Microeconomics 3
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Week of July5, lecture 18:

Treasures, Intuitive Contradictions, and How to Explain Them.

***Key readings* for Wednesday July 7, 15:15:**

Goeree & Holt (2001), Ten Little Treasures of Game Theory and Ten Intuitive Contradictions. American Economic Review 91, 1402 - 1422.

[for Thursday July 8]
Problem set # 8 ~ downloadable from
http://home.cerge-ei.cz/ortmann/CourseMaterials.html

Jacob Goeree & Charles Holt, “Ten Little Treasures of Game Theory and Ten Intuitive Contradictions“ American Economic Review December 2001.

-The authors run a series of two-person games, played once (i.e., no learning, no reciprocity, no reputation - see Nash’s response to Dresher and Flood’s repeated game experiments) in two treatments they call “treasure” and “contradiction” where the “treasure” treatment is a standard experimental design and implementation and the contradiction uses a parametrization that does not affect the prediction of deductive game theory but, sometimes dramatically, affects the experimental results (although most results are in line with our “intuition”)

- The games that Goeree & Holt investigate represent the four classes of games that we have also studied:
  - static games with complete info (Nash equilibria)
  - static games with incomplete info (Bayesian Nash equilibria)
  - dynamic games with complete info (subgame perfection)
  - dynamic games with incomplete info (sequential equilibria)

- The authors argue that “the cold logic of game theory can be at odds with intuitive notions about human behavior.” (p. 1409)

- The authors argue that the problem is one of theory which incorrectly assumes that
  a. people maximize payoffs and do so perfectly (no errors)
  b. people are consistent in their beliefs and actions (no surprises)

Goeree & Holt propose a new model of noisy decision making and in one-shot games. It is, by way of a probabilistic choice model (to be discussed below), characterized by decision errors that are sensitive to the magnitudes of payoff differences (Nash equilibrium requires perfect payoff maximization) and it is characterized by the possibility of surprises (Nash equilibrium requires consistency of actions and beliefs). This “logit-equilibrium” approach is a generalization of the Nash equilibrium in that (when noise zero) the Nash equilibrium emerges as solution.

II. Nash equilibrium of predictions of static games with complete info

– One-shot Traveler’s Dilemma Game
S Matching Pennies
S [Coordination Game with a Secure Outside Option]
S A Minimum-Effort Coordination Game
S The Kreps Game

III. Subgame perfection for dynamic games with complete info

S [Beard & Beil/Rosenthal (“Should you rely on others’ rationality?” game)]
S [Deterrence (“credible threat”) games]
S [Two-Stage Bargaining Games]

IV. Bayesian Nash for static games with incomplete info

S Auctions (FP SB)

V. Sequential equilibria for dynamic games with incomplete info

S [Signalling]

To repeat: The experimental results reported in this paper are for the most part for one-shot games, i.e. experiments where subjects have no chance to learn other than by introspection. (In general, it has to be said that the actual implementation of the experimental sessions is rather poorly described.)

One-shot Traveler's Dilemma Game

- two players choose independently and simultaneously integer numbers between and including 180 and 300.
- both players are paid the lower of the two numbers
- the player who submitted the higher number has to transfer R > 1 to the player with the lower number

-> What is the Nash equilibrium? Why?
-> Does the size of R matter game theoretically?
-> Does the size of R matter behaviorally?

See Figure 1

Matching Pennies

- symmetric matching pennies (deduct 60, divide by 20, to recapture the parameterization that we used before)
- asymmetric matching pennies (own payoff in upper left corner dramatically increased)

-> What is the Nash equilibrium in the two games? Why?
-> Does the asymmetry matter game theoretically?
(No, "a player's own decision probabilities should be such that the other player is made indifferent between the two alternatives. Since the column player's payoffs are unchanged the mixed-strategy Nash equilibrium predicts that row's decision probabilities do not change either.") Recall how we computed the mixed strategy equilibria via Bishop Cannings theorem.
-> Does the asymmetry matter behaviorally?

See Table 1

[A Coordination Game with a Secure Outside Option; this very similar to what we covered in Cachon & Camerer (1996)*]*

A Minimum-Effort ("Weak Link") Coordination Game

- two players choose independently and simultaneously integer numbers between and including 110 and 170.
- each person's payoff is the minimum of the two efforts, minus the player's own effort multiplied by a cost c.

I.e.

	Min choice		
	170-?	...	?
Your choice		...	
	?	...	110-?

->

	Min choice		
	3-3c	2-3c	1-3c
Your choice		2-2c	1-2c
			1-c

-> How many Nash equilibria are there if c < 1?

- What if you increase your effort by 1?
- What if you decrease your effort by 1?
- The higher effort cost, the higher risk of raising effort
- The higher effort cost, the lower risk of reducing effort

-> Does effort cost affect theoretical predictions?
-> Does effort cost make a behavioral difference?

See Figure 2

The Kreps Game

- two players choose independently and simultaneously from two (Row) and four (Column) actions.

-> What are the pure-strategy and mixed-strategy Nash equilibria of the Basic Game? What is the only strategy that is not part of a Nash equilibrium?

-> What is the outcome of the experiment?

-> What are the pure-strategy and mixed-strategy Nash equilibria of the Positive payoff frame variation of the Kreps Game (a monotone transformation of the Basic game, constructed by adding 300 cents to each payoff of the Basic Game)? What is the only strategy that is not part of a Nash equilibrium?

-> What is the outcome of the experiment? (And why did Goeree & Holt run it in the first place?)

Morale: The selection of the Non-Nash strategy/combination is not likely to be driven by loss aversion but based on the payoff magnitudes out of equilibrium (rather than the signs of payoff differences).

See Table 3

[Note that there is a third treatment – another variant of the Basic Game – hidden in the text that does not affect the equilibrium structure of the game.]

Beard & Beil (Rosenthal) (“Should you rely on others’ rationality?”) game

- two players choose sequentially
    - S first player chooses between R and S
    - S second player chooses between P and N
- (R,N) dominates (S,.) both individually and socially for both parameterizations of P

-> What is the (subgame-perfect) Nash equilibrium? Why?
-> Does the parameterization of P matter game theoretically?
-> Does the parameterization of P matter behaviorally? (What drives the result?)

See Figure 3

Deterrence (“credible threat”) games

- two players choose sequentially
    - S first player chooses between R and S
    - S second player chooses between P and N
- (R,N) dominates (S,.) socially but not individually for both parameterizations of P (which introduces relative payoff effects and hence considerations of inequity etc.)

-> What is the (subgame-perfect) Nash equilibrium? Why?
-> Does the parameterization of P matter game theoretically?
-> Does the parameterization of P matter behaviorally? (What drives the result?)

See Figure 4

[Two-Stage Bargaining Games; this very similar to what we covered in Johnson, Camerer, et al. (2002)*]*

Auctions (FP SB or SP SB?)

Vickrey's model of auctions with incomplete information: Private values are drawn from a uniform distribution. Bayesian Nash equilibrium predicts that bids will be proportional to value, which is generally consistent with laboratory evidence. Main deviation from theoretical predictions is the tendency of human subjects to "overbid". Risk aversion? Missing payoff-dominance?

Consider the following game in which each of two bidders receives a private value for a prize to be auctioned in a first-price, sealed-bid auction. Each bidder's value for the prize is equally likely to be $0, $2, or $5 (in the first treatment) or $0, $3, or $6 (in the second treatment). Bids are constrained to be integer dollar amounts, with ties decided by the flip of a coin.

Equilibrium Expected Payoffs for the (0,2,5) Treatment

v = ||	bid = 0	bid = 1	bid = 2	bid = 3	bid = 4	bid = 5
$0	0*	-.5	-1.66	-3	-4	-5
$2	.33	.5*	0	-1	-2	-3
$5	.83	2	2.5*	2	1	0

Equilibrium Expected Payoffs for the (0,3,6) Treatment

v = ||	bid = 0	bid = 1	bid = 2	bid = 3	bid = 4	bid = 5
$0	0*	-.5	-1.66	-3	-4	-5
$3	.5	1*	.83	0	-1	-2
$6	1	2.5	3.33*	3	2	1

Note that the increase in values from the (0,2,5) treatment to the (0,3,6) treatment does not alter the equilibrium bids in the unique Bayesian equilibrium. Is that what we see in the experiment? (What's your intuition?)

Look at payoff losses associated with deviations from the Nash equilibrium:

For example, the middle value bidder with expected payoffs shown in the second rows of the tables.
In the (0,3,6) treatment, the cost of bidding $1 above the equilibrium bid is $1 - $.83 = $.1, which is less than the cost of bidding $1 below the equilibrium bid: $1 - $.50 = $.50.
In the (0,2,5) treatment, the cost of bidding $1 above the equilibrium bid is $.5 - $0 = $.50, which is more than the cost of bidding $1 below the equilibrium bid: $.5 - $.33 = $.17.

Given the reversal in the relative cost of over- and underbidding, we should expect more overbidding for the (0,3,6) treatment.

Intuition is borne out by bid data for the 50 subjects who participated in a single auction under each condition. See Table 6.

Average bids for low, medium, and high value bidders in the (0,2,5) treatment – where cost of deviation was higher upward than downward – were $0, $1.06, and $2.64.

Average bids for low, medium, and high value bidders in the (0,3,6) treatment – where cost of deviation was higher downward than upward – were $0, $1.82, and $3.40.

As in previous games, deviations from Nash behavior in these private value auctions seems to be sensitive to the costs of deviation.

[This does not rule out that risk aversion plays a role. In fact, in a related paper by Goeree, Holt, & Palfrey you find a quantification of the importance of risk aversion.]

[Signalling]

Logit/Quantal Response Equilibrium (QRE)

McKelvey & Palfrey (1995, Games & Economic Behavior, 10(1), 6 - 38): Quantal Response Equilibria for Normal Form Games.

McKelvey & Palfrey (1998, Experimental Economics, 1(1), 9 - 41): Quantal Response Equilibria for Extensive Form Games.

Various papers by Goeree and Holt and associates such as:

"Stochastic game theory: for playing games, not just for doing theory"
"The Logit Equilibrium: A Perspective on Intuitive Behavorial Anomalies"
"A Model of Noisy Introspection"
“QRE and Overbidding in Private Value Auctions” (G, H, & Palfrey)

See their excellent web sites at
http://www.people.virginia.edu/~cah2k/
http://www.people.virginia.edu/~jg2n/jacobcv.htm

and many many more (e.g., Camerer, Ho, & Chong’s “Cognitive Hierarchy Theory of One-shot Games”)

Basic idea

S suppose there are 2 decisions D_1, D_2

S Nash

when $B^e (D_1) > B^e (D_2)$ then $P(D_1) = 1$

In other words, decisions are determined by the signs of the payoff differences, not by the magnitudes of the payoff gains or losses. The underlying assumption is that of “perfect error-free decision making and the consistency of actions and beliefs. The latter requirement may seem especially strong in the presence of multiple equilibria when there is no obvious way for players to coordinate.” (p. 1405)

S QRE

$P(D_1) = \text{Prob}\ [B^e (D_1) - B^e (D_2) > : ,]$

where , is a mean-zero random variable and
: is an "error" parameter

So, the QRE injects some degree of randomness well documented in people's choice behavior. How noisy exactly behavior is depends on the game and many other things (e.g., unobserved shocks in preferences, or, maybe the beer party the night before!)

Example:

, is a random variable with a double exponential distribution (see Mood, Graybill, Boes 1974, p. 117)

<u>Logit:</u> $P(D_1) = \text{Prob}\,[B^e\,(D_1) - B^e\,(D_2) > \,:\,,]$

$$= \frac{\exp(B^e\,(D_1)/:)}{\exp(B^e\,(D_1)/:) + \exp(B^e\,(D_2)/:)} \qquad (1)$$

Note 1: Better options are more likely to be chosen (but the best os not necessarily chosen with probability 1 as in Nash case)

Note 2: The choice probabilities are proportional exponential functions of expected payoffs. This is a feature of the double exponential distribution that generates the logit model used here. In general, the logit probability of choosing alternative *i* is proportional to $\exp(B^e\,(D_i)/:)$.

Note 3: Note 2 makes clear the role of : . It determines how sensitive choice probabilities are to payoff differences. If it is very large, then choice probabilities matter less. If it is very small, then choice probabilities matter a lot. In the limit we are back to "when $B^e\,(D_1) > B^e\,(D_2)$ then $P(D_1) = 1$" , i.e. the Nash formulation. Of course, these limit cases are not what motivates the approach. Rather it is intermediate values of : that interest us because they reflect the fact that people are neither perfectly noisy nor perfectly rational.

Note 4: Note that the expected payoffs on the right side of (1) are determined by choice probabilities that come out of the logit rule on the left side of (1). In order to use the logit best response (1) we need to model the process of belief formation, since beliefs ("^{e}") are used to calculate the expected payoffs on the RHS of (1). This leads to (2) on page 1418 in the article where successive logit responses to beliefs are in search for a fixed point.

Note 5: The logit equilibrium is a special case of the QRE.

Illustrations of the QRE:

[traveller's dilemma]

- claims between [180, 300]
- Nash = 180 whenever R > 1

Logit QRE: $$f(x) = \frac{\exp(B^{e}(x)/:)}{I \exp(B^{e}(y)/:)\, dy}$$

-> $: f'(x) = f(x)\, B^{e'}(x) = f(x)\,(1 - F(x) - 2R\, f(x))$

[Illustration for f_{180}, f_{5}]

-> "snowball' effect may push decisions as far away from Nash as possible.

own-payoff effects
[illustration - symmetric matching pennies game]
[illustration - asymmetric matching pennies game]