Ben Bernanke vs. Janet Yellen:
Exploring the (a)symmetry of individual and aggregate inflation expectations

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Legal Issues

Ben Bernanke vs. Janet Yellen: Exploring the (a)symmetry of individual and aggregate inflation expectations*

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Abstract

We conducted a simple, anonymous survey at the beginning of 2014, asking around 200 economists worldwide to reveal their inflation expectations, conditional on either Ben Bernanke or Janet Yellen being the chair of the Board of Governors of the Federal Reserve. We use the change in the Fed's leadership to focus attention on the difference in conditional expectations, while we are interested in the distribution of those expectations. The outcome of the survey shows that a significant share of respondents revealed asymmetric inflation expectations and that the deviation from symmetry is sizeable. Nonetheless, individual asymmetry in forecasts appears to be irrelevant for the aggregate distribution, as the number of respondents who factor in excess inflation broadly matches the number of those who gave more weight to disinflationary outcomes. The aggregate distribution we obtain is largely comparable to the outcome of the Survey of Professional Forecasters for the first quarter of 2014.

Keywords: inflation expectations, subjective probability distributions
JEL Classifications: C42, E31

1 Introduction

Inflation expectations constitute a vital part of decision–making by companies, households and policymakers alike. In surveys about expected inflation, respondents are asked to provide their inflation expectations by specifying a point forecast, an interval[1] or an entire distribution of possible outcomes.[2] The question of how to aggregate point forecast or interval data and compute summary statistics touches upon a rich literature examining subjective probability distributions. As García and Manzanares (2007) show in the context of the Survey of Professional Forecasters (SPF), subjective expectation distributions can exhibit skewness, implying that routinely reported summary statistics do not give a good picture of perceived inflation risks. In particular, they document that during the Volcker era, when inflation was low or negative, the SPF respondents' expectations factored in inflation risks, even while mean expected inflation was low or declining. Asymmetries in inflation expectations are important, they argue, as they might explain the inflation scares observed in the bond market (particularly in 1983–1984).

In this paper, we conduct a simple survey to directly test for asymmetries in inflation expectations provided in interval form. We make use of the transition of Fed leadership from Ben Bernanke to Janet Yellen in the beginning of 2014 to present respondents with a political framing while focusing on technical aspects (symmetry) in inflation expectations. Our respondents are a sample of non–professional forecasters with an economic background (so that we can be sure they know what inflation is). In a first step, we ask them to provide intervals for their inflation expectations under Ben Bernanke's or Janet Yellen's leadership. In a second step, we randomize the participants into groups which are then asked about the probability that they assign to inflation being higher or lower than the midpoints of the intervals that they have provided. We document significant departures from symmetry of the individual probability distributions.

Interestingly though, these asymmetries seem to be irrelevant for the aggregate distribution. We follow the aggregation method of the Survey of Professional Forecasters (SPF) to distinguish between disagreement (among respondents as

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[1]For example, the Regional Network Company Survey conducted by the Swiss National Bank (SNB). Survey results are regularly published in the monetary policy report: link (in German).

[2]Most notably, the Survey of Professional Forecasters conducted by the Federal Reserve Bank of Philadelphia: link.

reflected in different views regarding expected future inflation) and uncertainty (as reflected in different degrees of confidence in expressed views). Our experimental design allows us to 'switch off' asymmetry in individual distributions and test whether the aggregate distribution changes. We find that asymmetry of individual distributions plays no role in the aggregate, because respondents who assigned more weight to inflation being above their mid-range are broadly offset by respondents who regarded it as more likely that inflation would stay below their mid-range. Finally, we conduct a robustness check to mitigate concerns that our results are driven by the non-sophistication (in terms of forecasting) of our sample. We do not find that subjective distributions of more sophisticated or experienced forecasters exhibit a different degree of asymmetry.

Our paper relates to the literature on the analysis of expectation surveys, such as the Survey of Professional Forecasters (SPF). There is no consensus yet on the correct distribution to model subjective expectations. García and Manzanares (2007) find skewness at certain points in time, which is also what Lahiri, Teigland and Zaporowski (1988) find, using a different data set. Murasawa (2013) reports similar findings for household inflation expectations. Contrary to these findings, Clements (2014) finds little evidence for asymmetry in SPF inflation expectation distributions. In line with the latter paper and using survey data, De Bruin, Manski, Topa and van der Klaauw (2011) find that the mean of individual distributions is an accurate statistic for expected inflation at the aggregate level. However, in many cases it offers a poor description of individual expectations. A different but related strand of the literature compares forecasters' point predictions with the central tendencies of their subjective probability distributions, generally finding that the two measures do not always agree (Engelberg, Manski and Williams (2009), Clements (2010)).

The rest of the paper is structured as follows. Section 2 describes the survey and provides some illustrations for the inflation expectations of our respondents; in section 3 we provide results on the symmetry of expected inflation distributions, how these affect aggregation, and perform a robustness check; section 4 concludes.

2 The survey

In this section we detail our survey methodology. We designed the survey to be short in order to get a maximum response rate. The target group comprised non-professional forecasters with an economic background, so that we could be sure that they were familiar with the basic concepts and knew who Ben Bernanke and Janet Yellen are. We sent invitations to complete the online survey by e-mail between December 2013 and February 2014, providing a link to a homepage hosted by the University of Zurich. The survey was answered by about 200 economists from the Federal Reserve System, the European System of Central Banks, Norges Bank, Riksbank, Stanford University, University of Chicago, Columbia University, University of California at Berkeley, Bocconi University, University of St. Gallen, University of Zurich and Swiss National Bank, among others. The online survey presented participants with four questions on three pages about headline inflation expectations in the US over the next two years. Their answers were saved in a database. The estimated response time was roughly 1.5 minutes.

An overview of the four questions is given in Table 1. The first question, "Do you have a background in economics and/or statistics?" (yes/no), was designed to test whether we were reaching the target audience and was used to select only those that actually did have such a background (only two respondents indicated that they didn't have an economic background). In question 2, respondents were asked to provide an interval for their expectations regarding headline inflation over the next two years after Janet Yellen begins her appointment as chair of the Federal Reserve. In question 3, respondents were asked to provide an interval under the counterfactual assumption that Ben Bernanke would remain at that post. For question 4 we randomly assigned participants to one of four groups as detailed in Table 1. We asked participants to report the probability (in %) that average headline inflation would be below (groups 1 and 3) or above (groups 2 and 4) the midpoint of the interval that they provided in questions 2 and 4, if Ben Bernanke had remained chairman (groups 1 and 2), or under Janet Yellen (groups 3 and 4).

The political framing of the questions was intended to prevent participants from answering the survey as if it were a purely technical inquiry. We anticipated that most of the respondents in our sample would be well aware of different methods for estimating inflation, and we intended to put the focus on a real–world scenario instead of on the methodological aspects. Questions 2 and 3 were posed on the

same survey page so that respondents directly saw that they needed to provide two intervals, one for Janet Yellen as chair, and one for Ben Bernanke as chair. The intention, beside distracting respondents from technicalities, was to see whether political beliefs caused shifts in the probability distributions.

The randomization regarding whether average inflation would be below or above the midpoint of the respondent-provided interval intended to capture asymmetries in the distribution. An alternative method would have been to ask every respondent to give the probability of inflation being below or above their interval midpoint or to elicit individual distributions in some other way. We chose the between-subjects randomization strategy instead of a within-subjects design for the following reasons. First, we are only interested in whether expected inflation probability distributions are symmetric and whether asymmetries matter for aggregation, not in the shape of individual distributions. Secondly, our worry with a within-subjects design was that respondents would be trying to give consistent answers instead of emphasizing their subjective probability for excess risks of higher inflation and lower inflation, respectively. Thirdly, the between-subjects design allowed us to keep the survey very short, which we thought would help us to reach a higher response rate.

Table 1: **Survey design**

Question	Group	Wording	Answers
1	all	Do you have a background in economics and/or statistics?	yes/no
2	all	Where do you expect to see average headline inflation* in the U.S. over the next two years after *Janet Yellen* begins her appointment as the new chairman of the Federal Reserve (Fed)?	interval a to b
3	all	Where do you expect to see average headline inflation* in the U.S. over the next two years if *Ben Bernanke* had remained chairman of the Fed?	interval a to b
4	1	Were Ben Bernanke to remain Chairman of the Fed, what would be the probability of average headline inflation over the next two years being *below* $(a+b)/2^\dagger$?	p
4	2	Were Ben Bernanke to remain Chairman of the Fed, what would be the probability of average headline inflation over the next two years being *above* $(a+b)/2^\dagger$?	p
4	3	After Janet Yellen takes the helm of the Fed, what is the probability of average headline inflation over the next two years being *below* $(a+b)/2^\dagger$?	p
4	4	After Janet Yellen takes the helm of the Fed, what is the probability of average headline inflation over the next two years being *above* $(a+b)/2^\dagger$?	p

† $(a+b)/2$ refers to the midpoint of the interval provided by respondents in questions 2 and 3, respectively. The sign * denoted a footnote in questions 2 and 3 that stated: "* Annual percentage change in the Consumer Price Index (CPI) released by the U.S. Bureau of Labor Statistics". The respondents were randomly assigned to one of the four groups for question four, as explained in the main text. Both the intervals (questions 2-3) and probability (question 4) were asked in terms of a field where any number could be entered. Small arrows on the side allowed respondents to modify their number upwards or downwards in 0.1 increments.

184 respondents completed the survey between December 6, 2013 and February 28, 2014.[3] Table 2 shows descriptive statistics for this sample. Regarding the inflation prediction intervals, we see that they look similar both in terms of spread and midpoint, irrespective of whether Janet Yellen or Ben Bernanke were heading the Fed. A few respondents factor in some probability for deflation (negative inflation) in their lower bounds, while some indicate at least a possibility for very high inflation (8%). The midpoints are close to two percent. The mean indicated probability that average inflation is higher or lower than the midpoint is close to 50%.

Table 2: **Descriptive statistics**

Question	Mean	st.dev.	Min	Max
Q1. Economist (0=no, 1=yes)	1.000	0.000	1.0	1.0
Q2. Yellen lower bound	1.204	0.812	-2.0	4.0
Q2. Yellen upper bound	2.826	1.030	1.0	8.0
Q2. Yellen midpoint	2.015	0.734	0.5	5.0
Q3. Bernanke lower bound	1.157	0.753	-2.0	3.0
Q3. Bernanke upper bound	2.677	0.914	0.9	8.0
Q3. Bernanke midpoint	1.917	0.634	0.5	5.0
Q4. Prob. smaller/larger than midpoint	0.497	0.170	0.250	0.900
Observations	184			

Finally, in Table 3, we check whether our randomization strategy worked, by comparing answers to questions 2 and 3 among our four groups. Note that randomization only affected question 4, so there should not be a statistically significant difference in answers to the previous questions. Group sizes are similar and close to 50. Lower and upper bounds of the inflation intervals, as well as the midpoints, are similar for the four groups. In column 4 of Table 3, we report P-Values for the Wald test when regressing these outcomes on group indicator variables. The P-Values are well above any usually accepted significance level, which suggests that assignment to a group was not related to previous answers. We conclude from these results that our randomization strategy worked.

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[3]This excludes 2 respondents who indicated that they did not have an economic background, and three who gave a probability of 0 for inflation below/above their midpoints provided.

Table 3: **Randomization**

Question	Mean answer				P > F[†]
	Group 1	Group 2	Group 3	Group 4	
Q2. Yellen lower bound	1.272	1.183	1.051	1.318	0.426
Q2. Yellen upper bound	2.972	2.937	2.636	2.745	0.354
Q2. Yellen midpoint	2.122	2.060	1.843	2.032	0.311
Q3. Bernanke lower bound	1.181	1.154	1.038	1.259	0.580
Q3. Bernanke upper bound	2.798	2.798	2.536	2.559	0.327
Q3. Bernanke midpoint	1.990	1.976	1.787	1.909	0.407
Observations	43	52	45	44	184

[†] Column "P > F" reports the P-Value for the Wald test when regressing question answers on group indicator variables. If belonging to a group had explanatory power regarding questions 2 and 3, this value should be low (e.g. below 0.05).

2.1 Intervals of expected inflation

As discussed above, every survey respondent could specify an interval for expected inflation in two scenarios: with Ben Bernanke or Janet Yellen being the Fed chair. Figure 1 reports the intervals provided in ascending order, from the respondent whose interval had the lowest mid-range to the one with the highest mid-range.

The majority of respondents gave the same interval for the two scenarios. 57 out of 184 (31%) of them provided a different interval and we compared the samples of lower and upper bounds for the two scenarios using the Kolmogorov-Smirnov test to see whether these differences are statistically important. We could not reject the null hypothesis that the two distributions are the same statistically, with a test statistic of 0.054 (p-value 0.94) for the lower bound and 0.0761 (0.64) for the upper bound. We plot kernel densities of the four samples in Figure 2.

Figure 1: **Surveyed intervals for expected inflation.**
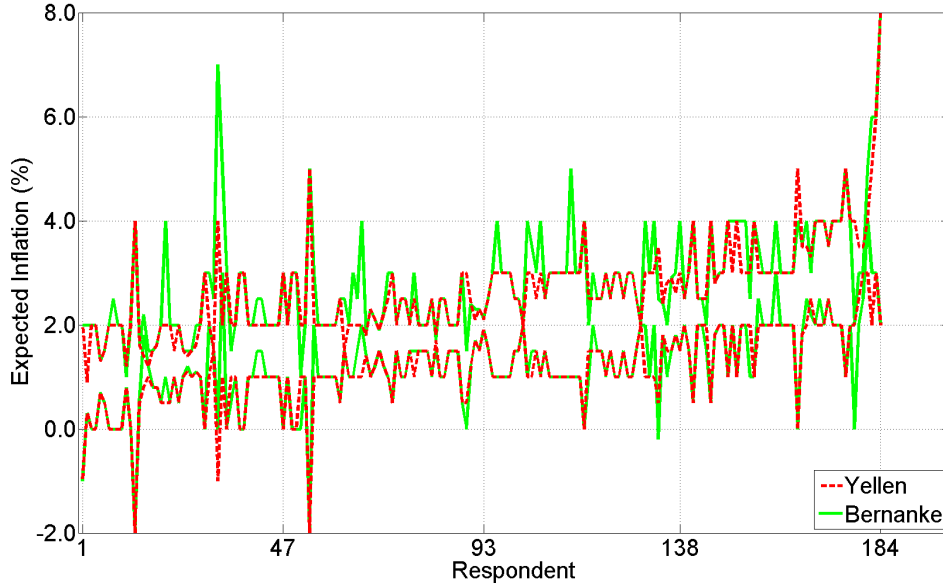
The figure reports surveyed intervals for expected inflation across the respondents and conditional on Janet Yellen (dashed red line) or Ben Bernanke (green solid line) being Fed chair. The intervals are reordered from the one with the lowest mid-range to the one with the highest mid-range.

2.2 Comparison with SPF

Finally, we compare inflation expectations from our survey to the outcome of the Survey of Professional Forecasters (SPF) released in February 2014 for annual core CPI inflation in 2014 and 2015.[4]

For every individual in the sample, we assume:

- a coverage ratio of 100%. The coverage ratio does not matter much, if one is interested in the probability above/below the midpoint m. Admittedly, the assumption that the coverage ratio is equal for all the respondents is strong.

- a discrete uniform subjective distribution function. If a and b are the surveyed lower and upper bound, respectively, the cumulative distribution function is given by:

$$F(k,a,b) = \frac{k-a+1}{n}$$

for any $k \in [a,b]$ and where $n = b-a+1$.

Figure 2: **Kernel densities of surveyed intervals.**
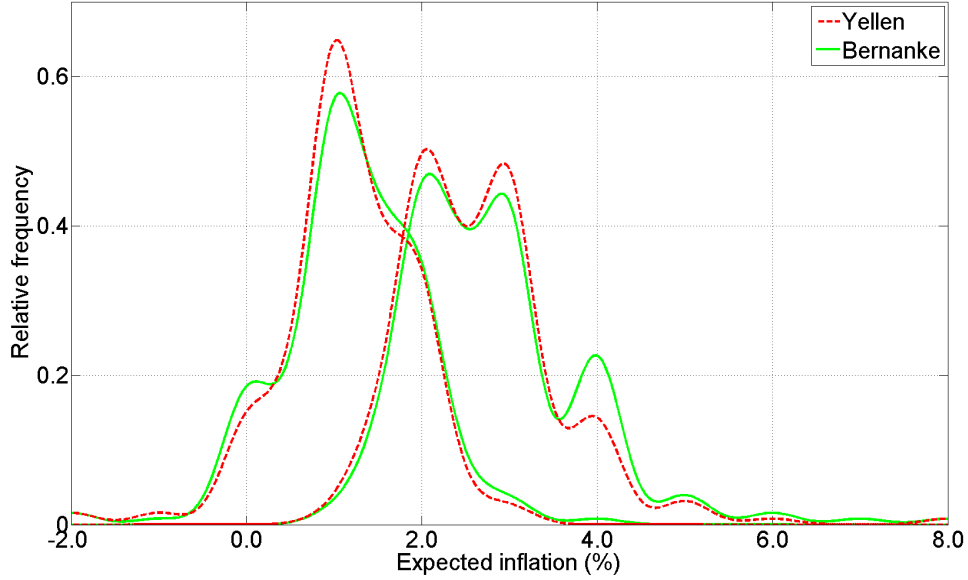
The figure reports estimated densities of lower and upper bound for expected inflation conditional on Janet Yellen (dashed red line) or Ben Bernanke (green solid line) being Fed chair. The estimate is based on a normal kernel function, using a window parameter (width) that is a function of the given number of points.

If a respondent provided a symmetric distribution, the probability mass function (PMF) is equal to $f(x) = \frac{1}{n}$ if $a \le x \le b$, and zero otherwise. If the respondent gave a probability $p \ne 0.5$, we assume the PMF to be:

$$
f(x) = \begin{cases} \frac{p}{m-a+1} & \text{if } x < m \\ \frac{1-p}{b-m+1} & \text{if } x \ge m \end{cases}
$$

for all those who were asked to provide the probability of inflation being *below* the midpoint, and:

$$
f(x) = \begin{cases} \frac{1-p}{m-a+1} & \text{if } x \le m \\ \frac{p}{b-m+1} & \text{if } x > m \end{cases}
$$

for the respondents who had to provide the probability of inflation being above m.[5] Figure 3 illustrates the idea.

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[5]Needless to say, the point forecasts got the PMF of 1. In particular, there are two respondents in the sample who provided $a = b$.

Figure 3: **Three illustrative examples.**
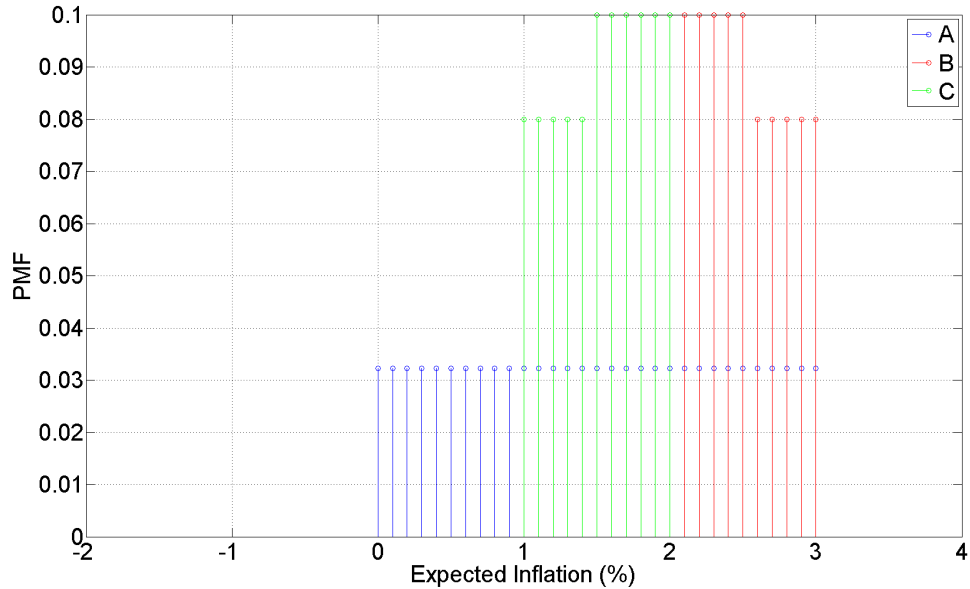
The figure plots the PMFs for three representative observations from the sample: Respondent A: $a = 0.0\%$, $b = 3.0\%$, $p = 0.5$; Respondent B: $a = 2.0\%$, $b = 3.0\%$, $p = 0.3$, 'above'; Respondent C: $a = 1.0\%$, $b = 2.0\%$, $p = 0.4$, 'below'.

Once we obtain the individual PMFs, we aggregate them by following the logic of the Survey of Professional Forecasters (SPF). For a number of variables, the SPF asks the participants to provide "the mean probability that the fourth-quarter over fourth-quarter percent change in [a variable] falls in a particular range." We use the ranges defined in the SPF to sum up the PMFs for individual participants, and then we take the average across the sample for every range. Figure 4 shows that our data is broadly comparable to the outcome of the SPF in the first quarter of 2014.[6]

This is interesting for two reasons. First, a simple interval survey question leads to the same aggregate expectation distribution at much less of a cost to the individual respondent. Secondly, our results on symmetry outlined below touch on a subject of great interest in the literature, which has mainly focused on the SPF data. As our survey leads to comparable predictions, we think that our results connect well to the existing literature.

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[6]The results barely change, if we assume a uniform distribution for all the responses. See Section 3.1.

Figure 4: **Comparison to the survey of professional forecasters.**
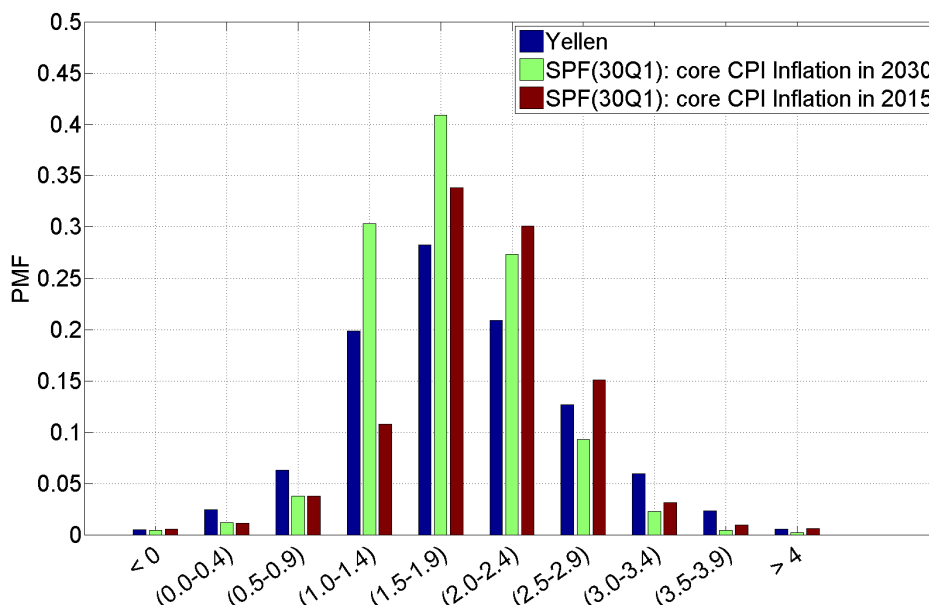
This figure compares the aggregate histogram of responses from the groups 3 and 4 (see Table 1) to the annual core CPI inflation forecasts for 2014 and 2015 from the Survey of Professional Forecasters released in February 2014.

3   Asymmetry in subjective distributions

Are subjective inflation expectation distributions symmetric? Using the results from our survey, we can directly test this question. We asked respondents to provide the probability that US headline inflation would be below/above the midpoint of the intervals they provided. In column (1) of Table 4 we report the percentage of respondents who responded with a probability different from 0.5. For the whole sample and for all sub-groups, this percentage clearly exceeds 0.5, implying that the majority of our sample has asymmetric inflation expectation distributions.

If we treat the probability they supplied as a Bernoulli variable, taking on 1 if they indicate $p \neq 0.5$, and 0 if they indicate $p = 0.5$ with a "success rate" r, column (1) reports our estimate $\hat{r}$ and we can calculate approximate normal confidence intervals for $\hat{r}$, reported in column (2). The bounds of our confidence intervals are far away from 0 and 1. For the whole sample, the confidence interval excludes 0.5 and the corresponding z-test against $H_0 : r = 0.5$ rejects at the 1% significance level.

This simple test does not take into account the possibility that reported asymmetries could be very small. All respondents who report $p \neq 0.5$ could deviate only trivially, since we did not provide them with categories or a scale for their answers. For example, the reported probability could be 0.5001, which would clearly not constitute a meaningful deviation. To get a sense of how far our respondents deviate from symmetry, we report the mean absolute deviation from $p = 0.5$ for the respondents who answered $p \neq 0.5$. The average absolute deviation for the whole sample is 0.1939 (see column (3) in Table 4) and statistically different from 0 at any conventional significance level. In each of the randomly assigned sub-samples, the deviation is large and strongly significantly different from 0.

From the results presented so far, we conclude that subjective inflation expectations are asymmetric for a significant proportion of our respondents and that the deviation from symmetry is sizeable.

3.1 Aggregating Subjective Distributions

Does asymmetry in inflation expectations matter for the *average* probability that inflation is above/below the midpoints? Perhaps surprisingly, the answer is no. In columns (3) and (4) of Table 4 we report the mean probability that inflation would be below/above the interval midpoints, together with standard errors, for all respondents, and excluding those who answered $p = 0.5$. In both cases, the means are close to 0.5 for the whole sample and all sub-groups. Thus, while some respondents factor in excess risks for high or low inflation, these asymmetries appear to be symmetric. For every respondent who factors in the probability that Janet Yellen will preside over excess inflation, there is a corresponding respondent who factors in a risk of low inflation.

To illustrate this point we compare aggregate distributions obtained according to Section 2.1 and those where we assume a univariate distribution for all the responses. Figure 5 shows that incorporating skewness of subjective distributions seems to be irrelevant in the aggregate.

Table 4: **Symmetry in Inflation Expectations**

Sample	Obs.	share with $p \neq 0.5$	95% CI	Mean absolute dev. from $p = 0.5$ (excl. $p = 0.5$)	Mean p	Mean p (excl. $p = 0.5$)
		(1)	(2)	(3)	(4)	(5)
Whole sample	184	0.6033	[0.5326, 0.6739]	0.1939 (0.0095)	0.4950 (0.0125)	0.4917 (0.0208)
G1: BB<midpoint	43	0.6047	[0.4585, 0.7508]	0.1942 (0.0185)	0.5012 (0.0258)	0.5019 (0.0430)
G2: BB>midpoint	52	0.6346	[0.5037, 0.7655]	0.2153 (0.0196)	0.4868 (0.0270)	0.4792 (0.0427)
G3: JY<midpoint	45	0.5778	[0.4335, 0.7221]	0.1904 (0.0168)	0.4918 (0.0238)	0.4858 (0.0415)
G4: JY>midpoint	44	0.5909	[0.4456, 0.7362]	0.1700 (0.0198)	0.5018 (0.0231)	0.5031 (0.0393)

This table reports results for the question(s) "Were Ben Bernanke (BB) / Janet Yellen (JY) chairman of the Fed, what would be the probability of average headline inflation over the next two years being below/above $(a + b)/2$?" where a and b denote the endpoints of the interval the respondent provided in question 2/3 (see Section 2 for details).
Column (1) reports the share of respondents who answered $p \neq 0.5$, column (2) reports approximate 95% confidence intervals for this estimate if treated as a Bernoulli variable (where success is defined as $p \neq 0.5$), column (3) reports the mean absolute deviation from $p = 0.5$ for respondents who indicated $p \neq 0.5$, column (4) reports the mean and standard error of the indicated probabilities p, column (5) reports the same but excluding answers where $p = 0.5$, .

14

Figure 5: **Does Asymmetry Matter for Aggregation?**
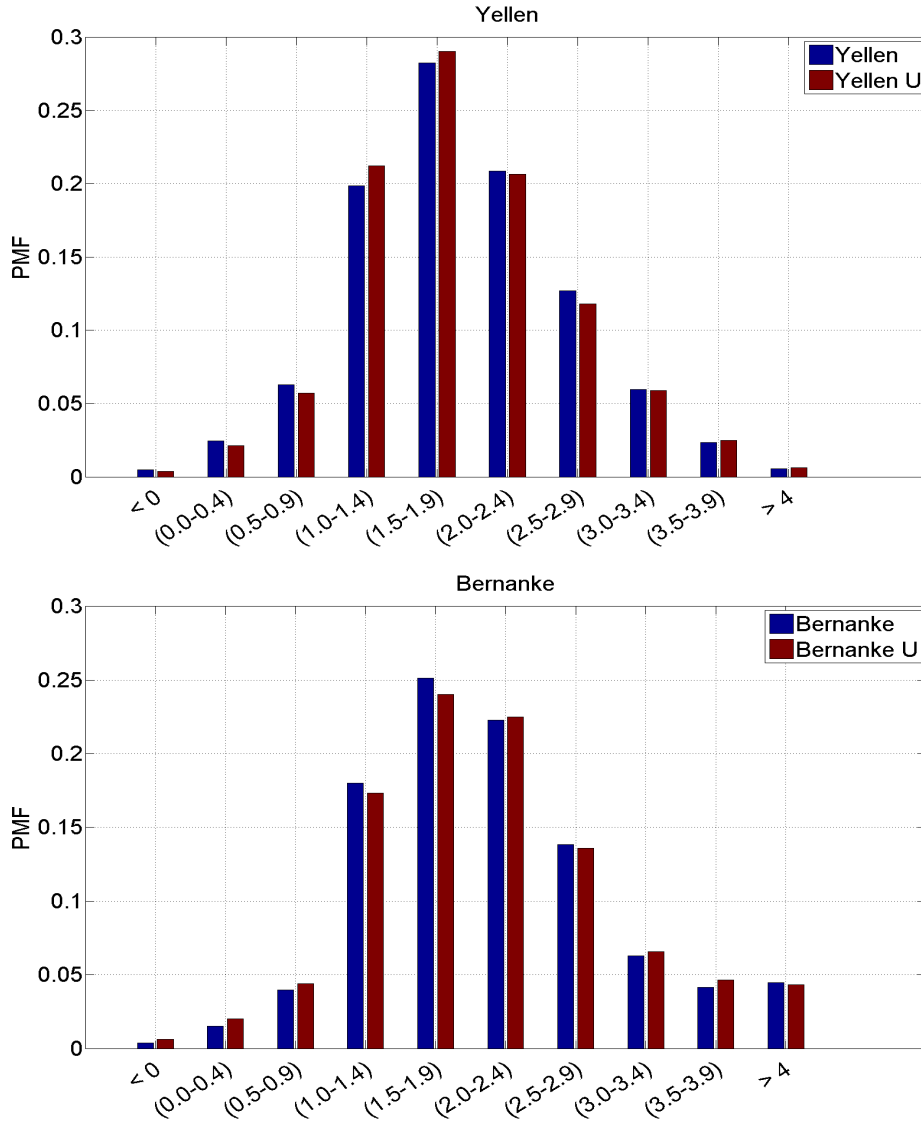
The figure shows aggregate distributions of responses from groups 3 and 4 (upper panel) and groups 1 and 2 (lower panel) defined in Table 1. The aggregations denoted as 'Yellen' and 'Bernanke' follow the logic explained in Section 2.1 and the aggregations 'Yellen U' and 'Bernanke U' assume a uniform distribution for each respondent, regardless of provided probability.

3.2 Asymmetry and Sophisticated Forecasters

Our sample consists primarily of non-professional forecasters. If only sophisticated forecasters tend to incorporate excess upside/downside risks in the form of asymmetric distributions, our conclusion that asymmetry does not seem to be important for aggregation could suffer from a selection bias. The claim could be that our sample has too many 'non-sophisticated' forecasters and the results might look very different if the respondents were similar to the ones questioned in the SPF.

We address this concern by distinguishing between different 'degrees of sophistication' among our respondents. We check whether respondents who provided narrower intervals and who are arguably less uncertain about their forecast tend to have more asymmetric distributions. Panel A of Table 5 shows that almost half of the respondents provided an interval narrower than 1 percentage point (pp) in the Ben Bernanke scenario and that roughly 59.55% of them answered question 4 with $p \neq 0.5$, which is very close to the 60.33% observed in the whole sample. A similar picture emerges when we consider larger intervals and the Janet Yellen scenario. There is no clear association in terms of the share of respondents with asymmetric expectations and prediction uncertainty.

Table 5: **Interval Length and Asymmetry**

Range (% points)	Obs.	share with $p \neq 0.5$	95% CI
Panel A. Interval based on Ben Bernanke scenario			
<= 1.0	89	0.5955	[0.4935, 0.6975]
> 1.0 and <= 2.0	63	0.6349	[0.5160, 0.7538]
> 2.0 and <= 3.0	22	0.5455	[0.3374, 0.7535]
> 3.0	10	0.6000	[0.2964, 0.9036]
Whole sample	184	0.6033	[0.5326, 0.6739]
Panel B. Interval based on Janet Yellen scenario			
<= 1.0	98	0.6327	[0.5372, 0.7281]
> 1.0 and <= 2.0	60	0.5667	[0.4413, 0.6921]
> 2.0 and <= 3.0	17	0.5882	[0.3543, 0.8222]
> 3.0	9	0.5556	[0.2309, 0.8802]
Whole sample	184	0.6033	[0.5326, 0.6739]

See notes to Table 4 for details.

4   Conclusion

In this paper we presented evidence from a simple survey that tests for asymmetries in inflation expectation distributions. The survey was conducted among a sample of non–professional forecasters with an economic background. We asked respondents to provide their inflation expectations in interval form under two different Fed chairs, namely Ben Bernanke if had not stepped down, and Janet Yellen. Our results show that many respondents have asymmetric inflation expectation distributions, but that these asymmetries do not matter greatly when calculating average expected inflation or an aggregate probability distribution from inflation expectations elicited in interval form. One implication of this result would be that using interval midpoints from surveys gives an accurate representation of average expected inflation. This could be augmented by interval length as one possible summary statistic for the degree of uncertainty, although we did not investigate how well this proxies for different measures of uncertainty.

Our results are in line with several previous studies that analyzed the Survey of Professional Forecasters or similar data sets, and found that asymmetries do not play an important role. However, we caution that our results reflect expectations at a particular point in time, and that it may well be that our findings depend on the general business cycle situation. We address concerns about different degrees in forecasters' sophistication and find no evidence that this aspect matters for symmetry. From a political standpoint, it seems interesting to note that our sample – economists from reputable academic and policy institutions – expects lower inflation under Janet Yellen's leadership compared to the hypothetical scenario of Ben Bernanke remaining chair of the Fed.

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