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Abstract

Survey measures of consumer inflation expectations have an important shortcoming in that, while providing useful summary measures of the distribution of point forecasts across individuals, they contain no direct information about an individual's uncertainty about future inflation. The latter is important not only for forecasting inflation and other macroeconomic outcomes, but also for assessing a central bank's credibility and effectiveness of communication. This paper explores the feasibility of eliciting individual consumers' subjective probability distributions of future inflation outcomes.

In November 2007, we began administering web-based surveys to participants in RAND's American Life Panel. In addition to their point predictions, respondents were asked for their subjective assessments of the percentage chance that inflation will fall in each of several predetermined intervals. We find that our measures of individual forecast densities and uncertainty are internally consistent and reliable. Those who are more uncertain about year-ahead price inflation are also generally more uncertain about longer term price inflation and future wage changes. We find also that participants expressing higher uncertainty in their density forecasts make larger revisions to their point forecasts over time. 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.

Finally, we relate our direct measure of aggregate consumer uncertainty to a more conventional approach that uses disagreement among individual forecasters, as seen in the dispersion of their point forecasts, as a proxy for forecast uncertainty. Although the two measures are positively correlated, our results suggest that disagreement and uncertainty are distinct concepts, both relevant to the analysis of inflation expectations.

Key words: inflation expectations, forecast uncertainty, wage expectations, probabilistic survey questions

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Introduction

An important shortcoming of existing survey-based measures of consumer inflation expectations is that while providing us with useful summary measures of the distribution of point forecasts across individuals, they contain no direct information about an individual's uncertainty about future inflation realizations. The latter is important not only for forecasting future inflation and other macroeconomic outcomes, but also for assessing the effectiveness of the communication strategy adopted by Central Banks in their conduct of monetary policy.

In this paper we explore the feasibility of eliciting individual consumers' subjective probability distribution of future inflation outcomes. More specifically, we conducted a series of surveys to report their point forecasts as well as their density forecasts for price and wage inflation. The questions about density forecasts ask survey participants 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 both 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 with point forecasts and respondent characteristics.

We focus on five main research questions. First, we examine the feasibility of asking probabilistic questions, as seen in response rates, the internal consistency of probabilistic responses, in terms of adding up to 100%, and the measurement reliability of probabilistic responses, as seen in correlations to related measures of expectations. Second, we examine the degree of heterogeneity in price and wage inflation expectations, and whether it systematically reflects respondent characteristics. Third, we compare density forecasts with point forecasts for expected inflation in terms of level and time trend. Fourth, we examine the relationship between individuals' forecast levels and uncertainty. Finally, we contrast our measure of individual inflation uncertainty with a measure of disagreement among individuals in their expectations and study at the individual level the dynamic properties of inflation expectations and their relationship with individual uncertainty over time.

Our findings indicate that individuals are willing and able to provide probabilistic information about future inflation; responses appear to be consistent across related questions. We

find that individuals who report a range when they are asked for their 'point' forecast of inflation generally express higher levels of uncertainty in their subjective probability distribution, with the width of this self-reported range being positively correlated with measured uncertainty.

The subjective probability distributions point to considerable heterogeneity in uncertainty across individuals, with uncertainty about future inflation being positively related to point forecast levels as well as density means and medians. 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. Those who are more uncertain about year-ahead price inflation are also generally more uncertain about longer-term price inflation and about future wage changes. We also find that participants expressing higher uncertainty in their density forecasts make larger revisions to their point forecasts over time.

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 scored high or low on the financial literacy test and those who expressed higher versus lower uncertainty.

Finally, we relate our direct measure of aggregate consumer uncertainty to a more conventional approach that uses disagreement among individual forecasters, as seen in the dispersion of their point forecasts, as a proxy for forecast uncertainty. Although the two measures are positively correlated, the dispersion in point forecasts across consumers generally far exceeds the average level of individual uncertainty about future inflation. Moreover, we find periods in which disagreement and uncertainty move into opposite directions, showing diverging beliefs across income and education groups whose individual members at the same time appear to have become less uncertain. These results suggest that disagreement between individuals and individual forecast uncertainty are distinct concepts, both relevant to the analysis of inflation expectations.

Motivation and existing literature

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. Density forecasts, eliciting individuals' subjective probability distribution across a range of inflation outcomes, have two advantages over point forecasts of inflation. First, they provide a measure of the uncertainty each forecaster has about future outcomes. Second, they remove a potential source of ambiguity over which (if any) measure of central tendency an individual's point forecast corresponds to (see Engelberg, Manski and Williams 2009). As a result, the extent of disagreement among forecasters can be more accurately measured using a common measure of central tendency, such as the mean or the median of individuals' subjective probability distribution.

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.[1] 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 different monthly random sample of individuals for their point forecasts for the change in "prices in general" during the next 12 months as well as 5 to 10 years into the future.

However, recent empirical research on expectations has found that it is feasible to ask members of the general public to report probabilistic expectations of 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

[1] 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.

press, Fischhoff et al 2000, Dominitz, Manski and Fischhoff 2001, Walker 2001), and waves of the Michigan Survey (Dominitz and Manski, 2004, 2005).

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 reliable, such that responses are consistent across similar questions, and valid, in terms of being related to whether or not the predicted events happen in respondents' lives. That pattern has been observed for a diverse set of future events, over different time horizons, and with respondents of different ages. Because the interpretation of probabilities are well-defined, there is also good reason to expect that responses to be interpersonally comparable.

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.

Overall project goals

Starting in November 2007, a team composed of economists in the Federal Reserve System, academic economists and psychologists set out to study the feasibility of improving the measurement and analysis of consumer inflation and wage expectations through surveys. The project's main goals are (i) to assess the information content and validity of the Michigan Survey measures; (ii) to improve the quality of existing measures and to better align the measurement of household inflation expectations with the central role that inflation expectations play in current

monetary policy formulation and communication; (iii) to improve our understanding of how consumers form and update their inflation expectations; (iv) to empirically assess the links between inflation expectations and consumer choice behavior.

In addition to measuring individual uncertainty about future inflation outcomes, our project to date has primarily focused on examining how people interpret the Michigan Survey questions, developing additional questions asking about price inflation expectations using different question wordings and time horizons, measuring not just price but also wage inflation expectations, as well as improving our understanding of the inflation expectations formation process by tracking expectations of the same set of individuals time.

Question wording and sequence

We administered web-based surveys to participants in RAND's American Life Panel (ALP), who participated in either a one-time "special survey" or a repeated "panel survey." Both surveys are described in this section; sample composition in the next. The special and panel surveys both asked questions to elicit point forecasts and density forecasts of price inflation and wage growth. Next, we first describe the wording of these questions, and then present the sequence in which these and additional questions appeared in the special and panel surveys.

Our question asking for a point forecast of 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 the response options "Go up," "Stay the same," and "Go down." Those who respond "stay the same" are asked whether they mean that prices would go up at the same rate as now, or not go up. Those who indicate that they mean that prices would go up at the same rate are then given the same follow-up questions as those who originally answer that they believe prices will go up.

Subsequently, respondents who answer that they expect 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?" As reported in Curtin (2006) some respondents in the telephone survey provide a range as answer, after which they are prodded for a best guess. Accordingly, we instructed respondents as follows: "Below, please give your best guess OR your

best guess for a range" followed by answer options "My best guess is that prices will go [up/down] by ____ percent" as well as "My best guess for a range is that prices will go up between ____ percent and ____ percent." Respondents who only fill out the lower bound or the higher bound of the range are prompted to fill out both. Those who only give a range are subsequently also asked for a best guess.

Following the same procedure as applied in the Michigan Survey, respondents who give a best guess of over 5% are given the opportunity to revise their answer, using the following prompt: "Let me make sure I have that correct. You said that you expect prices to go [up/down] during the next 12 months by [x] percent. Is that correct?" Finally, respondents who have not given a best guess or a range are prompted one more time with the question "How many cents on the dollar do you expect prices to go [up/down] on the average, during the next 12 months?"

The probabilistic version of the price inflation expectation question follows a format similar to that employed, among others, in the Survey of Professional Forecasters and the Bank of Italy's Survey of Household Income and Wealth. We define several possible bins for the rate of change of prices in general.[2] We then ask respondents to assign probabilities (the 'percent chance') to these pre-defined bins: "What do you think is the percent chance that, over the next 12 months, the following things may happen? Prices in general will:" followed by these options, and the reminder that numbers need to add up to 100%:[3]

go up by 12% or more	_____ percent chance
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

[2] We chose this specific set of bins based on historical patterns as well as initial findings from a set of pilot and cognitive interviews.

[3] These questions are presented with instructions adapted from those used previously in the Survey of Economic Expectations (Dominitz and Manski , 1997a): "Now we would like you to think about the percent chance that different things may happen to prices in general during the next 12 months. The percent chance can be thought of as the number of chances out of 100. You can use any number between 0 and 100. For example, numbers like: 2 and 5 percent may be "almost no chance", 20 percent or so may mean "not much chance", a 45 or 55 percent chance may be a "pretty even chance", 80 percent or so may mean a "very good chance", and a 95 or 98 percent chance may be "almost certain"." Underneath the question, it states "Please note: The numbers need to add up to 100%." Respondents who nevertheless give answers that do not add up to 100% receive the notice "Your total adds up to [x%]. Please go back and change the numbers in the table so they add up to 100% or choose next to continue."

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 regarding expected changes in wage earnings during the next 12 months, where respondents who are currently employed are asked to think of a setting in which other job attributes are held constant.[4] More specifically, individuals are told "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 version of the wage expectations question, which was included in the survey module starting in June 2008, adopts a format similar to that for "prices in general", and uses the same bins.

With regard to the overall sequence of questions in our surveys, all our surveys begin with asking respondents to report their general perceptions of and expectations for their financial situation as well as for business conditions, as is done in the Michigan Survey, in order to provide the same general lead-in to the inflation expectations questions. In the special survey, participants then received a question asking for a point forecast of 12-month-ahead price inflation, using the "prices in general" wording described above. Subsequently, they were asked the probabilistic version of the expectations question they answered. After each expectations question, respondents were asked to rate the clarity of the question they had 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. reverse-coded so that higher ratings reflected more ease of responding. Respondents also were asked to report on their interpretation of the question (not analyzed here). Those currently working were then asked the point forecast and probabilistic versions of the wage earnings expectations questions, again

[4] 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.

followed by questions on ease of responding and clarity.[5] Participants also provided demographic information, completed a financial literacy test, and answered questions about their planning horizons for spending and saving decisions and the extent of responsibility for various household tasks.[6]

The panel surveys also begin with the same preliminary questions as in 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 reported demographic characteristics and completed the financial literacy test. In both the special and the panel surveys, respondents were allowed to skip questions, but those who tried to do so received a prompt encouraging them to provide an answer.

Sample composition

Both the special and the panel surveys were administered online to participants in RAND's American Life Panel (ALP). ALP participants were recruited from participants in the Michigan Survey at the University of Michigan's Survey Research Center, who were 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. In administering our various survey modules we divided potential participants into two groups: those part of the initial or 'old sample' of individuals (aged 40 and older) who participated in a monthly Michigan Survey prior to December 2006, and those in the

[5] The survey did not ask about the clarity and difficulty of the probabilistic version of the wage inflation question.
[6] 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, 2009b, 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 various household tasks was measured by responses to the question "In your household, how much responsibility do you have for the following tasks", with choices varying from none (1) to all (5).

'new sample' (aged 18 and older) who participated in the Michigan Survey after December 2006. All individuals who were part of the 'new' sample were invited to participate in the special survey and all individuals who were part of the 'old' sample were invited to participate in the panel surveys.

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; the most recent survey from which data was used in the analysis of this paper entered the field on July 31, 2009 (thus the panel contains 14 waves so far). In our analysis of the panel survey we will only consider responses for those participants who filled out the survey within the first 30 days since it was fielded,[7] in order to avoid generating spurious heterogeneity in responses due to changing economic conditions over time. In addition, to maintain a relatively stable sample composition over time, in our analyses we only include in our panel those respondents who participated in at least five of the first nine waves we fielded. This criterion yields a panel with a fairly stable composition and number of responses over time, with on average slightly over 400 responses per survey.

Table 1 describes some demographic characteristics of the participants in our two samples. The sample composition differs slightly between the special and panel surveys, in part because of our selection rule for inclusion in the panel, but primarily because of the different age selection criteria used for the 'new' and 'old' ALP samples. Relative to the special survey, there is a slightly larger presence of male and more highly educated participants in the panel surveys. The age composition of the two samples is very similar among participants 40 years and older: the fraction of participants who are at least 60 years old is 37% in the panel and 38% in the special survey.

Trends in point forecasts

[7] 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. A unique login and password is provided to avoid having the same person fill out the survey more than once.

To provide the context in which we study consumer uncertainty about future inflation outcomes, Figure 1a presents the time trend of the median point forecast for year-ahead changes in prices in general, as reported in our panel.[8] Also shown in the figure are corresponding changes in the 25th and 75th percentiles of point forecasts in each wave. The difference between latter, which is the interquartile range, represents a measure of disagreement among forecasters. Similarly, Figure 1b plots the median point forecast for the expected change in wage earnings during the next 12 months, as well as the first and third quartiles of the point forecast distribution.

Consumers' median price inflation expectations reached a peak in the summer of 2008, plunged in the period December 2008 – February 2009 following the financial crisis, and have slightly increased since then.[9] During the same period, the dispersion across consumers in their inflation expectations rose as the median inflation forecasts jumped up during the Spring of 2008, but while median inflation forecasts fell rapidly during the Fall of 2008, the disagreement as measured by the difference between the 25th and 75th percentile of point forecasts remained more elevated (staying at more than five percentage points) and only saw a more significant decline in the late Spring and early Summer of 2009.

As shown in Figure 1b, median expectations for nominal wage earnings growth dropped from roughly 2.5% in the summer of 2008 to almost zero from February 2009 onwards, reflecting the impact of the recession and rise in unemployment. During the same period the disagreement regarding wage inflation expectations gradually fell, but remains fairly high with an IQR of around three percentage points, pointing to persistent heterogeneity in expected wage growth across workers.

Evaluating responses to probabilistic questions

[8] 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).
[9] 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.

We use each individual's responses to the probabilistic questions to parametrically approximate 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 that the underlying distribution belongs to the generalized Beta distribution. This four-parameter distribution, in which two parameters determine its support and the two others determine its shape, represents a very flexible specification for which its mean, median and mode all can take on different values. For cases in which the respondent assigned positive probability to only one or two intervals, the underlying distribution was assumed to have the shape of an isosceles triangle.[10]

After estimating an individual probability density function for each respondent, one can compute a rich range of measures to represent an individual's expectations. In what follows we focus on density means and medians as measures of central density; we then compare these measures to actual point forecasts expressed by the same individuals. Further, we use the density Inter-Quartile Range (IQR) as a measure of individual forecast uncertainty. The IQR is less sensitive than the standard deviation to small variations in the tails of the estimated density.

We now discuss qualitative aspects of the responses given to the probabilistic versions of our expectations questions. To examine the feasibility of eliciting probabilistic responses, we report response rates, the proportion of responses with positive probability mass on more than one bin, the average number of bins with positive probability and the incidence of responses with positive probability on non-contiguous bins. We then also examine internal consistency of probabilistic responses, in terms of their adding up to 100%, and the reliability of the computed statistics by examining their correlation with responses to related expectations questions (e.g., the relationship between number of bins with positive probability and the use of interval responses in point forecast questions). Finally, we discuss respondents' ratings of question clarity and ease of responding to these questions.

As shown in Table 2, the response patterns appear very promising. First, the response rates are close to 100% for both special and panel surveys and for both price and wage inflation questions. Moreover, almost all probabilistic responses showed internal consistency, with only about one percent of respondents providing assessments that did not add to unity. These response

[10] 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).

patterns may be attributed in part to specific features of our surveys, which request that respondents go back to the previous question after they try to skip it, and which 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%.

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 general" question: 96% in the special survey (during which median expectations were relatively high) and about 89% in the panel. In fact, the average number of bins that receive positive probability ranges from about 3.8 in the panel to about 4.8 in the special survey. Thus, the results seem to indicate that, when given the opportunity to do so, respondents tend to express fairly diffuse forecasts (implying non-degenerate densities) rather than concentrate their forecast on a single bin. 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), but lower than for price inflation; this is consistent with survey participants having more firm views and more information about their own future wage earning growth than about price inflation in general.

A similar pattern holds for the average number of bins with positive probability, with the numbers being lower for wage earnings (2.7 for the panel, 3.2 for the special survey) than for prices in general. This pattern of results is directly reflected in the 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, implying that respondents are less uncertain about changes in own future wage earnings (conditional on keeping constant a set of job attributes) than about general price inflation.

Finally, 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. Therefore, the resulting forecast densities can be approximated reasonably well by our parametric specifications which assume probabilistic beliefs to be unimodal.

Even though the "point forecast" questions are essentially asking for a number, some respondents seem to prefer to express their expectations in the form of a range or interval rather than as a single point forecast. Table 2 reports that roughly between 30% and 40% of all

respondents report a range when responding to the point forecast version of the "prices in general" question.[11] The use of ranges is positively correlated to both individual uncertainty and to the number of bins that received 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 number of bins used and the level of individual uncertainty derived from the probabilistic question. Among those reporting a range, the 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 reflect a reliable measure of uncertainty.

Table 3 shows that respondents consider the question asking for a point forecast of wage inflation to be significantly easier to answer and significantly clearer than the question asking for a point forecast of price inflation. While the differences in clarity and difficulty between the probabilistic version of the price inflation question and its counterpart asking for a point forecast are statistically significant, the differences are relatively small, especially in comparison to that between the wage and price inflation questions. Thus, despite finding probabilistic questions slightly less clear and more difficult to answer, respondents do seem to be willing to give responses reflecting their uncertainty about future inflation outcomes.

Examining heterogeneity in inflation expectations

As shown earlier in Figures 1a and 1b, there is substantial heterogeneity across individuals in their point forecasts for price and wage inflation. Table 4 shows that this heterogeneity also exists across different demographic groups and extends beyond point

[11] This is with or without a point forecast. In the special survey, more than half of these respondents reported a range only.

forecasts to uncertainty about future inflation. The top section of the table relates to heterogeneity in expectations for price inflation, the bottom one for wage inflation, and the results in both sections are based on the pooled data from all currently available waves (14 altogether) of our panel.

The first column in each section reports the median point forecast by demographic categories: gender, education, marital status, income, age and financial literacy.[12] The second column reports the median of an individual measure of central tendency – the individual density median – in each demographic subgroup. The third and fourth columns report two measures of disagreement in forecasts across respondents, namely the IQR of point forecasts and of individual density medians, respectively. The fifth column focuses on individual uncertainty, again reporting the median within demographic categories. The final column reports the number of observations from the pooled waves of our panel.

With regard to price inflation, we find that both point forecasts and median density forecasts are significantly higher for respondents who were female (vs. male), less educated (vs. more educated), single (vs. respondents who were married or living with a partner), poorer (vs. less poor), and older (vs. younger). Both measures of disagreement among respondents also tend to be higher within these demographic groups, with the partial exception of the age categories. Individual uncertainty is also 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.[13] Those who scored lower on the financial literacy test report higher point forecasts and higher disagreement, which is consistent with the observation that higher financial literacy is associated with higher education levels.[14] In the 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.

With regard to wage inflation expectations, slightly higher point forecasts and density medians tend to be expressed by respondents who are male (vs. female), more highly educated

[12] 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.
[13] 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. (2009b), Table 1.12.
[14] See Bruine de Bruin et al., 2009b, for an extensive discussion.

(vs. less educated), older (vs. younger) and those who scored higher (vs. lower) on a financial literacy test. Disagreement and individual forecast uncertainty tend to behave similarly across these demographic groupings, with male, college educated, the more financially literate, richer and older respondents exhibiting higher internal disagreement (especially in terms of density medians) and median uncertainty.

Thus, the association between expectations levels, disagreement and uncertainty on the one hand and individuals' demographic characteristics on the other hand changes sign depending on whether we consider price or wage inflation. However, for both price and wage inflation we 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 forecast uncertainty and measures of financial literacy, planning horizons and responsibility for investment decisions, based on data from the special survey which was fielded before the onset of the 2008 financial crisis. Forecast uncertainty about future price inflation shows a significant negative correlation to performance on the financial literacy measure.[15] It is also negatively correlated with longer planning horizons for consumption and saving decisions, and with a variable measuring the extent of responsibility the respondent caries within the household for investment decisions. A similar pattern holds for point forecasts for future price inflation.[16]

Thus, respondents who are more financially savvy or possess more financial knowledge tend to express less diffuse density forecasts, as well as lower forecast levels, which are closer to actual levels of realized inflation for the broad period under consideration. In part, that response pattern may also reflect respondents' tendency to use 0% as the lower bound of the scale for price inflation – such that noisy estimates potentially due to uncertainty will drive responses upwards (Bruine de Bruin et al., 2009b; Curtin, 2006). 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.

[15] In Table 5 we use the total number of correct answers out of 12 questions for financial literacy.
[16] 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.

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. By allowing respondents to assign a `percentage chance' to various possible outcomes instead of forcing them to commit to a single number (point forecast), we aim to collect a more accurate and complete representation of individuals' subjective expectations. Further, we are able to measure the degree of uncertainty that respondents attach to their forecasts.

Collecting expectations as density forecasts enables us to examine what particular measure respondents report when forced to give a point forecast. In the spirit of Engelberg et al. (2009), we analyze the relationships between individual density medians, means, and 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/means, as well as the proportion of cases in which the point forecast falls within different quartiles of the individual forecast distribution.

Table 6 collects these results, using both the special survey and pooled data from our panel. The first thing to note is that point forecasts are highly correlated with both medians and means of individual densities (in the panel, the correlation is between 0.83 and 0.84 depending on the specific measure of central tendency for the "prices in general" question; between 0.76 and 0.77 for wage earnings; the correlations are slightly weaker in the special survey). This provides further evidence that the individual probability densities reported by respondents have measurement reliability. For price inflation, the median gap between point forecasts and measures of central tendency from the densities is zero in the panel and only slightly negative in the special survey. Instead, for wage inflation, point forecasts tend to be systematically lower than density means or medians.

These findings are confirmed by the analysis of where the point forecast tends to fall within an individual's density forecast: for the "prices in general" question, the point forecast lies between the first and the third quartile of the individual density in roughly 55-57% of our observations (depending on the survey); it lies in each tail (above the third quartile or below the first quartile) with roughly the same frequency, between 20 and 23 percent. For wage earnings,

on the other hand, the point forecast lies below the density median in the majority of cases (56 to 58 percent), with the bulk of respondents expressing point forecasts below the first quartile of their estimated individual density forecast (44% in 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.

Our results seem to indicate that questions that force respondents to report point forecasts for their subjective expectations of future **wage** inflation tend to produce responses which are systematically lower than measures of central tendency based on individual probability densities. On the other hand, for **price** inflation point forecasts appear close to measures of central tendency in a median sense when pooled across individuals and waves, but we still find a lot of dispersion in the location of the point forecast relative to the quartiles of the density forecast. Moreover, as will be seen below, during the survey period of our panel, the median gap showed spells during which it took on reasonably large positive and negative values.

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.[17] 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, for both price and wage 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 high uncertainty than for low uncertainty respondents.

To complete our analysis of the relationship between point forecasts and measures of central tendency from the individual densities, we report in Figures 2a,b the time trends of each measure from the panel surveys, aggregated using the median across respondents. The pattern is

[17] 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.

clear: 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. 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.

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 with measures of central tendency from the individual densities pointing upwards while point forecasts have remained very close to zero.[18] We conjecture that allowing 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.

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 the individual density. We study the relationship between individual point forecasts and uncertainty with regard to both price and wage inflation; we also consider uncertainty for inflation expectations at different time horizons.

Figure 3 collects scatterplots of individual point forecasts vs. 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 is from the special survey, the middle row reports plots for the pooled data from the panel surveys, and the bottom row also uses pooled data from the panel surveys, but with point forecasts and IQRs demeaned in each wave. The results are consistent across all cases: higher point forecasts are associated with a larger amount of forecast uncertainty. This is also in line with the heterogeneity analysis in Table 4 as

[18] 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.

well as the earlier finding in the special survey that some individual characteristics including financial literacy are negatively correlated with both individual point forecasts and individual uncertainty. Table 8 confirms that the finding of a positive association between individual forecast uncertainty and expectations levels is robust: it holds across surveys, across measures of central tendency (point forecasts, density medians and means) and for both price and wage inflation.

Figure 4 offers a more detailed picture of the relationship between point forecasts and uncertainty. Here we split the sample for each wave of the panel into high vs. low uncertainty respondents (again using the median forecast uncertainty in each wave); we then plot histograms of point forecasts from the pooled panel data separately for these two groups. The differences are striking: in the case of price inflation, for the low uncertainty group most point forecasts are concentrated in a few bins, roughly between zero and five percent, with a further spike at ten percent. Point forecasts for the high uncertainty respondents, on the other hand, are much more dispersed, with significant fractions of respondents giving point forecasts equal to ten, 15, or above 20 percent. A similar pattern occurs for wage inflation, again with much higher dispersion and more extreme point forecasts for high uncertainty respondents.

Forecast uncertainty is expressed consistently by survey participants across different price expectations questions, and at different time horizons. The correlation in forecast uncertainty between general price inflation and wage earnings growth expectations is 0.32 across all panel surveys, and that between inflation expectations 12 months and three years ahead is 0.66. The time trend of inflation forecast uncertainty at these short and medium term horizons is interesting: as Figure 5 shows, forecast uncertainty has fallen slightly over the sample period at both horizons, but uncertainty at the three year horizon tends to be higher than at the 12 month horizon.[19]

This finding could be surprising if one expects inflation to be a stationary process, with temporary shocks affecting inflation at a higher time frequency than over a longer horizon. In this case, one would expect forecast uncertainty to be higher in the short term. More generally, measures of forecast uncertainty for inflation outcomes at different time horizons can be used by

[19] These results concerning different time horizons come from expectations questions about the "rate of inflation" rather than "prices in general". The 12-months-ahead "rate of inflation" probabilistic question was only fielded starting in June 2008. Bruine de Bruin et al. (2009a) focuses on the impact of different question wordings on reported expectations.

monetary policymakers as an early warning sign for situations in which inflation expectations became progressively less "well anchored" relative to an explicit or implicit inflation target. In the case of Figure 5, the gap in uncertainty between 12 months and three years ahead seems to be narrowing rather than diverging over time, so this can be interpreted as a reassuring signal for policymakers.

Examining Disagreement, Uncertainty and Dynamics

This section describes dynamic features of our panel survey data. We first present general time trends for our various expectations questions, including patterns in heterogeneity by demographics over time. We then present some results from panel estimation of the relationship between individual uncertainty in one period and subsequent uncertainty and point forecasts. Finally, we examine whether higher forecast uncertainty is associated with a larger variability in individual forecasts over time.

Figures 6a and 6b relate the median levels of price and wage inflation uncertainty to the measure of disagreement in point forecasts across individuals. Also included in each figure is the earlier reported trend in the median inflation expectation. Both charts show a decline in inflation uncertainty during the past year or so, with median individual price inflation uncertainty dropping from about three percent during the Summer of 2008 to about two percent in Winter 2008-09 and median individual wage inflation uncertainty declining slightly over the sample period, staying in a small interval between one and two percent.

It is interesting to note here that disagreement and median forecast uncertainty, while following roughly similar patterns, often move in opposite directions. In the case of price inflation expectations, for instance, disagreement among respondents rose slightly and then stayed fairly high during the period October 2008 – January 2009, while median uncertainty decreased markedly by more than 25% (see Figure 6a). This is consistent with respondents dividing into two camps, with one group expecting very low inflation due to the recessionary environment, and the other group expecting higher inflation because of the quantitative easing by the Federal Reserve, as illustrated by Figures 7a and 7b when differentiating individuals by education and financial literacy levels. At the same time, views within each broad camp seemed

to firm up over this period, as evidenced by the decrease in individual uncertainty as shown in Figures 7c and 7d. That disagreement among respondents is a poor proxy for individual forecast uncertainty is also a finding in recent work by Rich and Tracy (2008) based on expectations of professional forecasters.

Figures 7 and 8 report heterogeneity in point forecasts and uncertainty, respectively for price and wage inflation expectations, across education and financial literacy categories. The time trends reflect what we reported in Table 4 from the pooled panel data. With regard to price inflation, respondents with more education and higher financial literacy consistently report lower forecast levels and as noted earlier, it is the more educated and financially literate participants who expect very low inflation or even deflation in December 2008. For uncertainty the pattern is more mixed: respondents with higher education and financial literacy express lower uncertainty in the waves preceding the onset of the 2008 financial crisis, and slightly higher uncertainty 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); it 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.

With regard to wage inflation expectations, the plots in Figure 8 shed some light on the mostly insignificant differences across education categories for point forecasts, reported in Table 4. Through early Fall 2008, wage expectations are higher for the more highly educated workers; in early December 2008, however, wage inflation expectations drop dramatically for the higher education category, perhaps reflecting a concern about the impact of the financial crisis on wages and employment in highly skilled occupations and industries. From January 2009 onwards, however, wage inflation expectations fall for the lower education group as well, perhaps reflecting the spread of the recession from the financial and banking sectors to the broader economy. With regard to uncertainty, consistently with Table 4, more highly educated and financially literate respondents express higher uncertainty about future earnings than lower education and financial literacy respondents over the entire sample period.[20]

[20] The same patterns as those shown in Figures 7 and 8 appear when comparing those with incomes above and below $75,000.

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 look at the relationship between uncertainty in period *t-1* and subsequent 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. Therefore, while there seems to be a lot of persistence in individual forecast uncertainty, the persistence seems to be explained by permanent time-invariant idiosyncratic differences across individuals. Interestingly, higher uncertainty in one period is associated with larger revision 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). This finding is consistent with a model of Bayesian updating by individuals.

Finally, Figure 9 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. Again, this is roughly consistent with Bayesian updating in expectations.

Conclusion

In this paper, we examined five main research questions. First, we examined the feasibility of asking probabilistic questions about price and wage inflation, as well as the reliability of responses to probabilistic questions. Our results suggest that members of the general public are willing and able to give probabilistic responses, as seen in high response rates and assessed probabilities adding up to 100%. Moreover, individuals who express higher levels

of uncertainty in their subjective probability distribution are more likely to report a range when they were asked for their 'point' forecast; the width of this self-reported range is also positively correlated with measured uncertainty.

Second, we examined 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 uncertainty by demographic characteristics and financial literacy.

Third, we compared 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, an individual's point forecast does not fall between the first and the third quartile of her 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 larger than point forecasts for wage earnings growth. We find little difference in the median gaps between individuals who scored high or low on the financial literacy test and those who expressed higher versus lower uncertainty.

Fourth, we find a robust positive relationship between individuals' forecast levels and uncertainty, suggesting that responses were consistent across point forecast and density forecast questions. Those who are more uncertain about year-ahead price inflation are also generally more uncertain about longer-term price inflation and about future wage changes. We also find that participants expressing higher uncertainty in their density forecasts to make larger revisions to their point forecasts over time. Such response consistency suggests that uncertainty can be measured reliably.

Finally, we contrast our measure of individual inflation uncertainty with a measure of disagreement among individuals in their expectations. Although the two measures are positively correlated, the dispersion in point forecasts across consumers generally far exceeds the average level of individual uncertainty about future inflation. Moreover, we find periods in which disagreement and uncertainty move into opposite directions, showing diverging beliefs across income and education groups whose individual members at the same time appear to have become

less uncertain. These results suggest that disagreement across individuals and individual forecast uncertainty are distinct concepts, both relevant to the study of inflation expectations.

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.

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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%

Table 2. Qualitative Features of Responses to Probabilistic Questions

	Price Inflation		Wage Inflation	
	Special Survey	Panel	Special Survey	Panel
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**

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 hard to come up with answers that added up to 100%? (1=very easy, 7=very hard)		3.7	
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**	2092
Male	4.1	3.8	3.6	3.5	2.3	1996
No B.A	4.8**	4.9**	7.1	5.2	2.4	1948
B.A. or More	4.1	3.8	3.9	3.7	2.5	2140
Single	4.6*	4.7**	5.4	4.3	2.6*	1467
Married	4.4	4.0	4.5	4.1	2.4	2621
Income<=75K	4.8**	4.9**	6.9	5.2	2.6*	2391
Income>75K	3.9	3.6	3.7	3.7	2.4	1696
Age 40-59	4.4*	4.1**	4.4	4.2	2.6**	2613
Age > 59	4.6	4.6	5.3	4.0	2.3	1475
Low Financial Literacy	4.7**	4.2	7.2	4.5	2.4	1678
High Financial Literacy	4.2	4.2	4.0	4.0	2.5	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**	928
Male	1.5	2.3	3.4	2.5	1.5	821
No B.A	0.5	1.9*	3.4	2.0	1.0**	762
B.A. or More	0.7	2.2	3.3	2.2	1.6	987
Single	1.2	2.0	3.4	2.1	1.3	643
Married	0.5	2.0	3.3	2.2	1.3	1106
Income<=75K	0.8	2.0*	3.4	2.0	1.1*	861
Income>75K	0.5	2.2	3.3	2.3	1.5	888
Age 40-59	0.5	2.0**	3.3	2.0	1.1*	1475
Age > 59	1.6	2.6	3.9	2.8	1.7	295
Low Financial Literacy	0.5	1.7**	3.3	2.0	1.1**	729
High Financial Literacy	1.2	2.5	3.4	2.5	1.5	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.

Table 5. Heterogeneity in Uncertainty by Knowledge/Financial Behavior

	PRICE INFLATION		WAGE INFLATION	
Rank correlations	Uncertainty	Point Forecast	Uncertainty	Point Forecast
Financial Literacy	-0.24**	-0.26**	0.07	0.00
Planning Horizon – Spending	-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 various household tasks was measured by responses to the question 'In your household, how much responsibility do you have for the following tasks', 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

	Price Inflation		Wage Inflation	
Correlation Between Uncertainty (Individual IQR) and:	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**

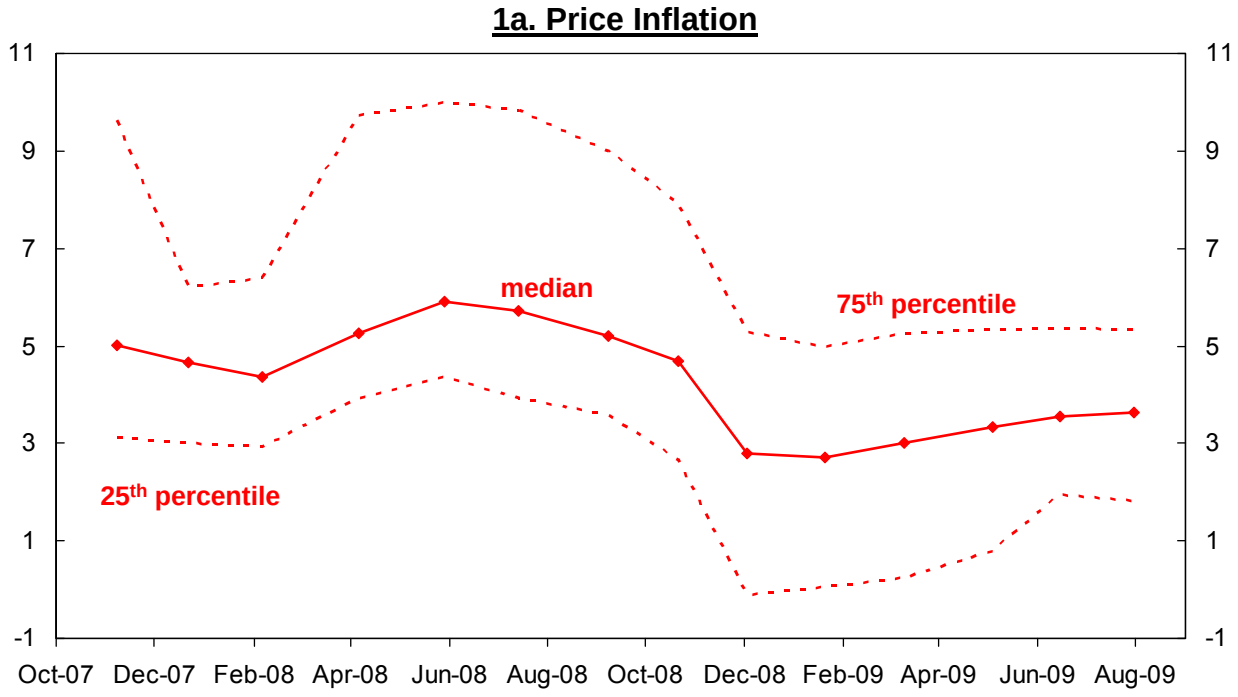
All reported correlations are Spearman rank correlations: ** p<0.01; * p<0.05.

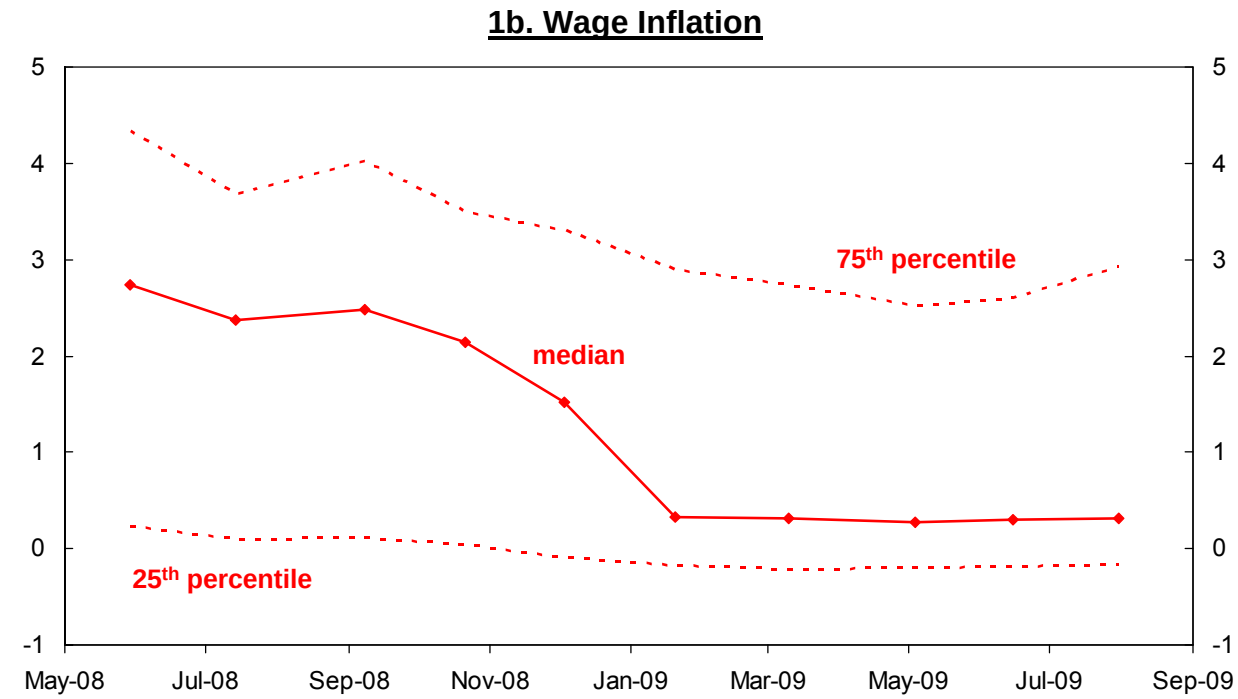
Table 9. Dynamics - Panel Data Regressions

	Estimate (std error) of a_1	
	Price Inflation	Wage Inflation
Model 1: $iqr(\pi)_{it} = a_0+a_1\, iqr(\pi)_{it-1}+\varepsilon_{it}$	0.42 (0.02)	0.67 (0.03)
Model 2: $iqr(\pi)_{it} = a_0+a_1\, iqr(\pi)_{it-1}+X_i'b+\varepsilon_{it}$	0.41 (0.02)	0.67 (0.03)
Model 3: $iqr(\pi)_{it} = a_0+a_1\, iqr(\pi)_{it-1}+X_i'b+\theta_i+\varepsilon_{it}$	0.08 (0.03)	-0.06 (0.09)
Model 4: $\lvert\pi_{it}-\pi_{it-1}\rvert = a_0+a_1\, iqr(\pi)_{it-1}+X_i'b+\varepsilon_{it}$	0.56 (0.03)	1.45 (0.16)
Model 4: $\lvert\pi_{it}-\pi_{it-1}\rvert = a_0+a_1\, iqr(\pi)_{it-1}+X_i'b+\theta_i+\varepsilon_{it}$	0.33 (0.02)	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.

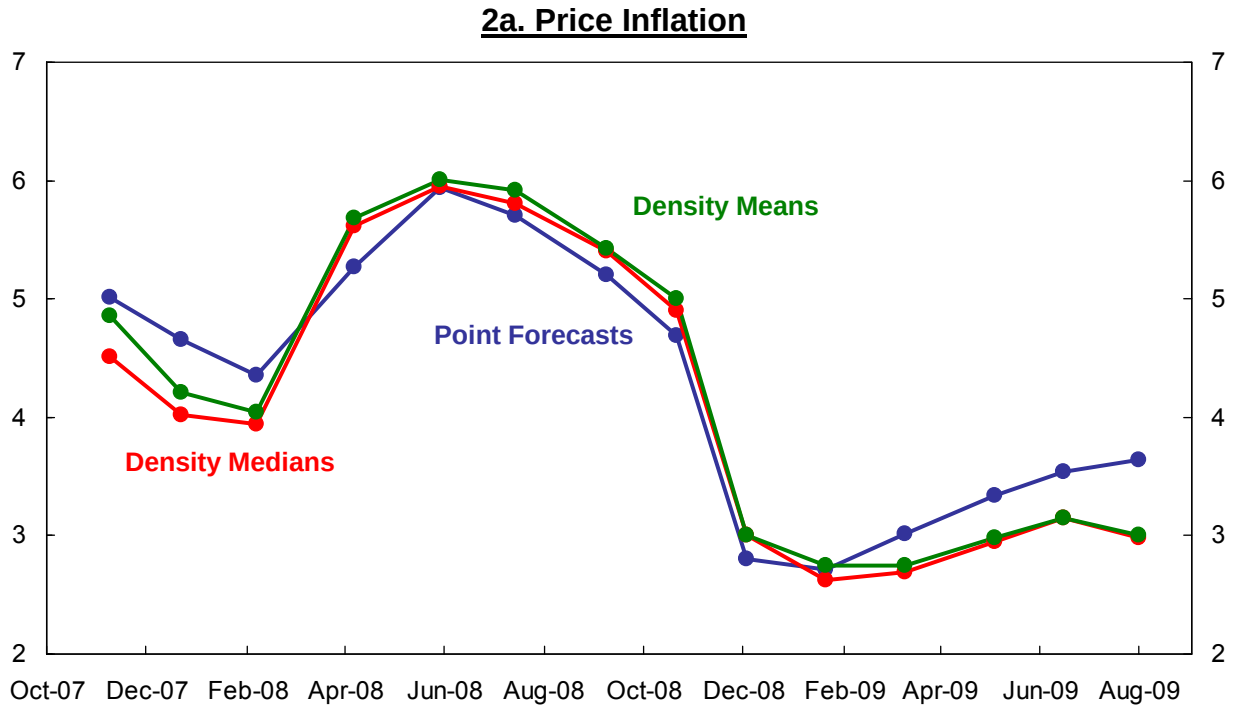
Figure 1. Year-Ahead Inflation Expectations

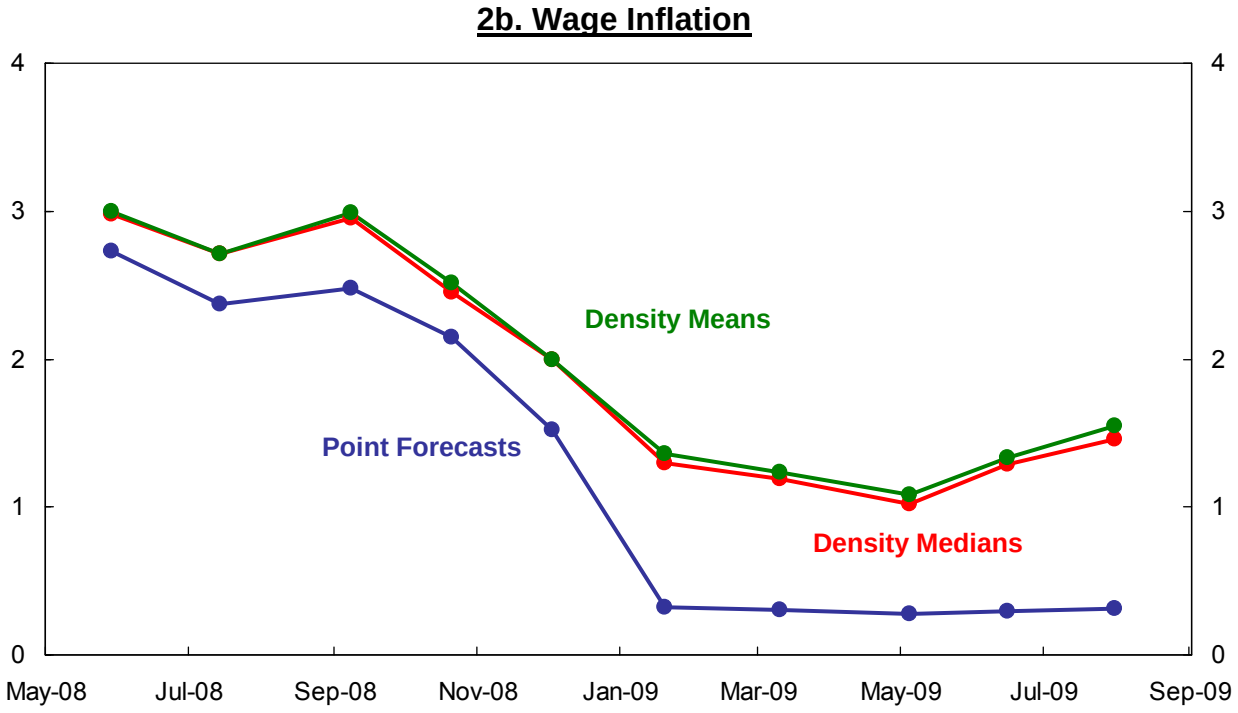




Panel. 25th, 50th, and 75th percentiles of the distribution of year-ahead point forecasts.

Figure 2. Density-Based Measures of Central Tendency

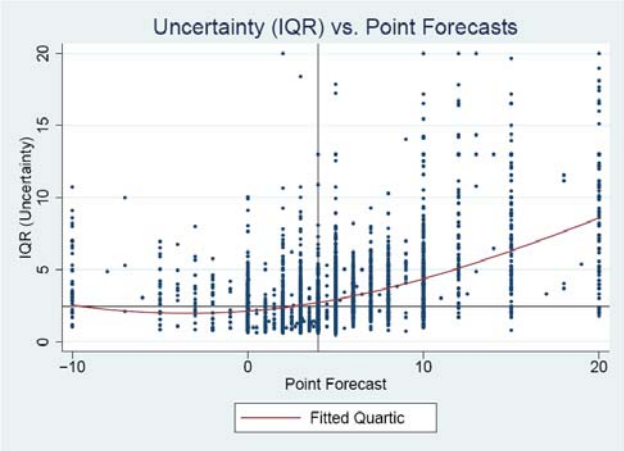




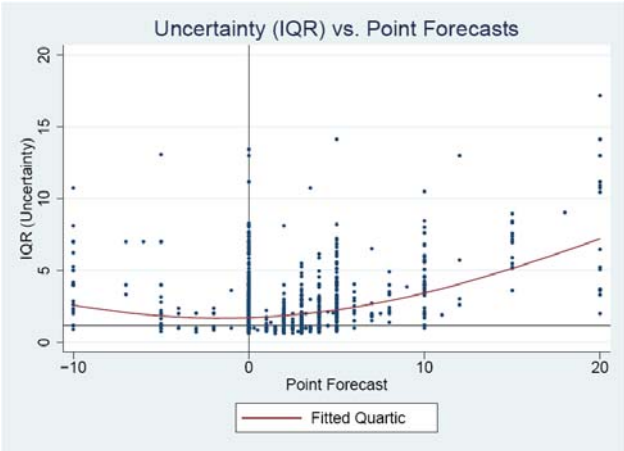
Panel. All reported numbers are sample medians.

Figure 3. Point Forecasts and Uncertainty

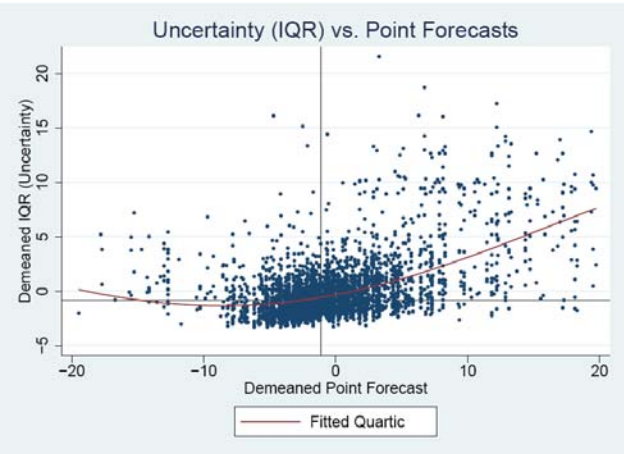
3a. Price Inflation, Panel



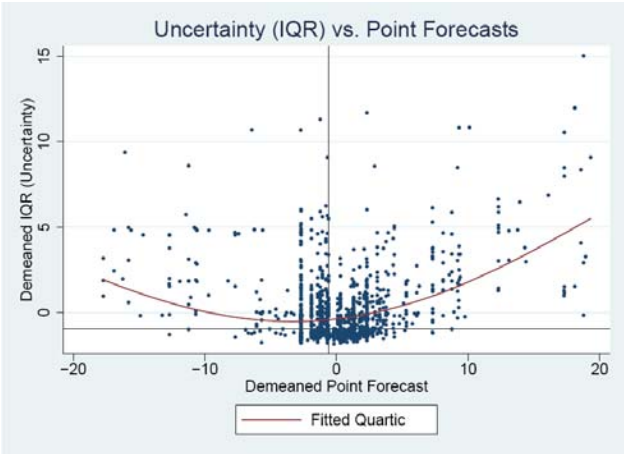
3b. Wage Inflation, Panel



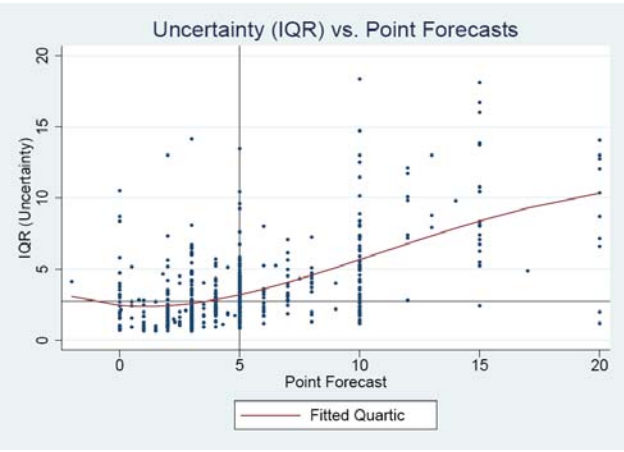
3c. Price Inflation, Panel, Demeaned by Wave



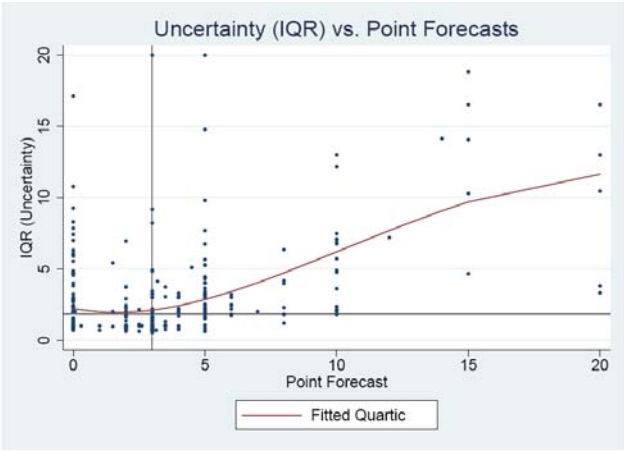
3d. Wage Inflation, Panel, Demeaned by Wave



3e. Price Inflation, Special Survey



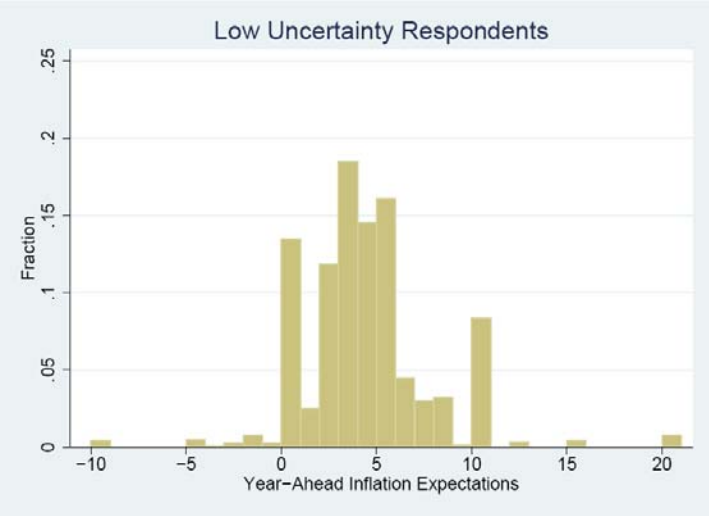
3f. Wage Inflation, Special Survey

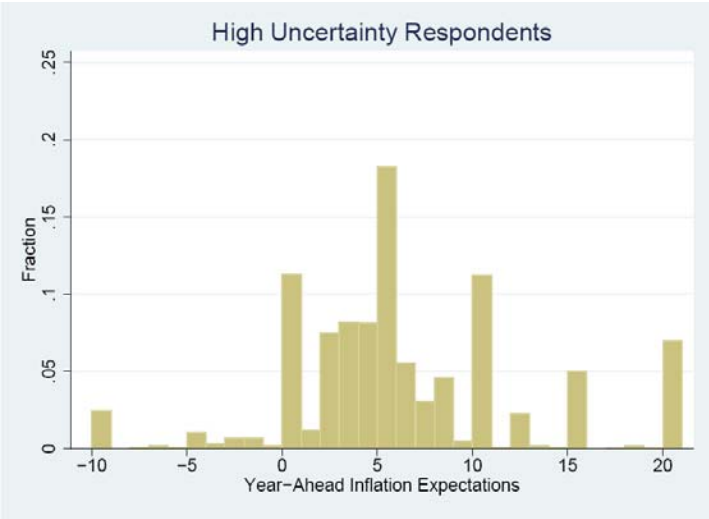


Panel and special survey. Uncertainty measured by individual IQRs.

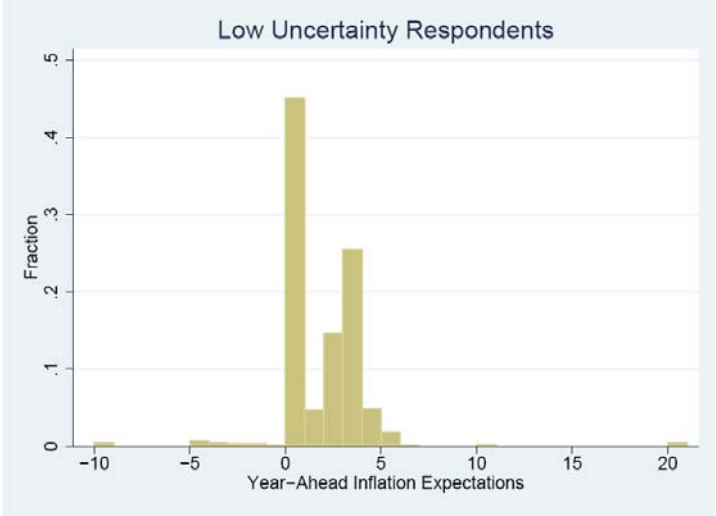
Figure 4. Histograms of Point Forecasts of by High/Low Uncertainty

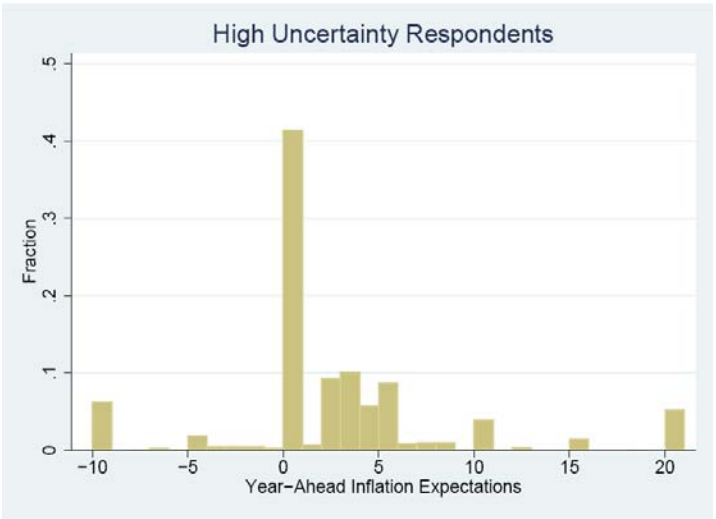
4a. Price Inflation





4b. Wage Inflation

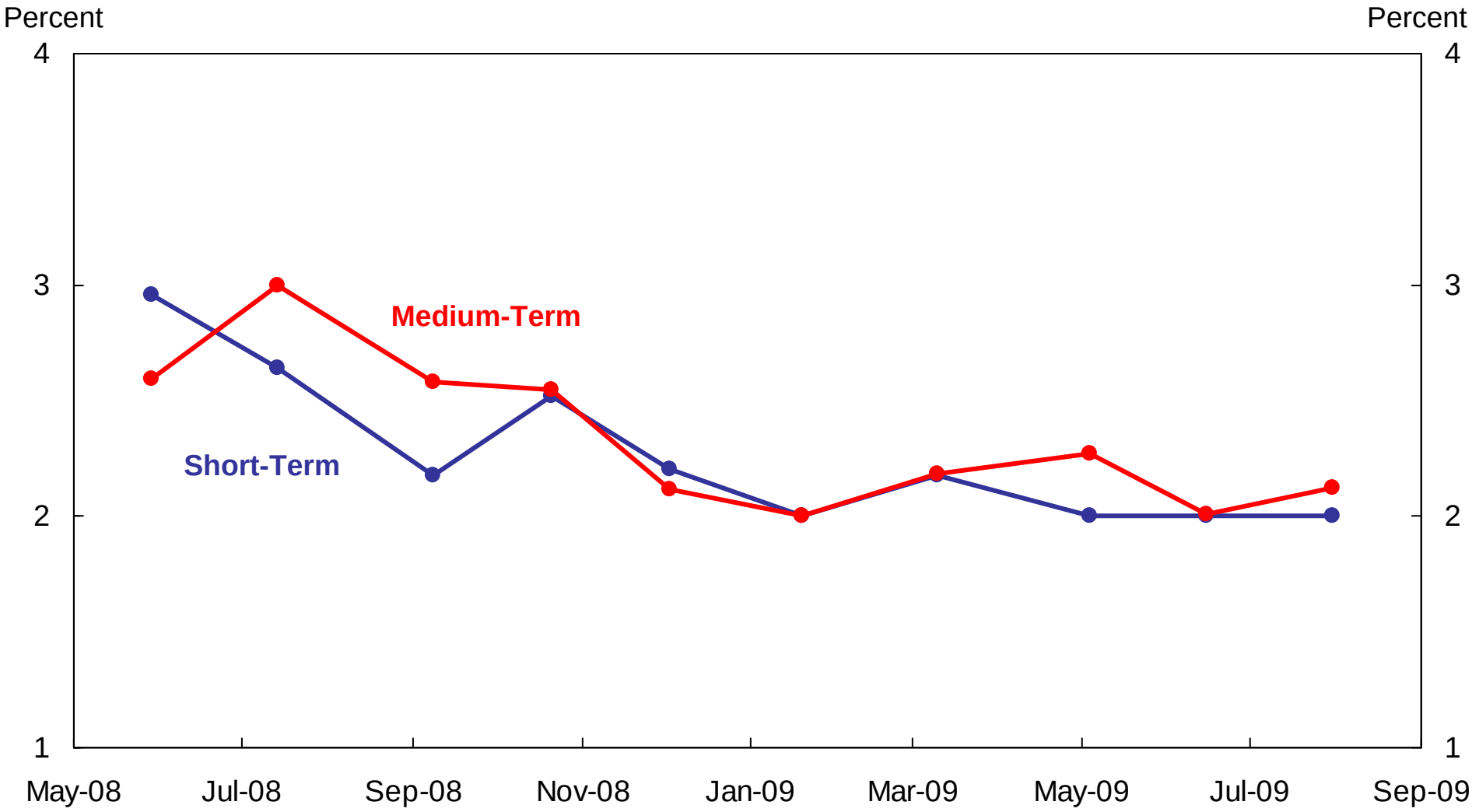




Pooled panel data. Values greater than 20 are coded to 20 and values less than -10 are coded to -10.

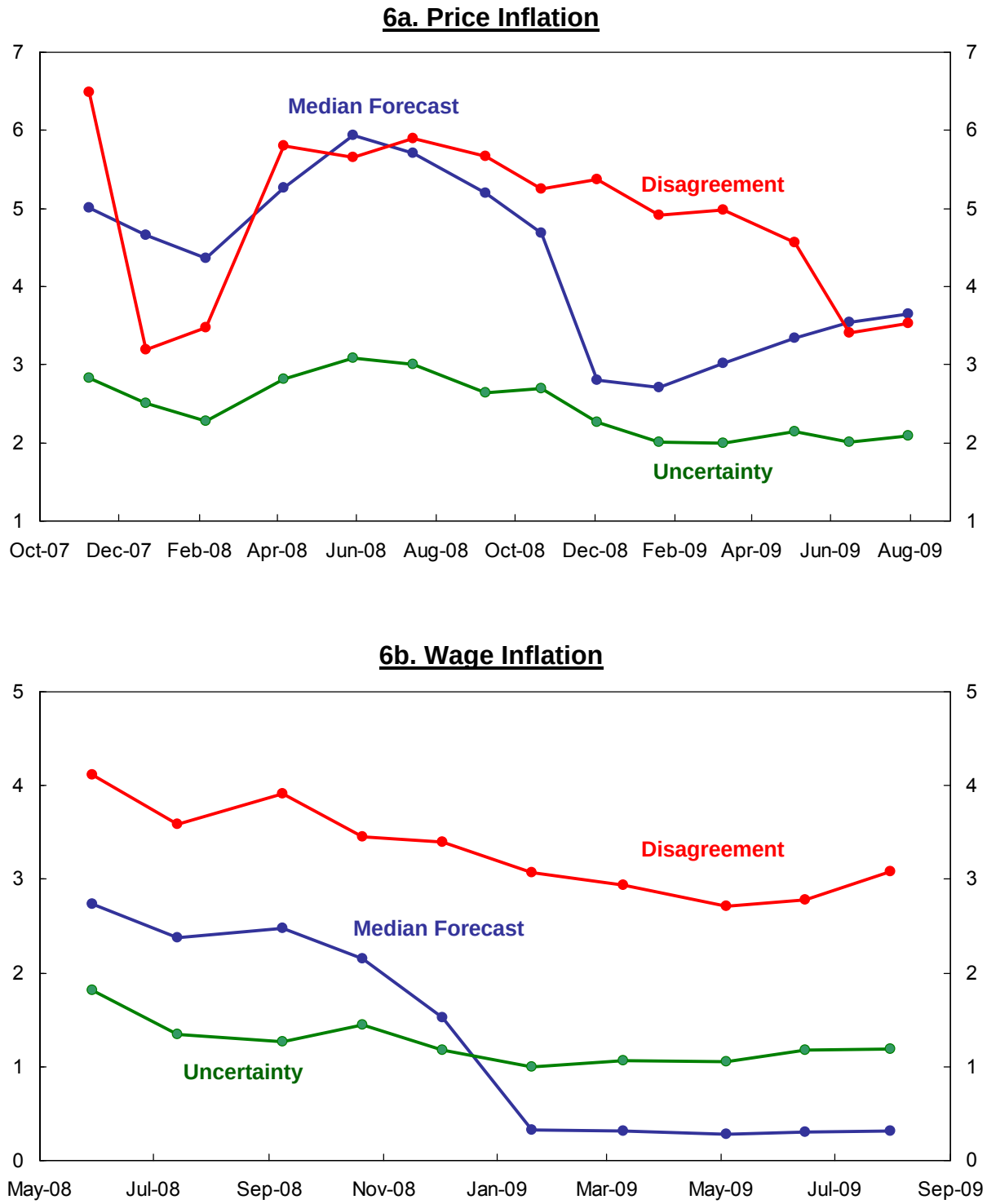
Figure 5. Price Inflation Uncertainty

Short- and Medium-Term Horizons



Panel. Sample medians of individual density IQRs for forecasts of one-year ‘rate of inflation’ for the current time period and two years forward. Measures only available since June 2008.

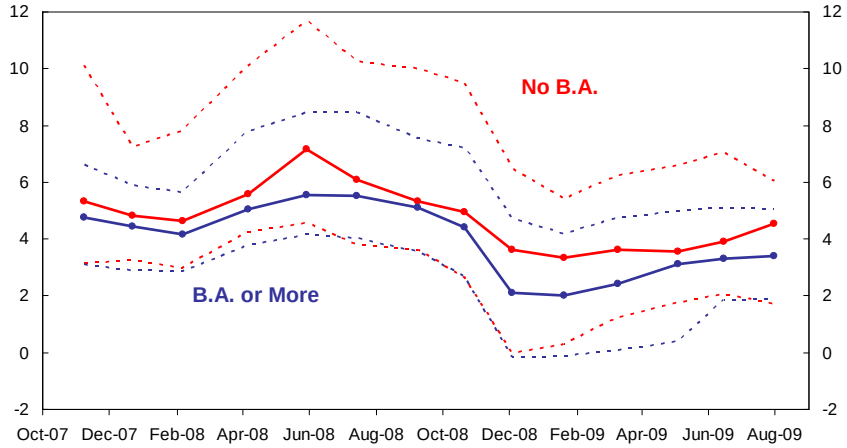
Figure 6. Year-Ahead Price Inflation Expectations: Median, Disagreement and Uncertainty



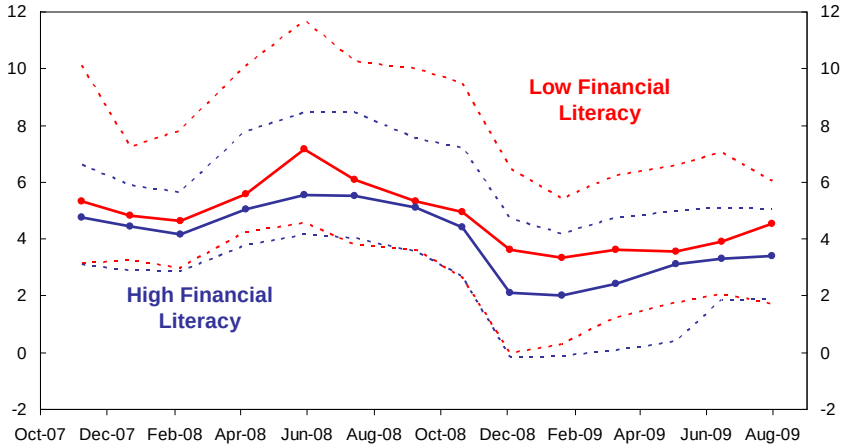
Panel. Median and InterQuartile Range (75th – 25th percentile) of point forecasts. Uncertainty measured as sample median of individual density IQRs.

Figure 7. Year-Ahead Price Inflation Expectations

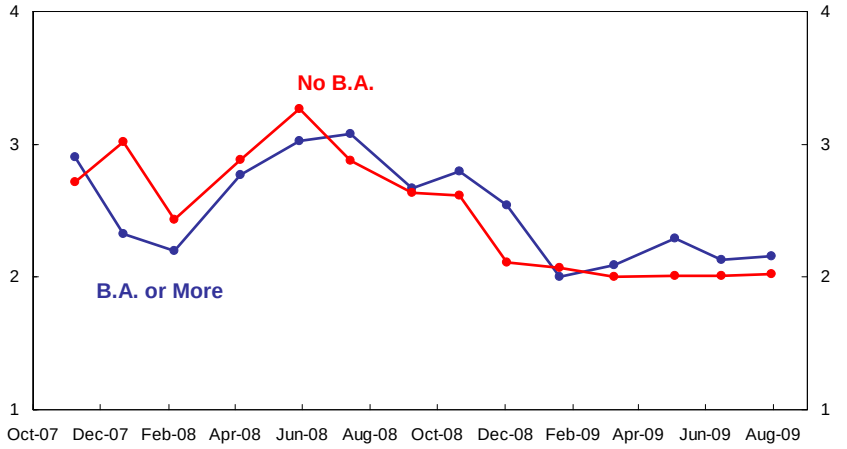
7a. Quartiles by Education



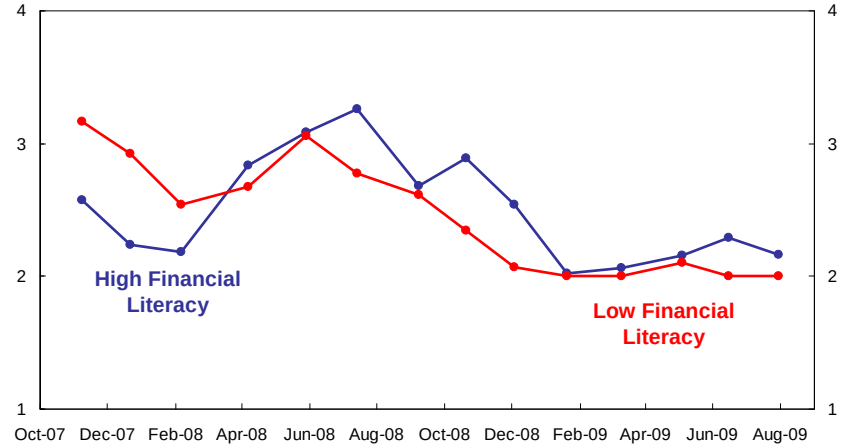
7b. Quartiles by Financial Literacy



7c. Uncertainty by Education



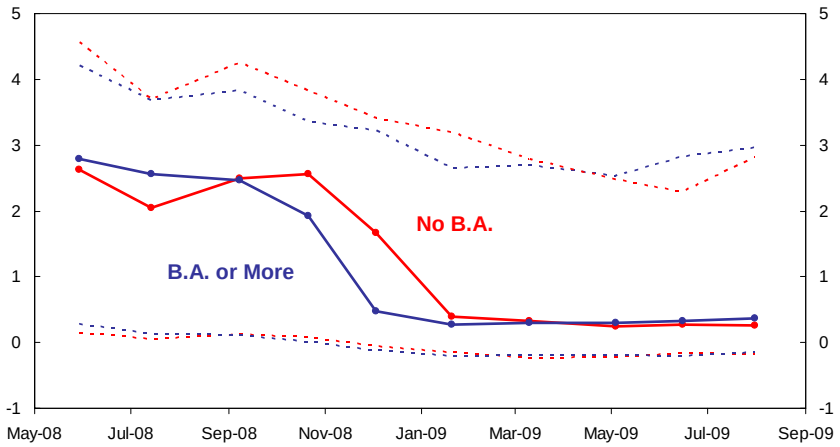
7d. Uncertainty by Financial Literacy



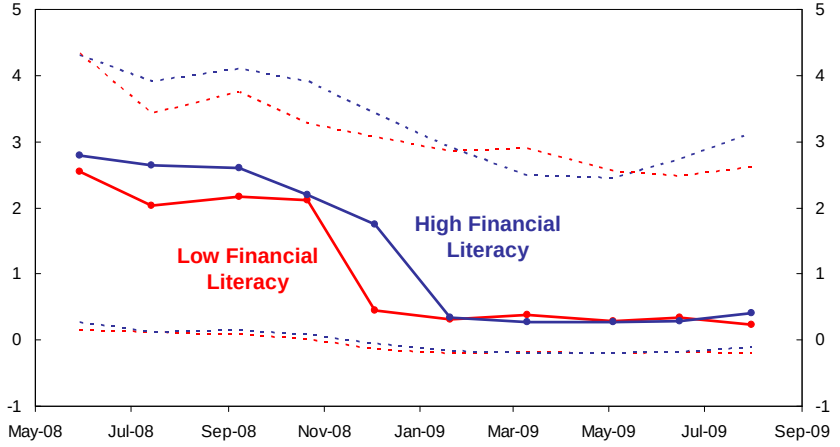
Panel. Quartiles are 25th, 50th, and 75th percentiles of the distribution of year-ahead point forecasts. Uncertainty is measured by the sample medians of individual density IQRs.

Figure 8. Year-Ahead Wage Inflation Expectations

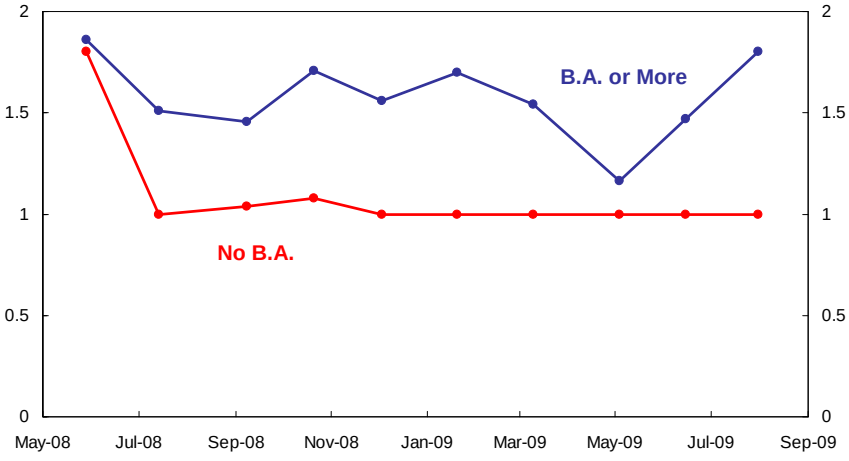
8a. Quartiles by Education



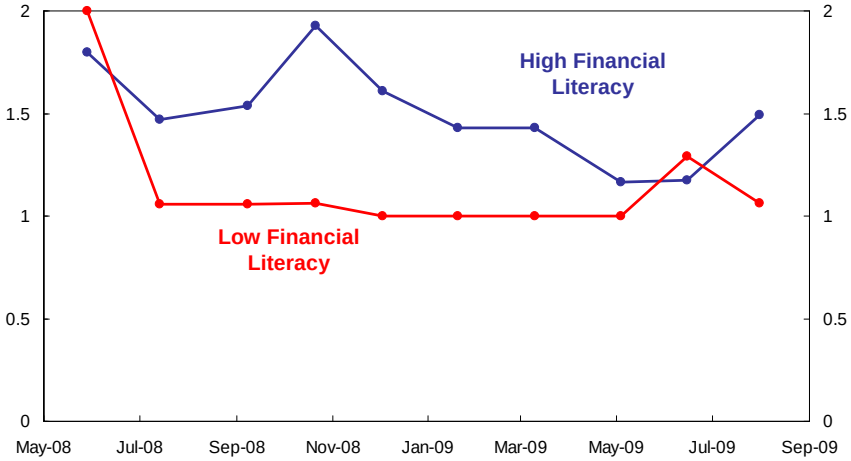
8b. Quartiles by Financial Literacy



8c. Uncertainty by Education

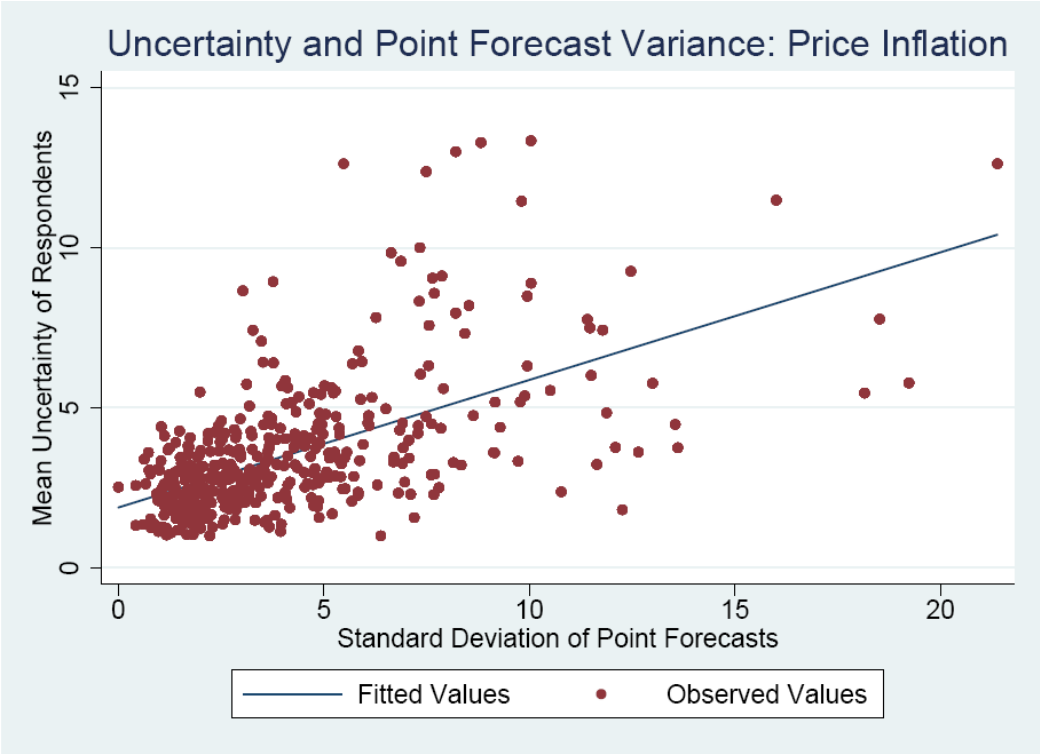


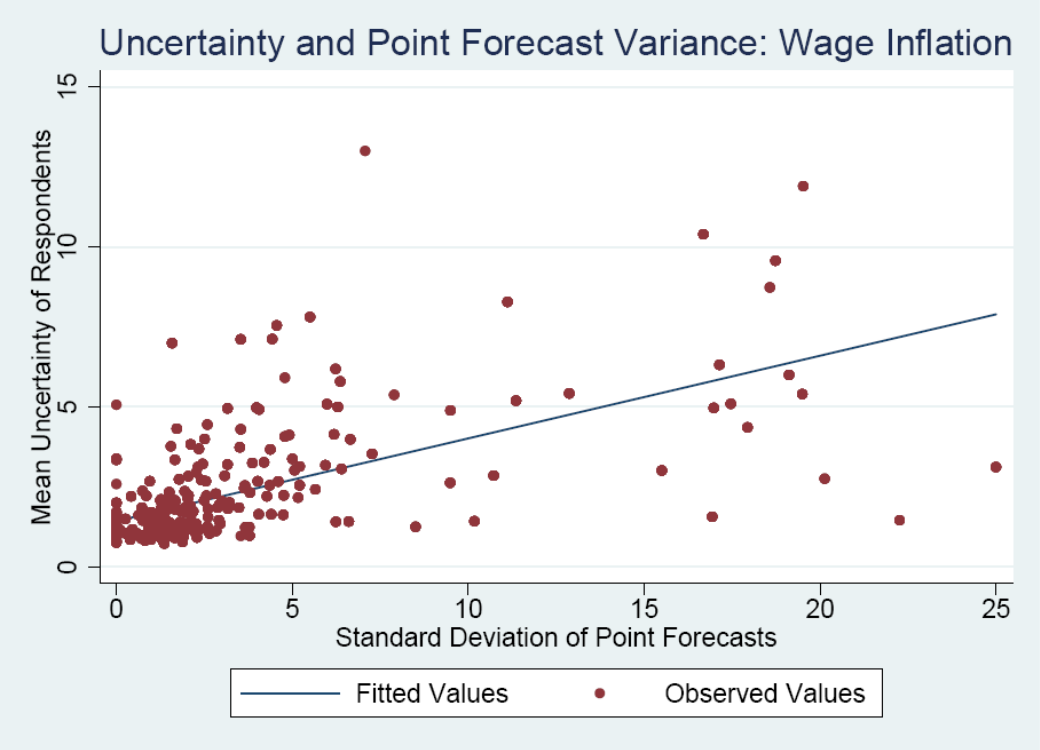
8d. Uncertainty by Financial Literacy



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.

Figure 9. 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.