Bargaining

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Bargaining

- Bargaining 討價還價
  - The process by which economic agents agree on the terms of a deal
- Common even in "competitive" markets
  - The "pit market" in NYSE/market experiments
  - Edgeworth Box was created to show range of possible bargaining outcomes
- Have you ever bargained with someone?

Bargaining

- Nash (1950, 1951)
  - (Cooperative) Nash Bargaining Solution
  - (Non-cooperative) Nash Equilibrium
- Nash Program: NBS is NE/SPE of a game
  - Binmore, Rubinstein and Wolinsky (1986)
- References:
  - BGT, Ch. 4
  - HEE, Ch. 4
  - *MGS,* Ch. 23

Bargaining

- Cooperative NBS vs. Non-cooperative NE
  - Two approaches in experiments as well…
- Unstructured Bargaining Experiments
  - Free form procedure determined by players
  - More close to naturally occurring bargaining
- Structured Bargaining Experiments
  - Procedure specified by experimenter
  - Game theory makes specific predictions

Bargaining

- Negotiation Research: Bazerman et al. 00'
  - Applied psychology
  - Negotiate over numerical or categorial levels of several issues (like price or quantity)
  - Free form communication with a time deadline
  - Private point schedule (dep. on each issue)
- Results: Deals are not Pareto-efficient, affected by systematic heuristics and other cognitive variables (unrelated to the game)

Bargaining

- Why not much overlap?
  - Game theory assumes too much rationality
  - Solvable games are too simplified
  - Hard to apply game theory to Negotiation games
- But the research questions are the same!
- Like 2 traditions of experimental economics
  - Game experiments are too simplified
  - Hard to apply game theory to market experiments

Unstructured Bargaining

- Test: Nash Bargaining Solution
  - The point maximizing the product of utility gains (beyond the disagreement point)
- Only point satisfying
  - Symmetry
  - Independence of Irrelevant Alternatives
  - Independence from affine utility transformation

Unstructured Bargaining

- Roth and Malouf (1979)
- Player bargain over 100 lottery tickets
  - Binary Lottery: Induce risk neutrality
  - "Works" if compound lotteries can be reduced
- 1 ticket = 1% chance of winning fixed prize
- Equal ($1) vs. Unequal Prize ($1.25/$3.75)
- Full vs. Partial (know own prize) Information
- NBS: 50-50 split

Unstructured Bargaining

Info. Con.	Money Prizes	# of Tickets for Player 2							Frac. of Disagree.
		20	25	30	35	40	45	50	
Full	1/1	0	0	1	0	1	0	20	0.00
	1.25/3.75	1	6	3	2	2	1	4	0.14
Part.	1/1	0	0	0	0	0	1	14	0.06
	1.25/3.75	0	0	0	0	0	3	13	0.00

Unstructured Bargaining

- Results: Agreements cluster at 50-50
  - Rare Disagreement
  - 14% Disagreement when both know inequality
  - Divide tickets equally vs. $$$ payoffs equally
  - Sensitive to $$$ payoffs (violate independence of affine transformation)
- Pairs settle in the final minutes (Stubbornness?)
- Follow-up: "strong reputation" trained by computers carry on to new human opponents

Unstructured Bargaining

- Mehta, Starmer and Sguden (1992)
- Nash Demand Game
  - Each state demand
  - Get their demand If sum < 10, zero otherwise.
- Focal point: Two players split 4 aces
  - 2-2: 50-50 Split
  - 1-3: Half 50-50, Half 25-75; 25% disagreement

Unstructured Bargaining

- Roth (1985): Coordination game – propose 50-50 or h -(100-h) simultaneously
- MSE: $p_1 = \frac{h-50}{150-h}$ $p_2 = \frac{h-50}{h+50}$
- Disagreement rates:
  - Prediction: 0→7→10 (Actual: 7→18→25)
- Murnighan et al. (1988):
  - Prediction: 1→19 (Actual: constant across h)

Unstructured Bargaining

- Cause of Disagreement: Self-Serving Bias
  - "What is better for me" is "Fair"
- Loewenstein et al. 93, Babcock et al. 95, 97
  - Bargain how to settle a legal case
  - Guess what the judge would award (if disagree)
- Diff. in E(judgement) predicts disagreement
  - Vanishes if don't know roles before reading case
  - Vanishes if "first list weakness of my own case"

Structured Bargaining

- Finite Alternating-Offer Game
- Binmore, Shaked & Sutton (1985): 2 period
- 1 offers a division of 100p to 2
- If 2 rejects, makes counteroffer dividing 25p
- SPE: Offer 25-75
- Experimental Results: mode at 50-50, some 25-75 and others in between

Structured Bargaining

- Neelin, Sonnenschein and Spiegel (1988)
  - Economics undergrads yield different results
- Are they taught backward induction? Also,
- Binmore – "YOU WOULD BE DOING US A FAVOR IF YOU SIMPLY SET OUT TO MAXIMIZE YOUR WINNINGS."
- Neelin – "You would be discussing the theory this experiment is designed to test in class."

Structured Bargaining

- Social Preference or Limited Strategic Thinking?
- Johnson, Camerer, Sen & Rymon (2002), "Detecting Failures of Backward Induction: Monitoring Information Search in Sequential Bargaining," *Journal of Economic Theory,*104 (1), 16-47.
- See Student Presentation…

Structured Bargaining

- Random Termination vs. Discounting
- Zwick, Rapoport and Howard (1992)
- Divide $30 with random termination
- Continuation probabilities 0.90, 0.67, 0.17
- SPE: 14.21, 12, 4.29
  - Accepted final offers: 14.97, 14.76, 13.92
- Close to discounting results (50-50 & SPE)
  - 14.90, 14.64, 13.57

Structured Bargaining

- Fixed Delay Cost in Bargaining
  - Lost wages, profits, etc.
- The side with the lower delay cost should get almost everything
- Rapoport, Weg and Felsenthal (1990)
- Divide 30 shekels
- Fixed Cost: 0.1 vs. 2.5 or 0.2 vs. 3.0
- Strong support for SPE (BGT, Table 4.7)

Outside Option and Threat Points

- Binmore, Shaked and Sutton (1989)
- Bargain over £7; player 2 has outside options of £0, £2, or £4
  - Split-the-difference: NBS predicts dividing surplus gained beyond the threat points
  - Deal-me-out: SPE predicts change in results only when threat is credible
- BGT, Fig. 4.4: Deal-me-out wins

Incomplete Information

- Add asymmetric information to bargaining
- More realistic, but
  - Hard to bargain for a bigger share AND convey information at the same time
- Might need to turn down an offer to signal patience or a better outside option

Seller Make Offer to Informed Buyer

- Rapoport, Erve, and Zwick (MS 1995)
- Seller: Own item (worthless to herself)
- Buyer: Private reservation price ~ unif.[0,1]
- Seller makes an offer each period
- Common discount factor δ

Seller Make Offer to Informed Buyer

- Unique Sequential Equilibrium:

$$\text{Seller Offer}: p_0 = \gamma \cdot \frac{1-\delta}{1-\gamma\cdot\delta}, \gamma = \frac{1-\sqrt{1-\delta}}{\delta}$$

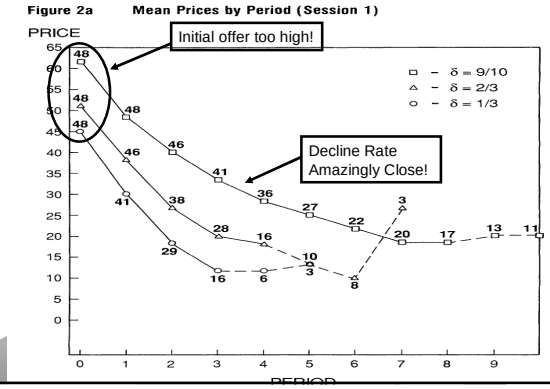
$$\text{Subsequently}: p_t = p_0 \cdot \gamma^t$$

$$\text{Buyer Accepts if } p_t \le v \cdot \frac{1-\delta}{1-\gamma\cdot\delta}$$

Seller Make Offer to Informed Buyer

- Complicate Strategy: Depend on δ
  - Price discriminate high/low-value buyers
  - Price declines slow enough so high-value buyers will not want to wait
- Can subjects get these in experiments?
  - Different δ: H (0.90), M (0.67), L (0.33)
  - Opening p_0: H (0.24), M (0.36), L (0.45)
  - Discount γ: H (0.76), M (0.68), L (0.55)

Seller Make Offer to Informed Buyer



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  - Discount γ: H (0.76), M (0.68), L (0.55)
- Buyers accept the 1st or 2nd offer below *v*
  - Accept offers too soon
- Sellers ask for higher prices (than equil.)
  - But discount γ: H (0.81), M (0.68), L (0.55)

Strikes and 1-Sided Information

- Forsythe, Kennan and Sopher (AER 1991)
- Only Informed bargainer I sees pie size
  - Either large (π_g) or small (π_b)
- Free form bargaining
- Uninformed U can strike to shrink pie by γ
- Can we predict what happens?

Strikes and 1-Sided Information

- Myerson (1979): Revelation Principle
  - I announces true state
  - U strikes to shrink pie by γ_g or γ_b
  - I gives U (based on true state) x_g or x_b
- IC requires:

$$(\gamma_g - \gamma_b)\pi_b \le x_g - x_b \le (\gamma_g - \gamma_b)\pi_g$$

Strikes and 1-Sided Information

- Interim Incentive Efficiency requires:

$$\gamma_g = 1, x_g - x_b = (1-\gamma_b)\pi_g$$

- Strike ($\gamma_b < 1$) if and only if $p\pi_g > \pi_b$
- Deriving this is complicated…
- Could ANY subject get close to this?

Strikes and 1-Sided Information

- Random Dictator (RD) Axiom:
  - Agree fair mix between each being dictator to propose mechanism
- Then:

$$\gamma_g = 1, x_g = \frac{\pi_g}{2}, \gamma_b = \frac{1}{2}, x_b = 0 \text{ when } p\pi_g > \pi_b$$

$$\gamma_g = 1, x_g = \frac{\pi_b}{2}, \gamma_b = 1, x_b = \frac{\pi_b}{2} \text{ when } p\pi_g < \pi_b$$

Strikes and 1-Sided Information

- This is a win-win experiment:
  - Success if theory predictions are close
  - If not, will point to which assumption fails
- Forsythe et al. (AER 1995):
  - 10 minute sessions; written messages
- Is Myerson (1979) confirmed?
  - Surprisingly yes, though not perfect…

Strike Condition Off $p\pi_g < \pi_b$

Game	p	State	π	π_U	π_I	total	%Strike
III	0.5						
		aver.	3.50	1.50	1.80	3.29	6.0
		pred.		1.40	2.10	3.50	0.0
IV	0.25						
		aver.	3.50	1.21	2.04	3.24	7.4
		pred.		1.20	2.30	3.50	0.0

Strike Condition Off $p\pi_g < \pi_b$

Game	p	State	π	π_U	π_I	total	%Strike
III	0.5	b	2.80	1.47	1.18	2.66	5.2
		g	4.20	1.52	2.41	3.93	6.5
		aver.	3.50	1.50	1.80	3.29	6.0
		pred.		1.40	2.10	3.50	0.0
IV	0.25	b	2.40	1.08	1.04	2.12	11.8
		g	6.80	1.58	5.03	6.61	2.9
		aver.	3.50	1.21	2.04	3.24	7.4
		pred.		1.20	2.30	3.50	0.0

Strike Condition On $p\pi_g > \pi_b$

Game	p	State	π	π_U	π_I	total	%Strike
I	0.5						
		aver.	3.50	1.05	2.00	3.05	13.0
		pred.		1.50	1.75	3.25	7.1
II	0.75						
		aver.	3.50	1.41	1.76	3.18	9.3
		pred.		1.46	1.75	3.21	8.3

Strike Condition On $p\pi_g > \pi_b$

Game	p	State	π	π_U	π_I	total	%Strike
I	0.5	b	1.00	0.31	0.30	0.61	39.0
		g	6.00	1.78	3.70	5.48	8.7
		aver.	3.50	1.05	2.00	3.05	13.0
		pred.		1.50	1.75	3.25	7.1
II	0.75	b	2.30	1.06	0.84	1.90	17.2
		g	3.90	1.53	2.07	3.59	7.9
		aver.	3.50	1.41	1.76	3.18	9.3
		pred.		1.46	1.75	3.21	8.3

Sealed-Bid in Bilateral Bargaining

- Both buyers and sellers have private info.
- Sealed-Bid Mechanism
  - Both write down a price
  - Trade at the average if $p_b > p_s$
  - Call Market: Many buyers vs. many sellers
- Two-Person Sealed-Bid Mechanism
  - One form of bilateral bargaining

Sealed-Bid in Bilateral Bargaining

- Two-Person Sealed-Bid Mechanism
- Buyer Value $V \sim \text{uniform}[0,100]$
- Seller Cost $C \sim \text{uniform}[0,100]$
- Piecewise-linear equilibrium: (not unique)
  - Chatterjee and Samuelson (1983)

$$p_b = \begin{cases} V & \text{if } V < 25 \\ \frac{25}{3} + \frac{2}{3}V & \text{if } V \geq 25 \end{cases} \quad p_s = \begin{cases} 25 + \frac{2}{3}C & \text{if } C < 25 \\ C & \text{if } C \geq 75 \end{cases}$$

  - This equilibrium maximizes ex ante gains
  - Myerson & Satterthwaite (1983)

Sealed-Bid in Bilateral Bargaining

- Radner and Schotter (JET 1989): 8 sessions
- 1, 2, 8: Baseline as above
- 3: Trade at price $(v + c + 50) / 3$ if $v > c+25$
  - Should bid their values $v=V$, $c=C$
- 4: Price = v , (Buyers should bid $v=V/2$)
- 5,6: Alternative distribution for more learning
  - Distribution w/ more trade (for learning): $m=0.438$
- 7: Face-to-face bargaining

Est. Buyer Bid Function Slope

	Below cutoff			Above cutoff		
Session	β	β _hat	T-stat	β	β _hat	T-stat
1	1	1.00	(0.01)	0.67	0.85*	(4.14)
2	1	0.91	(-0.52)	0.67	1.06	(1.28)
8	1	0.91	(-0.14)	0.67	0.80*	(2.32)
3	1	0.92	(-0.08)	1	0.73*	(-2.64)
4	0.5	0.55	(0.66)	0.5	0.58*	(2.32)
5	1	0.80*	(-4.17)	0.438	0.50	(1.12)
6(-20)	1	0.85	(-1.40)	0.438	0.40	(-0.56)
6(21-)	1	1.11	(0.70)	0.438	0.32	(-1.55)

Est. Seller Bid Function Slope

	Below cutoff			Above cutoff		
Session	β	β _hat	T-stat	β	β _hat	T-stat
1	0.67	0.58	(-1.38)	1	0.97	(-0.32)
2	0.67	0.74	(1.28)	1	1.07	(0.14)
8	0.67	0.75	(1.65)	1	1.07	(0.17)
3	1	1.06	(1.04)	1	0.67	(-0.58)
5	0.438	0.48	(0.87)	1	1.00	(0.60)
6(-20)	0.438	0.57*	(2.16)	1	0.97	(-0.79)
6(21-)	0.438	0.52	(1.20)	1	0.95	(-0.69)

Sealed-Bid in Bilateral Bargaining

- Face-to-face yields efficiency 110%
  - Some truthfully reveal; others don't
- Radner and Schotter (1989, p.210),
- "The success of the face-to-face mechanism, if replicated, might lead to a halt in the search for better ways to structure bargaining in situations of incomplete information. It would create, however, a need for a theory of such structured bargaining in order to enable us to understand why the mechanism is so successful."

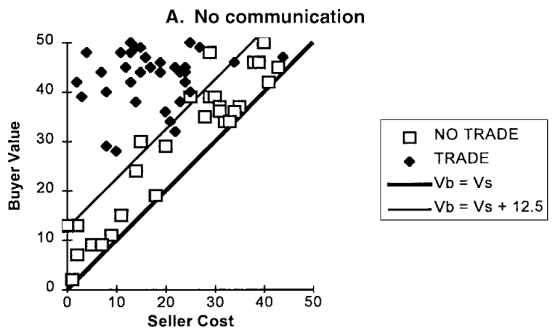
Sealed-Bid in Bilateral Bargaining

- Follow-up Studies:
- Schotter, Snyder and Zheng (GEB 2000)
  - Add agents
- Rapoport and Fuller (1995)
  - Strategy method; asymmetric value dist.
- Daniel, Seale and Rapoport (1998)
  - Asymmetric value distribution (20 vs. 200)
- Rapoport, Daniel and Seale (1998)
  - Flip buyer-seller asymmetry; fixed pairing

Communication vs. Sealed-Bid

- Valley et al. (GEB 2002): Communication
- Buyer/Seller Values/Costs ~ uniform[0, $50]
  - Bargain by stating bids; 7 periods; no rematch
  - Half had no feedback
- No communication: Sealed-bid in 2 minutes
- Witten communication: Exchange messages for 13 minutes before final bid
- Face-to-face: Pre-game communication

Communication vs. Sealed-Bid



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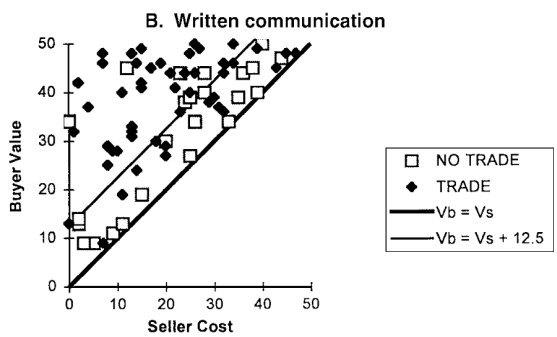

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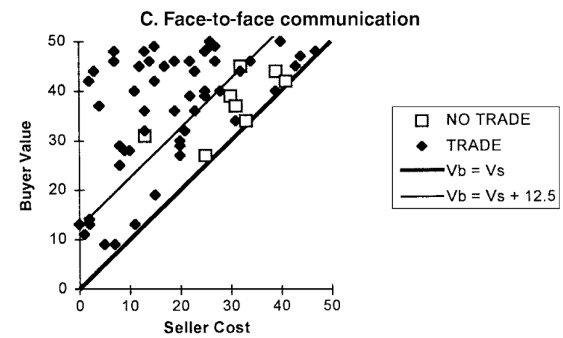

Communication vs. Sealed-Bid

- Empirical bid function slope = 0.7 (~0.67)
- Why are there “gains of communication”?
- Slope of buyer bids against seller bids=0.6
- Buyers bid higher when seller bids higher
  - Mutual bidding of values (common in students)
  - Mutual revelation of values (com. in students)
  - Coordinating on a price (40% written; 70% face)

Communication vs. Sealed-Bid

- Coordinating on a price
  - Happens 40% in written, 70% in face-to-face
- Not truth-telling (only 1/3)
  - TT not coordinated (4% written, 8% face)
- Feel each other out; give enough surplus
  - Modal – equal split of surplus
- Variance of surplus doubles (by mismatches)

Conclusion

- Unstructured Bargaining
  - Focal divisions; competing focal points
  - Self-serving bias (erased by veil of ignorance or stating weakness of own case)
- Structured Bargaining
  - Deviate toward equal splits
  - Social preference models could explain this
  - But Johnson et al. (JET 2002) suggest limited look-ahead as reason for such deviations

Conclusion

- Outside options affect bargaining divisions only if threats are credible
  - Lower fixed cost player gets everything
- Information Asymmetry: One-Sided
  - Revelation Principle + Random Dictator: Good
  - Bazaar mechanism:
    - Offers decline as theory predicts, but start too high and respond to δ wrongly
    - Buyers accept too early

Conclusion

- Bilateral Bargaining: Two-Sided
  - Sealed-bid mechanism: between truthful revelation and piecewise-linear equilibrium
- Players over-reveal values in face-to-face
  - Too honest, but "more efficient"
- Communication → agree on a single price
- Why theory does better in sealed-bid than alternative-offer bargaining?
  - Is sealed-bid cognitively more transparent?