Quantifying Subjective Uncertainty in Survey Expectations

Fabian Krüger
Heidelberg University

Lora Pavlova
Heidelberg University and
Deutsche Bundesbank

Motivation

- Growing interest in determinants and consequences of economic uncertainty.
- Research benefits from recent data sets on consumers' probabilistic forecasts, like Survey of Consumer Expectations (SCE, see Figure 1).

Goal of this paper: Propose a new measure of expectation uncertainty.

Stylized Facts on Response Behavior

- Many consumers use only one or two bins (see Figure 2). The latter behavior is rare for professional forecasters (e.g., SPF).
- Similarly, use of outer bins more common among consumers than among professionals.
- Response behavior correlated to socio-demographic characteristics.

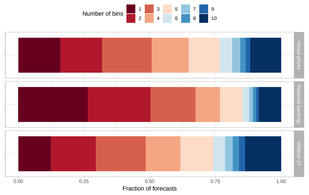


Figure 2: Number of bins used for different variables. Sample: Jan, 2014: Dec, 2017 of SCE.

Benchmark Method

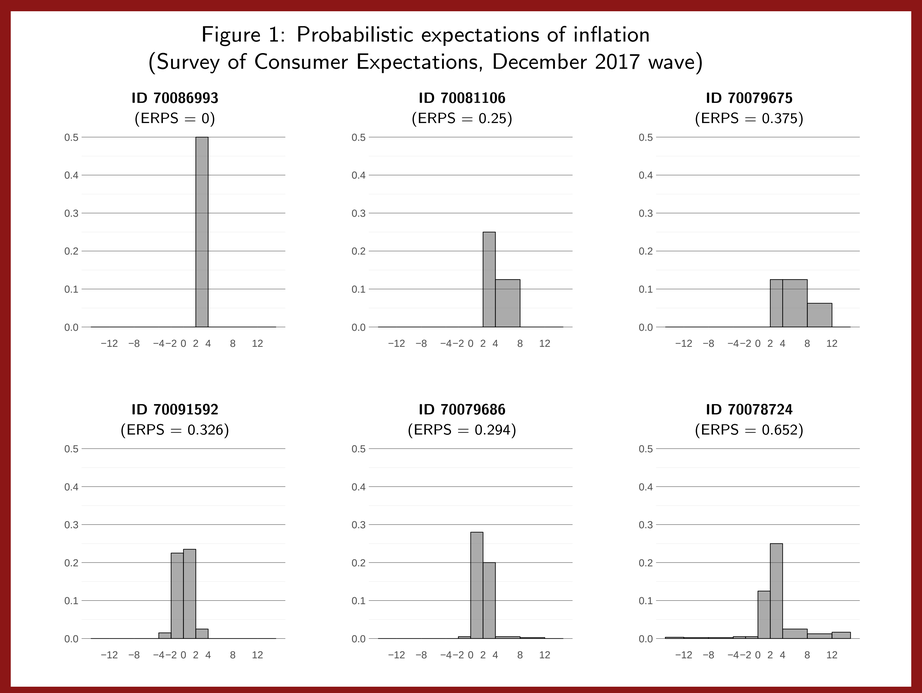
Standard approach (Engelberg et al., *JBES* 2009):

- Fit triangular distribution if only one or two histogram bins are used;
- Fit generalized beta distribution otherwise.

Pro: Obtain an entire probability distribution from which mean, std. dev., etc. can be computed. **Con:** Two different functional forms; requires assumptions and tuning parameters; some cases not covered (e.g. use of two non-adjacent bins)

We introduce a **simple**, **robust**, and **principled** measure of **uncertainty** in survey histograms

Figure 1: Probabilistic expectations of inflation
(Survey of Consumer Expectations, December 2017 wave)



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Our Proposal

Quantify uncertainty via the entropy function of the Ranked Probability Score (RPS):

- $\text{RPS}(\underline{p}, k)$ measures the 'error' of the probabilistic forecast $\underline{p} = (p_1, p_2, \ldots, p_K)'$ if the outcome falls into bin $k \in \{1, 2, \ldots, K\}$. Note: Ordinal ($\neq$ numerical) interpretation of histogram bins!
- Entropy as the expected forecast error under probability distribution $\underline{p}$. High if $\underline{p}$ is spread out, low if $\underline{p}$ focuses on few bins.

Proposed measure:
Expected Ranked Probability Score (ERPS)

$$\text{ERPS}(\underline{p}) = \sum_{k=1}^{K} p_k \text{RPS}(\underline{p}, k) = \sum_{k=1}^{K} P_k(1 - P_k).$$

with $P_k = \sum_{j=1}^{k} p_j$ = cumulative probability of first k bins.

Advantages: Simple; robust; theoretical motivation via entropy function; no assumptions needed.

Simulation Evidence

We validate the ERPS via two simulation studies:

- Both the ERPS and the measure by Engelberg et al. (2009) are robust across various sets of histogram bin definitions.
- The ERPS is robust to small changes in the probabilities. Standard deviation $\hat{\sigma}$ obtained from Engelberg et al. (2009) approach is not.

Empirical Evidence

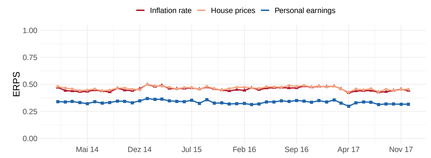

Figure 3: For each variable and month the figure shows the mean ERPS across survey respondents for different economic variables. Sample: Jan, 2014: Dec, 2017 of SCE.

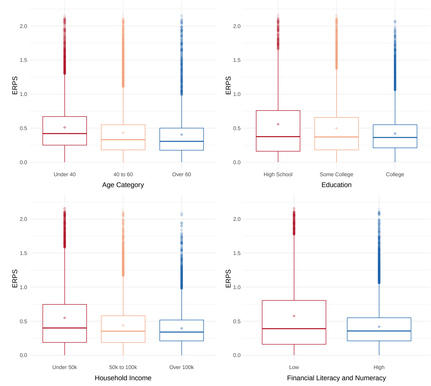

Figure 4: Subjective uncertainty across socio-demographic groups. Sample: Jan, 2014: Dec, 2017 of SCE.