



# A Choice-Based Approach to the Measurement of Inflation Expectations

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*This paper represents the authors' personal opinions and does not necessarily reflect the views of the Deutsche Bundesbank.*

# Measuring inflation expectations

- Subjective inflation expectations are measured by researchers and policymakers because they ...
    - ... affect the prices and wages firms set,
    - ... affect consumption-saving decision of households,
    - ... help to produce economic forecasts.
  - Manki (2004) popularized the use of survey questions that elicit the full subjective probability distribution about future outcomes.
  - Measuring full distributions allows to gauge (individual-level) uncertainty regarding expected inflation, not just (across-individuals) disagreement.
- ⇒ We assume the researcher / policy maker wants to measure the full distribution of beliefs, needs to choose some method.

# Probabilistic question: Bins

In your opinion, how likely is it that the rate of inflation will change as follows over the next twelve months?

*Note: The aim of this question is to determine how likely you think it is that something specific will happen in the future. You can rate the likelihood on a scale from 0 to 100, with 0 meaning that an event is completely unlikely and 100 meaning that you are absolutely certain it will happen. Use values between the two extremes to moderate the strength of your opinion. Please note that your answers to the categories have to add up to 100. You can also leave fields empty; these will be saved as a 0.*

- a = The rate of deflation (opposite of inflation) will be 12% or higher \_\_\_\_\_
- b = The rate of deflation (opposite of inflation) will be between 8% and less than 12% \_\_\_\_\_
- c = The rate of deflation (opposite of inflation) will be between 4% and less than 8% \_\_\_\_\_
- d = The rate of deflation (opposite of inflation) will be between 2% and less than 4% \_\_\_\_\_
- e = The rate of deflation (opposite of inflation) will be between 0% and less than 2% \_\_\_\_\_
- f = The rate of inflation will be between 0% and less than 2% \_\_\_\_\_
- g = The rate of inflation will be between 2% and less than 4% \_\_\_\_\_
- h = The rate of inflation will be between 4% and less than 8% \_\_\_\_\_
- i = The rate of inflation will be between 8% and less than 12% \_\_\_\_\_
- j = The rate of inflation will be 12% or higher \_\_\_\_\_

Bundesbank BOP

# Probabilistic question: Bins

## **The use of the probabilistic question format is widespread:**

- Survey of Consumer Expectations (**SCE**, New York Fed)
- Michigan Survey of Consumers
- Consumer Expectations Survey (European Central Bank)
- Deutsche Bundesbank
- Banque de France
- Banca d'Italia
- De Nederlandsche Bank
- Bank of England
- Bank of Canada

Typically also point prediction elicited alongside probabilistic question.

# Problems with bin format

- Difficult, especially for non-expert respondents (e.g., Bruine de Bruin et al., 2012, 2017; D'Acunto et al. 2020).
- Bins sizes and structure are basically chosen arbitrarily.
  - Scale designed to reflect better small values (e.g. smaller bins around „target“ inflation) – weaker performance in times of high/volatile inflation (Weber et al., 2022)
  - Bin structure affects elicited distribution of expectations (Becker et al., 2023). Change of bin structure over time makes it hard (or impossible) to interpret time series.
  - Empty bins and left-open and right-open bins may complicate analysis.

# Proposed method

We propose a new method to elicit inflation expectations (or also other macroeconomic expectations in fact):

- Decision-theoretic foundation (Hong and Sagi, 2006; Baillon, 2008)
- Simple binary comparisons.
- Elicitation process fully driven by respondent - no anchoring on any exogenously provided frames (contrary to bins).
- No magnitude-dependency; applicable to any economic environment
  - Allows comparison across time and across countries with very different levels of inflation.
  - Can be used to simultaneously elicit different macroeconomic expectations (high inflation, low economic growth)

# Exchangeability method: General idea

- Works by splitting the state space into subjectively equally likely events.
- Involves several series of chained choices:
  - Median is always elicited first (twofold partition)
  - Subsequent partition into two equally likely subevents (P25 / P75)
  - Further partition is also possible
- Finish when required precision is achieved – we set precision to 1.5%

# Exchangeability method: Implementation

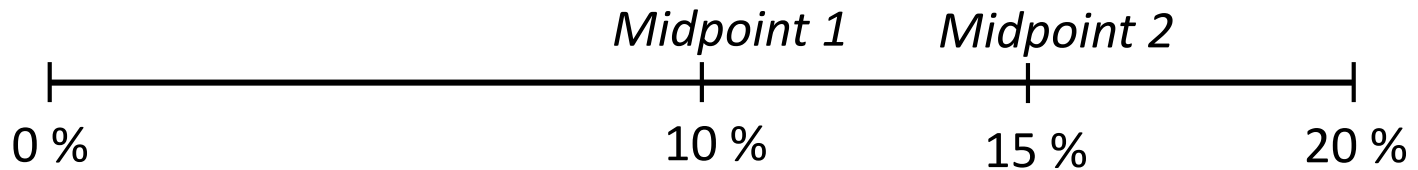
- Start by asking for a subjective **minimum** ( $b_0$ ) and **maximum** ( $b_1$ ) possible level of inflation
  - Prevents researcher-imposed starting point of process
  - Bounded interval helps participants to structure their expectations.
  - Informative (Pavlova, 2024)
- Then a bisection process starts: (median)
  - The first **midpoint** is calculated as:  $b_0 + \frac{b_1 - b_0}{2}$
  - The first choice set thus involves the following options:
$$\left( b_0, b_0 + \frac{b_1 - b_0}{2} \right] \text{ and } \left( b_0 + \frac{b_1 - b_0}{2}, b_1 \right)$$
  - Respondent indicates which one more likely. This implies how to adjust the intervals to approximate 2 subjectively equally likely intervals.
  - Continue depending on required precision.
- Then new bisection process starts to split elicited intervals further (P25, etc.)



# Exchangeability method: Illustration

- Minimum ( $b_0$ ): 0 %      Maximum ( $b_1$ ): 20 %
- Find Median: [Step 2]

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 15 %

Option B

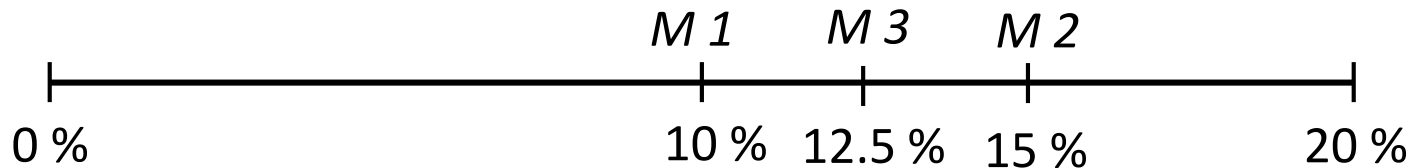
15 % - 20 %

- Calculate new Midpoint based on updated lower (10 %) and upper bound (15 %) for the median.
- Midpoint 3 (M3) = 12.5 %

# Exchangeability method: Illustration

- Minimum ( $b_0$ ): 0 %      Maximum ( $b_1$ ): 20 %
- Find Median: [Step 3]

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 12.5 %

Option B

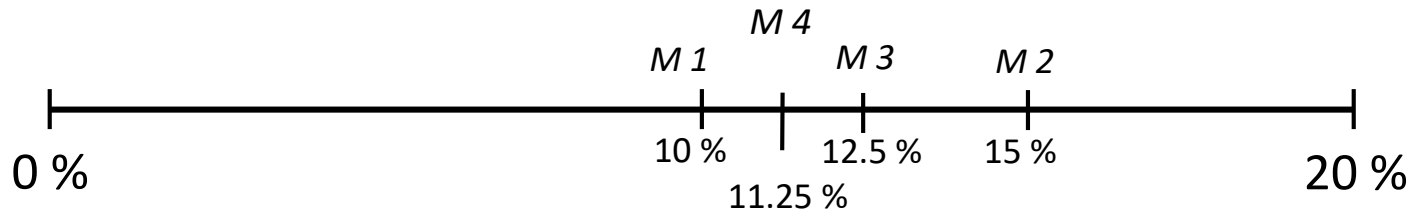
12.5 % - 20 %

- Calculate new Midpoint based on updated lower (10 %) and upper bound (12.5 %) for the median.
- Midpoint 4 ( $M_4$ ) = 11.25 %

# Exchangeability method: Illustration

- Minimum ( $b_0$ ): 0 %      Maximum ( $b_1$ ): 20 %
- Find Median: [Step 4]

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 11.25 %

Option B

11.25 % - 20 %

- Calculate new Midpoint based on updated lower (11.25 %) and upper bound (12.5 %) for the median.
- Midpoint 5 ( $M_5$ ) = 11.875%; Median in Range [11.25% , 12.5%] , given required precision of 1.5% we set **Median = 11.875%**

# Application

Data from two online surveys (collected via *Prolific*)

## UK September 2023 (N = 811)

- UK general population
- 4 treatment groups:
  - “Bin” method from SCE
  - “Bin” method with response scale around point prediction (Central Bank of Turkey)
  - Midpoint method with an endogenous number of steps and precision
  - Midpoint method with a fixed number of 2 steps and precision
- Latest Office for National Statistics UK release for CPI for September 2023 was 6.3%

## US November 2024 (N = 4,018)

- US general population
- 2 treatment groups:
  - “Bin” method from SCE
  - Midpoint method with an endogenous number of steps and precision
- RCT with 4 information treatments and control group
  - Highest/lowest professional forecast
  - Mean of professional forecasters
  - Mean + uncertainty of professional forecasters
- Latest Bureau of Labor Statistics release for CPI for October 2024 was 2.6%

# Application: Survey Structure

There are relevant differences in structure

- **All methods:**
  - Introductory instructions
  - Point prediction
- **RCT [Only November 2024]**
- **Bins:**
  - 1 screen, with several entries.
- **Midpoint method:**
  - 2 screens for  $b_0$  and  $b_1$  (question + confirmation screen)
  - 1 screen introducing sequence for median, screens with sequence for median
  - 1 screen introducing P25, screens with sequence for P25
  - 1 screen introducing P75, screens with sequence for P75
- **Postsurvey**

# Survey results: Practicability

	Perceived Difficulty (1 – 5)	Perceived Length (1 – 5)	Time Taken for Elicitation (in seconds)
<i>U.K. Data</i>			
<b>2-Step</b>	2.45 (1.06)	2.00 (0.17)	108.13 (91.23)
<b>Endogenous</b>	2.38 (1.07)	1.99 (0.14)	109.62 (84.56)
<b>Bins SCE</b>	2.48 (1.20)	2.00 (0.20)	116.72 (94.70)
<b>Bins Shift</b>	2.56 (1.11)	1.99 (0.20)	122.00 (108.54)
<i>U.S. Data</i>			
<b>Midpoint</b>	2.69 (1.12)	2.98 (0.30)	166.97** (315.01)
<b>Bins SCE</b>	2.69 (1.13)	2.98 (0.31)	183.48 (178.04)

- Midpoint method at least as easy and fast as bin methods, despite more steps, screens.
- Follow-up U.S. survey shows that midpoint method can be faster to complete

# Survey results: Implied means, uncertainty, disagreement

	U.K. Survey (Sep. 2023)			U.S. Survey (Nov. 2024)	
	Midpoint (N=405)	Bins SCE (N=200)	Bins Shift (N=206)	Midpoint (N=2,015)	Bins SCE (N=2,003)
<b>Implied Mean</b>	6.21	5.09***	6.27	3.99 (5.06)	2.75 (3.24)***
<b>Disagreement</b>	3.65	2.98***	3.88	6.01 (8.08)	2.75 (3.07)***
<b>Uncertainty</b>	1.46	3.78***	3.14***	1.30 (1.75)	3.36 (3.78)***

- Actual inflation at 6.3% (September 2023) and 2.6% (October 2024)
- Comparing “midpoints“ vs. “bins“:
  - Higher implied means than “Bins SCE” / no difference with “endogenous bin” -> anchoring at bin?
  - Higher disagreement (in particular with information treatments)
  - Lower uncertainty
  - Most differences with SCE method; less differences with Bins Shift method

# Quality Evaluation

## Quality Criteria:

1. Correlation with point forecast
2. Deflation expectations
3. Perceived “goodness of fit”
4. Correlation with spending

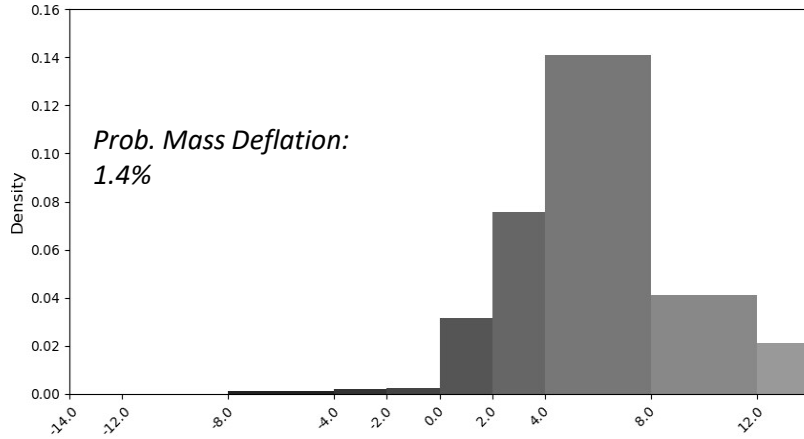
# Quality (1): Correlation with Point Forecast

	U.K. Survey (Sep. 2023)		U.S. Survey (Nov. 2024)	
	Correlation	Confidence Interval	Correlation	Confidence Interval
<b>Midpoint</b>	0.73 <sup>***</sup>	[0.68, 0.77]	0.75 <sup>***</sup>	[0.71, 0.79]
<b>Bins SCE</b>	0.51 <sup>***</sup>	[0.40, 0.61]	0.20 <sup>***</sup>	[0.10, 0.29]
<b>Bins Shift</b>	0.85 <sup>***</sup>	[0.81, 0.89]	–	–

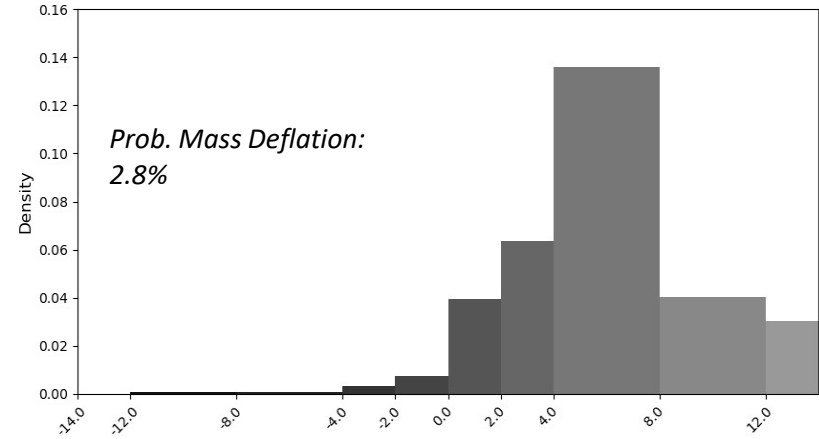
- High correlation with point prediction
  - Despite no direct “Number entry”, only comparison of the intervals!
  - Correlation for midpoint stable across high and low inflationary periods

# Quality (2): Deflation Expectations

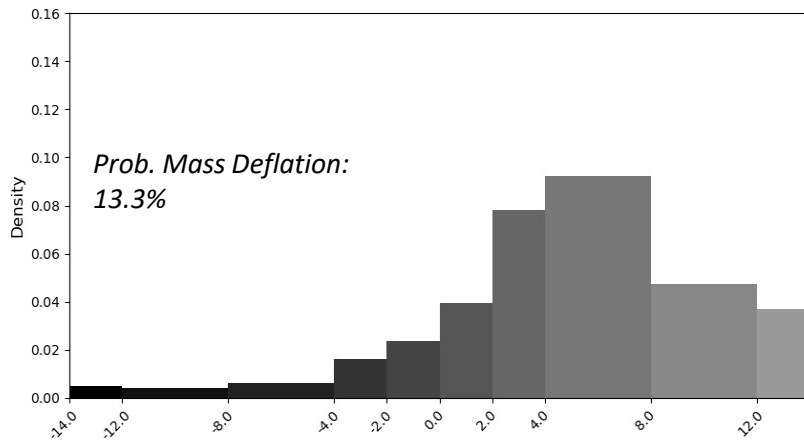
## 2-Step \*



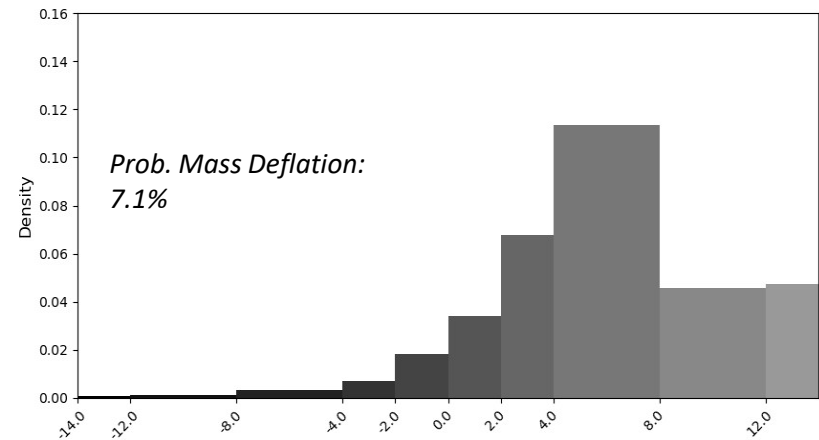
## Endogenous \*



## Bins (SCE)



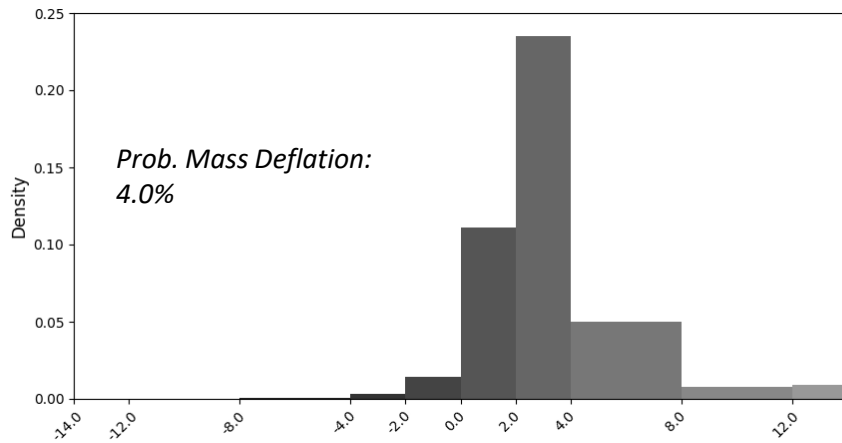
## Bins Shift



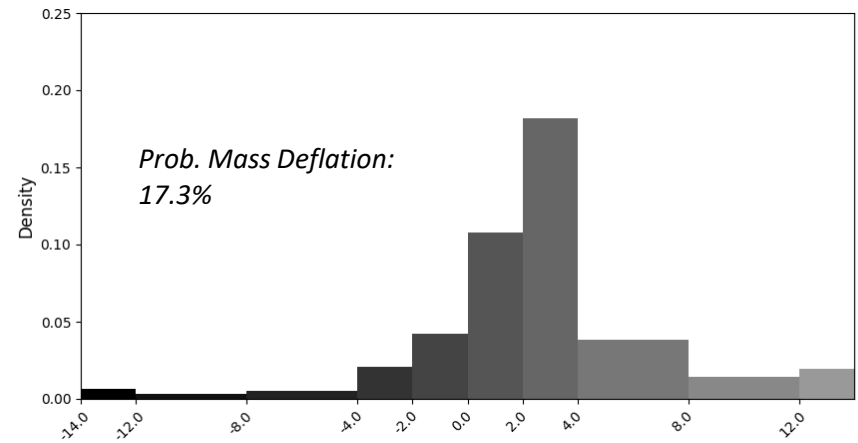
\* Calculated assuming uniform distribution within endogenous bins for each respondent

# Quality (2): Deflation Expectations

## Midpoint \*



## Bins \*



\* Calculated assuming uniform distribution within endogenous bins for each respondent

# Quality (3): Perceived “goodness of fit”

1. Calculate implied median and implied deflation probability from respondents’ answers in real-time
2. Ask respondents the following two questions:
  - “Would you agree that it is approximately equally likely that inflation in 12 months is higher or lower than [median]%?”
  - “Would you agree that the probability of there being deflation over the next 12 months is about [deflation probability]%?”

in %	Midpoint	Bins SCE
<i>Perception Median</i>		
<b>Agree</b>	60.40	57.56*
<b>Rather higher</b>	19.75	25.76
<b>Rather lower</b>	19.85	16.67###
<i>Probability of Deflation</i>		
<b>Agree</b>	56.18	46.28***
<b>Rather higher</b>	26.20	11.68
<b>Rather lower</b>	17.62###	42.04###

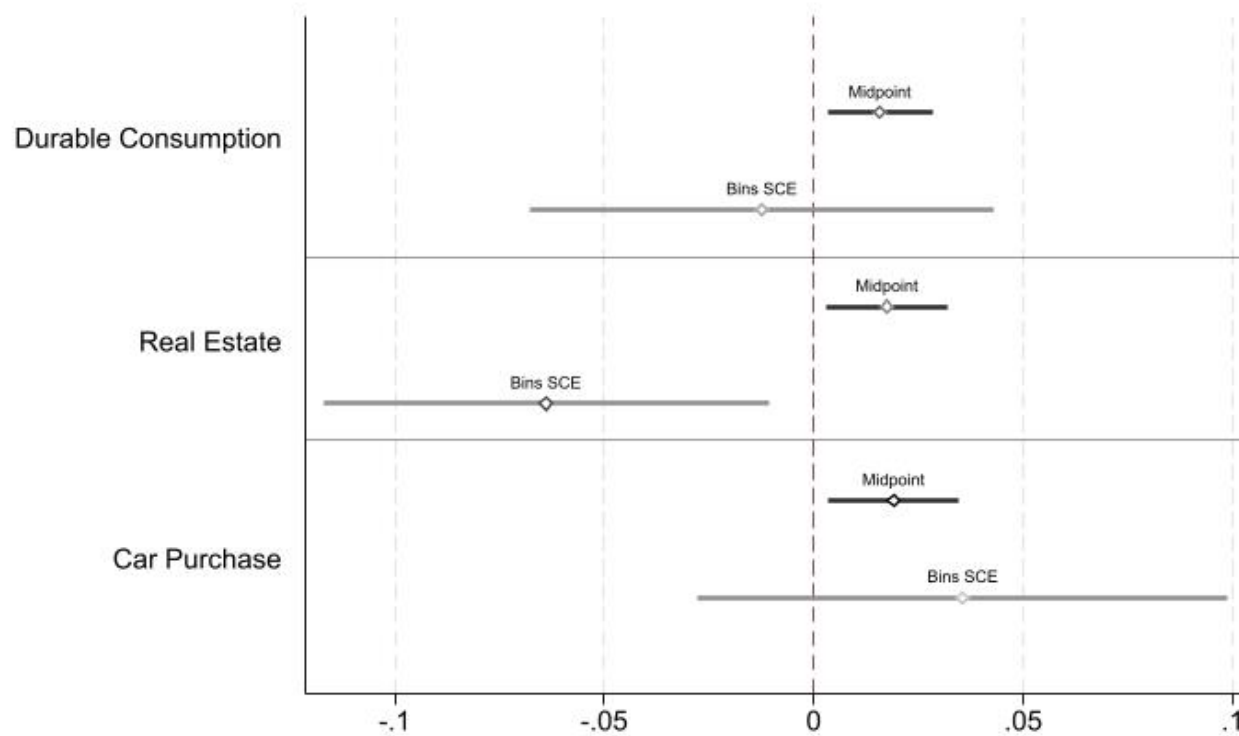
# Quality (4): Link to durable consumption

- Use our RCT design to establish the causal link between inflation expectations and spending behavior for both methods
  - We only focus on *current* durable goods spending by adopting three questions from the Michigan Survey of Consumer Expectations / EU Consumer Survey (*Answers from 1-5*):
    1. *Is this a good time or a bad time to buy durable goods like electronics, mobile phones, home appliances?*
    2. *Is this a good time or a bad time to invest in real estate in your city?*
    3. *Is this a good time or a bad time to buy a car?*
- *Positive relationship is predominantly documented and consistent with the consumption Euler equation (Duca-Radu et al., 2021; D'Acunto et al., 2022)*

# Quality (4): Link to durable consumption

$$\begin{aligned} \text{(1st Stage): } Post_i^{mean} &= a_0 + \sum_{j=1}^4 a_j \times I\{i \in Treat_j\} \\ &+ \sum_{j=1}^4 b_j \times I\{i \in Treat_j\} \times Prior_i^{mean} + Controls_i + error_i \end{aligned}$$

$$\text{(2nd Stage): } Spending_i = \alpha_0 + \alpha_1 Post_i^{mean} + Controls_i + error_i$$



# Conclusion

- Propose new method to elicit distribution of inflation expectations (or any other macroeconomic expectation)
  - Does not use bins or any other external framing or anchor
  - Can be used in any context (high and volatile environment) or across different variables
  - Perceived as easy; low cognitive or **educational** requirements
- Application
  - Measuring inflation in countries with high inflation and high heterogeneity in education of the population
  - Obtain comparable results over time even in volatile inflationary environments
  - Results can be compared across countries with different levels of inflation

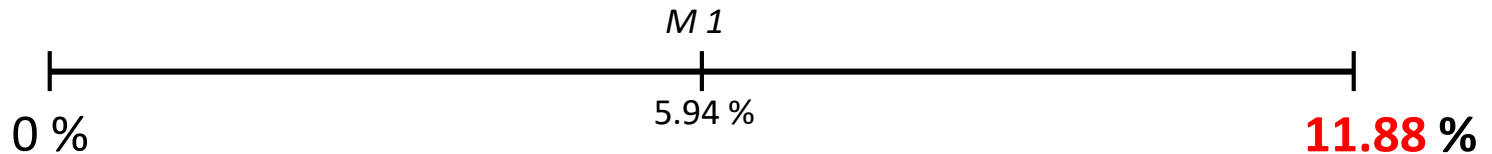
# Exchangeability method: Practical issues

- **Wide range ( $b_0, b_1$ ).**
  - Does not harm precise elicitation of percentiles.
  - But: May lead to large outer percentiles that are mostly empty; violates mass at midpoint assumption
  - Problem can be mitigated by further splitting percentiles endogenously depending on their size
- **Random choice in later questions.**
  - Implied by approaching indifference as we converge to the true median etc.
  - Add “cannot say” or “consider equal”; modest error if later in the sequence.
- **Error Propagation.**
  - Inherent to chained question (question  $n$  depends on answer to question  $n-1$ ).
  - Mitigate by requiring higher precision for earlier percentiles.
- **Midpoints exactly equal to elicited percentile.**
  - If some midpoint is exactly equal to the percentiles we initially move away from the true value with the choice sequence, then re-approach it.
  - E.g., in elicitation of median assume that true median is 10. With precision of 1.5% as in example, the process would have stopped at 10.624%.
  - Unlikely to happen? Reduce by requiring higher precision; “consider equal”
  - See graph simulation.

# Exchangeability method: Illustration

- **Find 25%-percentile:** [Step 1]
- Minimum ( $b_0$ ): 0 %      Median: **11.875 %**

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 5.94 %

Option B

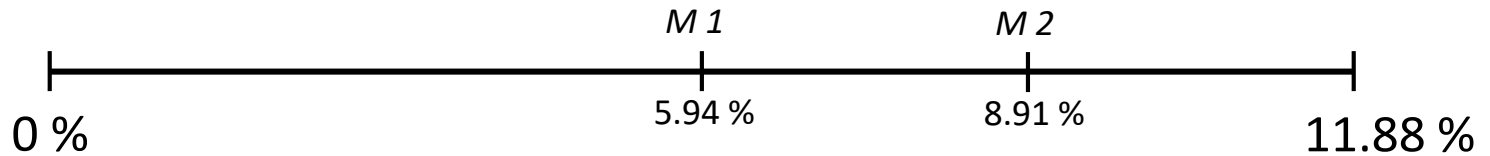
5.94 % - 11.88 %

- Calculate new Midpoint based on updated lower (5.94 %) and upper bound (11.88 %) for the 25%-percentile.
- Midpoint 2 (M2) = 8.91 %

# Exchangeability method: Illustration

- Find 25%-percentile: [Step 2]
- Minimum ( $b_0$ ): 0 %      Median: 11.875 %

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 8.91 %

Option B

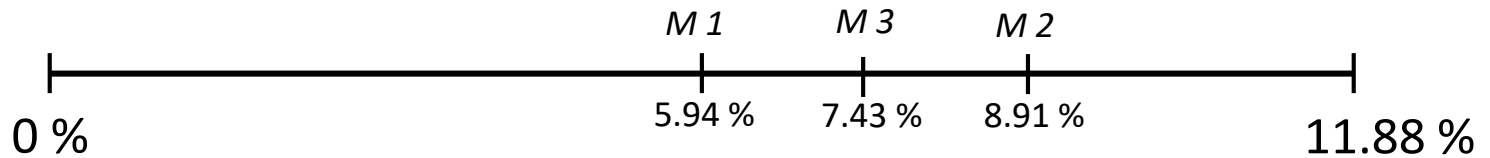
8.91 % - 11.88 %

- Calculate new Midpoint based on updated lower (5.94 %) and upper bound (8.91 %) for the 25%-percentile.
- Midpoint 3 (M3) = 7.425 %

# Exchangeability method: Illustration

- Find 25%-percentile: [Step 3]
- Minimum ( $b_0$ ): 0 %      Median: 11.875 %

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

0 % - 7.43 %

Option B

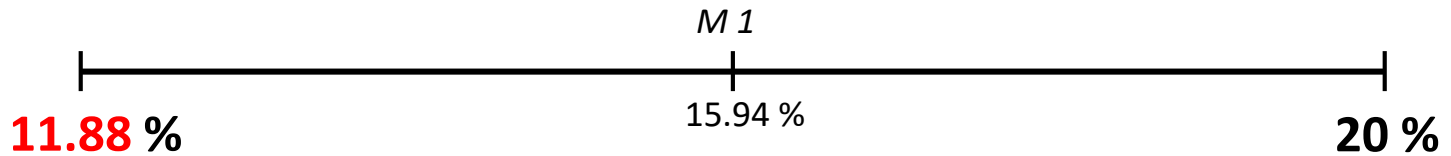
7.43 % - 11.88 %

- Calculate new Midpoint based on updated lower (5.94 %) and upper bound (7.43 %) for the 25%-percentile.
- Midpoint 4 (M4) = 6.685 % in Range [5.94 % , 7.43 %] , given required precision of 1.5% we set  $P25 = 6.685\%$

# Exchangeability method: Illustration

- Find 75%-percentile: [Step 1]
- Median: 11.875 %      Maximum ( $b_1$ ): 20 %

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

11.88 % - 15.94 %

Option B

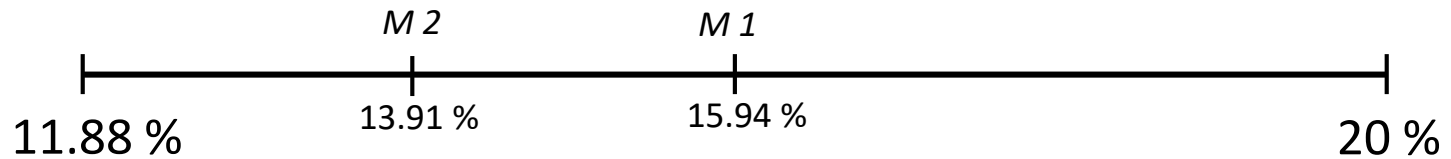
15.94 % - 20 %

- Calculate new Midpoint based on updated lower (11.88 %) and upper bound (15.94 %) for the 75%-percentile.
- Midpoint 2 (M2) = 13.91 %

# Exchangeability method: Illustration

- Find 75%-percentile: [Step 2]
- Median: 11.875 %      Maximum ( $b_1$ ): 20 %

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

11.88 % - 13.91 %

Option B

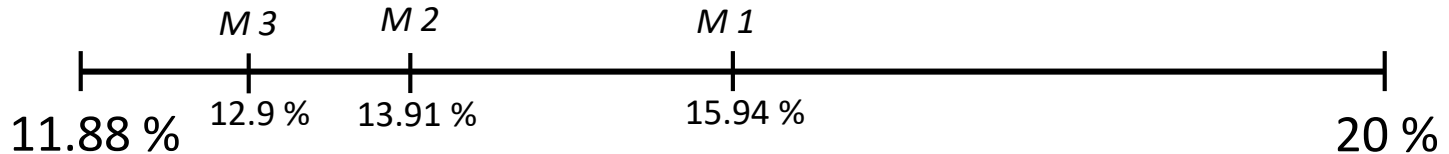
13.91 % - 20 %

- Calculate new Midpoint based on updated lower (11.88 %) and upper bound (13.91 %) for the 75%-percentile.
- Midpoint 3 (M3) = 12.895 %

# Exchangeability method: Illustration

- Find 75%-percentile: [Step 3]
- Median: 11.875 %      Maximum ( $b_1$ ): 20 %

*Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?*



Option A

11.88 % -  
12.9 %

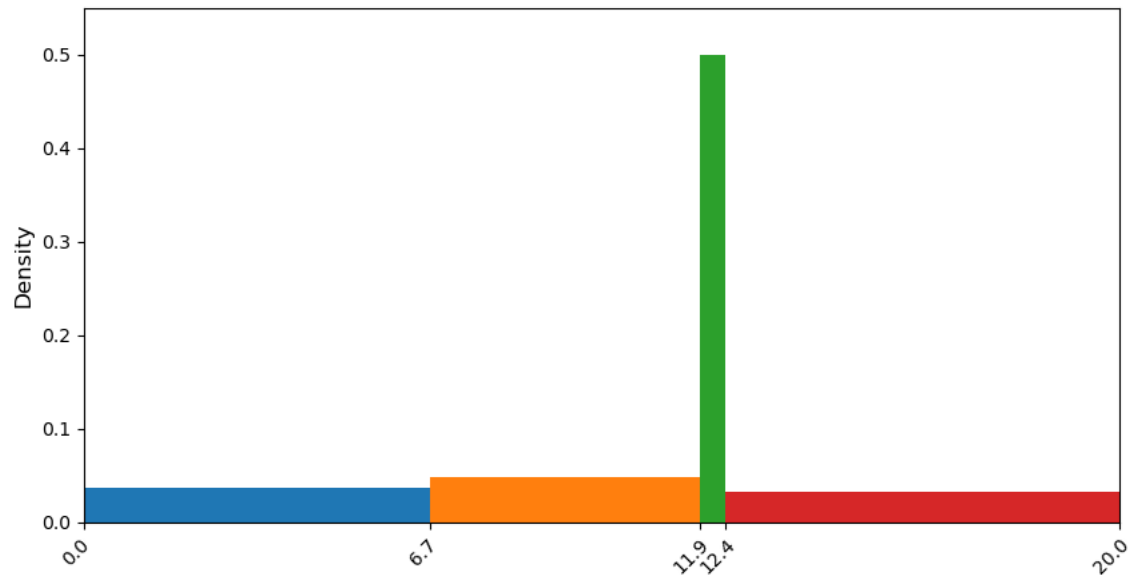
Option B

12.9 % - 20 %

- Calculate new Midpoint based on updated lower (11.88 %) and upper bound (12.9 %) for the 75%-percentile.
- Midpoint 4 (M4) = 12.39 % in Range [11.88 % , 12.9 %] , given required precision of 1.5% we set  **$P75 = 12.39%$**

# Exchangeability method: Illustration – Results Example

- Obtain four “bins” where bin width is endogenous (individual-specific); each bin contains 25% probability mass.
- Graph assumes uniform distribution within-bin.



# Survey Questions: Midpoint questions (sub-sample)

## Inflation Expectations

In your opinion, what is the minimum rate of inflation over the next twelve months for which you think that there is absolutely no chance the true rate of inflation will be lower?

Note: The aim of this question is to determine the absolute lowest possible rate of inflation (or negative numbers if you expect deflation) that you would consider realistic over the next twelve months.

 %

In your opinion, what is the maximum rate of inflation over the next twelve months for which you think that there is absolutely no chance the true rate of inflation will be higher?

Note: The aim of this question is to determine the absolute highest possible rate of inflation (or negative numbers if you expect deflation) that you would consider realistic over the next twelve months.

 %

Next

# Survey Questions: Midpoint questions (sub-sample)

## Question 1/2

Which of the following two scenarios regarding the rate of inflation over the next twelve months do you consider more likely?

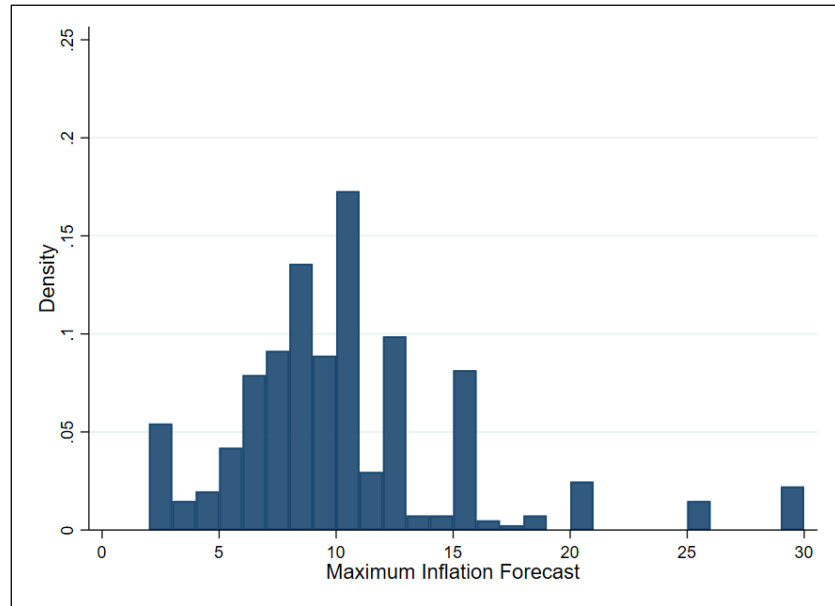
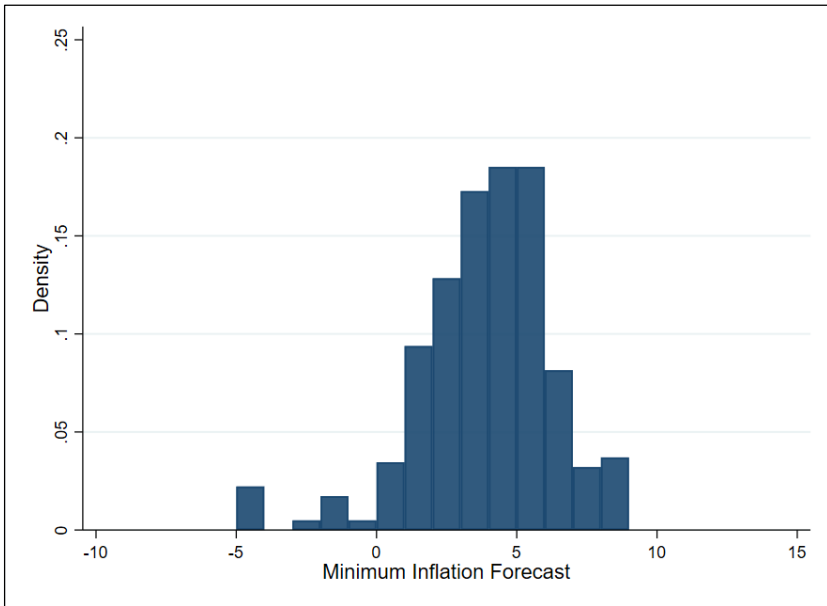
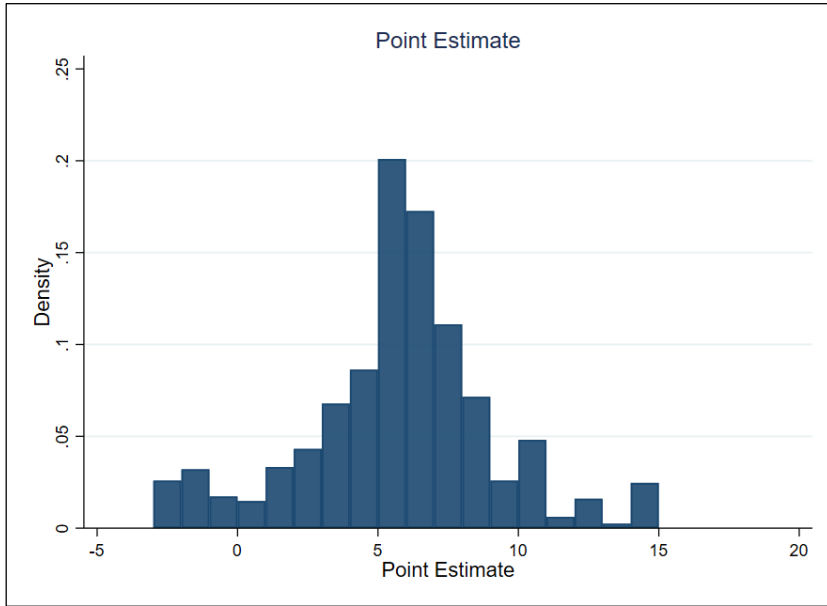
- 0.0% to 10.0%
- 10.0% to 20.0%

Next

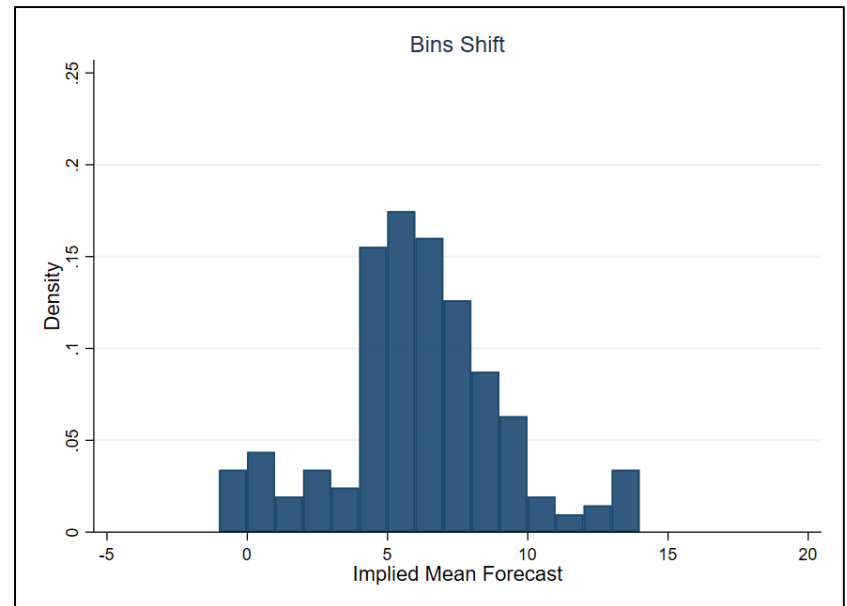
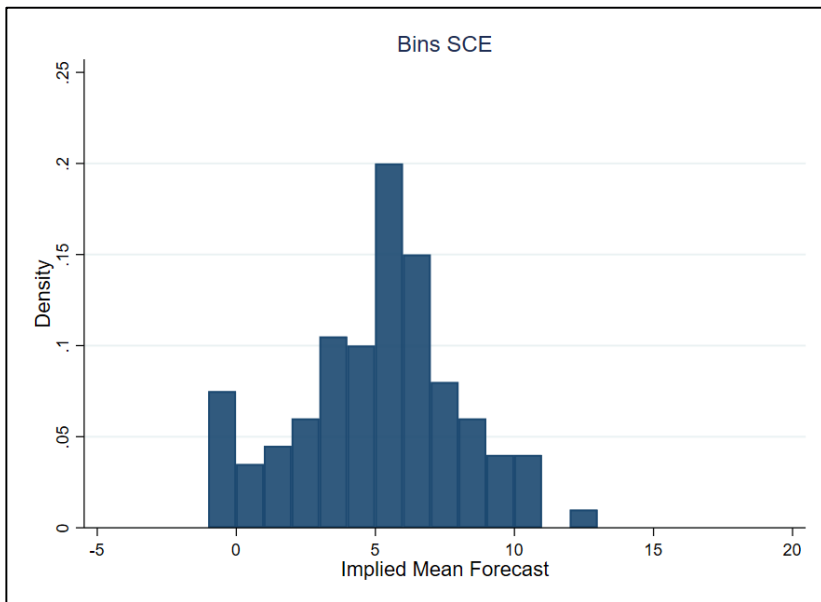
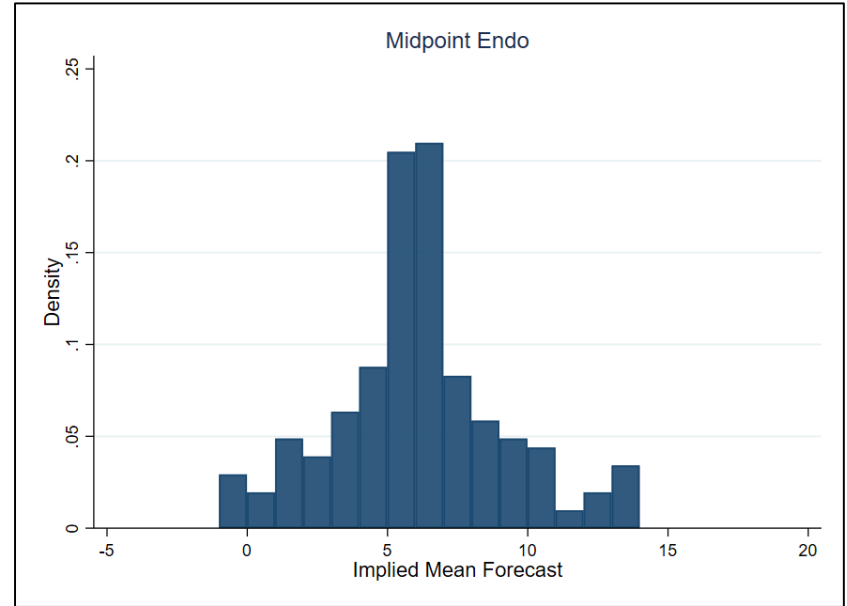
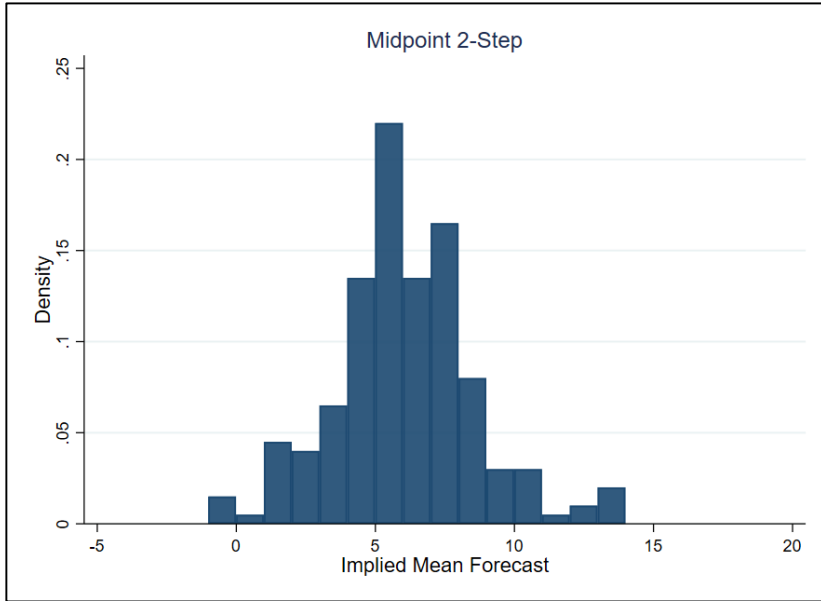
# Application: Summary Statistics

	Mean	Standard Deviation	Median	Min	Max
<b>Point Forecast</b>	5.51	4.43	6	-30	40
<i>Bin Treatments:</i>					
<b>#Bins used (SCE)</b>	<u>6.01</u>	2.65	<u>5</u>	1	10
<b>Bin Size (SCE)</b>	21.11	12.15	20	10	100
<b>#Bins used (Shift)</b>	<u>6.69</u>	2.53	<u>7</u>	1	10
<b>Bin Size (Shift)</b>	18.37	10.94	14.29	10	100
<i>Midpoint Treatments:</i>					
<b>Minimum (2-Step)</b>	3.41	2.49	4	<u>-8</u>	15
<b>Maximum (2-Step)</b>	10.18	6.23	9	1	<u>60</u>
<b>Number of Steps (2-Step)</b>	1.61	0.39	2	1	2
<b>Minimum (Endogenous)</b>	3.58	3.09	4	<u>-10</u>	17
<b>Maximum (Endogenous)</b>	10.06	6.15	9	1	<u>50</u>
<b>Number of Steps (Endogenous)</b>	<u>2.11</u>	0.86	2	1	4

# Application: Distribution of Beliefs (winsorized)

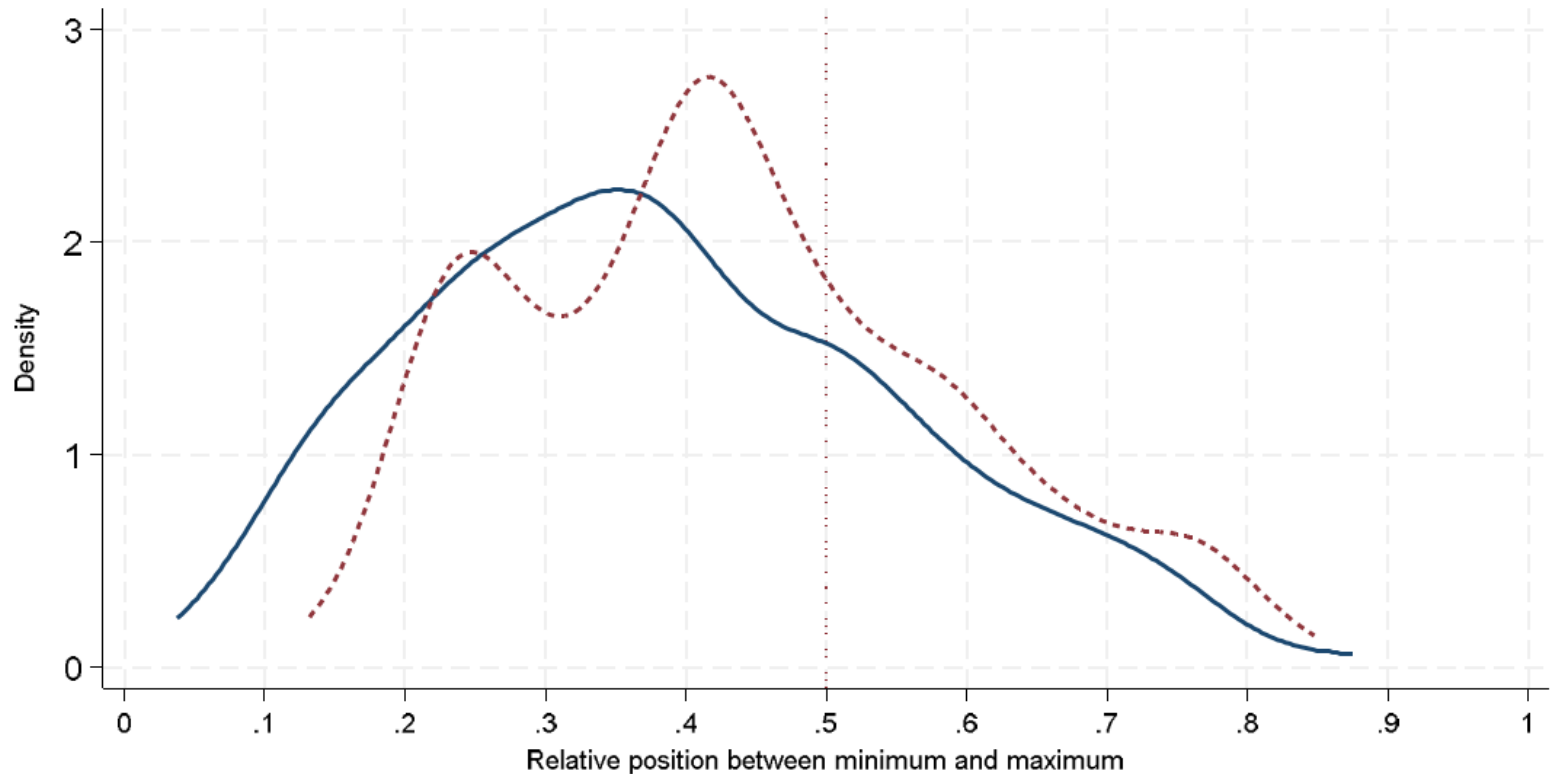


# Application: Distribution of Beliefs (winsorized)



# Application: Location of Point Forecast/ Implied Mean relative to Min and Max

**Figure 2: Sample Distribution of the Relative Position of Inflation Estimates between the Minimum and Maximum**

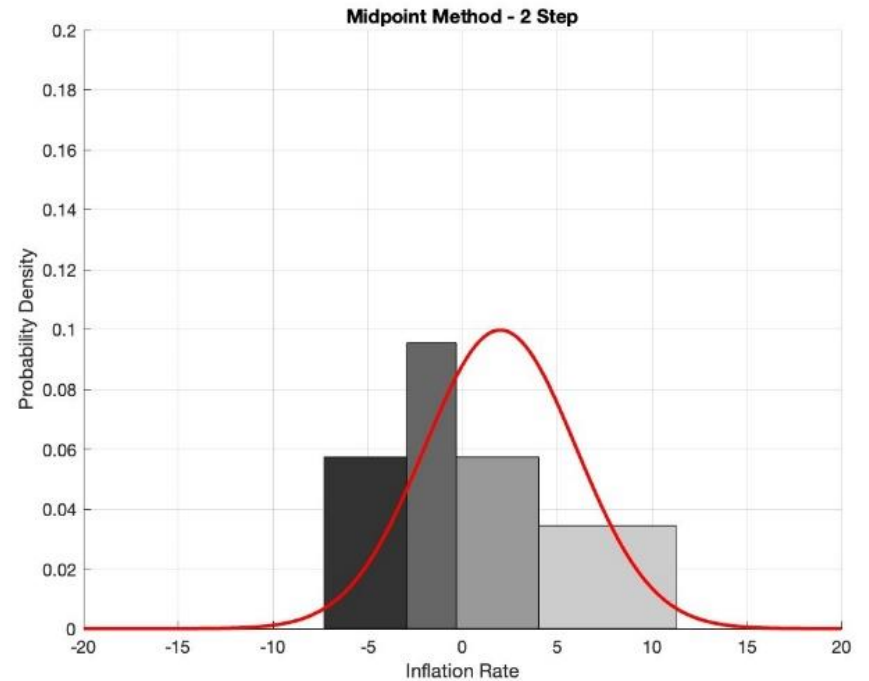
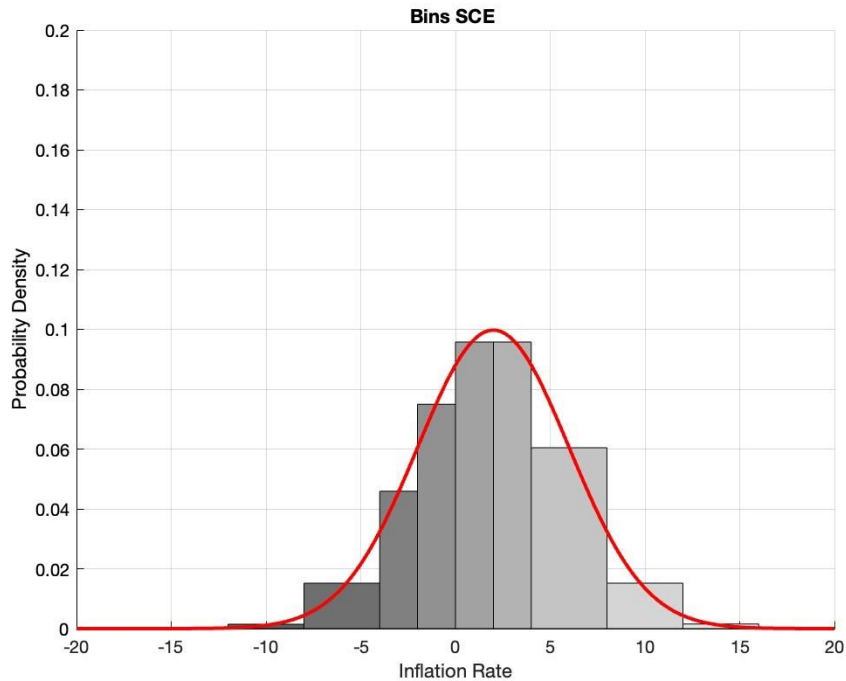


- Effect of random choice in Midpoint method

— Point    - - - - Implied Mean

# Mapping of latent on elicited beliefs

Symmetric normal distribution (mean  $\mu = 2$ , standard deviation  $\sigma = 4$ ); min-max 1<sup>st</sup> and 99<sup>th</sup> percentile



# Mapping of latent on elicited beliefs

Skewed normal distribution (mean  $\mu = 2$ , standard deviation  $\sigma = 4$ , skewness  $\alpha = 5$ ); min-max 1<sup>st</sup> and 99<sup>th</sup> percentile

