PREFERENCE AND BELIEF ELICITATION

- Consider the following example: an experimenter is selling a real object to the subjects via means of a sealed-bid auction. The objective is to understand the behavior of subjects in such auction. Bids of individual subjects will reflect home-grown valuations, subject beliefs about other subjects' values, their risk preferences, their strategic sophistication, etc. In order to see which of this potential determinants of bidding behavior is more important, it is useful to have measures of valuations, beliefs, risk preferences, other-regarding preferences and attitudes toward competition. We are in turn going to look at each of them.

Elicitation of Valuations: Becker-DeGroot-Marschak Procedure

- Considering the above example, it is sometimes useful to reveal how much a subject values some object that an experimenter can transfer to her. Generally, there may be a difference between willingness to pay (WTP) and willingness to accept (WTA), but we will ignore this difference here for the sake of simplicity.

- Simply asking may not do; subjects have no motivation to reveal the truth.

- What we need is an **incentive-compatible** (or truth-revealing) mechanism to reveal the answer. In an incentive-compatible mechanism, telling the truth is a dominant strategy.

- An often-used method is due to **Becker, DeGroot and Marschak (1964)**.

- Suppose that a subject valuation is known not to exceed $\overline{V}$. You first ask a subject to report his valuation V. You then generate a random number b from the uniform distribution on the interval $[0, \overline{V}]$. This number is not disclosed to the subject. What happens next depends on whether the object is already in the ownership of the subject of not.

  1. If the subject does not own the object, then if $b < V$, the subject receives the object and pays b. If $V \leq b$, then the subject does not receive the object and does not pay anything. This is equivalent to the subject bidding for the object in the second-price sealed bid auction in which it is a dominant strategy to bid one's own true valuation. This procedure elicits WTP.
  2. If the subject already owns the object, then if $b < V$, the subject keeps the object and does not receive any payment. If $V \leq b$, then the subject loses the object and receives a payment b. This is equivalent to the subject being an auctioneer in the first-price sealed bid auction in which he establishes a secret reserve price. Setting the secret reserve price equal to one's own true valuation is a dominant strategy in such auction. This procedure elicits WTA.

- Instead of drawing a random number, the procedure may also be implemented using a series of binary choices incentivized by the strategy method (one of the choices is selected at random *ex post* and implemented). For example, consider the situation when the subject does not own the object. Then you can face the subject with a series of choices of the form "If I were to charge you b for the object, would you be interested in obtaining it?", where b is gradually increased from 0 to $\overline{V}$. This variant of the procedure may be more transparent to subjects.

- **Limitation:** for obvious reasons, this method cannot be used to value things that the experimenter cannot transfer to or from the subject, such as health, achievements in professional and personal life, etc.

Elicitation of Beliefs Using the BDM Procedure

- Beliefs about probabilities of different events are one of the crucial components used in human decision-making. For example, considering the above example, it may be useful to know what beliefs a subject has about valuations of other bidders.

- Suppose we want to measure a subject's belief (subjective probability) that a particular event A will be realized. How do we do it?

- We can use a variant of Becker-DeGroot-Marschak procedure. You first ask a subject to report his belief $\widehat{p}(A)$ that event A will happen. You then generate a random number b from the uniform distribution on the interval $[0, 1]$. This number is not disclosed to the subject. If $\widehat{p}(A) > b$, then the subject will be endowed with a lottery that pays a positive monetary prize of M if event A indeed happens and zero otherwise. If $\widehat{p}(A) \leq b$, then the subject will be endowed with a lottery that pays M with probability b and zero otherwise. Under this procedure, it is a dominant strategy for the subject to report his true belief about the likelihood of event A happening, i.e., to set $\widehat{p}(A) = p(A)$. This is true regardless of the level of subject's risk aversion.

- As with elicitation of valuations, the procedure may also be implemented using a series of binary choices incentivized by the strategy method (one of the choices is selected at random *ex post* and implemented). You can face a subject with a series of binary choices between a lottery that pays M if event A happens and a lottery that pays M with probability b, where b is gradually increased from 0 to 1. This variant of the procedure may be more transparent to subjects.

- **Limitation:** like with the WTP/WTA elicitation, this method cannot be used to gauge beliefs about states of the world that are not *ex post* verifiable during the experiment. For example, one cannot gauge beliefs about whether the subject is going to live to be at least 80.

- **Design note:** Incentivization of belief elicitation means that a part of the experimental payoff will depend on the precision of one's beliefs. This may sway subjects to deviate from behavior they would otherwise follow in the experiment in order to boost their belief-elicitation payoffs. Such possibility is usually minimized by making the belief-elicitation payoffs to be positive, but small in comparison with the payoffs based on performance in the main part of the experiment.

Elicitation of Beliefs Using Quadratic Scoring

- There is also an alternative and often-used belief-elicitation procedure called **quadratic scoring**. For eliciting the probability of a single event, the choice between quadratic scoring and BDM is ambiguous, but quadratic scoring is more time-efficient in eliciting beliefs over multiple mutually exclusive and exhaustive events.

- Suppose that the state space is partitioned into (exclusive and exhaustive) events $A_1, ..., A_n$ and we want to elicit $p(A_1), ..., p(A_n)$. Under quadratic scoring, the subject is asked to report his beliefs $\widehat{p}(A_1), ..., \widehat{p}(A_n)$ such that these stated beliefs add up to 1 (or 100%). Depending on which state is eventually realized, the payoff is given by

$$\sum_{i=1}^{n} 1 - \left[1_{A_i} - \widehat{p}(A_i)\right]^2,$$

  where 1_{A_i} is an indicator variable for the realization of state i.

- Under risk neutrality, the subject maximizes the expected value of this payoff given by

$$\begin{aligned}
&\sum_{i=1}^{n} p(A_i) \left\{ 2\widehat{p}(A_i) - \widehat{p}(A_i)^2 + \sum_{j \neq i} \left[1 - \widehat{p}(A_j)^2\right] \right\} \\
&= \sum_{i=1}^{n} p(A_i)[2\widehat{p}(A_i) - \widehat{p}(A_i)^2] + [1 - p(A_i)] \left[1 - \widehat{p}(A_i)^2\right] \\
&= \sum_{i=1}^{n} 1 - p(A_i) + 2\widehat{p}(A_i)p(A_i) - \widehat{p}(A_i)^2 \\
&= \sum_{i=1}^{n} 1 - p(A_i) + p(A_i)^2 - [\widehat{p}(A_i) - p(A_i)]^2
\end{aligned}$$

  As a result, the belief elicitation payoff is maximized by truthful revelation of beliefs.

- There are two issues with this procedure, however:

  1. In comparison to BDM based on series of binary choices, quadratic scoring is less transparent to subjects. As a result, the instructions should note explicitly that it is in the best interest of the subject to report the beliefs truthfully.
  2. Quadratic scoring elicits beliefs reliably only under the assumption of risk neutrality. To see that, note that a maxmin, i.e., the most risk averse, subject would prefer to report $\widehat{p}(A_i) = 1/n$, since such reporting, even though inferior from the point of view of expected payoff, leads to zero variance in the payoff.

- **Design note:** The same design note regarding relative payoffs from belief elicitation and the main task of the experiment as in the case of BDM applies.

Elicitation of Risk Preferences

- The objective here is to assess individual preference for or aversion to monetary gambles. For example, considering the example above, it may be useful to know how far one is willing to risk by bidding aggressively (i.e., low) in order to secure a higher gain conditional on winning.
- Baseline: risk neutrality $\Longleftrightarrow$ lotteries are ranked by their expected values; the higher, the better
- But many people are demonstrably risk-averse: prefer a lottery with a lower expected payoff as long as risk (low outcomes, dispersion of payoffs) is reduced.
- Discuss CARA (constant absolute risk aversion) and CRRA (constant relative risk aversion) preferences.
- One can try to measure risk aversion by subjecting subjects to hypothetical choices involving large amounts of money; but because these choices are hypothetical, there is no guarantee that subjects would report the same decisions as if they faced the choice for real.
- **Holt and Laury (AER, 2002 and 2004)** develop an elicitation tool for risk aversion. Subjects are faced with 10 choices between pair of lotteries; one choice situation is randomly selected *ex post* and the chosen lottery is played out.

TABLE 1—THE TEN PAIRED LOTTERY-CHOICE DECISIONS WITH LOW PAYOFFS

Option A	Option B	Expected payoff difference
1/10 of \$2.00, 9/10 of \$1.60	1/10 of \$3.85, 9/10 of \$0.10	\$1.17
2/10 of \$2.00, 8/10 of \$1.60	2/10 of \$3.85, 8/10 of \$0.10	\$0.83
3/10 of \$2.00, 7/10 of \$1.60	3/10 of \$3.85, 7/10 of \$0.10	\$0.50
4/10 of \$2.00, 6/10 of \$1.60	4/10 of \$3.85, 6/10 of \$0.10	\$0.16
5/10 of \$2.00, 5/10 of \$1.60	5/10 of \$3.85, 5/10 of \$0.10	−\$0.18
6/10 of \$2.00, 4/10 of \$1.60	6/10 of \$3.85, 4/10 of \$0.10	−\$0.51
7/10 of \$2.00, 3/10 of \$1.60	7/10 of \$3.85, 3/10 of \$0.10	−\$0.85
8/10 of \$2.00, 2/10 of \$1.60	8/10 of \$3.85, 2/10 of \$0.10	−\$1.18
9/10 of \$2.00, 1/10 of \$1.60	9/10 of \$3.85, 1/10 of \$0.10	−\$1.52
10/10 of \$2.00, 0/10 of \$1.60	10/10 of \$3.85, 0/10 of \$0.10	−\$1.85

- In choices 1-4, Option A has a higher expected payoff than Option B, whereas the converse is true for choices 5-10. As a result, a risk-neutral subject would make exactly 4 "safe" choices. However, risk-averse subjects are likely to make more than 4 safe choices.
- Results:
- Demographic differences identified by Holt and Laury:
  - women are more risk-averse than men in low-payoff treatment, but not in high-payoff treatments

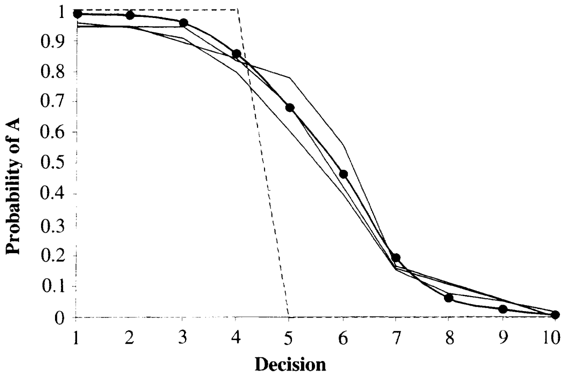


FIGURE 1. PROPORTION OF SAFE CHOICES IN EACH DECISION: DATA AVERAGES AND PREDICTIONS

Note: Data averages for low real payoffs [solid line with dots], 20x, 50x, and 90x hypothetical payoffs [thin lines], and risk-neutral prediction [dashed line].

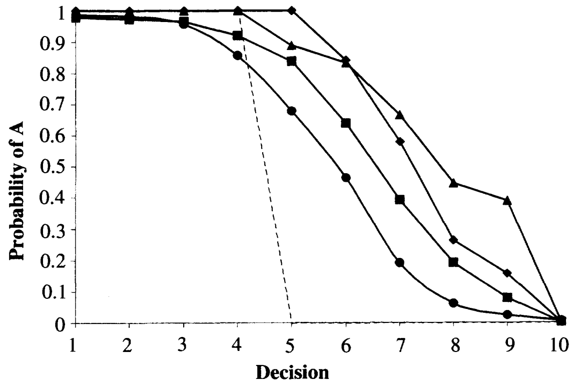


FIGURE 2. PROPORTION OF SAFE CHOICES IN EACH DECISION: DATA AVERAGES AND PREDICTIONS

Note: Data averages for low real payoffs [solid line with dots], 20x real [squares], 50x real [diamonds], 90x real payoffs [triangles], and risk-neutral prediction [dashed line].

  - risk-aversion decreases with income
  - no Black-White difference, Hispanics a bit less risk-averse

- Demographic differences identified in a follow-up work by **Harrison, Lau and Rutstrom (2005):**
  - middle-aged and more educated people are less risk-averse

- In terms of the Becked-DeGroot-Marschak method, the Holt-Laury procedure is analogous to the second option based on series of binary choices. One could also think of implementation analogous to the first option: ask a subject to report at what probability p of the higher outcome (\$2 or \$3.80) she would be indifferent between the two choices; then generate x from a uniform distribution on $[0, 1]$; if $p > x$, then endow the subject with Lottery A with the probability of the high outcome being p; if $p \leq x$, then endow the subject with Lottery B with the probability of the high outcome being x; in either case, play out the respective lottery *ex post.* I am not aware of any mention of such method in the literature, though. It is perhaps because the binary choice procedure is more transparent.

Elicitation of Other-Regarding Preferences

- In this section, we focus only on other-regarding preferences that account for payoffs, but not actions of other players. For the latter, see **Charness and Rabin (2002)**.

- Such preferences are typically elicited by facing subjects with series of dictator games with different relative tradeoffs between own and others' payoffs and observing their choices. Two methods have previously been used in the literature:

  (a) Series of continuous choices along budget lines of different slopes in the (π_i, π_{-i}) space: **Andreoni and Miller (2002)**; for more details, see the section on other-regarding preferences.

  (b) Series of binary choices between pair of allocations for oneself and for an anonymous other person, using the strategy method (**Charness and Rabin 2002; Fehr et al. 2008**)

- Here we are going to demonstrate the second approach. Subjects are given 12 binary choices incentivized by the strategy method:

Choice A	Choice B
$(3,3)$	$(3,0)$
$(3,3)$	$(4,1)$
$(3,3)$	$(5,2)$
$(3,3)$	$(6,3)$
$(3,3)$	$(5,4)$
$(3,3)$	$(4,5)$
$(3,3)$	$(3,6)$
$(3,3)$	$(2,5)$
$(3,3)$	$(1,4)$
$(3,3)$	$(0,3)$
$(3,3)$	$(1,2)$
$(3,3)$	$(2,1)$

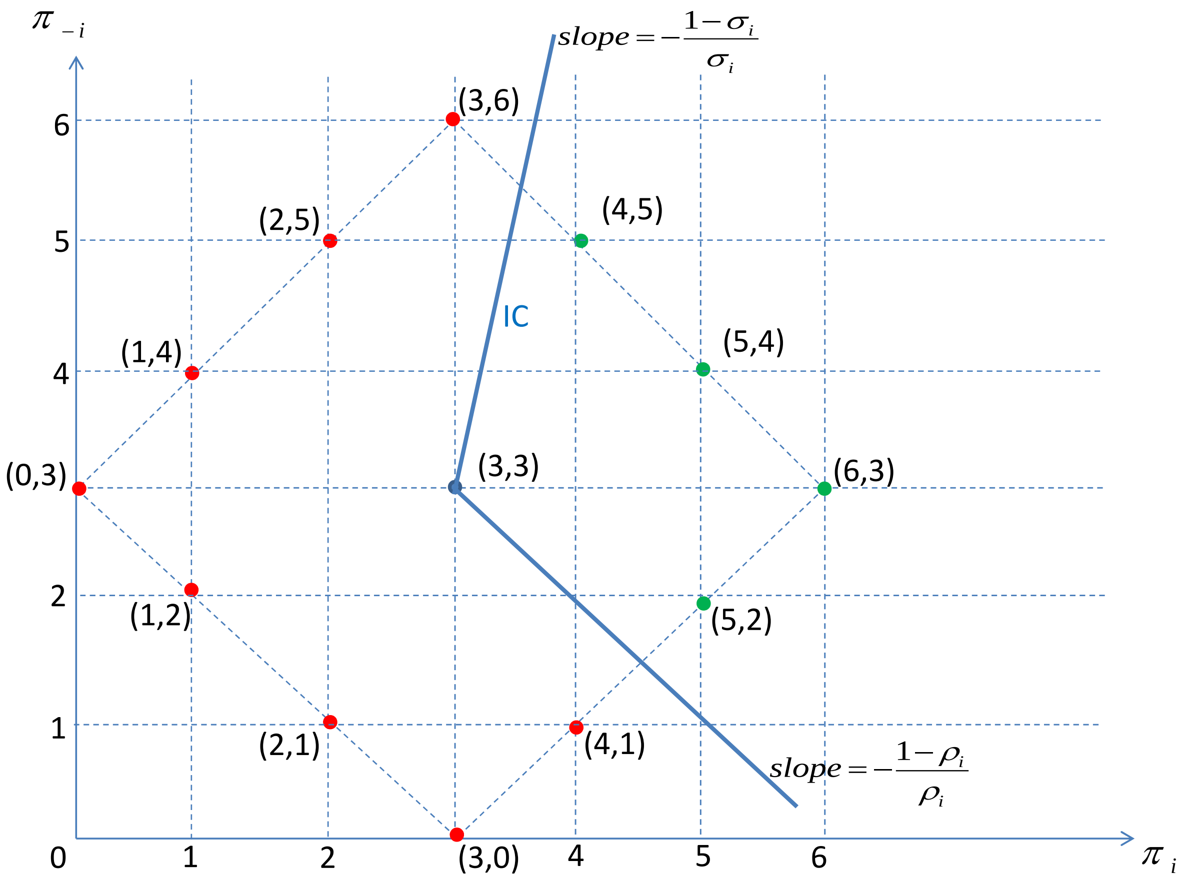
- In applications, the order of choices as well as whether the allocation $(3,3)$ is presented first or second should be randomized to control for order effects. Also, payoffs are suitably rescaled depending on the design of the experiment.

- As illustrated by the following figure, the pattern of choices can identify an approximate shape of indifference curves of a given subject in the (π_i, π_{-i}) space. For example, the figure illustrates a situation when the payoff combinations $(4,5)$, $(5,4)$, $(6,3)$ and $(5,2)$ are revealed preferred to $(3,3)$ whereas $(3,3)$ is revealed preferred to the other 8 payoff combinations. This suggests an indifference curve as pictured in the plot.

- In terms of the piecewise linear utility function

$$u_i(\pi_i, \pi_{-i}) = \begin{cases} (1-\rho_i)\pi_i + \rho_i \pi_{-i} & \text{if } \pi_i \geq \pi_{-i} \\ (1-\sigma_i)\pi_i + \sigma_i \pi_{-i} & \text{if } \pi_i < \pi_{-i} \end{cases} .$$

  discussed in the section on other-regarding preferences, such elicitation identifies ranges of $(1-\rho_i)/\rho_i$ and $(1-\sigma_i)/\sigma_i$, which can be used to identify ranges for the social preference parameters ρ_i and σ_i, respectively.



Elicitation of Attitudes toward Competition

- The objective is to assess how competitive a particular individual is. **Competitive individuals** are defined as individuals whose well-being is given by how well they do in comparison to how well the others do. **Non-competitive individuals** are defined as individuals whose well-being depends solely on their absolute level of payoff, without any attention being paid to the payoff of the others.

- The usual way of eliciting preferences for competitiveness is as follows:

  1. Subjects are introduced to a simple task such as adding numbers, counting objects, etc.
  2. In a randomized order, the subjects then conduct the task under both a piece rate and under a tournament against the others and are given feedback about their performance only.
  3. For the next stage of the experiment, subjects are given a choice between being paid by the piece rate or participating in the tournament. Attitudes toward competition are then measured by the residual from a linear probability model of deciding for the tournament as opposed to the piece rate when controlling for experienced productivity under both compensation schemes recorded in the previous stage of the experiment.

- For references, see the section on competitive behavior in **Crosson and Gneezy (2009)**, for example.