen, and Hiroshi Fujiki, "Aggregate vs Disaggregate Data Analysis - A Paradox in the Estimation of a Money Demand Function of Japan Under the Low Interest Rate Policy," *J*ournal of Applied Econometrics, 2005, *2*0 (5), 579–601.

Hsieh, Chang-Tai and Christina Romer, "Was the Federal Reserve Constrained by the Gold Standard During the Great Depression? Evidence from the 1932," *T*he Journal of Economic History, March 2006, *6*6 (1), 140–176.

Huttenlocher, Janellen, Larry Hedges, and Norman Bradburn, "Reports of elapsed time: Bounding and rounding processes in estimation," *J*ournal of Experimental Psychology: Learning, Memory, and Cognition, 1990, *1*6 (2), 196–213.

Hwang, Yoori and Se-Hoon Jeong, "Revisiting the Knowledge Gap Hypothesis: A Meta Analysis of Thirty Five Years of Research," *J*&MC Quarterly, 2009, *8*6 (3), 513–532.

Imbens, Guido and Jeffrey Wooldridge, "What's New in Econometrics?," *L*ecture Notes 6, NBER Summer, 2007, pp. 1–27.

Ittner, Andreas and Aurel Schubert, "Central banks should be boring — or should they? Communicating central bank statistics to the general public," *F*ifth ECB Conference on Statistics, 2010.

Iyengar, Shanto, "Cross-National versus Individual-Level Differences in Political Information: A Media Systems Perspective," *J*ournal of Elections, Public Opinion and Parties, 2010, *2*0 (3), 291–309.

_ and James Curran, "Media Systems, News Delivery and Citizens Knowledge of Current Affairs," *I*CA Mini-Plenary, Transformations of the Public Sphere, 2009.

Jalil, Andy and Gisela Rua, "Inflation Expectations and Recovery from the Depression: Evidence from the Narrative Record," 2013.

Jansen, Carel and M. Pollmann, "On Round Numbers: Pragmatic Aspects of Numerical Expressions," *J*ournal of Quantitative Linguistics, 2001, *8* (3), 187–201.

Jansen, Dennis, "Does Inflation Uncertainty Affect Output Growth? Further Evidence," *S*t. Louis Federal Reserve Economic Review, 1989, *7*, 43–54.

Judd, John and Glenn Rudebusch, "The Goals of U.S. Monetary Policy," *F*ederal Reserve Bank of San Francisco Economic Letters, 1999, *4*.

Kantor, Laurence, "Inflation Uncertainty and Inflation Hedging," *F*ederal Reserve Bank of Kansas City Economic Review, 1983, *3*, 23–37.

Kimball, Miles, "Precautionary Saving in the Small and in the Large," *E*conometrica, 1990, *5*8 (1), 53–73.

Knotek, Edward and Shujaat Khan, "How do Households Respond to Uncertainty Shocks?," *K*ansas City Federal Reserve Economic Review, 2011, *2*, 63–92.

Kocherlakota, Narayana, "Opening Remarks," *T*own Hall Forum, North Dakota State University, Fargo, North Dakota, April 2014.

Kozicki, Sharon and Peter Tinsley, "Permanent and transitory policy shocks in an empirical macro model with asymmetric information," *J*ournal of Economic Dynamics & Control, 2005, *2*9 (11), 1985–2015.

Krifka, Manfred, "Be Brief and Vague! And how Bidirectional Optimality Theory allows for Verbosity and Precision," in David Restle and Dietmar Zaefferer, eds., *S*ounds and Systems. Studies in Structure and Change, Mouton de Gruyter, 2002, pp. 429–448.

_ , "Approximate interpretations of number words: A case for strategic communication," *T*heory and Evidence in Semantics, 2009, pp. 109–132.

Kuhn, Britta, "The Communication Policy of the European Central Bank: A Review of the First Five Years," *I*ntereconomics, 2005.

Kuroda, Haruhiko, "Live: Bank of Japans Kuroda Speaks," *W*all Street Journal, April 8 2014.

Lahiri, Kahal and Fushang Liu, "Modelling multi-period inflation uncertainty using a panel of density forecasts," *J*ournal of Applied Econometrics, 2006, *2*1 (8), 1199–1219.

Lahiri, Kajal and Xuguang Sheng, "Measuring Forecast Uncertainty by Disagreement: The Missing Link," *J*ournal of Applied Econometrics, 2010, *2*5 (4), 514–538.

Lambert, Richard, "Inside the MPC," *B*ank of England Quarterly Bulletin, Spring 2005, pp. 56–65.

Lamla, Michael and Sarah Lein, "Rational Inattention, Inflation Perceptions and the Media: Lessons from the Euro Cash Changeover," *E*uropean Central Bank Working Paper Series, 2006, *0*588.

_ and Thomas Maag, "The Role of Media for Inflation Forecast Disagreement of Households and Professional Forecasters," *J*ournal of Money, Credit and Banking, 2012, *7*, 1325–1350.

Leduc, Sylvain and Zheng Liu, "Uncertainty Shocks are Aggregate Demand Shocks," *F*RBSF Working Paper, 2012, *1*0, 1–40.

Lee, Han Soo, "Analyzing the Multidirectional Relationships Between the President, News Media, and the Public: Who Affects Whom?," *P*olitical Communication, 2014, *31* (2), 259–281.

Leland, Hayne, "Savings and Uncertainty: The Precautionary Demand for Savings," *Q*uarterly Journal of Economics, 1968, *82*, 465–473.

Lessard, Donald and Franco Modigliani, "Inflation and the Housing Market: Problems and Potential Solutions," 1975.

Levin, Andrew, "The Design and Communication of Systemic Monetary Policy Strategies," 2014.

Lockhart, Dennis, "Federal Reserve Communication: Striving for Clarity in a Fast Changing World," in "Media Financial Management Association" May 2011.

Lusardi, Annamaria, "On the Importance of the Precautionary Saving Motive," *A*merican Economic Review, 1998, *88* (2), 449–453.

_ , "Financial Literacy: An Essential Tool for Informed Consumer Choice?," *N*BER Working Paper, June 2008, *14084*.

MacDonald, Don and Kimberly Winson-Geideman, "Residential Mortgage Selection, Inflation Uncertainty, and Real Payment Tilt," *J*ournal of Real Estate Research, 2012, *34* (1), 51–71.

Mackowiak, Bartosz and Mirko Wiederholt, "Business Cycle Dynamics under Rational Inattention," *E*CB Working Paper, 2011, *1331*, 1–74.

Mankiw, Gregory, "Consumer Durables and the Real Interest Rate," *R*eview of Economics and Statistics, 1985, *67*, 353–362.

_ and Ricardo Reis, "Sticky Information Versus Sticky Prices: A Proposal to Replace the New Keynesian Phillips Curve," *Q*uarterly Journal of Economics, 2002, *117* (4), 1295–1328.

Mankiw, N. Gregory, Ricardo Reis, and Justin Wolfers, "Disagreement about Inflation Expectations," in Mark Gertler and Kenneth Rogoff, eds., *N*BER Macroeconomics Annual, Vol. 18 MIT Press 2004.

Manski, Charles and Francesca Molinari, "Rounding Probabilistic Expectations in Surveys," *J*ournal of Business and Economic Statistics, 2010, *28* (2), 219–231.

Marcus, Gill, "Address to the Central Banks Communicators Conference," March 2014.

Mavroeidis, Sophocles, Mikkel Plagborg-Moller, and James Stock, "Empirical Evidence on Inflation Expectations in the New Keynesian Phillips Curve," *J*ournal of Economic Literature, 2014, *5*2 (1), 124188.

McTaggart, Doug, *I*nflation, Disinflation and Monetary Policy, Reserve Bank of Australia, 1992.

Melecký, Martin, Diego Rodríguez Palenzuela, and Ulf Söderström, *M*onetary Policy under Uncertainty and Learning, Vol. 13, Central Bank of Chile,

Mian, Atif and Amir Sufi, "The Great Recession: Lessons from Microeconomic Data," *A*merican Economic Review, 2010, *1*00 (2), 51–56.

Milani, Fabio, "Expectations, Learning and Macroeconomic Persistence," *J*ournal of Monetary Economics, October 2007, *5*4 (7), 2065–2082.

Mishkin, Frederic, "Illiquidity, Consumer Durable Expenditure and Monetary Policy," *A*merican Economic Review, 1976, *6*6, 642–654.

_ , *T*he Costs and Consequences of Inflation, Vol. 15, Carnegie Rochester Series on Public Policy,

_ , "Can Futures Market Data Be Used to Understand the Behavior of Real Interest Rates?," *J*ournal of Finance, 1990, *4*5 (1), 245–257.

_ , "Can Central Bank Transparency Go Too Far?," *N*BER Working Paper, 2004, *1*0829.

_ , "Whither Federal Reserve Communications," in "Peterson Institute for International Economics" July 2008.

Moore, Carl, *T*he Federal Reserve System: A History of the First 75 Years, Jefferson, NC: McFarland and Company, 1990.

Nelson, Daniel, "Was the Deflation of 1929-1930 Anticipated? The Monetary Regime as Viewed by the Business Press," *R*esearch in Economic History, 1991, *1*3, 1–65.

Olney, Martha, "Avoiding Default: The Role of Credit in the Consumption Collapse of 1930," *Q*uarterly Journal of Economics, 1999, *1*14 (1), 319–335.

Orlik, Anna and Laura Veldkamp, "Understanding Uncertainty Shocks," 2012. Working Paper.

Orphanides, Athanasios and John Williams, *T*he Inflation Targeting Debate, The University of Chicago Press,

Pagan, Adrian, "Econometric Issues in the Analysis of Regressions with Generated Regressors," *I*nternational Economic Review, February 1984, *2*5 (1), 221–247.

Persons, Charles, "Credit Expansion, 1920 to 1929, and Its Lessons," *Q*uarterly Journal of Economics, 1930, *4*5 (1), 94–130.

Petev, Ivaylo D. and Luigi Pistaferri, "Consumption in the Great Recession," *T*he Russell Sage Foundation and the Stanford Center on Poverty and Inequality, 2012.

Pew, "Tracking the Economic Slowdown," *P*ew Research Center Journalism Project, August 2008.

_ , "Covering the Great Recession," *P*ew Research Center Journalism Project, October 2009.

Pfajfar, Damjan and Emiliano Santoro, "Asymmetries in Inflation Expectation Formation Across Demographic Groups," *C*WPE, June 2008, *0*824.

Phelps, William, "Phillips Curve, Expectations of Inflation, and Optimal Inflation over Time," *E*conomica, 1968, *3*4.

Piazzesi, Monika and Martin Schneider, "Inflation and the Price of Real Assets," 2012.

Pudney, Stephen, "Heaping and leaping: Survey response behaviour and the dynamics of self-reported consumption expenditure," *I*nstitute for Social and Economic Research Working Paper, February 2008, *9*.

Ramey, Valerie and Matthew Shapiro, "Costly capital reallocation and the effects of government spending," *C*arnegie-Rochester Conference Series on Public Policy, June 1998, *4*8 (1), 145–194.

RES, "General Economic Conditions," *R*eview of Economics and Statistics, May 1933, *1*5 (2), 61–65.

_ , "The United States: Index of General Business," *R*eview of Economic Statistics Monthly Supplement, January 1933, (1), 1–2.

_ , "The United States: Index of General Business," *R*eview of Economics and Statistics Monthly Supplement, June 1933, (4), 97–99.

Rich, Robert and Joseph Tracy, "The relationships among expected inflation, disagreement, and uncertainty: evidence from matched point and density forecasts," *R*eview of Economics and Statistics, 2010, *9*2, 200–207.

_ , Joseph Song, and Joseph Tracy, "The Measurement and Behavior of Uncertainty: Evidence from the ECB Survey of Professional Forecasters," *F*ederal Reserve Bank of New York Staff Reports, 2012, *5*88, 1–48.

Romer, Christina, "The Great Crash and the Onset of the Great Depression," *Q*uarterly Journal of Economics, 1990, *1*05, 597–624.

_ , "What Ended the Great Depression," *J*ournal of Economic History, December 1992, *52* (4), 757–784.

_ , "Remeasuring Business Cycles," *J*ournal of Economic History, September 1994, *54*, 573–609.

_ , "It Takes a Regime Shift: Recent Developments in Japanese Monetary Policy throught the Lens of the Great Depression," *N*BER Macroeconomics Annual, 2013, *28* (1), 383–400.

_ and David Romer, "A New Measure of Monetary Policy Shocks: Derivation and Implications," *A*merican Economic Review, 2004, *94* (4), 1055–1084.

_ and _ , "The Missing Transmission Mechanism in the Monetary Explanation of the Great Depression," *A*merican Economic Review, 2013, *103* (3), 66–72.

Rowland, M, "Self-reported weight and height," *A*merican Journal of Clinical Nutrition, 1990, *52*, 1125–1133.

Sargent, Thomas, "The Ends of Four Big Inflations," in Robert Hall, ed., *I*nflation: Causes and Effects, University of Chicago Press, 1983.

Schwartz, Anna, *M*oney in Historical Perspective, University of Chicago Press,

Schweitzer, Mark and Eric Severance-Lossin, "Rounding in Earnings Data," *F*ederal Reserve Bank of Cleveland Working Paper, 1996, *9612*.

Selten, Reinhard, *B*ounded Rationality: The Adaptive Toolbox, The MIT Press, 2002.

Shiller, Robert, *R*educing Inflation: Motivation and Strategy, University of Chicago Press, 1997.

_ , *I*rrational Exuberance, Princeton University Press, 2000.

Sigurd, Bengt, "Round Numbers," *L*anguage in Society, 1988, *17* (2), 243–252.

Sims, Chris, "Implications of Rational Inattention," *J*ournal of Monetary Economics, 2003, *50*, 665–690.

Souleles, "Expectations, Heterogeneous Forecast Errors, and Consumption: Micro Evidence from the Michigan Consumer Sentiment Surveys," *J*ournal of Money, Credit and Banking, 2004, *36* (1), 39–72.

Steelman, Aaron, "The Federal Reserves "Dual Mandate": The Evolution of an Idea," *F*ederal Reserve Bank of Richmond Economic Brief, 2011, *1*1-12.

Stein, O.C., "Discussion of price forecasting at a conference with State representatives," *A*nnual outlook meeting of the Bureau of Agricultural Economics, January 1928.

Steindl, Frank, *E*H.Net Encyclopedia March 2008.

Swanson, David and Dan Nimmo, *N*ew Directions in Political Communication: A Resource Book, Sage, 1990.

Sydnor, Justin, "Sweating the Small Stuff: The Demand for Low Deductibles in Homeowners Insurance," 2006.

Taylor, John, "Discretion versus Policy Rules in Practice," *C*arnegie-Rochester Conference Series on Public Policy, 1993, *3*9, 195–214.

_ , "Housing and Monetary Policy," *N*ational Bureau of Economic Research Working Paper, 2007, *1*3682.

Temin, Peter, *D*id Monetary Forces Cause the Great Depression?, New York: W. W. Norton, 1976.

_ and Barry Wigmore, "The End of One Big Deflation," *E*xplorations in Economic History, 1990, *2*7 (4), 483–502.

Tichenor, Phillip, G. A. Donohue, and C. N. Olien, "Mass Media Flow and Differential Growth in Knowledge," *T*he Public Opinion Quarterly, 1970, *3*4 (2), 159–170.

van der Klaauw, Wilbert, Wandi Bruine de Bruin, Giorgio Topa, Simon Potter, and Michael Bryan, "Rethinking the Measurement of Household Inflation Expectations: Preliminary Findings," *F*ederal Reserve Bank of New York Staff Report, 2008, *3*59.

van Rooij, Maarten, Annamaria Lusardi, and Rob Alessie, "Financial Literacy and Stock Market Participation," *J*ournal of Financial Economics, August 2011, *1*01 (2), 449–472.

Voth, Hans-Joachim, "Inflationary Expectations and Uncertainty during the Great Depression in Germany," 1999.

Watts, Michael, "What Works: A Review of Research on Outcomes and Effective Program Delivery in Precollege Economic Education," 2005.

Westerhoff, Frank, "Anchoring and Psychological Barriers in Foreign Exchange Markets," *J*ournal of Behavioural Finance, 2003, *4* , 65–70.

Wheelock, David, "Monetary Policy in the Great Depression: What the Fed Did, and Why," *S*t. Louis Federal Reserve Economic Review, 1992.

Williams, John, "Accommodative Monetary Policy: Savior or Saboteur?," *P*resentation to the Utah and Montana Bankers Association, June 2014.

Woodford, Michael, "Imperfect Common Knowledge and the Effects of Monetary Policy," in Philippe Aghion, Roman Frydman, Joseph Stiglitz, and Michael Woodford, eds., *K*nowledge, Information, and Expectations in Modern Macroeconomics: In Honor of Edmund S Phelps, Princeton University Press, 2001.

Wooldridge, Jeffrey, *E*conometric Analysis of Cross Section and Panel Data, Cambridge: MIT Press, 2002.

Wright, Jonathan and Jon Faust, "Forecasting Inflation," *H*andbook of Forecasting, Forthcoming, 2012.

Wright, Stephen, "Monetary Policy, Nominal Interest Rates, and Long-Horizon Inflation Uncertainty," *S*cottish Journal of Political Economy, February 2002, *4*9 (1), 61–90.

Yellen, Janet, "Communication in Monetary Policy," in "Society of American Business Editors and Writers 50th Anniversary Conference" Washington, D.C. April 2013.

_ , "Testimony," *C*onfirmation hearing before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, Washington, D.C., November 2013.

_ , "What the Federal Reserve Is Doing to Promote a Stronger Job Market," in "National Interagency Community Reinvestment Conference" Chicago, Illinois 2014.

Yu, Lumeng, "The Great Communicator: How FDR's Radio Speeches Shaped American History," *H*istory Teacher, November 2005, *3*9 (1), 89–106.

Zandweghe, Willem Van and John Carter Braxton, "Has Durable Goods Spending Become Less Sensitive to Interest Rates?," *F*ederal Reserve Bank of Kansas City Economic Review, 2013.

Zarnowitz, Victor and Louis A. Lambros, "Consensus and Uncertainty in Economic Prediction," *J*ournal of Political Economy, 1987, *9*5 (3), 591–621.

Zelnick, Melvin, "Age Heaping in the United States Census: 1880-1950," *T*he Milbank Memorial Fund Quarterly, July 1961, *3*9 (3), 540–573.

Zhao, Jing, Wei-Yu Kuo, and Tse-Chun Lin, "Does Cognitive Limitation Affect Investor Behavior and Performance? Evidence from Limit Order Clustering," Technical Report 2012.

Appendix A

Consumer Inflation Uncertainty Appendices

A.1 Data Descriptions

The expectations and attitude questions from the MSC used in this research are:
A2. Would you say that you (and your family living there) are better off or worse off financially than you were a year ago?

A3. Now looking ahead—do you think that a year from now you (and your family living there) will be better off financially, or worse off, or just about the same as now?

A7. And how about a year from now, do you expect that in the country as a whole business conditions will be better, or worse than they are at present, or just about the same?

A9. As to the economic policy of the government—I mean steps taken to fight inflation or unemployment—would you say the government is doing a good job, only fair, or a poor job?

A10. How about people out of work during the coming 12 months—do you think that there will be more unemployment than now, about the same, or less?

A11. No one can say for sure, but what do you think will happen to interest rates for borrowing money during the next 12 months—will they go up, stay the same, or go down?

A12b. By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?

A13b. By about what percent per year do you expect prices to go (up/down) on the average, during the next 5 to 10 years?

A15a. By about what percent do you expect your (family) income to (increase/decrease) during the next 12 months?

A16. Generally speaking, do you think now is a good time or a bad time to buy a house? (A16a. Why do you say so?)

A18. About the big things people buy for their homes–such as furniture, a refrigerator, stove, television, and things like that. Generally speaking, do you think now is a good or a bad time for people to buy major household items? (A18a. Why do you say so?)

A19. Speaking now of the automobile market–do you think the next 12 months or so will be a good time or a bad time to buy a vehicle, such as a car, pickup, van or sport utility vehicle? (A19a. Why do you say so?)

A20c. About how many cents per gallon do you think gasoline prices will (increase/decrease) during the next twelve months compared to now?

A25. [Introduced September 1999] The next questions are about investments in the stock market. First, do you (or any member of your family living there) have any investments in the stock market, including any publicly traded stock that is directly owned, stocks in mutual funds, stocks in any of your retirement accounts, including 401(K)s, IRAs, or Keogh accounts?

A26. [Introduced September 1999] Considering all of your (family's) investments in the stock market, overall about how much would your investments be worth today?

Table A.1: Spending attitude and aggregate expenditure variables

Variable	**Code**	**Description**
Spending Attitude Variables		
HOM	A16	Dummy: Good time to buy a house
DUR	A18	Dummy: Good time to buy durables
CAR	A19	Dummy: Good time to buy a car
HOM_BA	A16a	Dummy: Buy home in advance of rising prices
DUR_BA	A18a	Dummy: Buy durables in advance of rising prices
CAR_BA	A19a	Dummy: Buy car in advance of rising prices
BA	A16a, A18a, A19a	DUR_BA+CAR_BA+HOM_BA
LowR	A16a, A18a, A19a	Dummy: Mentions low rates as reason for spending attitude
HighR	A16a, A18a, A19a	Dummy: Mentions high rates as reason for spending attitude
MentionsR	A16a, A18a, A19a	Dummy: LowR==1 or HighR==1
Aggregate Expenditure Variables (with FRED codes)		
Real Durables Expenditures	PCEDG	Personal consumption expenditures on durable goods, divided by CPI and multiplied by CPI in 2000
Car Sales	ALTSALES	Lightweight vehicle sales, millions of units, seasonally adjusted
Home Sales	HSN1F	New one family houses sold, thousands of units, seasonally adjusted

Notes: MSC data from University of Michigan and Thomson Reuters. Other data from Federal Reserve Economic Data (FRED).

Table A.2: Control variables in spending attitudes regressions

Variable	**Code**	**Description**
Demographic Control Variables from Michigan Survey of Consumers		
Log Real Income		Natural log of real income
Education		Highest grade of education completed
Female		Dummy: Female
Married		Dummy: Married
Married*Female		Dummy: Interaction of Female and Married
Age		Age in years
Age Squared		Age in years, squared
Region		Dummies: West, Northeast, and South
Race		Dummies: White, African-American, and Hispanic
Investment quintile*	A25-26	Stock investments: none (0), lowest (1),...,top (5)
Attitude and Expectation Control Variables from Michigan Survey of Consumers		
PAGO	A2	Personal finances better (1), same (0), or worse (-1) than last year
PEXP	A3	Personal finances will be better (1), same (0), or worse (-1) next year
BEXP	A7	Business conditions will be better (1), same (0), or worse (-1) next year
GOVT	A9	Opinion of government economic policy is favorable (1), neutral (0), or unfavorable (-1)
UNEMP	A10	Expect unemployment rate to rise (1), stay same (0), or fall (-1)
RATEX	A11	Expect interest rates to rise (1), stay same (0), or fall (-1)
π^e	A12b	Expected % change in prices in next 12 mos.
INEX	A15a	Expected % change in family income in next 12 mos.
GAS*	A20c	Expected change in gas prices in next 12 mos. (cents)
Macroeconomic Control Variables (with FRED codes)		
Unemployment	UNRATE	Civilian unemployment rate
Fed funds rate	FEDFUNDS	Federal funds rate
Inflation	CPIAUCSL	CPI inflation rate, year-over-year
ZLB	FEDFUNDS	Dummy: Fed funds rate $\leq 0.25\%$

Notes: MSC data from University of Michigan and Thomson Reuters. Other data from Federal Reserve Economic Data (FRED). *Denotes variables not included in regressions unless specified.

A.2 Identifying Heaping with Whipple Indices

Demographer George Whipple developed the Whipple Index to quantify the prevalence of heaping at multiples of five in self-reported age data. The index is five times the number of multiple-of-five responses divided by the total number of responses. For inflation expectations data, let N_j be the number of responses of value j. The Whipple Index is:

$$W = \frac{N_{-10} + N_{-5} + N_0 + ... + N_{25}}{N_{-10} + N_{-9} + ... + N_{24} + N_{25}} * 5, \tag{A.1}$$

Values of W above 1.75 indicate very prevalent heaping (**?**). For the Michigan Survey inflation expectations data, W is 2.45.

Modifications of the Whipple Index, including the Myers' Blended Index and the digit-specific Whipple Index, are designed to identify heaping at any value, not just multiples of five. The index involves comparison of the frequencies of reported values to frequencies that would occur under the population distribution of true values, under some assumptions about the true distribution. Existing modified Whipple indices are designed specifically for use with age data as they assume true ages should be uniformly distributed on certain ranges. I modify the Myers' Blended Index to be used with inflation data. Suppose we have T observations of realized inflation. Let M_j be the number of inflation realizations in $[j - 0.5, j + 0.5)$, the integer bin centered at j. Then the modified Whipple Index for j is:

$$\hat{W}_j = \frac{N_j}{N_{-10} + N_{-9} + ... + N_{24} + N_{25}} \frac{T}{M_j} \tag{A.2}$$

The highest values of $\hat{W}_j$ occur at $j = 0, 5, 10$, and 15 (see Table A.3). $\hat{W}_j$ is undefined for $j < -2$ or $j > 15$ since $M_j = 0$ for such j. Notably, $\hat{W}_1$, $\hat{W}_2$, and $\hat{W}_3$ are less than or equal to one, indicating no heaping at these values.

Table A.3: Inflation forecasts and inflation realizations

Inflation (%)	**Responses (%)**	**Realizations (%)**	**Ratio**
-10	0.5	0.0	.
-9 to -6	0.2	0.0	.
-5	0.7	0.0	.
-4	0.1	0.0	.
-3	0.4	0.0	.
-2	0.3	0.2	1.5
-1	0.4	1.1	0.3
0	15.0	1.1	13.5
1	7.1	7.1	1.0
2	8.3	21.1	0.4
3	14.7	29.3	0.5
4	4.4	17.1	0.3
5	14.8	6.7	2.2
6	1.4	2.4	0.6
7	3.2	1.8	1.8
8	0.9	0.9	1.0
9	0.8	1.8	0.4
10	7.4	2.0	3.7
11 to 14	1.7	4.0	0.4
15	1.4	0.0	.
16 to 19	0.3	0.0	.
20	1.1	0.0	.
21 to 24	0.1	0.0	.
25	0.6	0.0	.
All multiples of 5	41.4	9.8	4.2

Notes: This table compares the distribution of MSC inflation expectations to the distribution of inflation realizations rounded to the nearest integer. Last column shows the ratio of responses to realizations in each bin. Ratios significantly greater than one indicate response heaping.

A.3 Non-Normal Distributional Assumptions

In Section 1.3, I assume that the cross sectional distribution of forecasts from consumers of type $\tau \in \{l, h\}$ is normal with mean $\mu_{\tau t}$ and variance $\sigma^2_{\tau t}$. Estimates are not particularly sensitive to this normality assumption. The logistic distribution has heavier tails (higher kurtosis) than the normal distribution, with probability density function:

$$f(x; \mu, s) = \frac{e^{=\frac{x-\mu}{s}}}{s(1 + e^{-\frac{x-\mu}{s}})^2}, \tag{A.3}$$

where the mean is μ and the variance is $\sigma^2 = s^2\pi^2/3$.

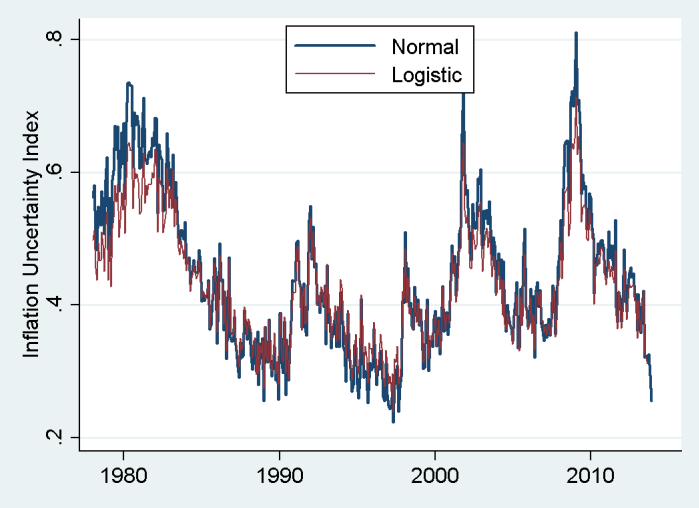
Table A.4 compares the maximum likelihood estimates and inflation uncertainty index under the assumptions of normal and logistic cross-sectional distributions, and Figure A.1 plots the index under both distributional assumptions. Results are quite similar in each case.

Table A.4: Maximum likelihood estimates with normal and logistic errors

Estimate	Mean with normal distribution	Mean with logistic distribution	Correlation between normal and logistic
λ	0.34	0.36	0.998
μ_l	3.52	3.36	0.999
μ_h	5.60	5.05	0.995
σ_l	2.88	2.70	0.988
σ_h	5.79	5.53	0.956
U_t	0.44	0.42	0.990

Notes: Estimates from Section 1.3 are computed under alternative assumptions on the cross-sectional distributions of forecasts by type. Last column shows correlation coefficient between resulting estimates.

Figure A.1: Inflation uncertainty index with normal and logistic error distributions



Notes: Inflation uncertainty index estimated as in Section 1.3 under assumption that the cross section of forecasts from each consumer type is normally or logistically distributed.

A.4 Disagreement and Uncertainty

The inflation uncertainty proxy ζ_{it} constructed in Section 1.3 is an estimate of the probability that a consumer i is the "high uncertainty" type at time t given her survey response R_{it}. I assumed that each consumer i has a subjective probability distribution over inflation with mean f_{it} and variance v_{it}, and that consumers round f_{it} to the nearest multiple of five if v_{it} is sufficiently high, say above some threshold V. We know that v_{it} is higher for type-h than for type-l consumers, but how much higher? Let v_{ht} and v_{lt} be the average uncertainty of type-h and type-l consumers, respectively, at time t.

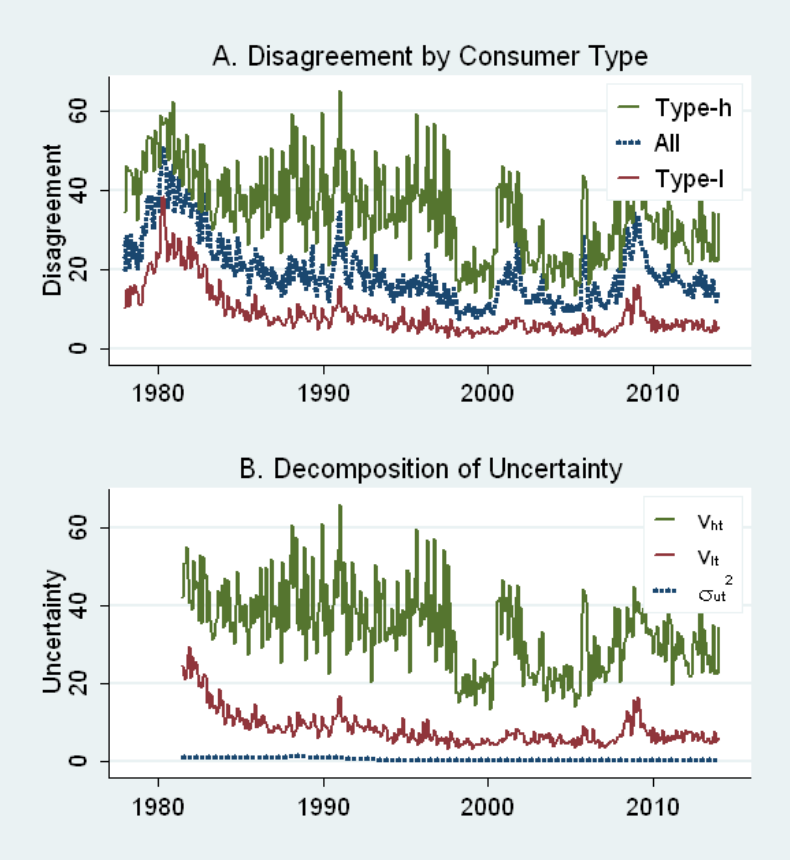
Disagreement, or the cross-sectional variance of point forecasts, is often used as an estimate of average uncertainty. For professional forecasters, who provide density forecasts for inflation, disagreement and average uncertainty are similar. Lahiri and Sheng (2010) derive a relationship between disagreement and the average uncertainty of a group of forecasters by assuming that each agent's forecast error $e_{it} = f_{it} - \pi_{t+12}$ is the sum of a common component ν_t and an idiosyncratic component ϵ_{it}:

$$e_{it} = u_t + \epsilon_{it}. \tag{A.4}$$

They make these assumptions: $E[u_t] = E[\epsilon_{it}] = 0$, $var(u_t) = \sigma^2_{ut}$, $var(\epsilon_{it}) = \sigma^2_{\epsilon it}$,$E(u_t u_{t-k}) = 0$ for any $k \neq 0$, $E(\epsilon_{it}\epsilon_{jt}) = 0$ for any $i \neq j$, and $E[\epsilon_{it}u_{t-k}] = 0$ for any i, k. Using this decomposition of forecast errors, Lahiri and Sheng show that the average uncertainty of a group g of forecasters is:

$$v_{gt} = \sigma^2_{ut} + D_{gt}, \tag{A.5}$$

Figure A.2: Inflation disagreement and mean inflation uncertainty by consumer type



Notes: Disagreement is cross-sectional forecast variance. For Panel B, see Equation (A.5).

where D_{gt} is disagreement, given by the cross-sectional variance of point forecasts. Recall that disagreement among type-h consumers is σ^2_{ht} and among type-l consumers is σ^2_{lt}, both of which were estimated by maximum likelihood in Section 1.3. Panel A of Figure A.2 plots disagreement among all consumers, among type-l consumers, and among type-h consumers. Type-h disagreement is about four times higher than that of type-l consumers. Using Equation (A.5), we can use σ^2_{lt} and σ^2_{ht} to compute v_{lt} and v_{ht}. For $\tau \in \{l, h\}$, $v_{\tau t} = \sigma^2_{ut} + \sigma^2_{\tau t}$.

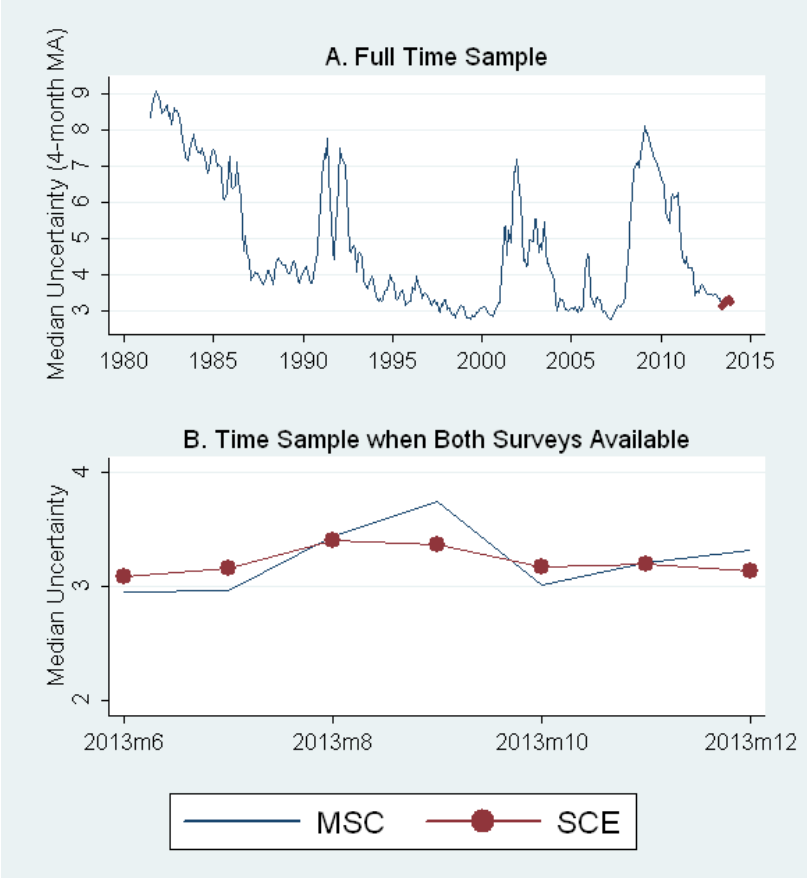
All that remains is to estimate σ^2_{ut}. Lahiri and Sheng suggest using probabilistic forecast data from the Survey of Professional Forecasters (SPF). SPF respondents assign probabilities summing to 100% that inflation will fall in different bins. From each forecaster j's density forecast, the variance can be computed. Let $v_{SPF,t}$ be the mean forecast variance across professional forecasters and $D_{SPF,t}$ be disagreement among professional forecasters. By Equation (A.5), we can compute $\sigma^2_{ut} = v_{SPF,t} - D_{SPF,t}$. Panel B of Figure A.2 plots σ^2_{ut}, v_{lt}, and v_{ht}. The mean of σ^2_{ut} is 0.65, which is an order of magnitude smaller than

the disagreement D_{lt} or D_{ht} of either group of consumers.[1] Thus, mean uncertainty $v_{\tau t}$ is only slightly greater than disagreement $D_{\tau t}$ for consumers of type $\tau \in \{l, h\}$. If consumer i has probability ζ_{it} of being type h, then an estimate of her forecast variance v_{it} is $v_{it} = \zeta_{it} v_{ht} + (1 - \zeta_{it}) v_{lt}$.

The New York Fed's Survey of Consumer Expectations (SCE) reports the median forecast interquartile range from probabilistic forecasts as a measure of uncertainty. For comparability, I transform v_{it} to the corresponding interquartile range, $1.349\sqrt{v_{it}}$. SCE and MSC uncertainty measures are both available from June through December 2013, when both average 3.2% with correlation coefficient 0.82 (Figure A.3). If we had not treated responses as coming from high and low uncertainty consumers, but had instead used disagreement of all consumers to compute mean uncertainty, the corresponding median interquartile range for June through December 2013 would average 3.6%, and would have a correlation of 0.62 with the SCE measure. Thus, using rounding behavior to distinguish between consumer types results in uncertainty estimates that are more comparable to those obtained by the SCE.

[1]The SPF is a quarterly survey conducted by the Philadelphia Federal Reserve. Forecasters provide fixed-horizon probabilistic forecasts of annual-average over annual-average GDP price level growth beginning in 1981Q3. See documentation at http://www.phil.frb.org/research-and-data/real-time-center/survey-of-professional-forecasters/spf-documentation.pdf, page 24. Because of the noise inherent in this data, I HP-filter the estimated σ^2_{ut} series, then linearly interpolate to convert the quarterly series into a monthly series.

Figure A.3: Inflation uncertainty estimates compared to Survey of Consumer Expectations



Notes: Inflation uncertainty in this figure is defined as the interquartile range of a respondent's inflation forecast. SCE series is inflation uncertainty as computed from probabilistic forecasts in the NY Fed's Survey of Consumer Expectations. MSC series is from this paper. Panel A shows entire time sample with four-month moving average filter. Panel B shows months for which both series exist.

A.5 Model of Inflation Uncertainty and Intertemporal Allocation

This simple two-period model of an endowment economy with a single consumption good clarifies basic effects of inflation uncertainty on saving. The consumer's probability distribution over π, the rate of inflation from period 0 to 1, is $N(0, v)$. For simplicity, let the nominal interest rate be 0, so the real rate r is given by $1 + r = (1 + \pi)^{-1}$. Lifetime utility is $U = u(c_0) + u(c_1)$, where c_t is consumption in period t and $u(c) = \frac{c^{1-\theta}}{1-\theta}$. Suppose the consumer receives an endowment Y in period 0. Then her budget constraint is $c_0 + c_1(1 + \pi) = Y$. Expected utility as a function of c_0 is:

$$E[U(c_0)] = \frac{c_0^{1-\theta}}{1-\theta} + E[\frac{(Y - c_0)^{1-\theta}}{(1-\theta)(1+\pi)^{1-\theta}}] = \frac{c_0^{1-\theta}}{1-\theta} + \frac{(Y - c_0)^{1-\theta}}{1-\theta} E[(1 + \pi)^{\theta-1}]. \quad \text{(A.6)}$$

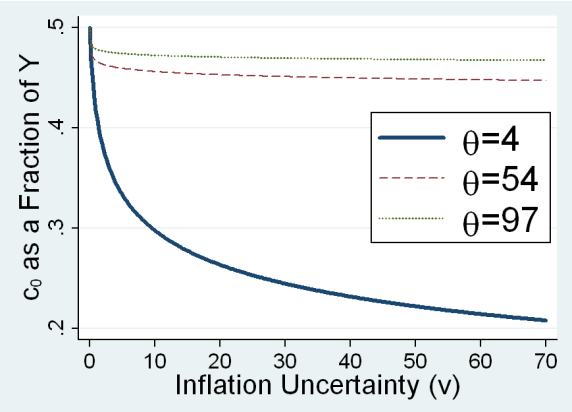
The first-order condition in c_0 is:

$$c_0^{-\theta} = (Y - c_0)^{-\theta} E[(1 + \pi)^{\theta-1}] \quad \text{(A.7)}$$

I take a second-order Taylor expansion of $(1 + \pi)^{\theta-1}$ around $\pi = 0$:

$$(1 + \pi)^{\theta-1} \approx 1 + \pi(\theta - 1) + \frac{\pi^2}{2}(\theta - 1)(\theta - 2). \quad \text{(A.8)}$$

Figure A.4: Consumption by inflation uncertainty



Notes: Graph shows fraction of endowment consumed in period 0 in a two-period model by inflation uncertainty v and coefficient of relative risk aversion θ. Estimates of θ from Gertner (1993), Sydnor (2006), and Cohen and Einav (2007).

Then substituting this approximation into Equation (A.7),

$$\frac{Y - c_0}{c_0} \approx E[1 + \pi(\theta - 1) + \frac{\pi^2}{2}(\theta - 1)(\theta - 2)]^{\frac{1}{\theta}} = (1 + \frac{v}{2}(\theta - 1)(\theta - 2))^{\frac{1}{\theta}}$$

$$\Rightarrow c_0 \approx \frac{Y}{(1 + \frac{v}{2}(\theta - 1)(\theta - 2))^{\frac{1}{\theta}} + 1} \tag{A.9}$$

Notice that if there is no inflation uncertainty ($v = 0$), optimal period 0 consumption is $c_0 = Y/2$. The consumer would simply smooth consumption across the two periods. If the consumer has log utility, so $\theta = 1$, then $c_0 = Y/2$ regardless of v. If $\theta \in (0, 1)$ or $\theta > 2$, then c_0 is decreasing in v. If $\theta \in (1, 2)$, then c_0 is increasing in v.

Empirical studies find a range of estimates of the coefficient of relative risk aversion θ. Gertner (1993) estimates that the coefficient of relative risk aversion is around 5. Sydnor (2006) estimate that it is 54 and Cohen and Einav (2007) estimate that it is 97. Figure A.4 plots c_0/Y as a function of v for these three empirical estimates of θ. In each case, initial consumption is decreasing in inflation uncertainty. Higher inflation uncertainty means that the return on savings is riskier, which makes saving less attractive. But the desire to smooth consumption intertemporally increases saving in the presence of uncertainty.

A.6 Inflation Uncertainty and Consumption

Table A.5 displays results from the baseline specification in which attitudes toward spending on durables, cars, and homes are regressed on the demographic, macroeconomic, and expectational control variables listed in Table A.2. The coefficients on the expectational control variables are of the expected sign. Consumers with more favorable expectations of their future income and financial situation, business conditions, and unemployment, or with more positive opinions of government policy, are more ready to spend. Nearly all demographic control variables have significant coefficients. Higher income consumers are more eager to spend, and men, particularly if married, express more readiness to buy houses.

Table A.6 summarizes the marginal effects of inflation uncertainty and expected inflation on spending attitudes for durables, cars, and homes for the baseline specification and a variety of alternative specifications. In the baseline, if uncertainty ζ_{it} increases from 0 to 1, the probability that the respondent will say it is a good time to buy durables falls by 3%.

In rows 2 and 3 of Table A.6, I restrict the time sample to exclude either the high inflation of the early 1980s or the Great Recession. Neither greatly effects the coefficients on ζ and π^e or their significance. Next, I omit π^e from the regression (row 4). The marginal effect of ζ is virtually unchanged from the baseline. Likewise if ζ is excluded and π^e is included, the marginal effect of π^e is similar to baseline (row 5).

In row 6 I include gas price expectations as a control. GAS_{it} is respondent i's expected change in gas prices, in cents, in the next year. Bachmann et al. (2013) include this variable in a robustness check in case some households primarily have gas prices in mind when reporting

Table A.5: Spending attitudes, inflation uncertainty, and inflation expectations

	(1) DUR		(2) CAR		(3) HOM	
v	-5.1e-03***	(6.0e-04)	-2.8e-03***	(4.3e-04)	-5.0e-03***	(6.6e-04)
π^e	-2.0e-03**	(1.0e-03)	-9.1e-03***	(8.9e-04)	-8.2e-03***	(1.0e-03)
log Real Income	4.6e-02***	(6.0e-03)	1.1e-01***	(6.0e-03)	1.4e-01***	(7.2e-03)
Education	-2.4e-03	(1.8e-03)	1.8e-02***	(1.6e-03)	3.3e-02***	(2.1e-03)
Female	-6.3e-02***	(1.2e-02)	-1.1e-02	(1.2e-02)	-2.0e-02*	(1.2e-02)
Married	9.4e-03	(1.1e-02)	-4.0e-03	(1.1e-02)	5.5e-02***	(1.2e-02)
Married Female	-4.9e-02***	(1.6e-02)	-6.7e-02***	(1.4e-02)	-4.8e-02***	(1.4e-02)
Age	-1.0e-02***	(1.4e-03)	-9.1e-03***	(1.3e-03)	7.7e-03***	(1.4e-03)
Age Squared	9.9e-05***	(1.3e-05)	9.5e-05***	(1.3e-05)	-8.2e-05***	(1.4e-05)
West	-3.8e-02***	(1.2e-02)	-2.2e-02**	(1.1e-02)	-1.0e-01***	(1.3e-02)
Northeast	-2.2e-02*	(1.2e-02)	3.6e-03	(1.0e-02)	-1.6e-01***	(1.4e-02)
South	-2.3e-02**	(9.9e-03)	-9.8e-03	(9.2e-03)	-3.5e-02***	(1.0e-02)
White	1.2e-01***	(2.2e-02)	1.4e-01***	(2.2e-02)	2.5e-01***	(2.3e-02)
African-American	8.0e-02***	(2.5e-02)	4.1e-02	(2.5e-02)	6.1e-03	(2.6e-02)
Hispanic	-4.7e-03	(2.7e-02)	-1.2e-02	(2.6e-02)	7.0e-02**	(2.8e-02)
INEX	1.3e-03***	(2.2e-04)	1.8e-03***	(2.4e-04)	2.8e-03***	(2.4e-04)
PAGO	1.4e-01***	(5.0e-03)	7.7e-02***	(4.3e-03)	8.7e-02***	(4.9e-03)
PEXP	4.4e-02***	(5.9e-03)	6.8e-02***	(6.3e-03)	6.3e-02***	(6.7e-03)
BEXP	9.3e-02***	(6.7e-03)	1.3e-01***	(6.0e-03)	1.2e-01***	(7.0e-03)
RATEX	7.2e-02***	(5.9e-03)	-1.2e-02**	(5.4e-03)	-3.2e-03	(7.9e-03)
UNEMP	-1.5e-01***	(7.0e-03)	-1.1e-01***	(6.5e-03)	-1.2e-01***	(7.7e-03)
GOVT	1.4e-01***	(7.2e-03)	1.3e-01***	(6.0e-03)	1.2e-01***	(7.8e-03)
Unemployment	-9.9e-02***	(6.4e-03)	-1.7e-02***	(6.2e-03)	-2.5e-02**	(1.1e-02)
Fed Funds Rate	3.3e-02***	(4.6e-03)	-5.8e-03	(3.8e-03)	-6.4e-02***	(5.9e-03)
Inflation	-7.3e-02***	(8.7e-03)	-7.8e-02***	(7.2e-03)	-1.1e-01***	(1.2e-02)
ZLB	5.8e-02	(4.0e-02)	-1.5e-01***	(3.1e-02)	-2.5e-01***	(5.4e-02)
Observations	151671		152186		155841	
Pseudo R^2	0.07		0.05		0.12	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Probit regressions with robust, time-clustered standard errors in parentheses. Variable descriptions in Table A.2.

Table A.6: Marginal effects of inflation uncertainty on spending attitudes

	Specification	**DUR**		**CAR**		**HOM**	
		ζ	π^e	ζ	π^e	ζ	π^e
(1)	Baseline	-3.0	-0.02*	-2.0	-0.29	-4.7	-0.16
(2)	Year>1984	-2.6	0.09	-1.3	-0.33	-3.7	-0.25
(3)	Year<2008	-2.7	-0.02*	-1.7	-0.26	-4.7	-0.11
(4)	No π^e	-4.0		-3.8		-6.5	
(5)	No ζ		-0.03		-0.33		-0.26
(6)	Include GAS	-2.9	-0.10*	-2.3	-0.32	-4.6	-0.25
(7)	No expectation controls	-3.7	-0.19	-1.6	-0.55	-4.3	-0.36
(8)	No controls	-7.8	-0.4100	-5.1	-1.00	-9.9	-1.1
(9)	Linear probability model	-3.1	-0.03*	-2.0	-0.30	-4.4	-0.16
(10)	Ordered probit	-3.3	-0.01*	-2.0	-0.28	-4.7	-0.15
(11)	Control function	-12.3	-0.08*	-9.2	-0.28	-18.4	-0.19
(12)	Rotating panel	-1.7	-.09*	-1.4	-0.32	-2.9	-0.19
(13)	Buy in advance of rising prices	-2.8	0.49	-2.1	0.24	-1.5	0.2

Notes: The marginal effect is the change in probability (in percentage points) of having a favorable spending outlook for a one unit increase in ζ or a one percentage point increase in π^e. When calculating marginal effects, remaining variables are set to their means. All effects are statistically significant with $p < 0.01$ unless noted.

inflation expectations. The estimated coefficient on GAS is negative, and the marginal effect indicates that a $1 increase in gas price expectations is associated with about 5 percentage points lower probability of saying it's a good time to buy durables, a car, or a home.

In another specification, Bachmann et al. omit the idiosyncratic expectations/attitude variables, in case controlling for the expectations variables mops up general equilibrium effects. An increase in expected inflation might, for example, cause an increase in growth expectations, which in turn increases willingness to spend. In row 7 I omit the expectations/attitude control variables, and in row 8 I omit all control variables. In both cases, the estimated marginal effects of ζ and π^e are larger in magnitude. Row 9 shows results from a linear probability model instead of a probit model. These are simply regressions of the form: $DUR_{it} = \beta_0\zeta_{it} + \beta_1\pi^e_{it} + X'_{it}\beta_2$. Again, results do not differ notably from the baseline.

Respondents may give positive, negative, or neutral responses to the spending attitude questions. In row 10, in place of the dummy variables DUR, CAR, and HOM, we can define spending attitude variables that take value 1 for positive, 0 for neutral, and -1 for negative responses, and use an ordered probit model instead of a probit model. This makes almost no difference to the regression results. Since about two thirds of respondents give positive responses to the spending attitude questions, distinguishing between negative and neutral

responses adds little useful variation.

In another robustness check, in place of ζ_{it}, I include a dummy variable $ROUND_{it}$ that takes value 1 if the respondent's inflation forecast is a multiple of five. Table A.7 reports estimated coefficients and marginal effects. I also define a "placebo" dummy variable $PLACEBO_{it}$ that takes value 1 if the respondent's inflation forecast plus one is a multiple of five, i.e. if the response is in $\{-6, -1, ..., 14, 19, 24\}$. If $PLACEBO_{it}$ is included as a regressor in place of $ROUND_{it}$, its coefficient is not statistically different from zero.

Table A.7: Spending attitudes, round number responses, and inflation expectations

		(1) DUR	(2) CAR	(3) HOM
ROUND	Coefficient	-3.7e-02***	-2.7e-02***	-6.8e-02***
	Std. Err.	(7.7e-03)	(6.4e-03)	(7.6e-03)
	Marginal Effect	-1.2%***	-0.97%***	-2.2%***
π^e	Coefficient	-2.2e-03**	-8.9e-03***	-7.0e-03***
	Std. Err.	(9.7e-04)	(8.6e-04)	(1.0e-03)
	Marginal Effect	-0.07%**	-0.32%***	-0.23%***
Observations		164621	165248	169258
Pseudo R^2		0.07	0.06	0.14

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Probit regressions with robust time-clustered standard errors in parentheses. Dummy variable ROUND takes value 1 if expected inflation is a multiple of five. Marginal effect is change in probability (in percentage points) of favorable spending attitude if ROUND increases from 0 to 1 or if π^e increases by one percentage point. Control variables from Table A.2 included.

Row 11 summarizes the marginal effects from a control function (CF) approach. Bachmann et al. (2013) use this approach to address two potential concerns with the baseline specification. The first is that an omitted variable may be relevant to both spending attitudes and expected inflation, biasing the coefficient on expected inflation. The second is that measurement error may bias the coefficient on expected inflation towards zero. Imbens and Wooldridge (2007) recommend the CF approach, which involves two stages. Restricting the sample to respondents who took the survey twice, in the first stage, Bachmann et al. regress expected inflation on the control variables X_{it} from the baseline and on expected inflation from the previous time the respondent took the survey. In the second stage, they estimate the baseline model but include the first stage residual as an additional control variable.

Similar concerns arise in my baseline specification with respect to inflation uncertainty, so I also use the CF approach (Table A.8). In the first stage, I regress inflation uncertainty ζ_{it} on lagged uncertainty $\zeta_{i,t-6}$ and the control variables from the baseline. In the second stage, I regress spending attitudes on inflation uncertainty, expected inflation, the same control variables, and the first stage residual. The marginal effects of ζ_{it} are negative, statistically significant, and larger in magnitude than in the baseline results. Bachmann et al. also find

marginal effects that are larger in magnitude using the CF approach. This suggests that measurement error in π^e and ζ biases the coefficients of interest toward zero in the baseline.

Table A.8: Control function approach

First Stage				
		ζ_{it}		
$\zeta_{i,t-6}$	Coefficient	0.242***		
	Std. Err.	0.0034		
Observations		74668		
R^2		0.14		
Std. Err. Of Residuals		0.36		
Second Stage				
		DUR	CAR	HOM
First stage residual	Coefficient	0.314***	0.236***	0.492***
	Std. Err.	0.062	0.060	0.064
ζ_{it}	Coefficient	-0.470***	-0.271***	-0.603***
	Std. Err.	0.0614	0.0608	0.0621
	Marginal Effect	-12.3***	-9.21***	-18.4***
π^e_{it}	Coefficient	-0.0027**	-0.0083	-0.0063
	Std. Err.	0.00137	0.00134	0.00142
	Marginal Effect	-0.082**	-0.283***	-0.194***
Observations		68235	68322	69835
Pseudo R^2		0.07	0.06	0.14

Notes: Marginal effect is change in probability of favorable spending outlook for one unit increase in uncertainty or one percentage point increase in expected inflation, with remaining variables set to means. In second stage, coefficient (marginal effect) is the standard coefficient (marginal effect) from probit regression divided by $(1 + (\text{coefficient on first stage residual})^2 * (\text{first stage std error of residual})^2)^{1/2}$, following Wooldridge (2002).

The specification in row 12 also uses of the rotating panel. Suppose there is some unobserved time-invariant characteristic of individuals that makes them more or less willing to spend, that is also correlated with inflation expectations or uncertainty. Bachmann et al. (2013) refer to this as optimism or pessimism, which could bias the coefficients on π^e_{it} and ζ^e_{it}. Using the rotating panel of respondents, and controlling for past spending attitudes, uncertainty, and expected inflation, while including both current and lagged values of the macroeconomic and expectational controls addresses this concern.

Row 13 summarizes a new that uses an alternative spending attitude variable. When asked to explain why they think it is a good or bad time to buy a house, car, or durables, MSC respondents commonly express a desire to buy in advance of rising prices. Let DUR_BA_{it} be a dummy variable that takes value 1 if the respondent says that it is a good time to

Table A.9: Inflation uncertainty and the desire to buy in advance of rising prices

	(1) DUR_BA		(2) CAR_BA		(3) HOM_BA	
ζ	-1.5e-01***	(1.2e-02)	-1.6e-01***	(1.4e-02)	-1.2e-01***	(1.5e-02)
π^e	2.7e-02***	(1.0e-03)	1.8e-02***	(1.4e-03)	1.6e-02***	(1.5e-03)
log Real Income	-1.5e-02**	(7.3e-03)	1.3e-02	(8.1e-03)	2.6e-02***	(8.0e-03)
Education	-5.6e-03***	(1.9e-03)	-2.4e-02***	(2.5e-03)	-9.7e-03***	(2.7e-03)
Female	-7.2e-02***	(1.4e-02)	-2.9e-02*	(1.6e-02)	-1.1e-01***	(1.7e-02)
Married	3.0e-02**	(1.3e-02)	3.1e-03	(1.7e-02)	1.5e-02	(1.6e-02)
Married Female	-4.6e-02***	(1.8e-02)	-3.5e-02	(2.2e-02)	-3.4e-02	(2.4e-02)
Age	-9.9e-03***	(1.7e-03)	-3.8e-03*	(2.0e-03)	-1.6e-02***	(2.1e-03)
Age Squared	1.6e-04***	(1.6e-05)	1.2e-04***	(1.9e-05)	2.1e-04***	(1.9e-05)
West	6.8e-02***	(1.3e-02)	8.0e-02***	(1.4e-02)	2.1e-01***	(1.8e-02)
Northeast	1.1e-02	(1.3e-02)	2.7e-02*	(1.6e-02)	4.6e-02***	(1.7e-02)
South	2.8e-02**	(1.1e-02)	4.4e-02***	(1.3e-02)	5.8e-02***	(1.4e-02)
White	-5.1e-03	(2.6e-02)	-9.4e-03	(3.0e-02)	-8.5e-02***	(3.2e-02)
African-American	-1.1e-01***	(2.9e-02)	-1.0e-01***	(3.5e-02)	-7.7e-02**	(3.4e-02)
Hispanic	-6.2e-02*	(3.3e-02)	-8.0e-02**	(3.8e-02)	-1.7e-02	(3.9e-02)
INEX	5.2e-04*	(2.8e-04)	6.2e-04*	(3.3e-04)	1.8e-03***	(3.2e-04)
PAGO	3.8e-02***	(5.7e-03)	4.3e-02***	(6.5e-03)	2.9e-02***	(6.4e-03)
PEXP	-2.9e-02***	(7.5e-03)	-1.6e-02*	(8.4e-03)	-1.0e-02	(8.9e-03)
BEXP	-5.4e-02***	(7.1e-03)	-3.1e-02***	(8.3e-03)	3.8e-03	(8.5e-03)
RATEX	1.5e-01***	(7.4e-03)	1.5e-01***	(8.5e-03)	1.5e-01***	(9.4e-03)
UNEMP	-1.6e-02*	(8.8e-03)	-6.2e-02***	(1.3e-02)	-8.8e-02***	(1.3e-02)
Opinion of Govt	-3.1e-02***	(7.7e-03)	6.6e-03	(9.7e-03)	1.5e-02	(9.9e-03)
Unemployment	1.1e-03	(6.8e-03)	-6.3e-03	(8.8e-03)	-7.0e-02***	(1.1e-02)
Fed Funds Rate	3.8e-02***	(5.2e-03)	4.4e-02***	(7.8e-03)	1.1e-02	(8.0e-03)
Inflation	4.6e-02***	(7.4e-03)	2.1e-02*	(1.2e-02)	6.8e-02***	(1.4e-02)
ZLB	-1.1e-01**	(4.7e-02)	-2.2e-01***	(5.6e-02)	4.4e-02	(7.4e-02)
Observations	164621		165248		169258	
Pseudo R^2	6.8e-02		5.6e-02		5.2e-02	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Probit regressions with robust, time-clustered standard errors in parentheses. Variable descriptions in Tables A.1 and A.2.

buy durables because she desires to buy in advance of rising prices. Define CAR_BA_{it} and HOM_BA_{it} analogously for cars and homes. Let $BA_{it} = DUR\_BA_{it} + CAR\_BA_{it} + HOM\_BA_{it}$. The mean of BA_{it} is 0.31.

In Table A.9, I regress DUR_BA, CAR_BA, and HOM_BA on inflation uncertainty ζ_{it}, expected inflation π^e_{it}, and the usual set of demographic, macroeconomic, and expectational control variables. Row 12 of Table A.6 summarizes the marginal effects of ζ and π^e. The coefficients on ζ are negative. In contrast to the regression in Table A.5 and all specifications using DUR, CAR, and HOM as dependent variables, the coefficients on π^e are positive and statistically significant. Moreover, the marginal effects of π^e are larger in magnitude. Many respondents base their spending attitudes on factors unrelated to inflation expectations, such as opinions about safety features in cars, which may explain why Bachmann et al. find such a small coefficient on π^e. The variable CAR_BA is a more direct measure than CAR of spending attitudes related to expected inflation.

In Table A.10, the dependent variable is BA_{it}, which takes values 0, 1, 2, and 3. The control variables from the baseline specification are included. Column (1) includes π^e_{it}, (2) includes π^e_{it} and ζ_{it}, and (3) includes π^e_{it}, ζ_{it}, and the interaction $\pi^e_{it} * \zeta_{it}$ as regressors. Notice that with the inclusion of ζ and $\pi^e * \zeta$, the estimated coefficient on π^e is larger, and the coefficient on the interaction term is negative and statistically significant.

Table A.10: Inflation uncertainty and the desire to buy in advance of rising prices

	(1) BA	(2) BA	(3) BA
π^e	2.0e-02***	2.4e-02***	2.9e-02***
	(1.0e-03)	(1.1e-03)	(2.3e-03)
ζ		-1.7e-01***	-1.3e-01***
		(1.1e-02)	(1.8e-02)
$\pi^e * \zeta$			-7.0e-03***
			(2.4e-03)
Observations	157872	157872	157872
Pseudo R^2	5.3e-02	5.4e-02	5.4e-02

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Ordered probit regressions with robust time-clustered standard errors in parentheses. BA_{it} measures desire to buy durables, cars, and homes in advance of rising prices. Control variables from Table A.2 included.

Uncertainty and Interest Rate Sensitivity

Let $LowR_{it}$ and $HighR_{it}$ be dummy variables that take value 1 if consumer i mentions low or high interest rates, respectively, in her explanations for any of her spending attitudes. Let

$MentionsR_{it}$ take value 1 if i mentions high or low interest rates, i.e. if $LowR_{it}+HighR_{it} > 0$. The means of $LowR_{it}$, $HighR_{it}$, and $MentionsR_{it}$ are 0.43, 0.17, and 0.57, respectively.

I run probit regressions of the form:

$$Pr(LowR_{it} = 1|\zeta_{it}, X_{it}) = \Phi(\beta_0\zeta_{it} + X'_{it}\beta_1) \tag{A.10}$$

where X_{it} includes demographic control variables in Table A.2 and time fixed effects. The marginal effects of ζ_{it} in Table A.11 imply that a highly uncertain consumer ($\zeta_{it} = 1$) has an 8.3 percentage points lower probability of mentioning low rates and a 6.8 percentage points lower probability of mentioning rates compared to a less uncertain consumer ($\zeta_{it} = 0$).

Table A.11: Marginal effects of inflation uncertainty on interest rate mentions in spending attitudes

	LowR	**HighR**	**MentionsR**
Marginal Effect	-8.29***	0.124	-6.82***
Std. Err.	0.346	0.208	0.349
Observations	222284	222284	222284
Pseudo R^2	0.24	0.22	0.16

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Probit regressions from Equation (A.10) with robust, time-clustered standard errors. Dependent variables described in Table A.1. Time fixed effects and demographic control variables from Table A.2 included. The marginal effect is the change in probability (in percentage points) of mentioning low interest rates, high interest rates, or any interest rates, for a one unit increase in ζ, with remaining variables set to their means.

A.7 Phillips Curve Robustness Checks

This section presents robustness checks for the Phillips curve regressions of Section 1.6. I estimate $\pi_t = \beta_l\mu_{lt} + \beta_{SPF}\mu_{SPFt} + \alpha\text{Unemployment}_t + \epsilon_t$ with and without the constraint $\beta_l + \beta_{SPF} = 1$ in Table A.12. I also vary the time sample, excluding the early 1980s or the years after 2007. Regardless, $\hat{\beta}_l$ indicates that the expectations of type-l consumers are a better proxy for price-setters' expectations than are the expectations of professional forecasters.

In Table A.13, I estimate $\pi_t = \beta_l\mu_{lt} + \beta_{SPF}\mu_{SPFt} + \alpha\text{Unemployment}_t + \epsilon_t$ and $\pi_t = \beta_l\mu_{lt} + \beta_\pi\pi_{t-1} + \alpha\text{Unemployment}_t + \epsilon_t$ with and without constraints on $\beta_l + \beta_c$ or $\beta_l + \beta_\pi$. Again, $\hat{\beta}_l$ is positive and statistically significant in every specification. Mean type-l inflation expectations are a better proxy than the mean consumer's inflation expectations for price-setter's expectations. Table A.14 shows that using alternative measures of real activity in place of the unemployment rate makes little difference to the result that coefficient on the inflation expectations of type-l consumers is larger and more significant than the coefficient on other agents' expectations.

An interesting result of using type-l expectations for Phillips curve estimation is that including lagged inflation is unnecessary. Purely forward-looking Phillips curves tend to have trouble matching the persistence of inflation, motivating the use of a hybrid Phillips curve with lagged inflation. When estimation uses the mean inflation expectation of all consumers, the coefficient on lagged inflation is positive and statistically significant. When the mean inflation expectation of type-l consumers is used instead, the coefficient on lagged inflation is not significantly different from zero (Table A.15).

Table A.12: Phillips curves with inflation expectations of different agent types

	(1)	(2)	(3)
μ_l	0.71***	0.53**	2.22***
	(0.20)	(0.22)	(0.33)
μ_{SPF}	0.29	0.47*	0.03
	(0.20)	(0.22)	(0.16)
Unemployment	-0.22**	-0.19*	-0.33***
	(0.10)	(0.11)	(0.10)
Observations	116	106	130
R^2	0.10	0.15	0.46
Time Sample	After 1984	Before 2008	Unrestricted
Regression Type	Constrained	Constrained	Unconstrained

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey-West standard errors in parentheses. SPF data is quarterly, so MSC data is aggregated to quarterly frequency. Dependent variable π_t is annualized quarter-over-quarter percent change in the Consumer Price Index, and μ_l and μ_{SPF} are mean inflation forecasts of type-l consumers and SPF forecasters. Specification: $\pi_t = \beta_l \mu_{lt} + \beta_{SPF} \mu_{SPFt} + \alpha \text{Unemployment}_t + \epsilon_t$, with $\beta_l + \beta_{SPF} = 1$ imposed in (1) and (2).

Table A.13: Phillips curves with inflation expectations of different agent types

	(1)	(2)	(3)	(4)
μ_l	1.76***	1.41***	0.72***	1.95***
	(0.65)	(0.28)	(0.08)	(0.20)
μ_c	-0.76*	0.44		
	(0.65)	(0.29)		
π_{t-1}			0.279***	-0.08
			(0.08)	(0.10)
Unemployment	-0.21**	-0.26***	-0.14	-0.30***
	(0.10)	(0.08)	(0.10)	(0.09)
Observations	144	144	144	144
R^2	0.12	0.76	0.38	0.76
Regression Type	Constrained	Unconstrained	Constrained	Unconstrained

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey-West standard errors in parentheses. SPF data is quarterly, so MSC data is aggregated to quarterly frequency. Dependent variable π_t is the annualized quarter-over-quarter percent change in the Consumer Price Index, and μ_l and μ_c are mean inflation forecasts of type-l consumers and all consumers. Specification (1) and (2): $\pi_t = \beta_l \mu_{lt} + \beta_c \mu_{ct} + \alpha \text{Unemployment}_t + \epsilon_t$, with $\beta_l + \beta_c = 1$ imposed in (1). Specification (3) and (4): $\pi_t = \beta_l \mu_{lt} + \beta_\pi \pi_{t-1} + \alpha \text{Unemployment}_t + \epsilon_t$, with $\beta_l + \beta_\pi = 1$ imposed in (3).

Table A.14: Phillips curves with alternative measures of real activity

	(1)	(2)	(3)	(4)	(5)	(6)
μ_l	0.63***	0.81***	0.84***	1.81***	1.81***	1.43***
	(0.18)	(0.19)	(0.19)	(0.64)	(0.59)	(0.64)
μ_{SPF}	0.37*	0.19	0.16			
	(0.18)	(0.19)	(0.19)			
μ_c				-0.83*	-0.84**	-0.47
				(0.64)	(0.59)	(0.64)
Unemployment Gap	0.26**			0.41***		
	(0.10)			(0.14)		
Capacity Utilization		0.13***			0.21***	
		(0.06)			(0.06)	
GDP Gap ($ Trillions)			-1.45***			-1.90***
			(0.63)			(0.66)
Observations	130	130	130	144	144	144
R^2	0.11	0.13	0.14	0.16	0.25	0.19

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey-West standard errors in parentheses. SPF data is quarterly, so MSC data is aggregated to quarterly frequency. Dependent variable π_t is annualized quarter-over-quarter percent change in the Consumer Price Index, and μ_l, μ_{SPF}, and μ_c are mean inflation forecasts of type-l consumers, SPF forecasters, and all consumers. Specification (1)-(3): $\pi_t = \beta_l \mu_{lt} + \beta_{SPF} \mu_{SPFt} + \alpha Y_t + \epsilon_t$, where $\beta_l + \beta_{SPF} = 1$ and Y_t is some measure of real activity. Specification (4)-(6): $\pi_t = \beta_l \mu_{lt} + \beta_c \mu_{ct} + \alpha Y_t + \epsilon_t$, where $\beta_l + \beta_c = 1$. Unemployment gap is natural rate of unemployment (FRED code NROUST) minus unemployment rate. Capacity utilization has FRED code TCU. GDP gap is potential real GDP (GDPPOT) minus real GDP (GDPC1).

Table A.15: Forward-looking and hybrid Phillips curves

	(1)	(2)	(3)	(4)
μ_l	1.81***	1.95***		
	(0.08)	(0.20)		
μ_c			1.90***	1.77***
			(0.10)	(0.20)
π_{t-1}		-0.08		0.05
		(0.10)		(0.09)
Unemployment	-0.28***	-0.30***	-0.20***	-0.19***
	(0.08)	(0.09)	(0.07)	(0.07)
Observations	144	144	144	144
R^2	0.76	0.76	0.73	0.73

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Newey-West standard errors in parentheses. SPF data is quarterly, so MSC data is aggregated to quarterly frequency. Dependent variable π_t is annualized quarter-over-quarter percent change in the Consumer Price Index, and μ_l and μ_c are mean inflation forecasts of type-l consumers and all consumers.

Appendix B

Fed Speak on Main Street Appendices

B.1 Summary of Consumer Surveys

Table B.1: Consumer Knowledge of the Federal Reserve and Monetary Policy

Survey	**Question**	**Date**	**Response Summary**
Roper Report	How well do you feel that you understand what the Fed does in the economy?	Mar-79	56% don't understand or don't know
Roper Report	When people in economics and media talk about monetary policy, do you have a good idea what they are talking about?	Oct-83	51% not much/none
Knowledge Of Business and The Economy	Total amount of money in circulation is determined by monetary policy. Who sets this monetary policy? [4 options]	Oct-84	54% Fed
National Council on Economic Education	Which is monetary policy: change in govt spending, discount rate, corporate profit?	1992	22% discount rate
Harris Poll	What does Alan Greenspan do for a living?	Aug-99	32% correct
Pew Research Center for the People & the Press	Who is Alan Greenspan?	May-97 Jun-00	40% correct 44% correct
Washington Post/Kaiser/Harvard*	Do you know who Alan Greenspan is?	Oct-00	71% yes
Princeton Survey Research Associates International/Newsweek	What is the name of Chairman of the Fed? [3 options]	Jun-07 Jun-08	31% Bernanke 36% Bernanke
AARP Investors Age 50+ *	How familiar are you with Fed Chair Ben Bernanke?	Nov-08	14% very, 37% somewhat
Pew Research Center for the People & the Press	Do you happen to know who is chairman of the US Federal Reserve Board? [4 options]	Mar-08 Apr-09 Oct-09	35% Bernanke 45% Bernanke 33% Bernanke
Economist/ YouGov	How familiar are you with the Fed?	Oct-10	50% very/somewhat
Pew Research Center for the People & the Press	What position does this person [show picture of Bernanke] hold? [4 options]	Nov-11	70% Fed chair
Pew Research Center for the People & the Press	What kind of policy is Fed responsible for? Monetary, tax, trade, or energy?	Sep-13	73% monetary

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

*Sample: 1,224 national registered voters.

Table B.2: Consumer Understanding of Meaning and Causes of Inflation

Survey	**Question**	**Date**	**Response Summary**
ORC Public Opinion Index	If a friend asked you what inflation means, what would you tell him?	Feb-52 Sep-57	47% dollar deval., 31% rising prices 46% dollar deval., 37% rising prices
ORC Public Opinion Index	If we have serious inflation, in what ways will that hurt the average man?	Feb-52	38% lower standard of living, 30% lower real wages
ORC Public Opinion Index	Which are the major causes of inflation in this country today?	Feb-52	67% govt spending, 49% people spending too much
ORC Public Opinion Index	Effect of inflation on savings? Effect of inflation on Soc. Sec. benefits? How to protect savings from inflation?	Sep-57 Sep-57 Sep-57	51% decreases, 14% don't know 58% decreases, 31% don't know 31% buy bonds, 21% don't know
ORC Public Opinion Index	Which are the major causes of inflation in this country today?	Jan-70	59% Vietnam war spending, 5% printing too much money
Harris Survey	High interest rate on borrowing money causes inflation?	Apr-70	56% major cause, 20% minor
American Retail Federation	Major cause of current inflation?	Apr-80	14% oil/energy, 10% govt spending
ABC News/Washington Post	Main cause of inflation?	Feb-81	38% govt spending, 28% oil price
Roper Report	When govt and media talk about inflation, do you have a good idea what they are talking about?	Apr-81 Oct-83	85% yes 95% yes
ABC News/Washington Post	Which group most to blame for inflation: govt, business, labor?	Feb-82	57% govt
Shiller*	What causes inflation?	1997	16% greed, 10% Fed/interest rates
Curtin**	Heard of Consumer Price Index?	2007	34% no
Gallup/USA Today	How worried that increased govt borrowing will produce inflation?	Feb-09	43% very, 35% somewhat
Nat'l Financial Capability Study***	Test of knowledge of inflation	2012	61% correct

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

*See Shiller (1997) for survey details.**See Curtin (2007) for survey details. ***See FINRA (2013) for survey details.

Table B.3: Consumer Expectations of Inflation and Beliefs about Controlling Inflation

Survey	**Question**	**Date**	**Response Summary**
ORC Public Opinion Index (ORC)	In Germany after WWI inflation made money so worthless that people used it to paper walls. Do you think that could happen in the US?	Feb-52	59% could happen
ORC	If you had to fix the blame on some person or group, who do you think is most responsible for the inflation we have had in recent years?	Feb-52 Jun-66 Sep-67 Feb-68	16% no opinion, 35% govt 35% no opinion, 28% govt 39% no opinion, 33% govt 34% no opinion, 32% govt
ORC	Which would be of most help in stopping inflation?	Sep-57	72% reduce govt waste, 56% tighten credit
ORC	Do you believe we are going to have serious inflation, that is, prices going way up?	Nov-52 Oct-65	49% yes, 36% no 53% yes, 33% no
Harris Survey	Is inflation inevitable?	Feb-66	55% can be avoided
Harris Survey	To check inflation: price-wage controls?	Oct-67	43% favor, 38% oppose
Harris Survey	To check inflation: high mortgage/loan rates?	Nov-67	20% favor, 56% oppose
ORC	What has to be done to bring inflation under control?	Jan-70 Jan-71	51% end war, 37% price controls 51% end war, 40% price controls
ORC	Major causes of inflation today?	Jan-71	53% war spending, 5% monetary
National Survey for RNC/NRCC	Do you agree that inflation is something no government can do much about?	Nov-79	73% disagree
Cambridge Reports National Omnibus	1970s was period of rapidly rising prices. In last few years inflation has declined and now is relatively low. Will US go through another period of high inflation?	Oct-85 Oct-86 Oct-87 Oct-88	55% yes 57% yes 63% yes 57% yes
Time/CNN/ Yankelovich Partners	Is problem of inflation, the rate at which prices increase, under control?	May-97	50% yes
Survey	Confident inflation will remain moderate next 10 yrs?	Mar-13	6% very, 33% somewhat

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

Table B.4: Consumer Interest in and Attention to Fed and Inflation

Survey	**Question**	**Date**	**Response Summary**
Office of Public Opinion Research Roosevelt Survey	Would you like President to discuss inflation, rationing, or war agencies on radio?	Aug-43	49% inflation
ORC Public Opinion Index	Have you heard or read anything about inflation recently?	Feb-52 Sep-57	46% yes 54% yes
Roper Report	Is news about govt proposals for dealing with inflation something you have recently been following closely, or casually, or not paying much attention to?	Mar-74 Dec-74 Apr-75 May-75	62% closely 61% closely 60% closely 55% closely
Roper Report	Does Fed increasing or decreasing the money supply affect you personally?	Sep-84	53% yes
ABC News/Money	How much do Fed actions affect you personally?	Jun-87	31% greatly, 23% some
News Interest Index	How closely did you follow news of Fed's interest rate reduction?	Jan-92	35% very, 31% fairly
News Interest Index	Has the Fed has raised or lowered interest rates in recent months, or have interest rates stayed the same?	Feb-95	68% raised (correct)
NBC News/WSJ	How interested were you in news of Fed increasing interest rates?	Apr-97	51% very/quite
Pew Research Center for the People & the Press	Has the Fed has raised or lowered interest rates in recent months, or have interest rates stayed the same?	Jun-00	54% raised (correct)
Curtin*	How important is it for a person like you to have exact info about rate of unemployment, rate of change in prices, and rate of change in GDP?	2007	6% extremely, 20% very
NBC News/WSJ	Greatest worry for you and family now? [7 options]	Nov-11	20% inflation

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.
*See Curtin (2007) for survey details.

Table B.5: Crediting the Federal Reserve for Economic Conditions

Survey	**Question**	**Date**	**Response Summary**
Time/Yankelovich, Skelly & White*	Since Reagan has taken office, inflation has decreased from 13% to 4%. How large a role did the Fed play?	Feb-84	47% major, 34% minor
Harris Survey**	Do you think Fed Chair Paul Volcker is part of the group that runs things in the country?	Apr-84	58% yes
Time/Yankelovich, Skelly & White*	Whom do you think is most responsible for the economic recovery?	Aug-84	28% Reagan, 9% Fed
NBC News/WSJ Poll	Who do you give most credit for economic upswing in 1993?	Jan-94	49% business cycle, 23% Clinton, 11% Bush, 4% Fed
Gallup/CNN/USA Today	Who has the greatest influence over how the economy performs?	Sep-96	8% Fed
Louis Rukeyser's Money Guide	Who should get the most credit for economy's performance in 1990s?	Jan-99	36% industry, 28% President, 15% Congress, 14% Fed
Los Angeles Times	Who do you think should get the credit for the economy doing well?	May-00	26% tech industry, 14% Clinton, 10% Fed
Gallup/CNN/USA Today	Who deserves the most credit for the good economy?	Jun-00 Aug-00	53% Fed, 38% Clinton 16% Fed, 33% entrepreneur/worker
UBS/Gallup Investor Optimism***	How much credit does Fed deserve for positive state of economy?	Aug-00 Sep-00	39% great deal, 37% fair amount 37% great deal, 44% fair amount

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

*Sample: 1000 registered voters. **Sample: 1000 likely voters.

***Sample: 1000 national adults with minimum of $10,000 in investable assets.

Table B.6: Blaming the Federal Reserve for Economic Conditions

Survey	**Question**	**Date**	**Response Summary**
Cambridge Reports National Omnibus	How much blame will the policies on interest rates of the Fed deserve if we have a recession?	Jul-78	28% a lot, 37% some, 15% hardly, 20% don't know
Los Angeles Times	How much do you blame the Fed for the economic conditions today?	Aug-82 May-83	24% v. much, 35% some 22% v. much, 32% some
Gallup/Newsweek*	How much do you blame the Fed for nation's economic problems?	Jan-91	31% a lot, 42% some, 18% not much, 9% don't know
NBC News/WSJ**	Who do you blame most for the country's economic problems?	Dec-91 Jan-92 May-92	20% Bush, 21% bus. cycle, 4% Fed 19% Bush, 30% bus. cycle, 4% Fed 24% Bush, 23% bus. cycle, 6% Fed
Los Angeles Times	Who or what do you think should get the blame for the economy?	May-07 Jan-08	20% Congress, 8% Fed 19% Pres., 3% Fed
AP/Ipsos-Public Affairs	How much blame does Fed deserve for country's economic problems?	Feb-08	19% a lot, 42% some, 18% little, 16% none, 5% don't know
Pew Research Center	How much do you blame Bernanke for nation's economic problems?	Feb-08	6% great deal, 24% fair amount, 46% not much, 24% don't know
CNN/ORC International	How much do you blame the Fed for economic conditions today?	Sep-11	37% v. much, 40% some, 21% not very or hardly

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.
*Sample: 750 adults. **Sample: 1000 registered voters.

Table B.7: Consumer Opinions of Federal Reserve's Role and Independence

Survey	**Question**	**Date**	**Response Summary**
Time/Yankelovich, Skelly & White*	How confident that Volcker has effective program for solving economic problems?	Dec-81	8% very, 39% some
Harris Survey	Approve of Volcker's reappointment as Chair?	Aug-83	57% yes, 24% not sure
Time/Yankelovich, Skelly & White	How responsible should Fed be in helping solve the budget deficit?	Feb-84	58% very, 34% somewhat
Knowledge Of Business and the Economy	Is independent Fed good check and balance, or should president control monetary policy?	Oct-84	78% good check and balance
Harris Survey	Rating of how Volcker handled job as Chair?	Apr-86	56% positive, 7% not sure
UBS/Gallup Index of Investor Optimism**	Which should have the primary role in setting economic policy: Fed, President, or Congress?	Dec-00 Jan-01 Apr-01 Jan-02	42% Fed, 8% Pres, 34% Congress 41% Fed, 10% Pres, 35% Congress 38% Fed, 10% Pres, 27% Congress 30% Fed, 19% Pres, 39% Congress
ABC News/Washington Post	Approve of Greenspan's job as Chair?	Jan-06	72% yes, 7% not sure
Associated Press/ Ipsos-Public Affairs	Confidence in Fed's ability to turn around the country's economy?	Feb-08	10% great deal, 45% some
CBS News/ New York Times	Confidence in Fed's ability to promote financial stability?	Apr-10	8% a lot, 31% some
CNBC All-America Econ.	Approve of Fed's job handling economy?	Oct-10	40% approve
Bloomberg	Should Fed be more accountable to Congress, left independent, or abolished?	Dec-10	39% more accountable, 37% indep., 16% abolished
Reason-Rupe	Favor a law allowing Congress to conduct annual internal review of Fed?	Sep-12	70% favor
CBS News	Confidence in Fed's ability to promote economic growth?	Jul-13 Sep-13	5% a lot, 23% some 5% a lot, 27% some
Gallup	Approve of Bernanke's job as Chair?	Jan-14	40% yes, 25% not sure

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

*Sample: 1000 registered voters. **Sample: 1000 national adults with minimum of $10,000 in investable assets.

Table B.8: Consumer Opinions of Federal Reserve Policies

Survey	**Question**	**Date**	**Response Summary**
Cambridge Reports National Omnibus	To slow inflation, Fed made it more difficult for banks to lend to consumers/businesses. Approve?	Oct-79	33% approve, 10% don't know
Cambridge Reports National Omnibus	Fed recently raised interest rates and restricted credit to fight inflation. In general, is this type of policy good or bad?	Jul-80 Oct-80 Jan-81	36% good, 44% bad 29% good, 47% bad 33% good, 48% bad
Harris Poll	Has Fed followed right policy by tightening when inflation high, easing when recession coming?	Oct-85 Oct-86	63% yes 65% yes
Time/CNN/ Yankelovich Partners	Should Fed have independent control of money supply and interest rates?	Apr-94	28% yes
NBC News/WSJ	Approve of Fed'sincreasing short-term interest rates to prevent increase in inflation?	May-94	41% approve, 24% don't know
UBS/Gallup Index of Investor Optimism*	Approve or disapprove of Fed's current interest rate policy?	Jul-80 Sep-00 2001 mean 2004 mean	41% approve, 8% don't know 54% approve, 37% don't know 51% approve, 37% don't know 47% approve, 45% don't know
Fox News/ Opinion Dynamics**	In June, Fed cut interest rate to lowest level in 40 years. Likely to help or hurt economy?	Jul-03	46% help, 34% no difference
Gallup/USA Today	Favor or oppose the Fed's decision to make loan to AIG?	Sep-08	40% favor
ABC News/ Washington Post	Approve of steps Fed and Treasury have taken to deal with stock market and financial institutions	Sep-08	44% approve
CNBC All-America Econ.	Approve of Fed's job handling economy?	Oct-10	40% approve
Bloomberg Poll	Bernanke helped or hurt economy since 2008?	Oct-10	29% helped, 40% not sure
Bloomberg Poll	Fed plans to buy $600 billion of longer-term federal govt debt. Will QE2 help economy?	Dec-10	25% will help

All surveys are nationally representative samples of at least 1000 adults unless otherwise indicated.

*Sample: 1000 national adults with minimum of $10,000 in investable assets. **Sample: 900 registered voters.

Appendix C

Inflation Expectations in the Great Depression Appendices

C.1 Data Descriptions

- CPI: FRED series CPIAUCNS. I seasonally adjust the series using X-12 ARIMA.
- Industrial Production: Adjusted Miron-Romer index from Romer (1994).
- Commercial Paper Rates: FRED series M13002US35620M156NNBR. Data for 1857-January 1937 from F.R. Macaulay, The Movement of Interest Rates, Bond Yields, and Stock Prices in the U.S. since 1856 (NBER No. 33, 1938), pp. A142-161. Data for February 1937-1942 computed by NBER from weekly data in Bank And Quotation Record, Commercial and Financial Chronicle.
- 10-Yr Treasury Constant Maturity Rate: GS10 from Robert Shiller's website, http://www.econ.yale.edu/ shiller/data.htm, accessed June 9, 2014.
- Sensitive Industrial Raw Materials: FRED series M04202USM349NNBR. Annualized quarter-over-quarter percent change.
- S&P500 Composite Price: from Robert Shiller's website, http://www.econ.yale.edu/ shiller/data.htm, accessed June 9, 2014.
- Coal Price: FRED series M0490BUSM294NNBR
- Money Growth: Annualized month-over-month percent change in the variable Cb64 (total money supply, millions of $, seasonally adjusted) from "A Monetary History of the United States " by Milton Friedman and Anna Schwartz.

C.2 New Keynesian Monte Carlo Simulations

Subsection 3.3 used a New Keynesian Phillips curve to estimate inflation expectations. The regression in Equation (3.7) may suffer from endogeneity. The parameters α and β are not structural. In this appendix I simulate a New Keynesian model. In each simulation I know the true values of π_t^e. Then I use the approach from Subsection 3.3 to construct estimates of π_t^e. I compare the true values to the simulated values to verify that the estimation procedure is valid.

Consider the three equation New Keynesian model consisting of a Phillips curve, an IS curve, and an interest rate rule:

$$\pi_t = \alpha E_t[\pi_{t+1}] + \beta x_t, \tag{C.1}$$

$$x_t = \psi^{-1}(i_t - \pi_t^e - R_t^N) + E_t[x_{t+1}] \tag{C.2}$$

$$i_t = \phi_\pi \pi_t + \phi_y x_t + \zeta_t, \text{ where } \zeta_t = \rho_\zeta + \epsilon_t^\zeta \tag{C.3}$$

We can eliminate Equation (C.3) and reduce the system of equations to:

$$\begin{pmatrix} x_t \\ \pi_t \end{pmatrix} = AE_t \begin{pmatrix} x_{t+1} \\ \pi_{t+1} \end{pmatrix} + B(R_t^N - v_t) = A \begin{pmatrix} x_{t+1} \\ \pi_{t+1} \end{pmatrix} + A \begin{pmatrix} \epsilon_{t+1}^x \\ \epsilon_{t+1}^\pi \end{pmatrix} + B(R_t^N - v_t)$$

By the rational expectations assumption, $E_t[\pi_{t+1}] = \pi_{t+1} + \nu_t^\pi$ and $E_t[x_{t+1}] = x_{t+1} + \nu_t^x$, where $E_t[\nu_t^\pi] = E_t[\nu_t^x] = 0$. Iterating Equation (C.2) one period forward and taking expectations of both sides,

$$E_t[\pi_{t+1}] = E_t[\alpha E_{t+1}[\pi_{t+2}] + \beta x_{t+1}] = \alpha E_t[\pi_{t+2}] + \beta(x_{t+1} + \epsilon_{t+1}^x) \tag{C.4}$$

Adding ϵ_{t+1}^π to both sides of Equation (C.2),

$$\pi_{t+1} + \epsilon_{t+1}^\pi = \alpha E_{t+1}[\pi_{t+2}] + \beta E_t[x_{t+1}] + \epsilon_{t+1}^\pi \tag{C.5}$$

Combining Equations (C.4) and (C.5), we obtain $\epsilon_{t+1}^x = \epsilon_{t+1}^\pi/\beta$. To simulate the model, I simulate π_1, x_1, and ϵ_t^ζ and ϵ_t^π for $t \in \{1, ..., T\}$, and then use the system of equations to obtain $\{\pi_t, x_t\}_{t=2}^T$. Then I regress π_t on π_{t+1} and x_t, as in Equation (3.7) to obtain estimates $\hat{\alpha}$ and $\hat{\beta}$, and use Equation (3.8) to compute estimates $\hat{\pi}_t^e$. I compute the correlation coefficient ρ_{pc} between the estimates $\hat{\pi}_t^e$ and the true values $\pi_t^e = \pi_{t+1} + \epsilon_{t+1}^\pi$.

I repeat the simulation 1000 times with $T = 180$. The mean of ρ_{pc} is 0.80 with standard deviation 0.08. The mean of $\hat{\alpha}$ is 0.38 with standard deviation 0.19, and the mean of $\hat{\beta}$ is 0.06 with standard deviation 0.01. The true values of α and β based on the parameters I use for the simulations are $\alpha = 0.9$ and $\beta = 0.15$. Thus, even though $\hat{\alpha}$ and $\hat{\beta}$ are biased estimates of α and β, the estimates $\hat{\pi}_t^e$ are informative of the true values π_t^e.