

# Bayesian Econometrics

## Elicitation

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# Outline

## 1 Elicitation

# Elicitation

## Definition

“Elicitation is the process of formulating a person’s knowledge and beliefs about one or more uncertain quantities into a (joint) probability distribution for those quantities.”

Garthwaite et al. (2005)

## What does it mean for an elicitation to be done well?

“An elicitation is done well if the distribution that is derived accurately represents the expert’s knowledge, regardless of how good that knowledge is.” Garthwaite et al. (2005)

# Elicitation

## Conduction the elicitation

- The aim is to elicit a distribution to represent the expert's current knowledge.
- Any interest that the expert has must be declared.
- Training should be given to familiarize the expert.
- A record should be kept of the elicitation.

## The fundamental steps (Kadane and Wolfson, 1998)

- Establishing the general framework of the elicitation process.
- Obtaining some characteristics of the probability distribution function of elicited parameters.
- Checking the consistency of the expert's statements.

# Elicitation

## Heuristic and Biases: Representativeness

### The problem of base-rate neglect

A particular heart disease has a prevalence of  $1/1000$  people. A test to detect this disease has a false positive rate of 5%. Assume that the test diagnoses correctly every person who has the disease. What is the chance that a randomly selected person found to have a positive result actually has the disease?

### Insensitivity to prior probability of outcomes

Mr. X is meticulous, introverted, meek, and solemn. What is the probability that Mr. X is engaged in one of the following occupations: farmer, salesman, pilot, librarian or physician?

# Elicitation

## Heuristic and Biases: Representativeness

### Conjunction fallacy

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations.

Which is more probable?

- Linda is a bank teller.
- Linda is a bank teller and is active in the feminist movement.

# Elicitation

## Heuristic and Biases: Representativeness

### Inensitivity to sample size

Consider the problem of two hospitals of different sizes in the same town. In the large hospital, 45 babies are born each day, whereas only 15 are born in the smaller hospital. 50% of all babies are boys, but on some days the percentage will be higher and on other days, it will be lower.

Which hospital would you expect to record more days per year, when over 60% of the babies born were boys?

### Miss-perception of chance and randomness: “the gambler’s fallacy”

Which sequence is more representative of a fair coin:  
H-T-H-T-T-H or H-H-H-T-T-T?

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## Heuristic and Biases: Availability

### Retrievability

A list of male and female names with famous people (women), and ask: what is the proportion between male and female names?

### Effectiveness of a search set

It is more likely that a word starts with **r** or that **r** is the third letter?

### Bias due to imaginability

Consider a group of 10 people who forms committees of **k** members,  $2 \leq k \leq 8$ . How many different committees of **k** members can be formed?



# Elicitation

## Heuristic and Biases: Anchoring and adjustment

### Insufficient adjustment

- What is the percentage of African countries in the United Nations?
- You have 5 seconds to say:
  - What is the outcome of  $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$ ?
  - What is the outcome of  $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ ?

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## Heuristic and Biases: Anchoring and adjustment

### Conjunctive vs disjunctive events

You have the opportunity to bet in one of the following three events:

- Draw a red ball from a box where there are 50% red balls and 50% white balls.
- Draw a red ball seven times in succession, with replacement, from a box where there are 90% red balls and 10% white balls.
- Draw a red ball at least once in seven successive tries, with replacement, from a box where there are 10% red balls and 90% white balls.

# Elicitation

## Heuristic and Biases: Anchoring and adjustment

### Anchoring by priming

- Do you think that Gandhi died older than 100 years?
- How old was Gandhi when he died?

### Anchoring by priming

- Do you think that Gandhi died older than 35 years?
- How old was Gandhi when he died?

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## Heuristic and Biases: Conservatism

### Conservatism

There are two boxes:

- Box 1: 70% of the balls are red and 30% are blue.
- Box 2: 70% of the balls are blue and 30% are red.

What is the probability that you draw from the box number 1 if you got 8 red balls and 4 blue balls, and the box was selected flipping a fair coin?

# Elicitation

## Heuristic and Biases: Law of small numbers

### Law of small numbers

Suppose a drug is effective in 80% of patients. If five patients are treated, how many will respond?

# Elicitation

## Heuristic and Biases: Hindsight bias

### Hindsight bias

In 1988, what was the probability that the Berlin Wall would come down within the next 5 years?

# Elicitation

## Heuristic and Biases (Tversky and Kahneman, 1974)

### Heuristic and Biases

- Representativeness
  - The problem of base-rate neglect
  - Insensitivity to prior probability of outcomes
  - Insensitivity to sample size
  - Miss-perception of chance and randomness
- Availability
  - Retrievability
  - Effectiveness of a search set
  - Bias due to imaginability

# Elicitation

Heuristic and Biases (Tversky and Kahneman, 1974)

## Heuristic and Biases

- Anchoring and adjustment
  - Insufficient adjustment
  - Biases in the evaluation of conjunctive and disjunctive events
- Conservatism
- Law of small numbers
- Hindsight bias
- Overconfidence



# Elicitation

## What summaries to elicit

### What summaries to elicit

- The sample proportion is well estimated
- Subjects estimate well the mode, mean and median when the p.d.f. is symmetric. But, if the p.d.f. is highly skewed, subjects' assessment of the mean is biased to the median.
- People are poor both at interpreting the meaning of variance and at assigning numerical values to it.
- There are two approaches to assessing credible intervals: the fixed interval method and the variable interval method.
- Assessing the extreme tails of distributions is difficult.

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## What summaries to elicit

### What summaries to elicit

- It seems better to elicit probabilities in terms of population of events, such as “what proportion of students starting a Ph.D. will complete it within 5 years?” rather than as single (one-shot) events, like “if a new Ph.D. student is picked at random, what is the probability that he or she will complete the Ph.D. within 5 years?”.
- Eliciting multivariate distributions is a very complicated task.

# Elicitation

## Fitting a distribution

### Fitting a distribution

- Uniform distribution: Bounds
- Triangular: Mode and bounds
- Hyperparameters
  - Proportions → Beta distribution
    - Quantile method (Winkler, 1972)
    - Hypothetical future sample
    - Equivalent prior sample (Winkler, 1967)
    - Probability density function (Winkler, 1967)

It seems that the quantile method is the best (Garthwaite et al., 2005).

- Linear regressions
  - Predictive vs structural elicitation (Kadane, 1980, Kadane and Wolfson, 1998).

# Elicitation

## Testing adequacy

### Internal consistency

A system of probability is coherent if the probabilities are all consistent with the laws of probability.

The simplest way to achieve this is to confront the expert.

- The internal approach
- Overfitting
- Feedback

# Elicitation

## Testing adequacy

### Sensitivity analysis

The objective of sensitivity analysis is to determine to what extent the posterior outcomes vary with other prior distributions that are consistent with experts' knowledge. How can we determine whether the result changes appreciably as the distribution changes? The answer depends on the decision made from the utility function.

# Elicitation

## Testing adequacy

### Robustness analysis

Despite the fact that there is a debate regarding the relevance of prior robustness analysis; on the one hand the coherent behavior claims for a single prior distribution, but on the other hand it can be very difficult to obtain such a fine prior distribution (Berger, 1985), we think that empirical arguments suggest a combination of elicitation procedures and robustness to possible prior misspecification as an advisable rule.

# Elicitation

## Testing adequacy

### Scoring rules

To compare assessed probability distributions with the observed data to provide an objective measure of its accuracy. However, better scores result both from the expert assessing his/her beliefs more accurately and from the expert having more knowledge.

# Elicitation

## Multiple experts

### Multiple experts

- Separate elicitation
  - Opinion pools  $\rightarrow$  weighted average individual priors
- Group elicitation
  - Delphi method



# Elicitation

## Future research

### Future research

“In the case of parametric elicitation, then, overfitting has the potential to either refine the specification of the hyperparameters or refine the assumed distributional family. Notice, however, that to decide between these two opinions, the facilitator needs to have some idea of the accuracy of the expert’s judgments. Given that this kind of judgment by the facilitator is required, it may be that an extension of the approach of LT&B might be developed for this case, but we are not aware of any published work in this direction”  
Garthwaite et al. (2005), page 695

# Elicitation

## Future research

### Future research

- Multivariate elicitation
- Nonparametric elicitation
- Graphical tools

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