AREC 815: Experimental and Behavioral Economics

Experiments Testing Prospect Theory

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Risk Preference Experiments

Risk preference experiments **not** testing prospect theory

- Binswanger(1980), Holt and Laury (2002)

Experiments calibrating the probability-weighting function

- Tversky and Fox (1995), Gonzalez and Wu (1999)

Experiments calibrating utility function, loss aversion parameter

- Tanaka et al (AER, 2010), Harrison et al (EJ, 2009)

Calibration experiments cannot separate PT from mis-specification (?)

Risk Preference Experiments

When do risk aversion and loss aversion make divergent predictions?

- Preference for certainty
- Probability weighting
- CPT's fourfold pattern of risk preferences
- Non-monotonicity
- Other cases

Specific experiments designed to test these predictions

- Harbaugh, Krause, and Versterlund (2009): fourfold pattern
- Andreoni and Sprenger (2012): uncertainty equivalents

The Fourfold Pattern of Risk Attitudes

Harbaugh et al (EJ, 2009) test PT's "fourfold pattern" or risk attitudes

- Risk-seeking over low probability gains
- Risk-averse over high probability gains
- Risk-averse over low probability losses
- Risk-seeking over high probability losses

Two approaches to preference elicitation

- BDM mechanism (1964)
- Simple choices between lotteries and their expected values

The Fourfold Pattern of Risk Attitudes

6 simple lotteries over gains and losses

- Probabilities chosen to match predictions of PT weighting function

The Six Prospects

Prospect Number	Probability	Payoff	Expected Value	Predicted FFP of Risk Attitude
1	0.1	+\$20	\$2	Seeking
2	0.4	+\$20	\$8	Neutral
3	0.8	+\$20	\$16	Averse
4	0.1	−\$20	−\$2	Averse
5	0.4	−\$20	−\$8	Neutral
6	0.8	−\$20	−\$16	Seeking

Theoretical Predictions

The choice task: lotteries vs. their expected values

- Under expected utility: $\mathcal{L} \succsim EV(\mathcal{L})$

$$u(w + p \cdot X) \geq p \cdot u(w + X) + (1 - p)u(w)$$

- Under CPT: probabilities are replaced with probability weights

$$\mathcal{L} \succsim EV(\mathcal{L}) \Leftrightarrow 1 \cdot u(w + p \cdot X) \geq \pi(p) \cdot u(w + X) + \pi(1 - p)u(w)$$

- This generates the fourfold-pattern:
  - Low (high) probability gains are more (less) attractive,
  - Low (high) probability losses are less (more) attractive

Theoretical Predictions

The price task: a Becker-DeGroot-Marschak mechanism

- Subjects state their maximum WTP/WTA for each lottery
  - Under EU-maximization, these should be close(r) to 0
  - CPT predicts higher (lower) WTP for low (high) probability gains
  - CPT predicts lower (higher) WTP for low (high) probability losses
- Threshold price chosen at random, making predictions complicated

Choices in the Price Task

Price-participants in the Price Task

Prospect			Mean Reported Price			Median Reported Price		
Description		Expected Value	Price	p-value, Wilcoxon Test	Mean Risk Attitude	Price	p-value, Sign Test	Median Risk Attitude
Gain +\$20	1. p = 0.1	\$2	\$4.9	0.007	Seeking	\$2.0	0.078	Neutral
	2. p = 0.4	\$8	\$8.1	0.500	Neutral	\$7.0	0.170	Averse
	3. p = 0.8	\$16	\$12.2	0.000	Averse	\$12.0	0.000	Averse
Loss −\$20	4. p = 0.1	−\$2	−\$5.7	0.000	Averse	−\$4.5	0.000	Averse
	5. p = 0.4	−\$8	−\$9.6	0.021	Averse	−\$9.0	0.064	Averse
	6. p = 0.8	−\$16	−\$12.6	0.000	Seeking	−\$13.0	0.000	Seeking

Notes. 32 participants, first-round decisions. The Wilcoxon test assumes the price distribution is symmetric and tests the hypothesis that the mean and median of the distribution equal the expected value of the gamble. The sign test does not assume symmetry and tests the hypothesis that the median of the distribution equals the expected value of the gamble.

Choices in the Choice Task

Choice-participants in the Choice Task

Prospect		Expected Value	Percentage Choosing Gamble	p-value for Exact Test	Median Risk Attitude
Gain +\$20	1. p = 0.1	+\$2	50.0	1.000	Neutral
	2. p = 0.4	+\$8	39.1	0.103	Averse
	3. p = 0.8	+\$16	56.3	0.382	Seeking
Loss −\$20	4. p = 0.1	−\$2	68.8	0.004	Seeking
	5. p = 0.4	−\$8	56.3	0.382	Seeking
	6. p = 0.8	−\$16	40.6	0.169	Averse

Notes. 64 participants, first-round decisions. The test is an exact binomial test of the null hypothesis that the proportion choosing the gamble = 0.5.

Theoretical Predictions

Extremely qualified evidence in support of CPT

- More complicated mechanism, smaller sample in price task

Harbaugh *et al* point out that most of the evidence for fourfold pattern comes from hypothetical decision situations, BDM elicitation tasks

Uncertainty Equivalents: Experimental Design

Consider a lottery: $\mathcal{L} = \{X, Y; p, 1-p\}$

- **Certainty equivalent**, C, solves:

$$pu(X) + (1-p)u(Y) = u(C)$$

- **Uncertainty equivalent**, q, solves:

$$pu(X) + (1-p)u(Y) = qu(Y) + (1-q)u(0)$$

- Andreoni-Sprenger use uncertainty equivalents to test independence axiom's assumption/implication of linearity in probabilities
  - Many observed violations involve certain payoffs

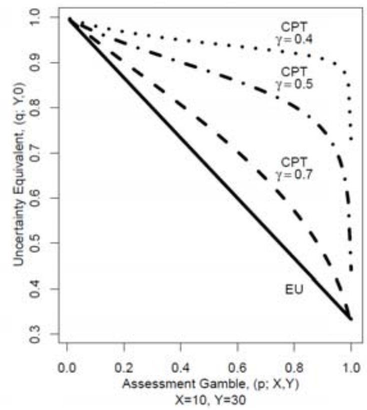
Uncertainty Equivalents: Predictions

- Normalizing $u(0) = 0$, and letting $\theta = u(X)/u(Y)$, definition of uncertainty equivalent implies that, under EU maximization:

$$q = 1 - p(1-\theta)$$

- Hence, $\partial q/\partial p = -(1-\theta) < 0$
- EU maximization $\Rightarrow$ linear relationship between p, q given (X, Y)

Uncertainty Equivalents: Predictions



Note: Empirical predictions of the relationship between assessment gambles, $(p; X, Y)$, and uncertainty equivalents $(q; Y, 0)$ for Expected Utility, and S-shaped CPT probability weighting with $\pi(p) = p^\gamma/(p^\gamma + (1-p)^\gamma)^{1/\gamma}$, $\gamma \in \{0.4, 0.5, 0.7\}$. Apart from probability distortions linear utility is assumed with $X = 10, Y = 30$ used for the figure.

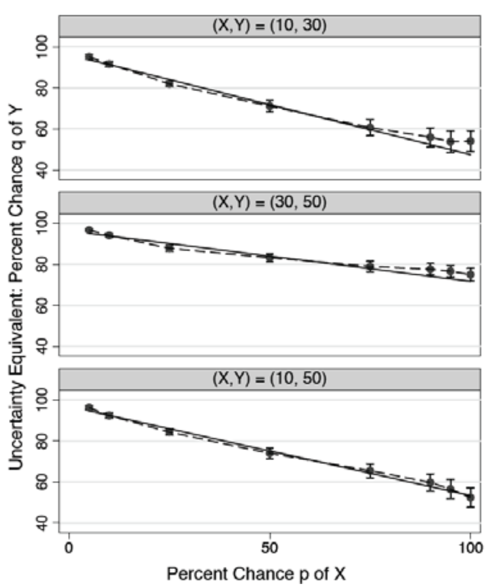
Certainty Equivalents

	Option A			*or*	Option B	
	Chance of \$30	Chance of \$0			Sure Amount	
	50 in 100	50 in 100	☑	*or*	\$0.00 for sure	☐
1)	50 in 100	50 in 100	☐	*or*	\$0.50 for sure	☐
2)	50 in 100	50 in 100	☐	*or*	\$1.00 for sure	☐
3)	50 in 100	50 in 100	☐	*or*	\$1.50 for sure	☐
4)	50 in 100	50 in 100	☐	*or*	\$2.50 for sure	☐
5)	50 in 100	50 in 100	☐	*or*	\$3.50 for sure	☐
6)	50 in 100	50 in 100	☐	*or*	\$4.50 for sure	☐
7)	50 in 100	50 in 100	☐	*or*	\$6.50 for sure	☐
8)	50 in 100	50 in 100	☐	*or*	\$8.50 for sure	☐
9)	50 in 100	50 in 100	☐	*or*	\$10.50 for sure	☐
10)	50 in 100	50 in 100	☐	*or*	\$13.50 for sure	☐
11)	50 in 100	50 in 100	☐	*or*	\$16.50 for sure	☐
12)	50 in 100	50 in 100	☐	*or*	\$19.50 for sure	☐
13)	50 in 100	50 in 100	☐	*or*	\$21.50 for sure	☐
14)	50 in 100	50 in 100	☐	*or*	\$23.50 for sure	☐
15)	50 in 100	50 in 100	☐	*or*	\$25.50 for sure	☐
16)	50 in 100	50 in 100	☐	*or*	\$26.50 for sure	☐
17)	50 in 100	50 in 100	☐	*or*	\$27.50 for sure	☐
18)	50 in 100	50 in 100	☐	*or*	\$28.50 for sure	☐
19)	50 in 100	50 in 100	☐	*or*	\$29.00 for sure	☐
20)	50 in 100	50 in 100	☐	*or*	\$29.50 for sure	☐
	50 in 100	50 in 100	☐	*or*	\$30.00 for sure	☑

Uncertainty Equivalents

	Option A			*or*	Option B		
	Chance of \$10	Chance of \$30			Chance of \$0	Chance of \$30	
	50 in 100	50 in 100	☑	*or*	100 in 100	0 in 100	☐
1)	50 in 100	50 in 100	☐	*or*	95 in 100	5 in 100	☐
2)	50 in 100	50 in 100	☐	*or*	90 in 100	10 in 100	☐
3)	50 in 100	50 in 100	☐	*or*	85 in 100	15 in 100	☐
4)	50 in 100	50 in 100	☐	*or*	80 in 100	20 in 100	☐
5)	50 in 100	50 in 100	☐	*or*	75 in 100	25 in 100	☐
6)	50 in 100	50 in 100	☐	*or*	70 in 100	30 in 100	☐
7)	50 in 100	50 in 100	☐	*or*	65 in 100	35 in 100	☐
8)	50 in 100	50 in 100	☐	*or*	60 in 100	40 in 100	☐
9)	50 in 100	50 in 100	☐	*or*	55 in 100	45 in 100	☐
10)	50 in 100	50 in 100	☐	*or*	50 in 100	50 in 100	☐
11)	50 in 100	50 in 100	☐	*or*	45 in 100	55 in 100	☐
12)	50 in 100	50 in 100	☐	*or*	40 in 100	60 in 100	☐
13)	50 in 100	50 in 100	☐	*or*	35 in 100	65 in 100	☐
14)	50 in 100	50 in 100	☐	*or*	30 in 100	70 in 100	☐
15)	50 in 100	50 in 100	☐	*or*	25 in 100	75 in 100	☐
16)	50 in 100	50 in 100	☐	*or*	20 in 100	80 in 100	☐
17)	50 in 100	50 in 100	☐	*or*	15 in 100	85 in 100	☐
18)	50 in 100	50 in 100	☐	*or*	10 in 100	90 in 100	☐
19)	50 in 100	50 in 100	☐	*or*	5 in 100	95 in 100	☐
20)	50 in 100	50 in 100	☐	*or*	1 in 100	99 in 100	☐
	50 in 100	50 in 100	☐	*or*	0 in 100	100 in 100	☑

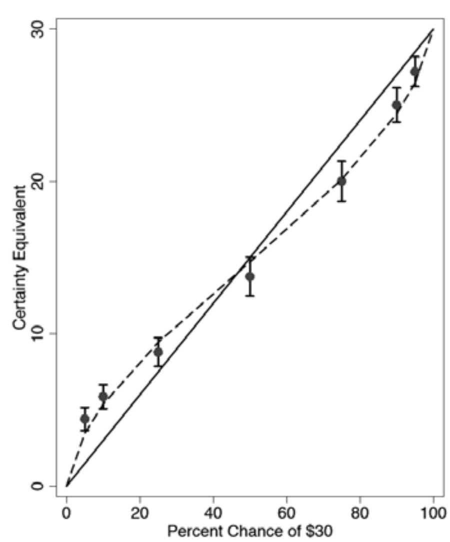
Uncertainty Equivalents: Results



Uncertainty Equivalents: Results

Panel B: Quadratic Estimates			
$p \times 100$	-0.660***	-0.376***	-0.482***
	(0.060)	(0.035)	(0.047)
$(p \times 100)^2$	0.002***	0.002***	0.001
	(0.001)	(0.000)	(0.000)
Constant	98.125***	97.855***	97.440***
	(0.885)	(0.436)	(0.642)
Log-Likelihood = -4502.77			
AIC = -9025.55, BIC = 9080.63			
Panel C: Linear Estimates			
$p \times 100$	-0.435***	-0.209***	-0.428***
	(0.027)	(0.016)	(0.027)
Constant	95.091***	95.603***	96.718***
	(0.678)	(0.512)	(0.714)
Log-Likelihood = -4510.49			
AIC = -9034.98, BIC = 9073.54			

Certainty Equivalents: Results



Certainty Equivalents: Results

Estimate the parameters of the utility, weighting functions assuming:

$$u(C) = \pi(p) \cdot u(30)$$

where

$$u(x) = x^{\alpha}$$

and

$$\pi(p) = \frac{p^{\gamma}}{\left[p^{\gamma} + (1-p)^{\gamma}\right]^{1/\gamma}}$$

Estimates: $\hat{\alpha} = 1.07(0.05)$, $\hat{\gamma} = 0.73(0.03)$

- Hypothesis of linearity in probability rejects
- Estimates similar to Tversky-Kahneman (1992): $\hat{\gamma} = 0.61$

The Certainty Effect

29 of 76 subjects violate stochastic dominance comparing $p = 0.95, 1$

- Certain outcome preferred to stochastically-dominant risky prospect

Assume $\alpha = 1$, estimate individual-level weighting function parameters

- $\hat{\gamma}_n$ significantly further from 1 for violators

Uncertainty Equivalents: Discussion

- How can we rationalize these results?
  - Good question
- Is the hypothesized CPT probability-weighting function an artifact of elicitation techniques involving certain payouts?
  - We know what Jim Andreoni thinks
- Theoretical alternative:
  - Andreoni-Sprenger propose **u-v utility**, plus decision errors
- Strong evidence for RD, weak evidence on probability weighting