

Measuring Consumer Uncertainty about Future Inflation

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1. Introduction

Existing surveys provide useful summary measures of consumers' expectations of price and wage inflation.¹ However, one shortcoming is that they force respondents to give a point forecast without allowing them to express their uncertainty regarding future inflation realizations. Such expressions of uncertainty can improve forecasts of future price and wage inflation as well as other macroeconomic outcomes, and are important for assessing the effectiveness of Central Bank communications about monetary policy. Mishkin (2008) has suggested that a central bank may want to view the costs of inflation in terms of both its level and its uncertainty. Also, to the extent that uncertainty about future inflation affects consumers' decisions, measuring that uncertainty is of direct interest to researchers and policy makers to better understand consumer behavior and for forecasting economic conditions.

In this paper we explore the feasibility of eliciting consumers' subjective probability distribution of future inflation outcomes. Specifically, we conduct a series of surveys that allow respondents to report their point forecasts as well as their density forecasts for price and wage inflation. The questions about density forecasts ask respondents to assign probabilities to pre-determined intervals or bins for future changes in the general price level and in wage earnings (e.g., go down by 0% to 2%, go up by 0% to 2%, go up by 2% to 4%, etc.). For each individual respondent, the resulting density forecasts of price and wage inflation enable us to construct individual measures of central tendency (e.g., the density median) and uncertainty (e.g., the dispersion of the reported probability distribution). We then study how these measures vary over time, as well as their correlations with point forecasts and respondent characteristics.

We focus on five main research questions. First, we examine the feasibility of asking probabilistic questions. We find that individuals are willing and able to provide probabilistic information about future inflation. Those who report a range when they are asked for their 'point' forecast of inflation generally express higher levels of uncertainty in their subjective

¹ As Bernanke (2007) has argued, joint consideration of price and wage inflation expectations is important. Like inflation expectations, expectations about changes in wage earnings may affect consumers' inter-temporal decisions, and are therefore of great value for understanding and forecasting economic behavior. Moreover, because price-setting behavior by firms is at least partly dependent on total labor cost, wage dynamics are an important determinant of expected and actual inflation. As we discuss later, here we define "wage inflation" as the change in personal wage earnings, holding constant other job attributes.

probability distribution, with the width of this self-reported range being positively correlated with measured uncertainty.

Second, we examine heterogeneity in expressed uncertainty, and whether it is systematically associated with respondent characteristics. Subjective probability distributions indeed show considerable heterogeneity. In a survey fielded before the 2008 financial crisis, we find that uncertainty about price inflation is negatively related to self-assessed responsibility for investment decisions, planning horizons for financial decisions, and respondent's performance on a financial literacy measure. Interestingly, more financially literate respondents express higher uncertainty during the financial crisis.

Third, we compare density forecasts with point forecasts for expected inflation in terms of level and time trend. Measures of central tendency derived from individual density forecasts are highly correlated with point forecasts, but they usually differ, often substantially, at the individual level. In aggregate, while the median difference between individual point forecasts and individual density means or medians is close to zero for general price inflation, it is negative for wage earnings growth. We find little difference in the median gaps between individuals who score high or low on the financial literacy test and those who express higher versus lower uncertainty.

Fourth, we further characterize some properties of our uncertainty measures. Uncertainty about future inflation is positively related to point forecast levels as well as density means and medians. Those who are more uncertain about year-ahead price inflation are also generally more uncertain about future wage changes.

Finally, we study at the individual level the dynamic properties of inflation expectations and their relationship with individual uncertainty over time. Individual forecast uncertainty is highly persistent over time, with such persistence being mostly captured by permanent time-invariant idiosyncratic differences across individuals. We also find that respondents who express higher uncertainty in their density forecasts make larger revisions to their point forecasts over time.

1.1 Motivation and existing literature

Surveys asking for point predictions of price and wage inflation can at most convey some notion of the central tendency of individuals' beliefs, and nothing about the uncertainty they feel when predicting outcomes. Density forecasts, eliciting individuals' subjective probability distribution across a range of inflation outcomes, have three advantages over point forecasts. First, they provide a measure of the uncertainty each forecaster has about future outcomes. Second, they remove ambiguity about which (if any) measure of central tendency an individual's point forecast corresponds to (see Engelberg, Manski and Williams 2009). Third, they allow for more accurate measures of disagreement between forecasters, using the same measure of central tendency (e.g., the mean or the median of individuals' subjective probability distribution), when making comparisons across individuals.

While the Survey of Professional Forecasters has been asking experts for their density forecasts of near-term and medium-term price inflation since 1968, surveys of consumers have only elicited point forecasts.² Currently the most widely used survey of consumer inflation expectations is the Reuters/Michigan Survey of Consumers ("Michigan Survey" hereafter). Conducted by telephone, it asks a monthly random sample of individuals for their point forecasts for the change in "prices in general" during the next 12 months and the next 5 to 10 years, as well as their "(family) income" during the next 12 months.³

However, recent empirical research has found that it is feasible to ask members of the general public to report probabilistic expectations for economic outcomes (see Manski 2004). Starting in the early 1990s, large-scale surveys have asked respondents drawn from the general population to assess probabilities for various significant events happening in their lives. These efforts include the Health and Retirement Survey (Juster and Suzman 1995, Hurd and McGarry 1995), the Bank of Italy's Survey of Household Income and Wealth (Guiso, Jappelli and Terlizzese 1992, Guiso, Jappelli and Pistaferri 2002), the Survey of Economic Expectations (Dominitz and Manski 1997a 1997b), the Dutch VSB Panel Survey (Das and Donkers, 1999), the 1997 cohort of the NLSY (Bruine de Bruin et al. 2007, Fischhoff et al. in press, Fischhoff et al 2000, Dominitz, Manski and Fischhoff 2001, Walker 2001), and specific waves of the Michigan Survey (Dominitz and Manski 2004, 2005).

² An important exception is the Bank of Italy's Survey of Household Income and Wealth which elicited expectations about future inflation and wage earnings growth during its 1989 and 1991 surveys.

³ More precisely, the Michigan survey is a hybrid of a repeated cross-section and a short panel. A fresh group of about 300 persons is interviewed each month. Of this group, about 200 are also interviewed six months later.

Most studies find that individuals are as willing to respond to well-written probabilistic questions as they are to traditional attitudinal questions on the same subject. Moreover, despite exhibiting a few systematic biases, the empirical evidence suggests that people's probability estimates are sensibly correlated to respondent characteristics and concurrent behaviors, as well as to whether or not the predicted events actually end up happening in respondents' lives. That predicted events tend to line up with actual occurrences has been observed for a diverse set of outcomes, over different time horizons, and with respondents of different ages. Moreover, stated probabilities are better predictors of later individual behavior than are yes/no intentions data (Juster 1966).

Following up on previous work, we examine whether consumers are willing and able to provide probabilistic expectations of different inflation outcomes. Measuring uncertainty in inflation expectations can improve our understanding of the linkages between consumers' expectations and actual economic behavior, and of the extent to which consumers' uncertainty about future inflation outcomes affects their inter-temporal decisions. Thus, such a measure has direct relevance for macroeconomic modeling, estimation and forecasting. Further, tracking inflation forecast uncertainty is crucial for assessing a central bank's credibility and effectiveness of communication. An increase in uncertainty about future inflation outcomes may be an early warning of eroding central bank credibility. More generally, such measures may be of interest to monetary policymakers to improve their forecast accuracy and to detect potential turning points in inflation expectations.

1.2 Overall project goals

Starting in November 2007, a team composed of economists in the Federal Reserve System, academic economists and psychologists has set out to study the feasibility of improving survey measurement of consumer inflation and wage expectations. The project's main goals are (i) to examine the validity of the Michigan Survey question of inflation expectations and questions using alternative wordings; (ii) to improve our understanding of how consumers form and update their inflation expectations; (iii) to examine consumers' uncertainty regarding future inflation outcomes; (iv) to provide measures of expectations for both price and wage inflation

(defined as the change in personal wage earnings); and (v) to empirically assess the links between inflation expectations and consumer choice behavior. Initial results have been published elsewhere (Bruine de Bruin et al. 2009, 2010; van der Klaauw et al. 2008).

The rest of the paper is organized as follows. Section 2 presents the various surveys used in the analysis, discusses their sample composition and presents some general trends from the data. Section 3 examines the ability of respondents to answer probabilistic questions and the reliability of their responses. We examine heterogeneity in expectations levels and in expressed uncertainty along various demographic characteristics in Section 4. Section 5 contains our comparison of point forecasts and measures of central tendency derived from individual density forecasts. We further characterize our uncertainty measures in Section 6, especially with regard to their relationship with point forecasts. Section 7 reports some time trends of our uncertainty measures and analyzes their dynamic properties, exploiting the panel dimension of our surveys. We offer some conclusions in Section 8.

2. Panel and Special Surveys

Members of RAND's American Life Panel (ALP) participate in either a one-time "special survey" or a repeated "panel survey," with sample composition being described in the next section. Both the special and panel surveys elicit point forecasts and density forecasts for price inflation and wage growth. The special survey includes additional measures relevant to examining respondents' understanding and consistency of responses with other measures. The panel survey is repeated over time, allowing us to examine time trends in reported forecasts. Next, we first describe the wording of the forecast questions, and then present the sequence in which questions appeared in the special and panel surveys.

Our point forecast question about price inflation follows the same format as in the Michigan Survey: first, respondents receive the question "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?" followed by response options "Go up," "Stay the same," and "Go down." Subsequently, respondents who indicate expecting prices to go up or go down receive the question "By about what percent do you expect prices to go [up/down] on the average, during the next 12 months?" Those who

go up by 8% to 12%	_____ percent chance
go up by 4% to 8%	_____ percent chance
go up by 2% to 4%	_____ percent chance
go up by 0% to 2%	_____ percent chance
go down by 0% to 2%	_____ percent chance
go down by 2% to 4%	_____ percent chance
go down by 4% or more	_____ percent chance
	100 % Total.

In addition to the questions on price inflation expectations, we ask a similar set of questions about expected changes in wage earnings during the next 12 months. Employed respondents are asked to assume that other job attributes are held constant:⁶ “Suppose that, 12 months from now, you actually are working in the exact same job at the same place you currently work, and working the exact same number of hours.” We then ask, “Twelve months from now, do you expect your earnings on this job, before taxes and deductions, to have gone up, or gone down, or stayed where they are now?” followed by “By about what percent do you expect that your earnings on this job, before taxes and other deductions, will have gone [up/down], 12 months from now, in that case?”. The probabilistic question about wage expectations has been included in the panel survey starting in June 2008, presenting the exact same bins as with the probabilistic question about price expectations.

The overall sequence of questions is similar across all of our surveys, beginning with warm-up questions from the Michigan Survey about their financial situation and perceived business conditions. In the special survey, participants then receive the point-forecast question about 12-month-ahead price inflation, using the “prices in general” wording described above. Subsequently, they are asked the probabilistic question about price inflation. After each expectations question, respondents are asked to rate the clarity of the question they received, on a scale from 1 (=very unclear) to 7 (=very clear), and how hard it was to come up with an answer to the question, on a scale from 1 (=very easy) to 7 (=very hard), with the latter being reverse-coded so that higher ratings correspond to more ease of responding. Respondents are also asked

⁶ Individuals who reported to be working for pay were first asked how many jobs they had. For those with more than one job, the wage expectations question was asked about their main job, which was defined to be the job at which they usually work the most hours.

to report their interpretation of the question (not analyzed here). Those currently working are then asked the point forecast and probabilistic versions of expected wage earnings, followed by questions on ease of responding and clarity.⁷ Participants also provide demographic information, complete a financial literacy test, and answer questions about their planning horizons for spending and saving decisions and the extent of responsibility for household investment decisions.⁸

The panel surveys also begin with the warm-up questions from the Michigan Survey. They then ask “prices in general” inflation expectations for 12 months ahead (point forecast and probabilistic), and wage earnings inflation expectations for 12 months ahead (point forecast and, since June 2008, probabilistic). Participants in the panel also report demographic characteristics and complete the financial literacy test. In both the special and the panel surveys, respondents are allowed to skip questions, but those who try to do so receive a prompt encouraging them to provide an answer.

2.1 Sample composition

Both the special and the panel surveys are administered online to participants in RAND’s American Life Panel (ALP), who were recruited from Michigan Survey respondents originally contacted through random-digit dialing. Those who expressed a willingness to participate in subsequent internet surveys and gave consent to have their information shared with RAND were invited to the panel. ALP participants are divided into (1) an ‘old sample’ of individuals aged 40 and older who participated in the Michigan Survey prior to December 2006, and (2) a ‘new sample’ of individuals aged 18 and older who participated in the Michigan Survey after

⁷ The survey did not ask about the clarity and difficulty of the probabilistic version of the wage inflation question.

⁸ Financial literacy is measured as the number of correct answers out of 12 in a series of questions measuring the ability to understand financial information and use financial numbers (see Bruine de Bruin et al, 2010, for details). For example, one question asks whether the following statement is true or false: “If the interest rate on your savings account is 1% per year and inflation is 2% per year, after one year, you will be able to buy more with the money in this account than you are able to buy today”. The planning horizon was measured by responses to two questions. The first asks “In deciding how much of their [family] income to spend, people are likely to think about different financial planning periods. In planning your [family’s] spending, which of the following time periods is most important to you [and your husband/wife/partner]”, with answers varying from “Next day” (1) to “Longer than 10 years” (9). A parallel question asked about decisions concerning how much income to save. The measure used in our analysis is a simple average of the answers to both questions. Responsibility for investing was measured by responses to the question “In your household, how much responsibility do you have for investing”.

December 2006. Those in the ‘old’ sample were invited to participate in the panel surveys, and those in the ‘new’ sample were invited to participate in the special survey.

A total of 589 participants from the ‘new’ ALP sample completed our special survey between December 22, 2007 and May 22, 2008, with 47.9% filling it out by December 31, 2007, and 86.0% by January 31, 2008. The first panel survey was fielded on November 7, 2007 and has been repeated since then every six weeks or so. Here, we report on the first 14 waves with the most recent one entering the field on July 31, 2009. In our analysis of each panel survey we only consider responses for those participants who fill it out within 30 days after the field date,⁹ in order to avoid spurious heterogeneity in responses due to changing economic conditions over time. In addition, our analyses include only those respondents who participated in at least five of the first nine waves. These criteria yield a panel with fairly stable composition and number of responses over time, with on average about 400 responses per survey.¹⁰

Table 1 describes demographic characteristics of the participants in our two samples.¹¹ The special and panel surveys are significantly different in terms of age but not with respect to any of the other sample characteristics, reflecting the different age criteria used for the ‘new’ and ‘old’ ALP samples. Yet, the age composition of participants aged 40 years and older appears similar, with 37% of panel survey participants and 38% of special survey participants being at least 60 years old. Relative to the special survey, the panel surveys do include slightly more males and more highly educated participants.

2.2 Time trends in point forecasts

⁹ In each wave an email is sent to survey participants with a link to the new survey. Participants can fill out the survey online at any time after the field date, although most people do so within the first two weeks. A unique login and password is provided to avoid having the same person fill out the survey more than once.

¹⁰ At the time of the first panel survey, 72% of all Michigan Survey respondents who had been invited to participate in the ALP survey had done so in at least one of the surveys up to that point. Respectively, 82% and 70% of individuals in this group who had been invited to participate in our special survey or in the first wave of our panel did so. Of the 646 respondents who participated in at least one of the first nine waves of our survey modules, 435 (67%) participated at least five times. Unit response rates among this group were consistently above 95% in the subsequent waves.

¹¹ Because our analyses focus on examining the relationships between measures rather than obtaining population estimates, we do not use sample weights.

We present time trends in point forecasts of price and wage inflation to set the context in which we studied consumer uncertainty. Figure 1a presents the time trend in median point forecasts for expected changes in prices in general during the next 12 months, as reported in our panel surveys.¹² Also shown in Figure 1a are corresponding trends for the 25th and 75th percentiles of point forecasts. The difference between these two percentiles equals the interquartile range which is a measure of disagreement among forecasters. This measure is less sensitive than the standard deviation to small variations in the tails of the response distribution. Median expectations of price inflation reach a peak in the summer of 2008, plunge in the period December 2008 – February 2009 following the financial crisis, and have slightly increased since then.¹³ Disagreement among consumers seems to rise as the median inflation forecasts jump during the Spring of 2008, and seems to decline after median inflation forecasts stabilize around 3% in December of 2009.

Figure 1b plots the time trend in median point forecasts for expected changes in wage earnings during the next 12 months, as well as corresponding 25th and 75th percentiles. Median expectations for expected wage earnings growth drop from roughly 2.5% in the summer of 2008 to almost 0% from February 2009 onwards, presumably reflecting the impact of the recession. During the same period, disagreement remains relatively stable, suggesting persistent heterogeneity in expected wage growth across workers.

3. Initial evaluations of responses to probabilistic questions

We use each individual's responses to the probabilistic questions to parametrically estimate the underlying forecast density function (following Engelberg, Manski & Williams, 2009). More specifically, when a respondent assigns a positive probability to three or more bins, we assume an underlying generalized Beta distribution, which has four-parameters, two to

¹² Note that while some respondents at first may have reported a range as their 'point' forecast, they all were subsequently asked for, and ended up reporting a point forecast. All median forecasts are based on reported point forecasts and were computed using a simple linear interpolation procedure to accommodate the almost universal use of integer responses (a similar procedure is used to compute median forecasts published by the Michigan Survey).

¹³ The trend in the median inflation forecast based on the "prices in general" question is very similar to that found when using the data from the Michigan Survey, except that the medians based on the ALP sample are consistently slightly above those for the Michigan Survey. See van der Klaauw et al (2008) for a more detailed comparison and discussion.

determine its support and two to determine its shape, allowing mean, median and mode to take on different values. For respondents assigning a positive probability to only one or two bins, the underlying distribution is assumed to have the shape of an isosceles triangle.¹⁴

Based on the probability density function for each respondent, we compute corresponding density means and medians. Further, we use the density Inter-Quartile Range (IQR) as a measure of individual forecast uncertainty. As mentioned above, the IQR is less sensitive than the standard deviation to small variations in the tails of the estimated density.

First, we examine respondents' willingness and ability to report probabilistic responses. As shown in Table 2, the qualitative features of responses to probabilistic questions appear promising. The response rates are close to 100% for questions about both price and wage inflation, as reported on the special and panel surveys.¹⁵ Only about one percent of respondents provide assessments that did not add to 100%. These response patterns may be attributed in part to specific features of our surveys, which ask respondents to return to a question after they try to skip it, and notify respondents if their assigned probabilities do not add up to 100%. If so, these findings suggest that with a little encouragement, probabilistic questions about future inflation are likely to have high response rates and a high proportion of respondents giving responses that add up to 100%.

Table 2 also presents various measures suggesting that, when given the opportunity to do so, most respondents choose to express uncertainty in their density forecasts. Reported uncertainty is significantly higher for expected price inflation than for expected wage inflation (at the 1% significance level). That pattern of results can not be explained by variations in the bins presented with the probabilistic questions, which are the same for the price and wage questions. Rather it is consistent with survey participants having more information about, and possibly more control over, their own future wage earning growth than about price inflation in general.

Specifically, Table 2 shows that the proportion of respondents who put positive probability mass in more than one bin is very high for the probabilistic version of the "prices in

¹⁴ For further details about the estimation of both distributions, including the treatment of positive probability bins that are open-ended (on the boundary), see Engelberg et al (2009).

¹⁵ The lower observation counts in Table 2 relative to those reported in Table 1 are due to the fact that in five out of the 14 panel surveys only a randomly chosen 50% of the respondents in our survey were asked the probabilistic price and wage inflation questions. Further, the latter were only asked to those who reported to be currently employed.

general” question: 96% in the special survey (conducted at a time when median expectations were relatively high) and about 89% in the panel surveys (conducted when median expectations varied). For wage earnings, the fraction of respondents who put positive probability in more than one bin is still substantial (76% in the special survey and 70% in the panel surveys), but lower than for price inflation. A similar pattern holds for the average number of bins with positive probability, which is higher for expected price inflation (4.8 for the special survey, 3.8 for the panel surveys) than for expected wage earnings (3.2 for the special survey, 2.7 for the panel surveys). Consistently with this pattern of results, we also find a higher median level of uncertainty (as measured by the density IQR) concerning price inflation compared to that for wage inflation, both in the special survey and in the panel.

Furthermore, the fraction of respondents who put positive mass on non-contiguous bins is very low, ranging from 1.3% in the special survey to 1.6% in the panel for price inflation and equal to about one percent for wage inflation. Generally we find that the resulting forecast histograms can be approximated reasonably well by our parametric specifications which assume probabilistic beliefs to be unimodal.

Finally, responses to the probabilistic questions appear reliable, as seen in significant correlations with other measures of uncertainty. Even though the “point forecast” questions specifically ask for a number, between 30% and 40% of all respondents give a range for expected price inflation (Table 2).¹⁶ This use of ranges is positively correlated to both the uncertainty expressed in individuals’ density forecasts, and to the number of bins that receive a positive probability mass in the probabilistic price inflation question: the correlation ranges from 0.04 to 0.11 across surveys. Further, the correlation between the width of the range reported and individual uncertainty is strongly positive (0.49 in the panel, 0.58 in the special survey for price inflation).

We find a similar pattern for wage inflation expectations. While the use of range responses is considerably lower (between 13% and 17%), suggesting less uncertainty about the point forecast, we again find a positive association between the reporting of a range in response to the point forecast question, and the level of individual uncertainty expressed and the number of bins used with the probabilistic question. Among participants reporting a range, the

¹⁶ This includes individuals who reported both a range and a point forecast. In the special survey, more than half of these respondents initially reported a range only.

correlation between the width of the interval and individual uncertainty is again high, varying between 0.52 and 0.57. Both sets of results help substantiate our view that the responses to the probabilistic versions of both our inflation expectations questions express a reliable measure of uncertainty.

Table 3 shows statistically significant differences between respondents' evaluations of the density and point forecast questions. That is, respondents consider the question asking for a density forecast of price inflation to be somewhat more difficult and less clear than the question asking for a point forecast of price inflation. Yet, the rated difference in clarity and difficulty appear relatively small, especially when considering what respondents think of the point forecasts for wage inflation, which are rated as much clearer and easier to answer than point forecasts of price inflation. Thus, despite finding probabilistic questions slightly less clear and more difficult to answer, respondents do seem to be willing to give responses expressing their uncertainty about future inflation outcomes.

Because questions about point forecasts always precede questions about density forecasts, we are unable to examine the effect of question order on reported ease of responding. Possibly, probabilistic questions are rated as harder only because they follow the relatively less complex questions about point forecasts. Doing so may therefore draw attention to the higher cognitive demand of the question about density forecasts – which may be less likely if density forecast questions were presented first. Alternatively, it may also be the case that presenting the questions asking for point forecasts before the questions asking for density forecasts makes it easier to respond to the latter.

4. Examining heterogeneity in inflation expectations

As shown in Figures 1a and 1b, there is substantial heterogeneity across individuals in their point forecasts for price and wage inflation. Table 4 examines whether the heterogeneity observed in the panel survey data (pooled across 14 waves) is associated with systematic differences between different demographic groups by gender, education, marital status, income,

age and financial literacy.¹⁷ The top section of the table shows demographic differences in expectations for price inflation, with both median point forecast and the median of individuals' density medians being significantly higher for respondents who are female (vs. male), less educated (vs. more educated), single (vs. married or living with a partner), poorer (vs. less poor), and older (vs. younger). Except for the age difference, these demographic differences are also seen in both measures of disagreement among respondents, the IQR of point forecasts and of individual density medians. Uncertainty, measured as the median of individuals' density IQR, is higher among women, singles, lower income respondents, and those younger than 60 years of age. Thus, demographic groups who tend to express higher point forecasts and forecast medians also tend to express higher forecast uncertainty, again with the exception of the age categories.¹⁸ Those who score lower on the financial literacy test, who also tend to be less educated,¹⁹ report higher point forecasts and higher disagreement. In these pooled panel data, individual uncertainty does not seem to vary by financial literacy. However, as we discuss below, this finding masks changing patterns over time.

The bottom section of Table 4 suggests that demographic differences in wage inflation expectations are less pronounced. We find slightly higher density medians for respondents who are male (vs. female), more highly educated (vs. less educated), financially better (vs. worse) off, older (vs. younger) and scoring higher (vs. lower) on a financial literacy test. Demographic differences in median point forecasts tend to be in the same direction, but are not statistically significant. Overall, these demographic differences in wage expectations appear to reflect actual variation in earnings growth and are consistent with individuals having access to that information.²⁰ Demographic groups show no significant differences in the two measures of disagreement, the IQR of point forecasts and of individual density medians. However, individual forecast uncertainty is significantly lower for respondents who are female, less educated, poorer,

¹⁷ In Table 4, financial literacy is measured as a binary variable (high/low), based on the number of correct answers being at least 10 out of 12 questions.

¹⁸ All these patterns also hold for the special survey, with the single exception of a significantly higher median uncertainty among those without a college degree relative to those with a college degree. See Bruine de Bruin et al. (2010), Table 1.12.

¹⁹ See Bruine de Bruin et al., 2010, for an extensive discussion. In this paper we also present results from multivariate analyses. Most demographic differences disappear once we control for financial literacy.

²⁰ Wage growth has been persistently higher for college graduates in recent decades (Elsby and Shapiro, 2009). As reported by Johnson and Mommaerts (2010), workers aged 65 and older experienced much higher wage growth during 2007-2009 than workers in all other age categories.

and less financially literate. This pattern replicates previously reported gender and income differences in individual uncertainty (Dominitz 1998; Dominitz & Manski 1997b).

Thus, demographic differences in expectations levels, disagreement and uncertainty depend on whether we consider expectations for price or wage inflation. However, for both price and wage inflation we do find that those who express higher levels of expectations also tend to express higher uncertainty in their subjective forecasts. We report further evidence of this positive association below.

Table 5 reports the correlation between our measure of individuals' forecast uncertainty and individual measures of financial knowledge and behavior collected in the special survey which was fielded before the onset of the 2008 financial crisis. Forecast uncertainty about future price inflation is significantly positively correlated to performing worse on the financial literacy measure, to reporting shorter planning horizons for household financial decisions, and to perceiving less responsibility for household investment decisions. A similar pattern holds for point forecasts for future price inflation.²¹ Thus, respondents who are more financially savvy or possess more financial knowledge tend to express less uncertainty, as seen in less diffuse density forecasts. They also give lower forecast levels, which are closer to actual levels of realized inflation for the broad period under consideration. In contrast to uncertainty about price inflation, Table 5 reveals little evidence in the special survey of a significant relationship between the various measures of cognitive skills and the expressed uncertainty about future wage growth.

5. Comparing point forecasts with measures of central tendency from density forecasts

A main innovation of our surveys is the introduction of probabilistic questions to elicit probability density forecasts about future inflation. Our respondents are allowed to assign a 'percent chance' to various possible outcomes instead of having to commit to a single point forecast. By doing so, we aim to collect a more accurate and complete representation of

²¹ While the negative correlation between uncertainty and financial literacy may appear at first glance inconsistent with our findings in Table 4, the difference is due to the particular timing of the special survey (December 2007). We discuss this in detail below.

individuals' subjective expectations, and the degree of uncertainty that they attach to their point forecasts.

Collecting expectations as density forecasts enables us to examine what particular measure of central tendency respondents report when forced to give a point forecast. In the spirit of Engelberg et al. (2009), we analyze the relationships of individual density medians and means, with the point forecasts reported in our surveys. In addition to the correlations between these measures, we also compute the median difference between point forecasts and individual medians and means, as well as the proportion of cases in which the point forecast falls within different quartiles of the individual forecast distribution.

Table 6 shows these results, using both the special survey and pooled data from our panel surveys. The first thing to note is that point forecasts are highly correlated with both medians and means of individual densities, suggesting reliability of measurement. For price inflation, the median gap between point forecasts and measures of central tendency from the individual forecast densities is zero in the panel and only slightly negative in the special survey. However, this may mask interesting patterns over time as we discuss below.²² For wage inflation, point forecasts tend to be lower than density means or medians, with differences being statistically significant at the 1% level.²³

Indeed, point forecasts for price and wage inflation tend to compare differently within individuals' density forecasts. For the "prices in general" question, the majority of respondents give point forecasts that fall between the first and the third quartile of the individual density (55% for the panel; 57% for the special survey). For wage earnings, in the majority of cases the point forecast actually falls below the density median (54% for the panel; 56% for the special survey), with the bulk of respondents expressing point forecasts below the first quartile (44% for the panel; 36% in the special survey). A striking finding from both analyses is the large number of cases (a little under 45% for price inflation and over 55% for wage inflation) in which the point forecast falls in either the top or bottom quartile.

²² In fact, when we look at each panel wave separately, the median gaps are significantly different than zero (at the 10% level) in nine out of 14 waves.

²³ It is interesting to note that median gaps between point forecasts and measures of central tendency do not shrink over time in our panel. This seems to rule out convergence in these measures as panel respondents get more used to these expectations questions over time. We would argue that measures of central tendency derived from density forecasts are more reliable summary expressions of expectations levels than point forecasts.

To further analyze the nature of the gap between point forecasts and density medians, we examine in Table 7 how the mean gap between point forecasts and density medians varies across respondents with high vs. low financial literacy, as well as high vs. low reported forecast uncertainty.²⁴ We may expect any gap between point forecasts and density medians to be particularly large for less financially savvy or less informed survey participants. The results are ambiguous: the median gap between point forecasts and individual density medians is significantly larger (in absolute value) for less financially literate respondents only in the special survey, with the difference being statistically significant only for price inflation. In the panel the gap does not vary much by financial literacy overall (but this may again mask interesting patterns over time). With regard to forecast uncertainty, again the gap does not vary much across high and low uncertainty respondents, with the exception of price inflation in the special survey, where the gap is actually larger for low uncertainty than for high uncertainty respondents.

To complete our analysis of the relationship between point forecasts and measures of central tendency from the individual density forecasts, we report in Figures 2a, b the time trends of each measure from the panel surveys, aggregated using the median across respondents. For the price inflation question, point forecasts are higher than density means and medians during periods of relatively low inflation expectations and lower than density means and medians in periods of higher inflation expectations. However, these differences in medians reach statistical significance only in three out of 14 waves of the panel. Interestingly, the gap seems to be widening in the most recent periods, with the density means and medians perhaps better reflecting the deflation scares that have arisen after the financial crisis of Fall 2008, although this difference in later periods is not statistically significant.

For wage earnings, consistently with Table 6, density means and medians are always above point forecasts. Again, the gap has been widening in recent months (and becoming highly statistically significant) with measures of central tendency from the individual densities pointing upwards while point forecasts have remained very close to zero.²⁵ We conjecture that allowing

²⁴ Here we define “high” and “low” financial literacy as in Table 4. For uncertainty, we use the median across respondents as a threshold, where the median is computed separately for each survey wave.

²⁵ We recognize that providing respondents with pre-assigned bins may provide them with a range of responses they may not have otherwise considered in an open-ended point forecast question asking them to fill in the blank (Bruine de Bruin, in press; Schwarz, 1999). As a result, comparisons of point forecasts with density means and medians could show systematic differences. However, because the reported differences between point forecasts and density means and medians are not consistent across the wage and price inflation questions or over time, such a response mode effect may not have played a role here.

respondents to give density forecasts enables them to express more nuanced views, with the probabilistic format allowing them to give some weight to a possible upside potential in own future wages.

6. Examining uncertainty

As mentioned above, one advantage of soliciting probability densities for inflation expectations is that we can construct a measure of individual uncertainty. Here we report our findings with regard to our measure of uncertainty, the IQR of individuals' density forecasts. We also study the relationship between individual point forecasts and uncertainty with regard to both price and wage inflation.

Figure 3 shows scatter plots comparing individual point forecasts with individual uncertainty. The left column reports results for the “prices in general” questions, whereas the right column is for the “wage earnings” questions. Horizontally, the top row reports plots for the pooled data from the panel surveys, the middle row shows these pooled panel data demeaned by wave, and the bottom row shows responses from the special survey. All graphs consistently show that higher point forecasts are associated with larger forecast uncertainty. These results are in line with the finding that members of some demographic groups and individuals with higher financial literacy report higher point forecasts and more forecast uncertainty (Table 4; Table 5). Table 8 further confirms that the positive association between point forecasts and individual forecast uncertainty is robust, holding across surveys, measures of central tendency (point forecasts, density medians and means) and expectations for price and wage inflation.

Figure 4 offers a more detailed picture of the relationship between point forecasts and uncertainty. It shows histograms of point forecasts for panel survey respondents expressing uncertainty above or below the median forecast uncertainty. The differences are striking. In the case of price inflation, most respondents with low uncertainty report point forecasts between zero and five percent, with a spike at ten percent. By comparison, point forecasts for respondents with high uncertainty are much more dispersed, with many giving point forecasts of ten, 15, or above 20 percent. A similar pattern occurs for wage inflation, showing much higher dispersion and more extreme point forecasts for respondents with high uncertainty.

7. Examining time trends in uncertainty

This section uses our panel survey data to examine time trends for our expectations questions, including patterns in heterogeneity by demographics over time. We then examine the relationship of individual uncertainty as reported in one period with subsequent individual uncertainty. Finally, we examine whether higher individual forecast uncertainty is associated with a larger variability in individual forecasts over time.

Figures 5 and 6 report heterogeneity in point forecasts respectively for price and wage inflation expectations, as well as related uncertainty, by respondents' education and financial literacy. The time trends are consistent with the demographic differences reported for the pooled data (Table 4). For price inflation, respondents with more education and higher financial literacy consistently report lower forecast levels, expecting very low inflation or even deflation in December 2008. However, their uncertainty varies over time: it is lower in the waves preceding the onset of the 2008 financial crisis, and slightly higher from then onwards. This pattern explains the lack of any significant difference in uncertainty by education and financial literacy reported in Table 4 (which uses pooled data over the entire sample period), and is also consistent with the negative association between financial literacy and uncertainty reported in Table 5, which refers to the special survey which was fielded primarily during December 2007-January 2008.

Figure 6 suggests why the pooled data show no significant differences in point forecasts for wage inflation across education categories (Table 4). Through early Fall 2008, wage expectations are higher for more highly educated workers. However, the pattern reverses in early December 2008, perhaps reflecting early concerns about the financial crisis on workers in highly skilled occupations such as the financial and banking sectors. From January 2009 onwards, wage inflation expectations also fall among respondents with lower levels of education, perhaps in accordance with the spread of the recession to the broader economy. Consistent with the pooled data (Table 4), more highly educated and financially literate respondents seem to

consistently express higher uncertainty about future earnings than do respondents with lower levels of education and financial literacy over the entire sample period.²⁶

We exploit the panel structure of our panel survey data in Table 9. The first three sets of regressions focus on the relationship between individual forecast uncertainty in period t and uncertainty in period $t-1$. The final two sets of regressions examine the relationship between uncertainty in period $t-1$ and subsequent (absolute) changes in point forecasts between period $t-1$ and t . We use various specifications, including individual demographic attributes as well as an individual random effect.

The regression results indicate that uncertainty at time t is positively associated with uncertainty in the previous period, even after controlling for individual attributes, for both price and wage inflation. However, the introduction of individual unobserved heterogeneity in the form of random effects captures this persistence almost entirely. Thus, the persistence in individual forecast uncertainty seems to be explained by permanent time-invariant idiosyncratic differences across individuals. Interestingly, higher uncertainty in one period is associated with larger absolute revisions in point forecasts from that period to the next, for both price and wage inflation expectations (model 4) and even after controlling for individual random effects (model 5).

These results are consistent with Figure 7, which displays the relationship between average individual uncertainty over the sample period and variability in individual forecasts over time (measured as the standard deviation of point forecasts for a given individual over the sample period). The top panel contains a scatterplot for price inflation and the bottom panel is for wage inflation. The results are similar across expectations questions: higher forecast uncertainty is associated with a higher variability in individual point forecasts over time. These findings are roughly consistent with a model of Bayesian updating by individuals, in which a more diffuse prior at one point in time is associated with larger revisions in point forecasts in subsequent periods.²⁷

²⁶ The same patterns as those shown in Figures 5 and 6 appear when comparing those with incomes above and below \$75,000.

²⁷ Another possible interpretation would be that there exists time-invariant variation in uncertainty across individuals, with more uncertain individuals randomly drawing from a more dispersed distribution and thus exhibiting larger variation from one period to the next. However, model 5 in Table 9 suggests that unobserved heterogeneity in uncertainty cannot be the whole story, since the association between uncertainty and revisions in point forecasts survives even after controlling for unobserved heterogeneity.

8. Conclusion

In this paper, we examine five main research questions. First, we study the feasibility of asking consumers for density forecasts of price and wage inflation, requiring them to assess the probabilities of various future outcomes. Our results suggest that members of the general public are willing to give density forecasts, as seen in high response rates. They also seem to have the ability to do so, as seen by probabilities adding up to 100%, and by the use of contiguous bins. Moreover, uncertainty expressed in consumers' density forecasts is reliably related to other measures of uncertainty. Individuals who express higher levels of uncertainty in their subjective probability distribution are more likely to report a range when they are originally asked for their point forecast, and the width of this self-reported range is positively correlated with measured uncertainty.

Second, we examine the degree of heterogeneity in price and wage inflation expectations. The subjective probability distributions point to considerable heterogeneity in measures of central tendency as well as of uncertainty, associated in part with differences between individuals from different demographic groups as well as variation in financial literacy.

Third, we compare density forecasts with point forecasts for expected inflation in terms of level and time trend. Measures of central tendency derived from individual density forecasts are highly correlated with point forecasts. However, for roughly half of the responses, point forecasts do not fall between the first and the third quartile of the same individual's forecast density. Nevertheless, in aggregate terms, the median difference between individual point forecasts and individual density means or medians is close to zero for general price inflation. On the other hand, individual density means and medians tend to be consistently larger than point forecasts for wage earnings growth. We find little difference in the median gaps between individuals who score high or low on the financial literacy test and those who express higher versus lower uncertainty.

Fourth, we further characterize some properties of our uncertainty measures. Uncertainty about future inflation is positively related to point forecast levels as well as density means and medians. Those who are more uncertain about year-ahead price inflation are also generally more uncertain about future wage changes.

Finally, we study at the individual level the dynamic properties of inflation expectations and their relationship with individual uncertainty over time. While individual forecast uncertainty is highly persistent over time, such persistence seems to be explained by permanent time-invariant idiosyncratic differences across individuals. We also find that respondents who express higher uncertainty in their density forecasts make larger revisions to their point forecasts over time.

Our results suggest that responses to probabilistic questions have internal consistency and measurement reliability, which is a necessary but not a sufficient condition for validity. In additional follow-up studies, we plan to examine whether probability density measures of inflation expectations have ‘concurrent validity’, in terms of being correlated to economic perceptions and behaviors. It would also be interesting to explore the forecasting power of individual uncertainty, by analyzing whether instances of especially high forecast uncertainty help predict future turning points in actual inflation and whether the forecast accuracy of survey-based measures of inflation expectations increases if individual point forecasts are weighted by their associated uncertainty (e.g., with weights being inversely proportional to expressed uncertainty).

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Table 1. Sample Composition

	Special Survey	Panel
Female	56%	51%
Married	66%	64%
B.A. or More	48%	52%
Income > \$75k	44%	41%
Age 40-59	48%**	63%
Age > 59	30%**	37%
Obs	559	5212

Test for difference in sample proportions special survey versus panel: ** p<0.01; * p<0.05.

Table 2. Qualitative Features of Responses to Probabilistic Questions

	Price Inflation		Wage Inflation	
	Special Survey	Panel	Special Survey	Panel
Item Response Rate	98.8%	99.6%	99.4%	99.5%
Percent Chance Response Does Not Add to 100%	1.1%	0.9%	0.6%	0.8%
Proportion With Positive Probability on More Than 1 Bin	96.4%	89.4%	76.2%	70.5%
Average Number of Bins With Positive Probability	4.76	3.83	3.23	2.72
Median uncertainty (IQR)	2.79	2.43	1.99	1.26
Proportion With Positive Probability on Non-Contiguous Bins	1.3%	1.6%	0.8%	1.1%
Proportion With Range Response	42.9%	28.9%	17.4%	12.6%
Correlation Between Range Use and Uncertainty	0.11**	0.05**	0.07	0.07**
Correlation Between Range Use and Number of Non-Zero Bins	0.09*	0.04*	0.04	0.06**
Correlation Between Range Size and Uncertainty	0.58**	0.49**	0.52**	0.57**
Obs	567	4088	382	1749

All reported correlations are Spearman rank correlations: ** p<0.01; * p<0.05.

Table 3. Question Clarity and Difficulty

Average Ratings	Price Point Forecast	Price Density Forecast	Wage Point Forecast
How hard was question? (1=very easy, 7=very hard)	3.6	3.9**	2.4**
How clear was question? (1=very unclear, 7=very clear)	5.5	5.3**	6.4**

Special Survey. Paired t-tests for equality of ratings versus those for point forecasts of price inflation: ** p<0.01; * p<0.05.

Table 4. Heterogeneity in Inflation Expectations by Demographics

PRICE INFLATION	Median Point Forecast	Median Density Median	Disagreement (IQR of Point Forecasts)	Disagreement (IQR of Density Medians)	Median Uncertainty (Density IQR)	Obs
Female	4.8**	4.7**	7.2	5.3	2.7**	2675 / 2092
Male	4.1	3.8	3.6	3.5	2.3	2521 / 1996
No B.A.	4.8**	4.9**	7.1	5.2	2.4	2505 / 1948
B.A. or More	4.1	3.8	3.9	3.7	2.5	2691 / 2140
Single	4.6*	4.7**	5.4	4.3	2.6*	1859 / 1467
Married	4.4	4.0	4.5	4.1	2.4	3337 / 2621
Income<=75K	4.8**	4.9**	6.9	5.2	2.6*	3046 / 2391
Income>75K	3.9	3.6	3.7	3.7	2.4	2149 / 1696
Age 40-59	4.4*	4.1**	4.4	4.2	2.6**	3261 / 2613
Age > 59	4.6	4.6	5.3	4.0	2.3	1935 / 1475
Low Financial Literacy	4.7**	4.2	7.2	4.5	2.4	2150 / 1680
High Financial Literacy	4.2	4.2	4.0	4.0	2.5	2889 / 2286

WAGE INFLATION	Median Point Forecast	Median Density Median	Disagreement (IQR of Point Forecasts)	Disagreement (IQR of Density Medians)	Median Uncertainty (Density IQR)	Obs
Female	0.5	2.0**	3.3	2.0	1.1**	1240 / 928
Male	1.5	2.3	3.4	2.5	1.5	1118 / 821
No B.A.	0.5	1.9*	3.4	2.0	1.0**	1022 / 762
B.A. or More	0.7	2.2	3.3	2.2	1.6	1336 / 987
Single	1.2	2.0	3.4	2.1	1.3	852 / 643
Married	0.5	2.0	3.3	2.2	1.3	1506 / 1106
Income<=75K	0.8	2.0*	3.4	2.0	1.1*	1155 / 861
Income>75K	0.5	2.2	3.3	2.3	1.5	1203 / 888
Age 40-59	0.5	2.0**	3.3	2.0	1.1*	1947 / 1475
Age > 59	1.6	2.6	3.9	2.8	1.7	411 / 295
Low Financial Literacy	0.5	1.7**	3.3	2.0	1.1**	964 / 729
High Financial Literacy	1.2	2.5	3.4	2.5	1.5	1326 / 970

Panel from November 2007 to July 2009. Difference between demographics statistically significant at the 5% (*) or the 1% (**) level. Disagreement is measured by the sample IQR of point forecasts or density medians, and uncertainty is measured by the sample median of the individual density IQRs. Observation counts correspond to the number of point forecast and density responses, respectively, for each demographic group.

Table 5. Heterogeneity in Uncertainty by Knowledge/Financial Behavior

Rank correlations	PRICE INFLATION		WAGE INFLATION	
	Uncertainty	Point Forecast	Uncertainty	Point Forecast
Financial Literacy	-0.24**	-0.26**	0.07	0.00
Planning Horizon	-0.18**	-0.14**	-0.04	0.09
Responsibility Investing	-0.13**	-0.11*	0.00	0.09

Special survey. Spearman rank correlations. ** p<0.01 ; * p<0.05.

Financial literacy is measured as number of correct answers out of 12. The planning horizon was measured by responses to the question 'In deciding how much of their [family] income to spend (save), people are likely to think about different financial planning periods. In planning your [family's] spending (saving), which of the following time periods is most important to you [and your husband/wife/partner]', with answers varying from 'Next day' (1) to 'Longer than 10 years' (9). Responsibility for investing was measured by responses to the question 'In your household, how much responsibility do you have]...[for investing and managing assets], with choices varying from none (1) to all (5).

Table 6. Relationship Between Point Forecasts and Individual Measures of Central Tendency

	Price Inflation		Wage Inflation	
	Panel	Special Survey	Panel	Special Survey
Correlation between Point Forecast & Density Median	0.83**	0.71**	0.77**	0.73**
Correlation between Point Forecast & Density Mean	0.84**	0.72**	0.76**	0.72**
Median of (Point Forecast – Density Median)	0.00	-0.08	-0.54**	-0.42
Median of (Point Forecast – Density Mean)	0.00	-0.08	-0.55**	-0.40
Percent of Observations with: Point Forecast < Density Q1	22.6%	20.4%	43.8%	35.6%
Density Q1 ≤ Point Forecast < Density Q2	24.6%	31.1%	13.7%	20.2%
Density Q2 ≤ Point Forecast < Density Q3	30.1%	25.7%	23.3%	25.2%
Density Q3 ≤ Point Forecast	22.7%	22.8%	18.6%	19.0%

All reported correlations are Spearman rank correlations: ** p<0.01; * p<0.05.

Table 7. Median Gap between Point Forecasts and Density Medians

	PRICE INFLATION				WAGE INFLATION			
	Panel		Special Survey		Panel		Special Survey	
	Median	Obs	Median	Obs	Median	Obs	Median	Obs
High Financial Literacy	-0.03**	2283	-0.18**	306	-0.62	893	-0.27	214
Low Financial Literacy	0.01	1674	0.46	223	-0.37	678	-0.57	141
High Uncertainty	0.00	2066	-0.17*	269	-0.48	905	-0.42	178
Low Uncertainty	0.00	2013	0.32	272	-0.50	842	-0.41	180

Panel. Difference between demographics statistically significant at the 5% (*) or the 1% (**) level. High uncertainty (density IQR) is measured as a value greater than the median uncertainty level in that survey wage. High financial literacy is defined as 10 or more correct answers out of 12.

Table 8. Correlation Between Measures of Central Tendency and Uncertainty

Correlation Between Uncertainty (Individual IQR) and:	Price Inflation		Wage Inflation	
	Panel	Special Survey	Panel	Special Survey
Point Forecast	0.46**	0.53**	0.11**	0.40**
Density Median	0.44**	0.47**	0.20**	0.48**
Density Mean	0.48**	0.53**	0.25**	0.53**

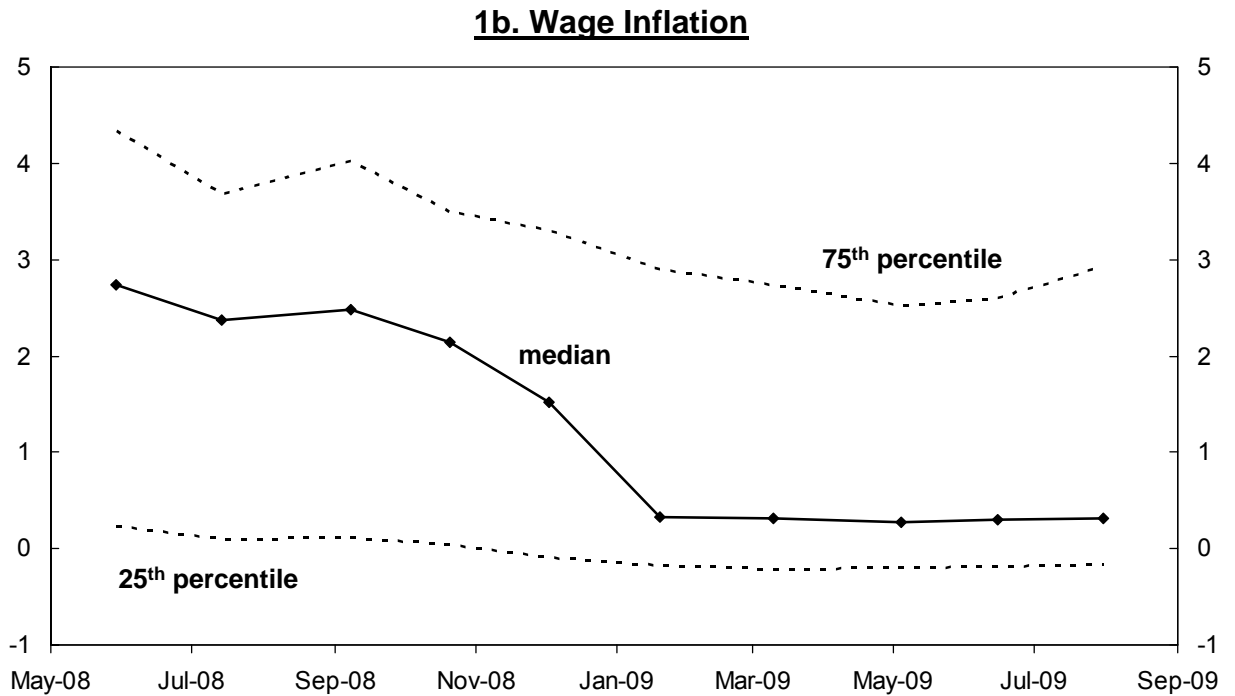
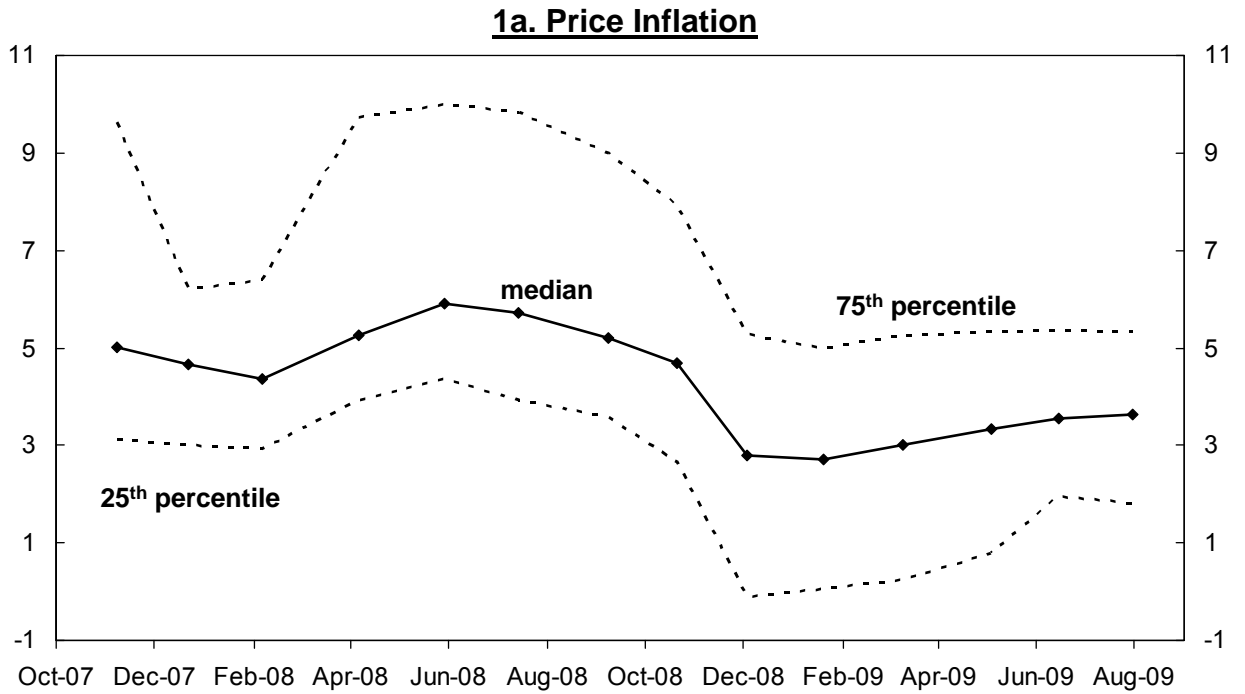
All reported correlations are Spearman rank correlations: ** p<0.01; * p<0.05.

Table 9. Dynamics - Panel Data Regressions

	Estimate (std error) of a_1	
	Price Inflation	Wage Inflation
Model 1: $iqr(\pi)_{it} = a_0 + a_1 iqr(\pi)_{it-1} + \varepsilon_{it}$	0.47 (0.05)	0.67 (0.04)
Model 2: $iqr(\pi)_{it} = a_0 + a_1 iqr(\pi)_{it-1} + X_i'b + \varepsilon_{it}$	0.45 (0.05)	0.67 (0.04)
Model 3: $iqr(\pi)_{it} = a_0 + a_1 iqr(\pi)_{it-1} + X_i'b + \theta_i + \varepsilon_{it}$	0.05 (0.03)	-0.03 (0.09)
Model 4: $ \pi_{it} - \pi_{it-1} = a_0 + a_1 iqr(\pi)_{it-1} + X_i'b + \varepsilon_{it}$	0.52 (0.07)	1.44 (0.34)
Model 5: $ \pi_{it} - \pi_{it-1} = a_0 + a_1 iqr(\pi)_{it-1} + X_i'b + \theta_i + \varepsilon_{it}$	0.39 (0.03)	0.41 (0.03)

Panel micro data – balanced panel. π_{it} denotes individual i -th point forecast of year-ahead inflation in survey wave t , and $iqr(\pi)_{it}$ denotes individual i -th uncertainty (as measured by the density IQR) of year-ahead inflation in survey wave t . X_i represents a vector of demographic characteristics of individual i , θ_i is an individual random effect and ε_{it} are i.i.d residuals. Models 3 and 5 were estimated using the Arellano-Bond estimation procedure in Stata. Panel-corrected (clustered by individual) standard errors.

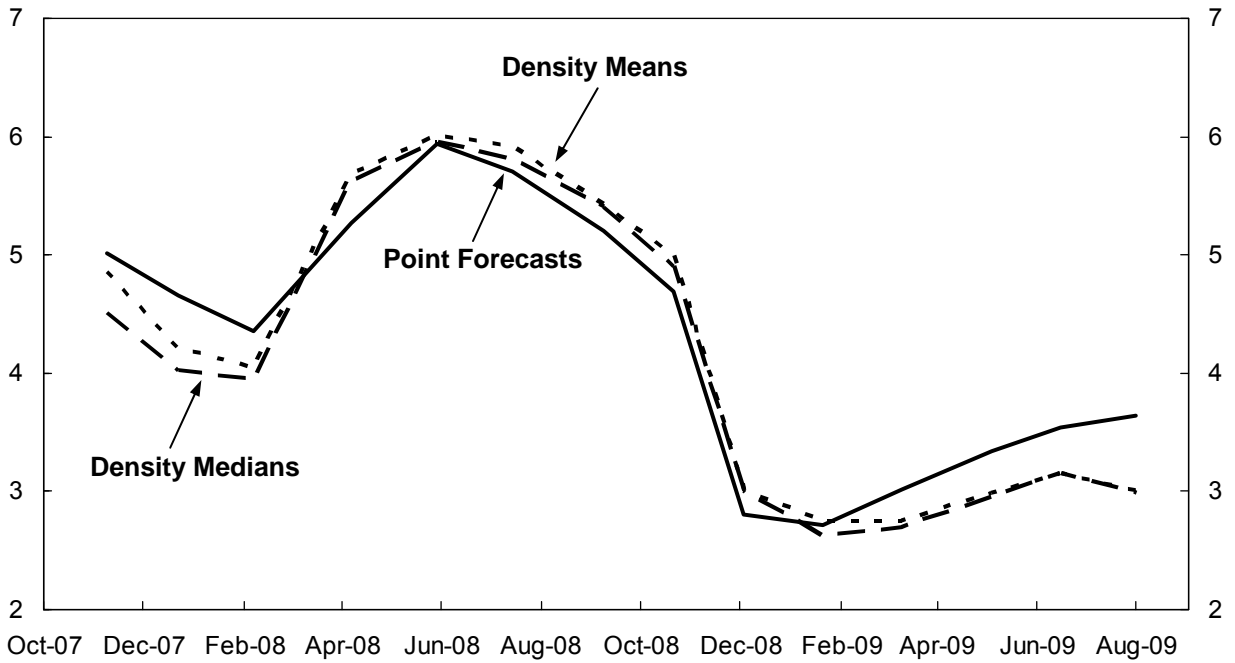
Figure 1. Year-Ahead Inflation Expectations



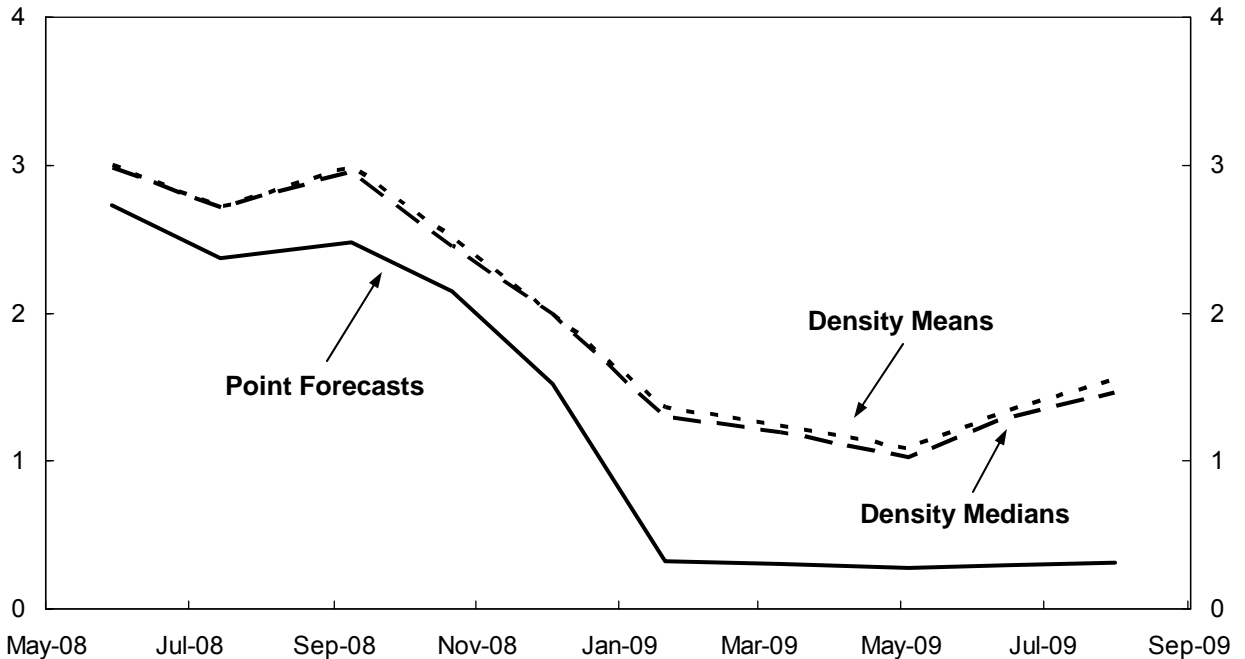
Panel. 25th, 50th, and 75th percentiles of the distribution of year-ahead point forecasts. Solid lines represent sample medians and dashed lines represent the 25th and 75th percentiles.

Figure 2. Density-Based Measures of Central Tendency

2a. Price Inflation



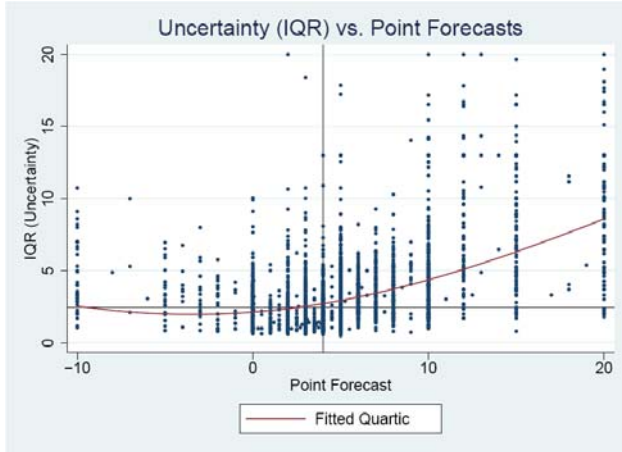
2b. Wage Inflation



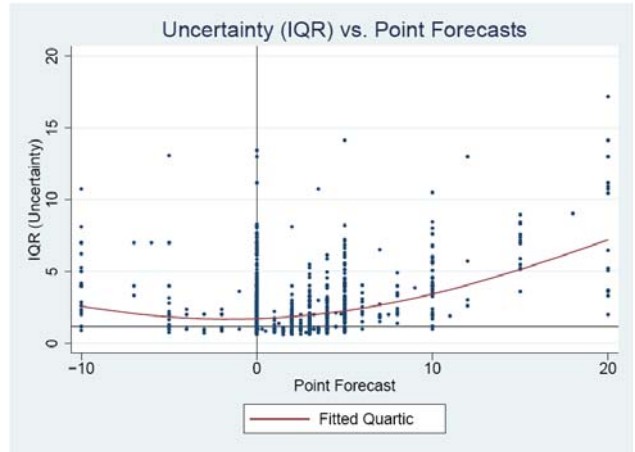
Panel. All reported numbers are sample medians. Solid lines represent point forecasts. Long dashed lines represent individual density medians. Short dashed lines represent individual density means.

Figure 3. Point Forecasts and Uncertainty

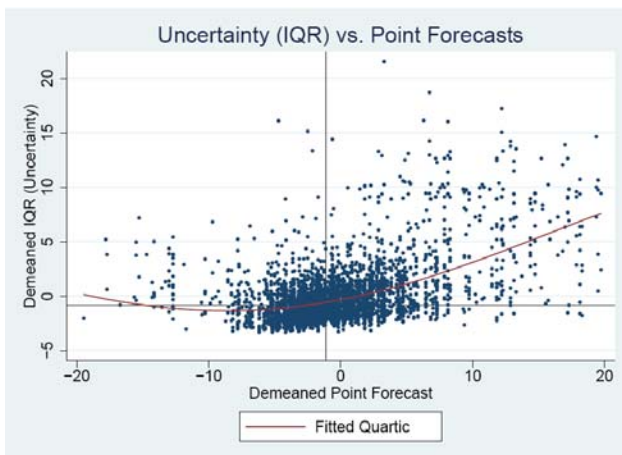
3a. Price Inflation, Panel



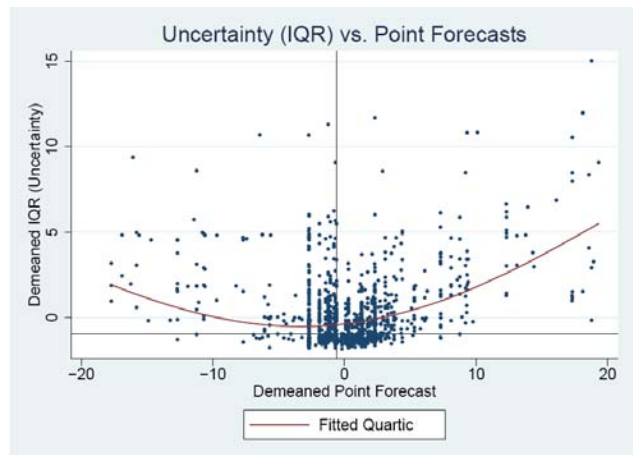
3b. Wage Inflation, Panel



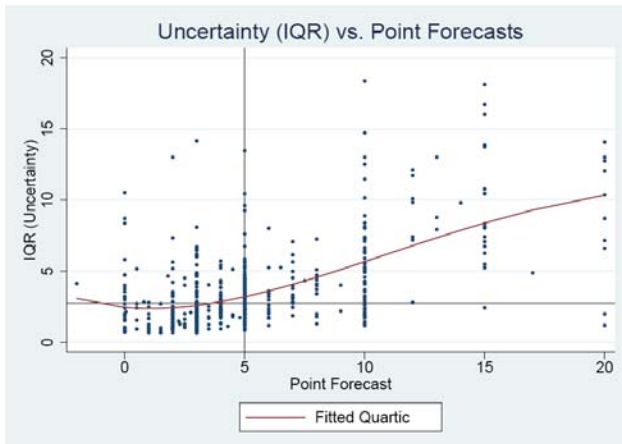
3c. Price Inflation, Panel, Demeaned by Wave



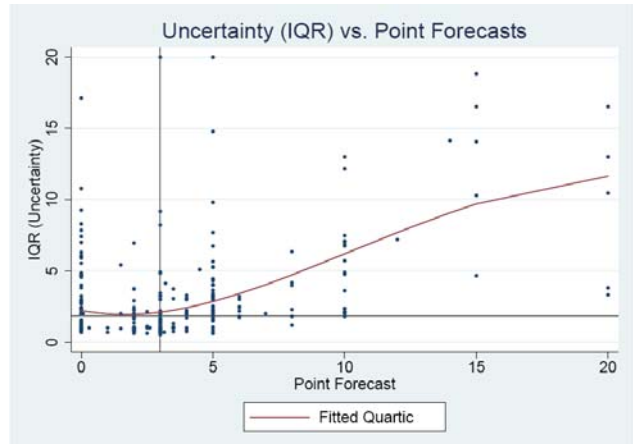
3d. Wage Inflation, Panel, Demeaned by Wave



3e. Price Inflation, Special Survey



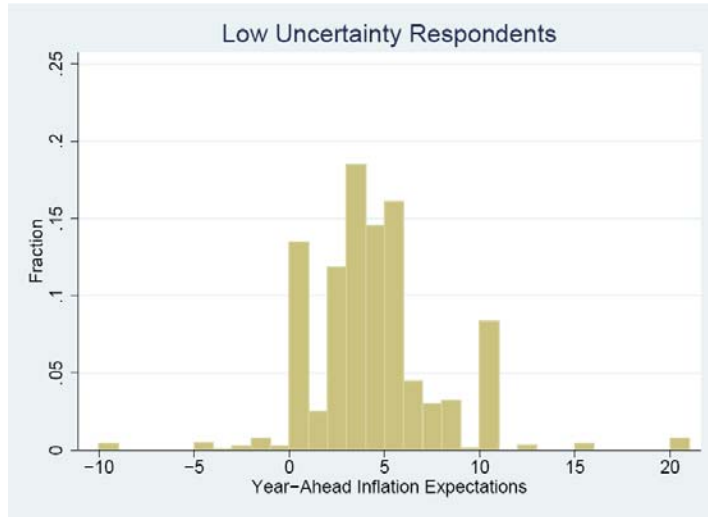
3f. Wage Inflation, Special Survey



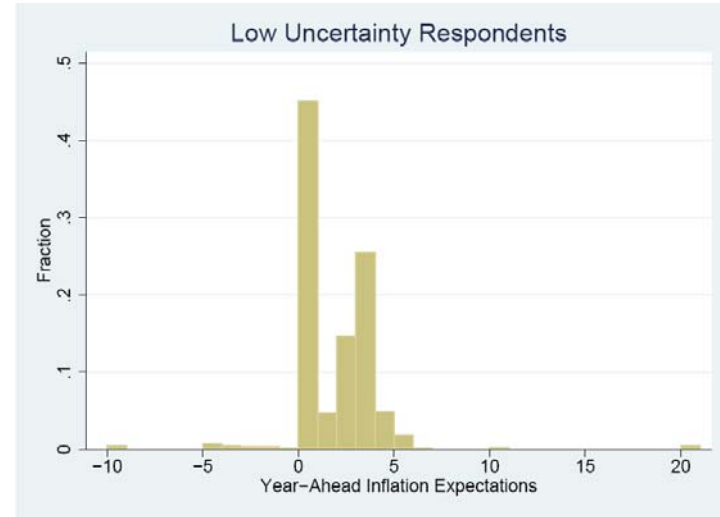
Panel and special survey. Uncertainty measured by individual IQRs.

Figure 4. Histograms of Point Forecasts of by High/Low Uncertainty

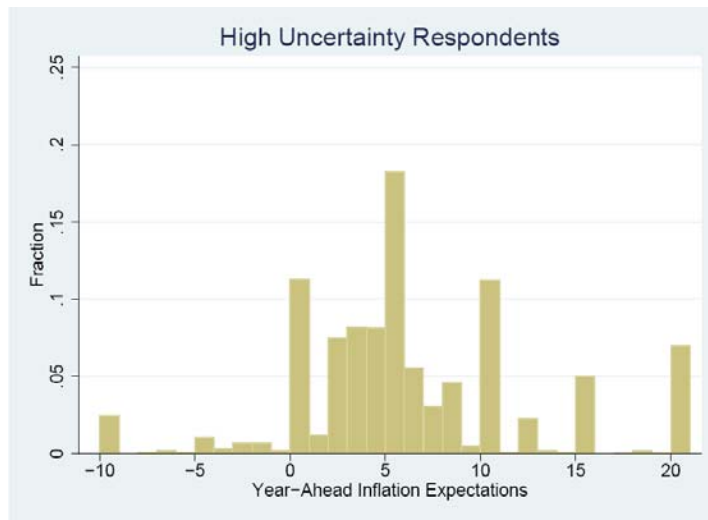
4a. Price Inflation



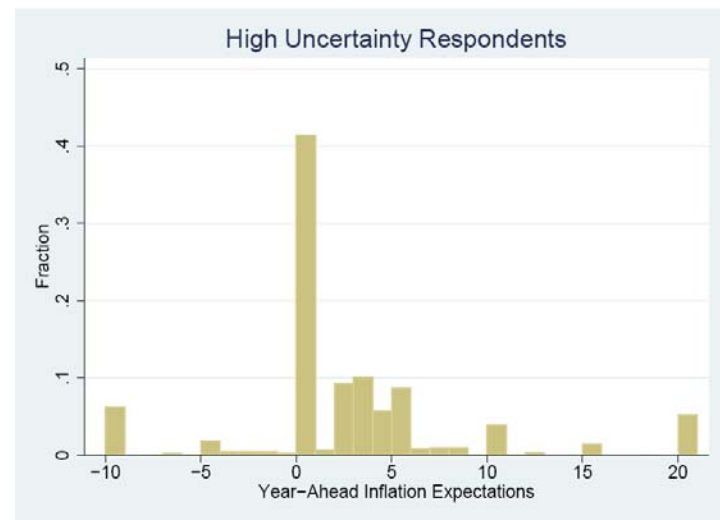
4b. Wage Inflation



High Uncertainty Respondents



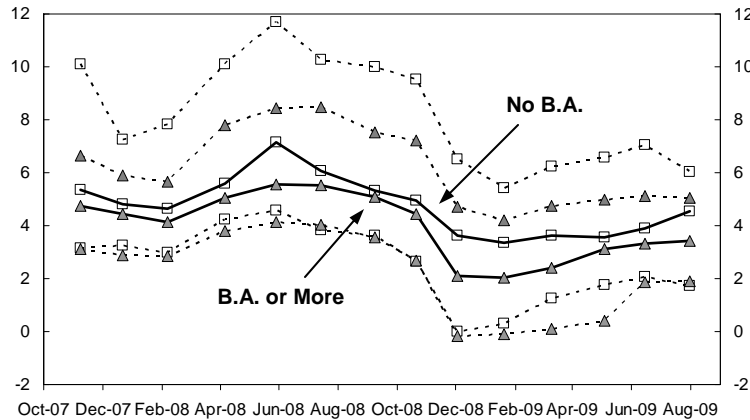
High Uncertainty Respondents



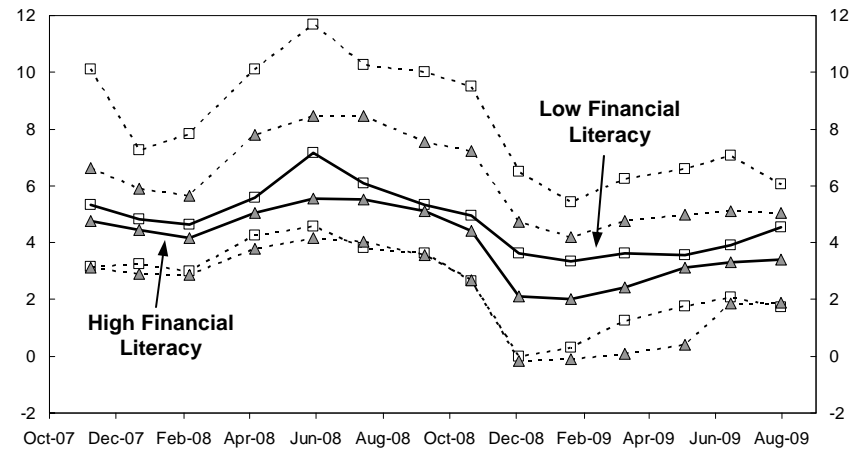
Pooled panel data. Values greater than 20 are coded to 20 and values less than -10 are coded to -10.

Figure 5. Year-Ahead Price Inflation Expectations

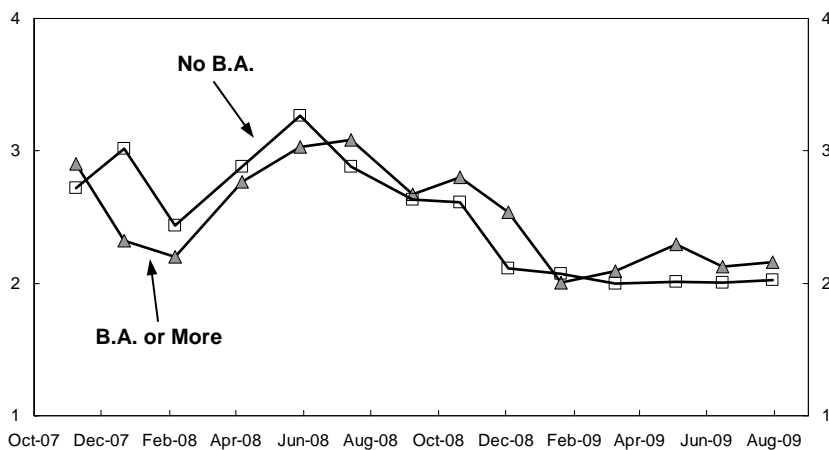
5a. Quartiles by Education



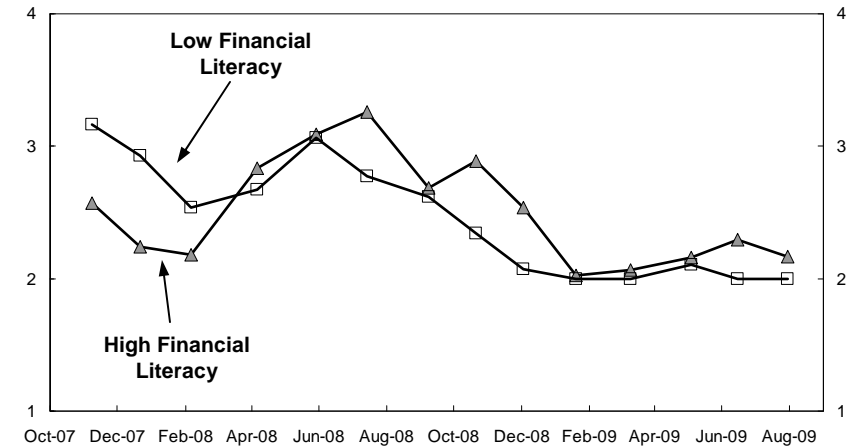
5b. Quartiles by Financial Literacy



5c. Uncertainty by Education



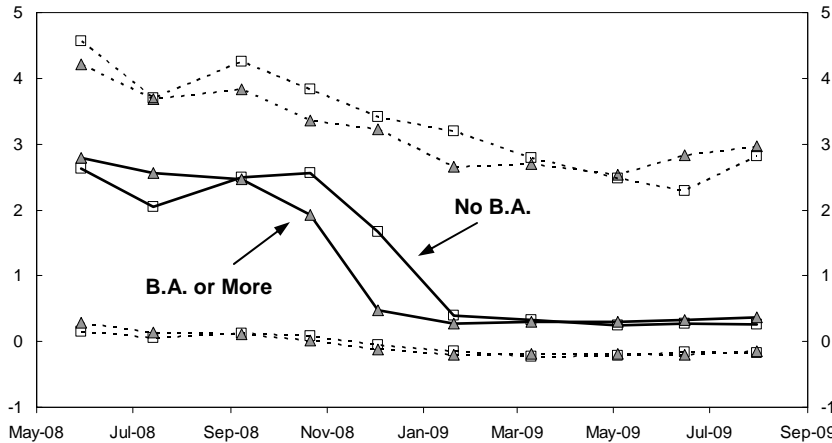
5d. Uncertainty by Financial Literacy



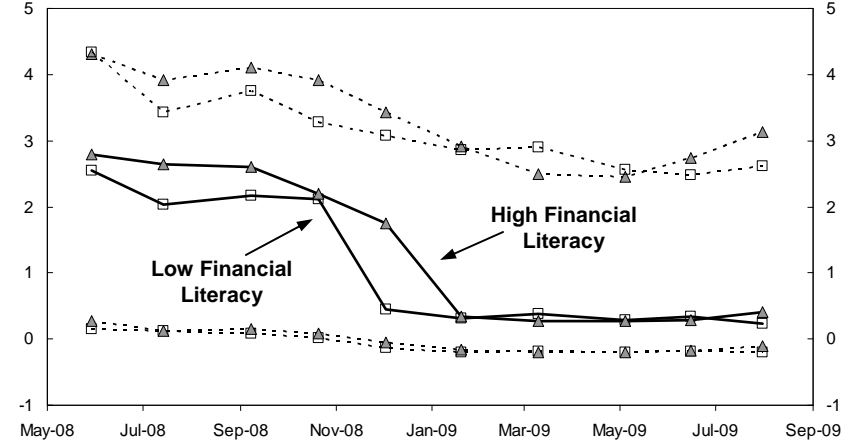
Panel. Quartiles are 25th, 50th, and 75th percentiles of the distribution of year-ahead point forecasts. Uncertainty is measured by the sample medians of individual density IQRs. Solid lines represent sample medians and dashed lines represent 25th and 75th percentiles. Empty squares represent “No B.A.” and “High Financial Literacy” samples, while shaded triangles represent “B.A. or More” and “High Financial Literacy” samples.

Figure 6. Year-Ahead Wage Inflation Expectations

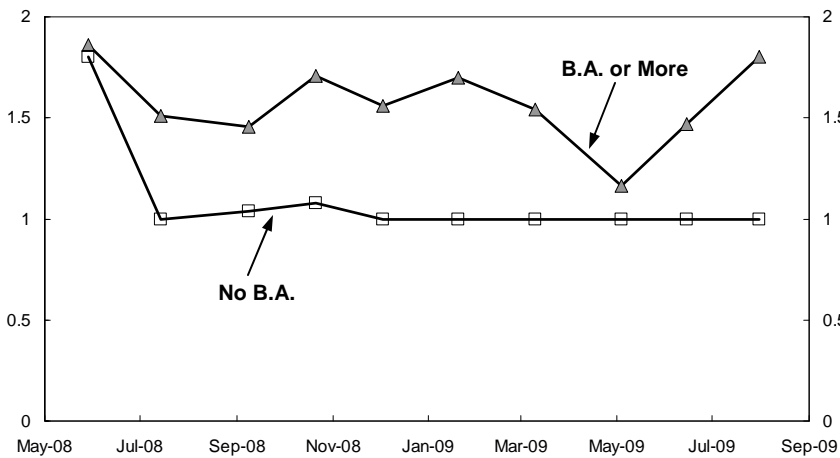
6a. Quartiles by Education



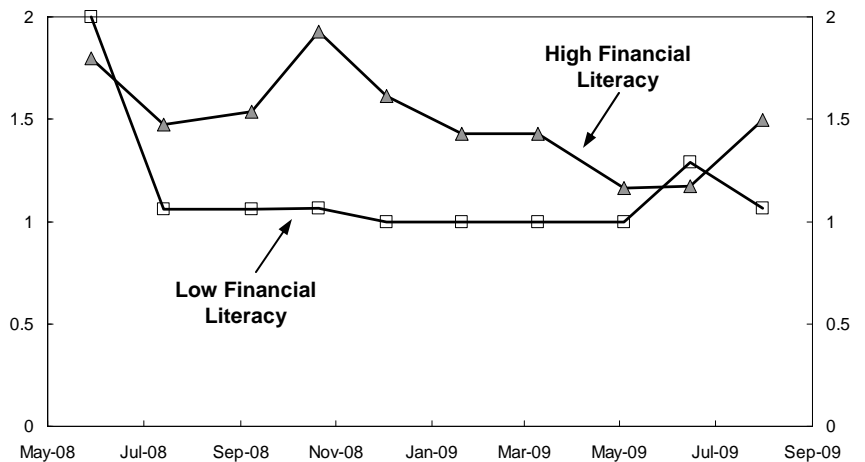
6b. Quartiles by Financial Literacy



6c. Uncertainty by Education

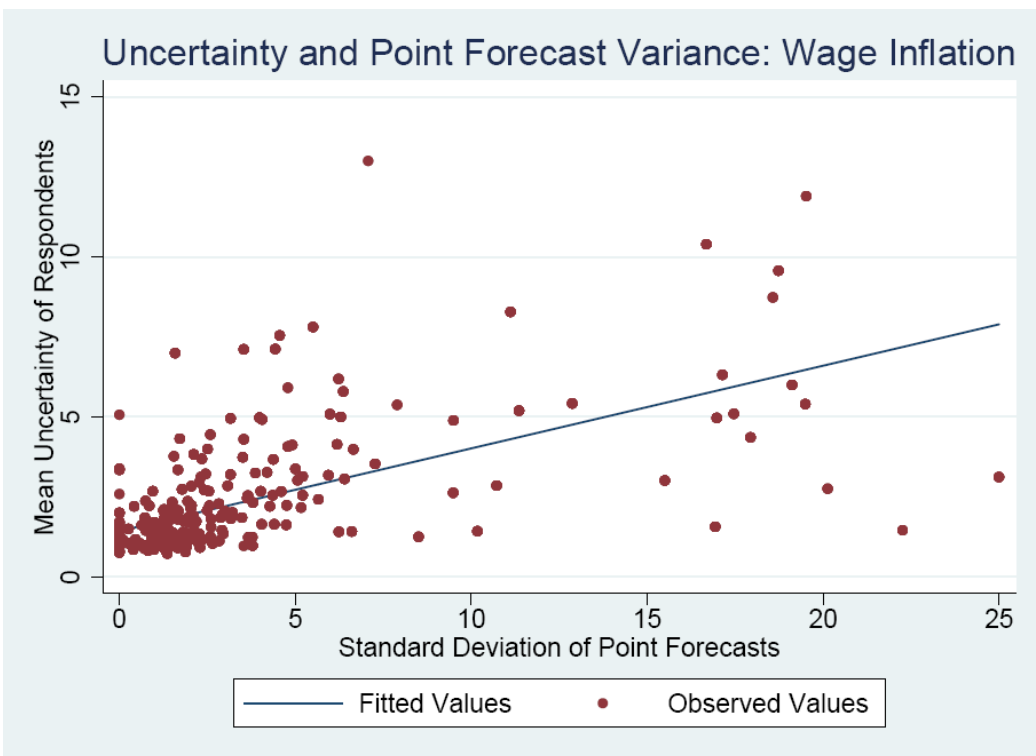
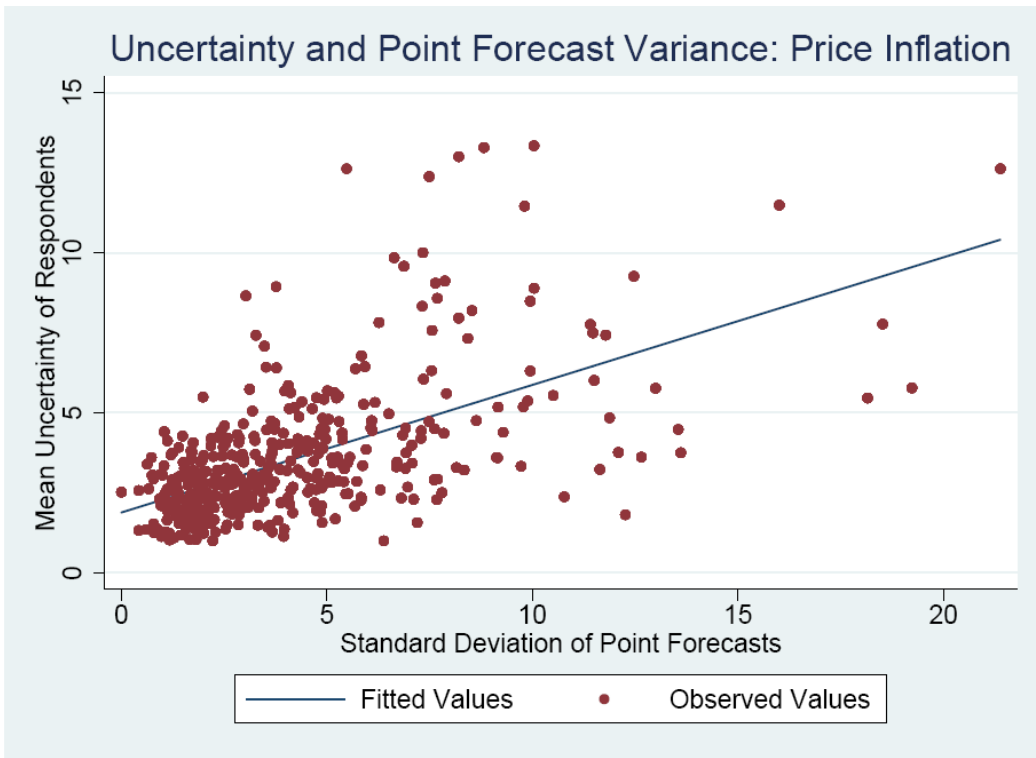


6d. Uncertainty by Financial Literacy



Panel. Quartiles are 25th, 50th, and 75th percentiles of the distribution of year-ahead point forecasts. Uncertainty is measured by the sample medians of individual density IQRs. Solid lines represent sample medians and dashed lines represent 25th and 75th percentiles. Empty squares represent “No B.A.” and “High Financial Literacy” samples, while shaded triangles represent “B.A. or More” and “High Financial Literacy” samples.

Figure 7. Volatility in Point Forecasts



Panel. Standard deviation of point forecasts calculated for each respondent across waves. Mean uncertainty is mean individual IQR for each respondent across waves.