

# Bargaining (議價談判)

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Lecture 6, EE-BGT

# Bargaining (議價談判)

- ▶ Bargaining (就是「討價還價」！)
- ▶ Process by which economic agents agree on the terms of a deal (個體間討論條件、達成交易的過程)
- ▶ Common even in competitive markets
  - ▶ The pit market in NYSE/market experiments
    - ▶ (即使在完全競爭市場也很常見，例如紐約股市的交易坑市場)
  - ▶ Edgeworth Box (原本是用來研究談判!) was created to show range of possible bargaining outcomes
- ▶ Have you ever bargained with someone?
  - ▶ 你有跟別人談判過嗎?

# Bargaining (議價談判)

- ▶ Nash (1950, 1951):
  - ▶ (Cooperative) Nash Bargaining Solution (奈許談判解)
  - ▶ (Non-cooperative) Nash Equilibrium (奈許均衡)
- ▶ Nash could have won two Nobels...
- ▶ **Nash Program:** Is NBS the NE/SPE of a particular game? (奈許問: NBS是否為某賽局的NE/SPE?)
  - ▶ Yes: Binmore, Rubinstein and Wolinsky (1986)
- ▶ References (參考章節):
  - ▶ BGT, Ch. 4, HEE, Ch. 4, MGS, Ch. 23

## 2 Bargaining Experiments (兩種談判實驗)

### ▶ Cooperative NBS vs. Non-cooperative NE

- ▶ 對應合作賽局NBS和非合作賽局NE，也有兩種談判實驗：

#### 1. Unstructured Bargaining Experiments

- ▶ Free form procedure determined by players

- ▶ Closer to naturally occurring bargaining

- ▶ 自由談判實驗：雙方自行決定談判形式過程，較接近實務上談判

#### 2. Structured Bargaining Experiments

- ▶ Procedure specified by experimenter

- ▶ Game theory makes specific predictions

- ▶ 制式談判實驗：形式過程由實驗者決定，賽局論能做出明確預測

# Negotiation Research in Applied Psychology

## 3. Negotiation Research: Bazerman et al. (2000)

- ▶ Bazerman, Magliozzi and Neale (1985)
  - ▶ Negotiate over several issues (ex: price/quantity)
  - ▶ Free form communication with fixed deadline
  - ▶ Private point schedule (dep. on each issue)
    - ▶ 應用心理學研究：雙方各自知道自己的報酬計分方式，在一定時限自由溝通討論，最後須在價格數量等多層面(連續或類別)上達成協議
- ▶ Results: Deals not Pareto-efficient
  - ▶ Affected by systematic heuristics and other cognitive variables (unrelated to game)
    - ▶ 結果：達成的協議不都有效率且受到無關的經驗法則與認知因素影響

# Negotiation Research (協商談判研究)

- ▶ Why not much overlap? (為何沒有交集?)
  - ▶ Game theory assumes too much rationality
  - ▶ Solvable games are too simplified
  - ▶ Hard to apply to Negotiation games
    - ▶ 賽局論假設完全理性，解得出來賽局又太簡單，很難用在協商研究
- ▶ Like 2 traditions of experimental economics
  - ▶ Game experiments are too simplified
  - ▶ Hard to apply to market experiments
    - ▶ 正如賽局論實驗太過簡單，很難用賽局論來預測市場實驗的結果
- ▶ But research questions are the same! (研究問題一樣)

# Unstructured Bargaining (自由談判)

- ▶ Test: Nash Bargaining Solution (NBS)
  - ▶ The point maximizing the product of utility gains (beyond the disagreement point)
    - ▶ 奈許談判解(NBS):與談判破裂相較讓雙方效用增加量的乘積最大的解
- ▶ Only point satisfying 4 axioms:
  1. Pareto Optimality (效率性、不受額外無關選項影響)
  2. Symmetry (對稱、不受效用平移伸縮影響)
  3. Independence of Irrelevant Alternatives (IIA)
  4. Independence from affine utility transformation

# Nash Bargaining Solution (NBS)

$$S^* = \arg \max_{(x_1, x_2) \in S} (x_1 - d_1)(x_2 - d_2)$$
$$= \arg \max_{(x_1, x_2) \in S} [u_1(x_1) - u_1(d_1)][u_2(x_2) - u_2(d_2)]$$

Satisfies:

1. **Pareto Optimality** (效率性):  $\forall x \in S^*, \nexists y \in S, y > x$   
 $\Leftrightarrow \underline{y_i \geq x_i \forall i, y_j > x_j}$
2. **Symmetry** (對稱):  
 $d_1 = d_2, (x_1, x_2) \in S^* \Rightarrow (x_2, x_1) \in S^*$
3. **IIA** (Independence of Irrelevant Alternatives; 不受額外無關選項影響)  
 $S^*$  solves  $(T, d)$  if  $S^*$  solves  $(S, d)$  and  $S \subset T$
4. **IAT** (Independence from affine utility transformation, 不受效用平移伸縮影響):  
 $u_1(x) = Ax + B, u_2(x) = Cx + D$



# Unstructured Bargaining (自由談判)

- ▶ Roth and Malouf (Psych Rev 1979)
- ▶ Player bargain over 100 lottery tickets
  - ▶ Risk neutral if can reduce compound lottery
  - ▶ 雙方談判如何分配100張彩券(每張 = 1%機率贏得獎金)。用彩券可讓人風險中立地決策(假設人們會把複合機率簡化成單一機率)
- ▶ 1 ticket = 1% chance winning a big prize
- ▶ Equal (\$1) vs. Unequal Prize (\$1.25/\$3.75)
- ▶ Full vs. Partial (know own prize) Info.
- ▶ NBS: 50-50 split (NBS預測: 50-50 對分)
  - ▶ 2x2實驗設計:獎金相同/不同, 資訊透明/不透明

# Unstructured Bargaining (自由談判)

Information	Money Prize	# of Tickets for Player 2							% of Dis-agreement
		20	25	30	35	40	45	50	
Full Info.	1/1	0	0	1	0	1	0	20	0%
	1.25/3.75	1	6	3	2	2	1	4	14%
Part. Info.	1/1	0	0	0	0	0	1	14	6%
	1.25/3.75	0	0	0	0	0	3	13	0%

# Unstructured Bargaining (自由談判)

- ▶ **Results: Agreements cluster at 50-50**
  - ▶ Rare Disagreement (很少未達成協議，大部分 50-50 對分)
- ▶ 14% Disagree when both know inequality
  - ▶ Divide tickets or \$\$\$ payoffs equally
  - ▶ Sensitive to \$\$\$ payoffs
  - ▶ Violate IAT (indep. of affine transformation)
    - ▶ 雙方清楚知道獎金不平等時，有14%未達成協議(彩券 vs. 金錢平分)
    - ▶ 結果受金錢多寡影響，違反「不受效用平移伸縮影響」公設
- ▶ Rawlsian Bargaining Solution explains this
  - ▶ Followup: Roth & Murnighan (ECMA 1982)

# Rawlsian Bargaining Solution (羅斯談判解)

$$S^* = \arg \max_{(x_1, x_2) \in S} (x_1 - d_1)(x_2 - d_2)$$
$$= \arg \max_{(x_1, x_2) \in S} [u_1(x_1) - u_1(d_1)][u_2(x_2) - u_2(d_2)]$$

Satisfies:

1. Pareto Optimality (效率性):  $\forall x \in S^*, \nexists y \in S, \underline{y} > x$
2. Symmetry ( $d_1 = d_2, (x_1, x_2) \in S^* \Rightarrow (x_2, x_1) \in S^*$ )
3. IIA ( $S^*$  solves  $(T, d)$  if  $S^*$  solves  $(S, d)$  and  $S \subset T$ )
4. Independence of utility transformation preserving preference order & which player has larger gain  
 $\underline{x_1 - d_1 \geq x_2 - d_2 \Leftrightarrow u_i(x_1 - d_1) \geq u_i(x_2 - d_2)}$   
 $\underline{x_i \geq y_i \Leftrightarrow u_i(x_i) \geq u_i(y_i)}$

# Unstructured Bargaining (自由談判)

- ▶ Review earlier studies to find: (回顧先前實驗發現)
  - ▶ Murnighan, Roth & Schoumaker (JRU 1988)
- ▶ Pairs settle @ final minutes (of 9-12 min)
  - ▶ Convey private info (Stubbornness/Delay Cost)?
    - ▶ 最後幾分鐘才達成協議 (用以表示自己很堅持/可以負擔延遲成本?)
- ▶ Follow-up: Roth & Schoumaker (AER 1983)
  - ▶ First play against computer that gives you a lot
- ▶ Expect & get this from later human players
  - ▶ Strong Reputation (如果有人先跟軟弱的電腦談判、被訓練覺得自己該拿比較多, 接下來面對真人態度也會較強硬、並且真的拿比較多)

# Unstructured Bargaining (自由談判)

- ▶ Mehta, Starmer and Sugden (bk chp. 1992)
- ▶ **Nash Demand Game** (奈許需求實驗): 2 Players
  - ▶ Each state demand (兩人分別列出自己的需求金額)
  - ▶ Get their demand If  $\text{sum} \leq \text{£}10$ , 0 otherwise.
    - ▶ 如果總和  $\leq 10$  英鎊就會得到所求，不然都得0
- ▶ **Focal point**: Players split 4 Aces + 4 deuces
  - ▶ Before bargain, players were told: "4 aces worth  $\text{£}10$  together, so to earn \$\$ you have to pool your aces and agree on how to divide the  $\text{£}10$ ."
    - ▶ (兩人抽八張牌，其中四張A、四張2)

# Unstructured Bargaining (自由談判)

▶ **Results:** 被告知四張A合起來值十英鎊，因此要賺錢就得把四張A合起來並同意如何平分十英鎊。實驗結果居然受此敘述(與報酬無關)影響!!

▶ Aces split 2-2:

▶ Agree **50-50** Split  
(各兩張A就對分)

▶ Aces 1-3: (一張/三張)

▶ Half **50-50**, (一半對分)

▶ Half **25-75**;

▶ **22% disagree**

(另一半要求25-75, 22%爆掉)

Demand	1A	2A	3A
£2.50	11	0	0
£3.00-4.50	5	1	1
£5.00	<u>16</u>	<b>40</b>	<u>17</u>
£5.50-7.00	0	1	11
£7.50	0	0	4
N	32	42	33

# Can BGT Explain This? (行為賽局論解釋?)

- ▶ Roth (1985) explains as **Coordination Game**
- ▶ Two sides simultaneously propose to split tickets either 50-50 or  $h-(100-h)$

▶ 可用協調賽局解釋: 雙方同時提議分配為 50-50 或  $h-(100-h)$

▶ MSE:

$$p_1 = \frac{h - 50}{150 - h} \quad p_2 = \frac{h - 50}{h + 50}$$

▶ Disagreement rates = 
$$\frac{(h - 50)^2}{(150 - h)(50 + h)}$$



# Can BGT Explain This? (行為賽局論解釋?)

- ▶ Roth (bk chp 1985)
- ▶ Disagreement rates = 
$$\frac{(h - 50)^2}{(150 - h)(50 + h)}$$
- ▶ Predicted to be 0% → 7% → 10%
  - ▶ For  $h = 50, 75, 80$  in pervious experiments
- ▶ Data: 7% → 18% → 25% (Direction is right!)
- ▶ Murnighan et al. (JRU 1988)
  - ▶  $h = 60, 70, 80, 90$  predict 1%, 4%, 10%, 19%
- ▶ Actual data not as good: Constant across  $h$

# Can BGT Explain This? (行為賽局論解釋?)

- ▶ Cause of Disagreement: Self-Serving Bias (自利偏誤)
  - ▶ "What is better for me" = "Fair" (對我有利才叫公平)
- ▶ Add this to the above coordination game
  - ▶ Can explain higher disagreement rate in data
- ▶ Same in Kagel, Kim and Moser (GEB 1996):
  - ▶ Ultimatum over 100 tickets (P/R value differently)
- ▶ Not know P value H/L → Propose 45%/30%
  - ▶ Know P value higher, R rejects 40%, wants >50%

(最後通牒談判分配100張(價值不同的)彩券，對方不知道價值時提議者提議55-45(價值高)/70-30(價值低)。知道對方價值較高時回應者會要求比50-50更好，拒絕40%的提議)

# Babcock et al. (AER 1995, Law&Social Inquiry 1997)

- ▶ Self-serving bias Exp: Loewenstein et al. (JLS 93')
- ▶ Read 27-page actual legal case (讀27頁卷宗/談判和解)
  - ▶ Motorcyclist sues driver: \$100,000 injury damage
  - ▶ Bargain for 30 min. to settle it for ?? dollars
    - ▶ \$5000 legal fees for every 5-min delay
    - ▶ Retired judge imposes award if no agreement
  - ▶ First Guess what judge would award
    - ▶ US\$1 (or 1 Grade Point) for every \$10,000
    - ▶ 30分鐘談判和解(訴訟金額\$100,000), 每延遲5分鐘須付\$5000律師費
    - ▶ 事先預測和解不成法官會如何判 (實驗中\$10,000 = 一美金或 1 GPA)

# Gap of E(judgment) Predicts Disagreement

- ▶ Baseline: 70% cases settled at period 3-4 (out of 6)
- ▶ E(judgment) differ by \$20,000 (20% of \$100,000)
  - ▶ 控制組結果: 70%的組在第3-4回合達成和解(總共6回合)
  - ▶ 雙方預期判決結果的落差在\$20,000左右(訴訟金額的20%)

Information	Settlement Stat.				E(judgmt) Gap	
	N	%	periods	(s. e.)	mean	(s. e.)
Control: Babcock 95'	47	72	3.75	(0.28)	\$18,555	(3,787)
Control: Babcock 97'	26	65	4.08	(0.46)	\$21,783	(3,956)

# More Pairs Settled (and More Rapidly) if...

- ▶ Don't know role @ reading: 94% (in 2.51 pds)
  - ▶ Or, before bargaining, 1st tell about bias and
- ▶ List Weakness of own case: 96% (in 2.39 pds)

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	N	%	periods	(s. e.)	mean	(s. e.)
Control: Babcock 95'	47	72	3.75	(0.28)	\$18,555	(3,787)
Didn't know roles <i>p</i> <0.01	47	94	2.51	(0.21)	-\$6,275	(4,179)
Control: Babcock 97'	26	65	4.08	(0.46)	\$21,783	(3,956)
1 <sup>st</sup> List Weakness <i>p</i> =0.01	23	96	2.39	(0.34)	-\$4,676	(6,091)

# Summary for Unstructured Bargaining

- ▶ **Focal points** affect bargaining outcome
- ▶ **Chip value** affect bargaining outcome
  - ▶ Violate IAT Axiom of NBS
- ▶ **BGT Explanation:** Bargainers try to coordinate under multiple focal points
- ▶ **Self-serving bias** predict costly delay/settle
  - ▶ "Outcome favoring me is more likely/fair"
  - ▶ Caused by knowing my role when reading case

# Structured Bargaining (制式談判)

- ▶ Finite Alternating-Offer Game (有限回交互提案)
- ▶ **Binmore, Shaked & Sutton (1985):** 2 period
- ▶ 1 offers a division of 100p to 2
- ▶ If 2 rejects, makes counteroffer dividing 25p
  - ▶ 成員甲提議如何分配100p, 成員乙回應。若拒絕則由他提議分配25p
- ▶ **SPE:** Offer 25-75 (子賽局完全均衡: 成員甲提議25-75)
- ▶ **Experimental Results:** mode at 50-50, some 25-75 and others in between
  - ▶ 實驗結果: 提議分配的眾數在50-50, 有些在25-75, 其他在兩者之間

# Structured Bargaining (制式談判)

- ▶ Neelin, Sonnenschein and Spiegel (1988)
  - ▶ Economics undergrads yield different results
- ▶ Are they taught backward induction? Also,
  - ▶ 經濟系大學部學生實驗結果不同，因為學過倒推法？還是實驗說明？
- ▶ 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 (制式談判)

- ▶ Social Preference or Limited Strategic Thinking? (是因為人們有社會偏好，還是理性思考有限制?)
- ▶ Johnson, Camerer, Sen & Rymon (2002), "Detecting Failures of Backward Induction: Monitoring Information Search in Sequential Bargaining," *Journal of Economic Theory*, 104 (1), 16-47.
- ▶ Some do not even look at the last stage payoffs in 3-stage bargaining games!
  - ▶ 三回合談判，有人「不看」最後一回合

# Structured Bargaining (制式談判)

- ▶ Random Termination vs. Discounting
- ▶ Zwick, Rapoport and Howard (ToD 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 (制式談判)

- ▶ Fixed Delay Cost in Bargaining
  - ▶ Lost wages, profits, etc.
- ▶ SPE: Strong side (lower delay cost) gets all
- ▶ Rapoport, Weg and Felsenthal (ToD 1990)
  - ▶ Divide 30 shekels (pseudo-infinite horizon)
  - ▶ Fixed Cost: 0.10 vs. 2.50 or 0.20 vs. 3.00
- ▶ Strong support for SPE: In the 1st round,
  - ▶ Strong P offer 4.4-7.9, weak R accept 60-80%
  - ▶ Weak P offer low, strong R accept 30%, but later quickly settle in 2<sup>nd</sup> (35%) or 3<sup>rd</sup>-4<sup>th</sup> (22%)

# Outside Option and Threat Points

- ▶ **Binmore, Shaked and Sutton (QJE 1989)**
  - ▶ Two players bargain over £7, discount
  - ▶ Player 2 has outside option of £0, £2, or £4
- ▶ **Split-the-difference (NBS): 47%, 64%, 76%**
  - ▶ Divide surplus beyond the threat points
- ▶ **Deal-me-out (SPE): 47%, 47%, 57%(=4/7)<sub>δ</sub>**
  - ▶ Options matter only if is credible; ignore if  $< \frac{\delta}{1 - \delta}$
- ▶ **BGT, Figure 4.4: Deal-me-out wins**
  - ▶ £0, £2: spike around 50% / £4: cluster @ 57%

# Incomplete Information (資訊不透明)

- ▶ 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 is unif.  $[0,1]$
- ▶ Seller makes an offer each period
- ▶ Common discount factor  $\delta$

# Seller Make Offer to Informed Buyer

- ▶ Unique Sequential Equilibrium:
- ▶ Seller Offer:

$$p_0 = \gamma \cdot \frac{1 - \delta}{1 - \gamma \cdot \delta}, \quad \gamma = \frac{1 - \sqrt{1 - \delta}}{\delta}$$

- ▶ Subsequently:  $p_t = p_0 \cdot \gamma^t$

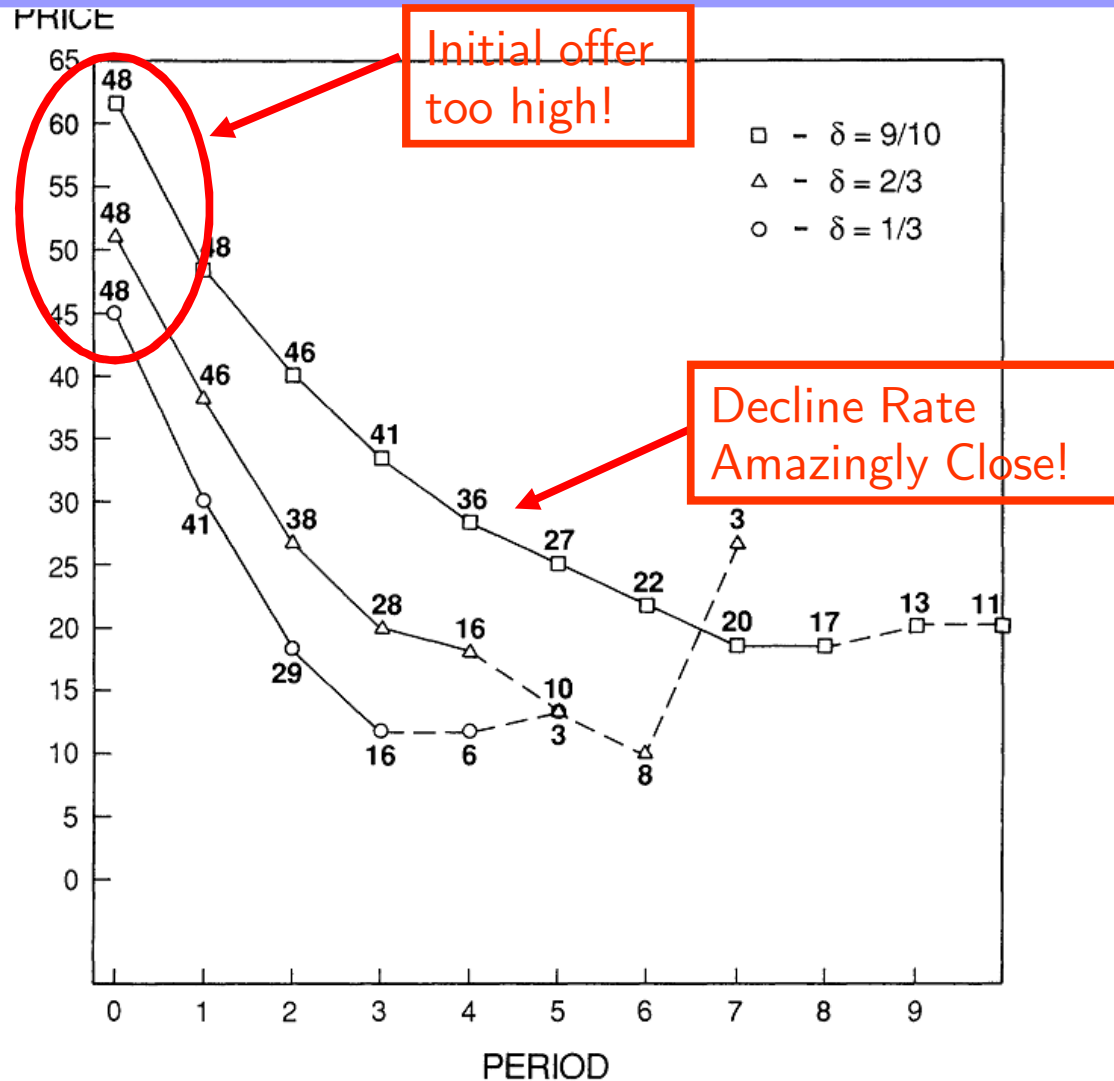
- ▶ Buyer Accepts if  $p_t \leq v \cdot \frac{1 - \delta}{1 - \gamma \cdot \delta}$

# Seller Make Offer to Informed Buyer

- ▶ Complicate Strategy: Depend on  $\delta$ 
  - ▶ 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  $\delta$  : H (0.90), M (0.67), L (0.33)
  - ▶ Opening  $p_0$  : H (0.24), M (0.36), L (0.45)
  - ▶ Discount  $\gamma$  : H (0.76), M (0.68), L (0.55)



# Seller Make Offer to Informed Buyer



# Seller Make Offer to Informed Buyer

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  - ▶ Different  $\delta$  : H (0.90), M (0.67), L (0.33)
  - ▶ Opening  $p_0$  : H (0.24), M (0.36), L (0.45)
  - ▶ Discount  $\gamma$  : H (0.76), M (0.68), L (0.55)
- ▶ Buyers accept the 1<sup>st</sup> or 2<sup>nd</sup> offer below  $v$ 
  - ▶ Accept offers too soon
- ▶ Sellers ask for higher prices (than equil.)
  - ▶ But discount  $\gamma$  : 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 ( $\pi_g$ ) or small ( $\pi_b$ )
- ▶ Free-form bargaining
- ▶ Uninformed **U** can strike to shrink pie by  $\gamma$
- ▶ Can we predict what happens?

# Strikes and 1-Sided Information

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  - ▶ Only Informed bargainer **I** sees pie size  $\pi_g$  or  $\pi_b$
  - ▶ Uninformed **U** can strike to shrink pie by  $\gamma$
  - ▶ Can we predict what happens?
    - ▶ Free-form bargaining
- ▶ Myerson (1979): Revelation Principle
  - ▶ **I** announces true state
  - ▶ **U** strikes to shrink pie by  $\gamma_g$  or  $\gamma_b$
  - ▶ **I** gives **U** (based on true state)  $x_g$  or  $x_b$

# Strikes and 1-Sided Information

- ▶ IC requires:

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

- ▶ 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:

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

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

# 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	$\pi$	$\pi_U$	$\pi_I$	Total	% Strike
III	0.5	b	2.80				
		g	4.20				
		aver.	3.50	1.50	1.80	3.29	6.0%
		pred.		1.40	2.10	3.50	0.0%
IV	0.25	b	2.80				
		g	6.80				
		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	$\pi$	$\pi_U$	$\pi_I$	Total	% Strike
I	0.5	b	1.00				
		g	6.00				
		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				
		g	3.90				
		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 information
- ▶ 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  $V$ : unif.[0,100]; Seller  $C$ : unif.[0,100]
- ▶ Piecewise-linear equilibrium: (not unique)
  - ▶ Chatterjee and Samuelson (1983)
  - ▶ Max. ex ante gains (Myerson & Satterthwaite 83)

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

# 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

# Estimated Buyer Bid Function Slope

Below Cutoff

Above Cutoff

Session	$\beta$	$\hat{\beta}$	t-stat	$\beta$	$\hat{\beta}$	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	(-0.88)	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)

# Estimated Seller Bid Function Slope

Below Cutoff

Above Cutoff

Session	$\beta$	$\beta$	t-stat	$\beta$	$\beta$	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 do not
- ▶ 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

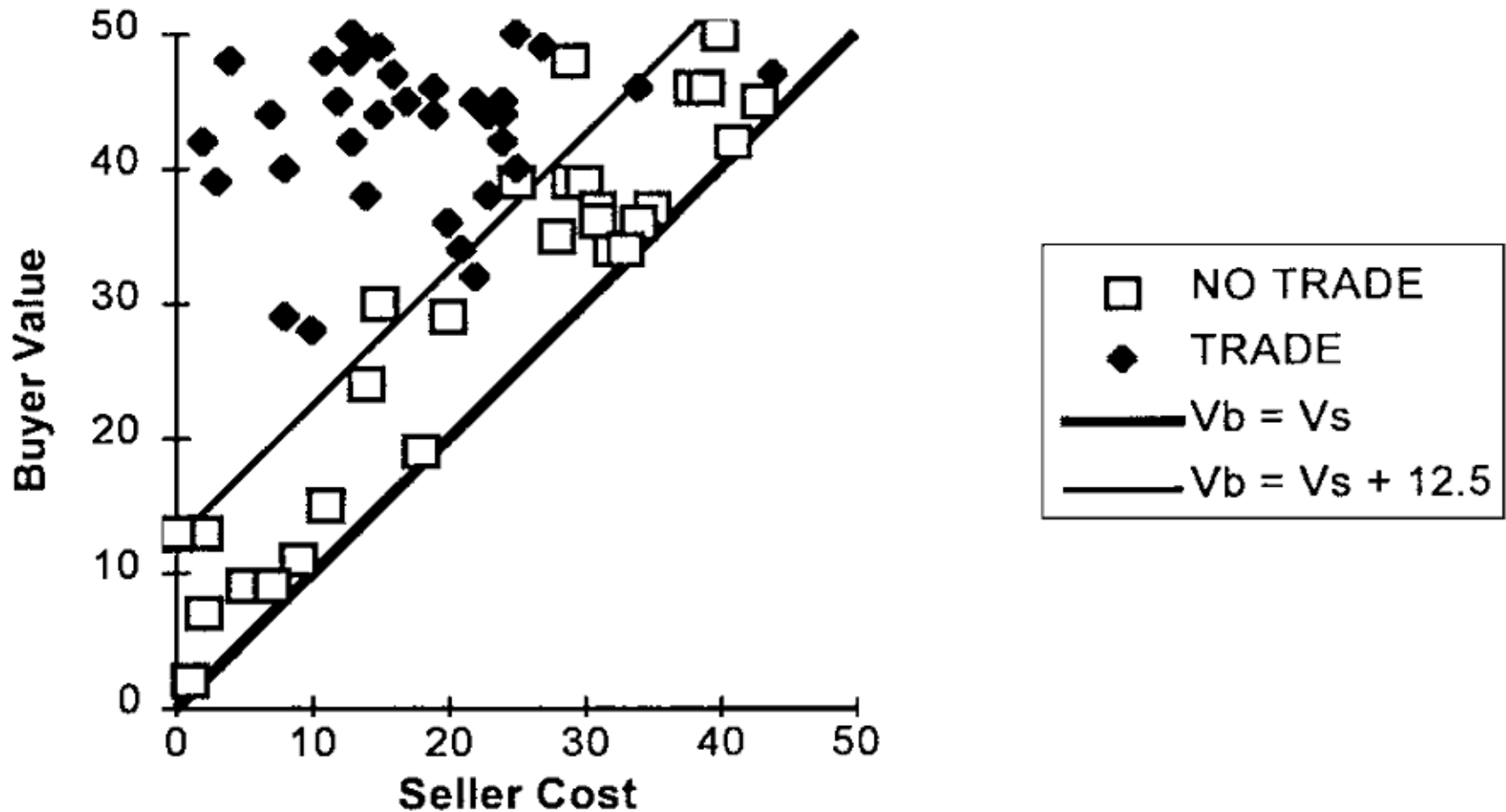


# Communication vs. Sealed-Bid

- ▶ **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
- ▶ **Written communication:** Exchange messages for 13 minutes before final bid
- ▶ **Face-to-face:** Pre-game communication

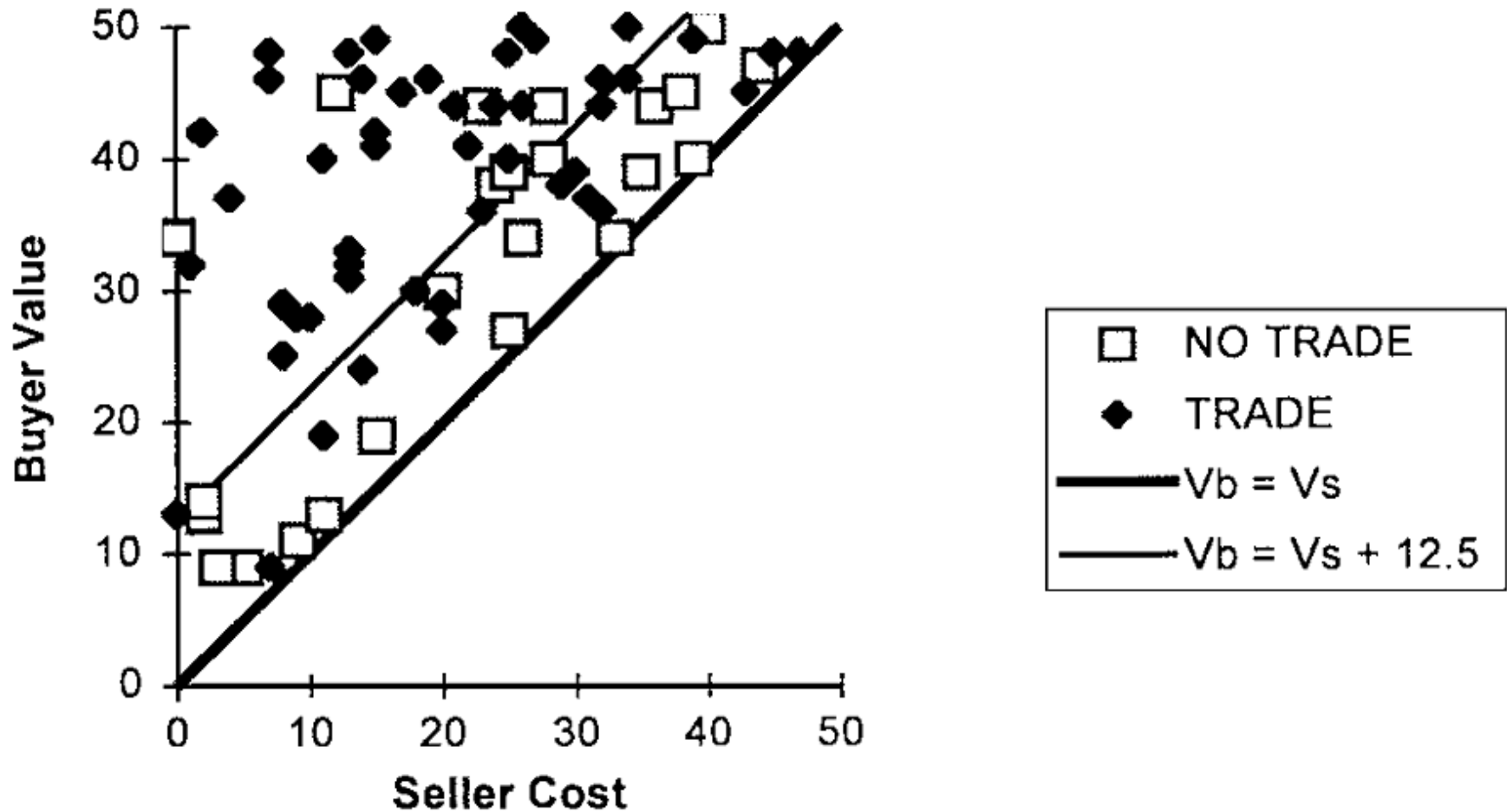
# Communication vs. Sealed-Bid

A. No communication



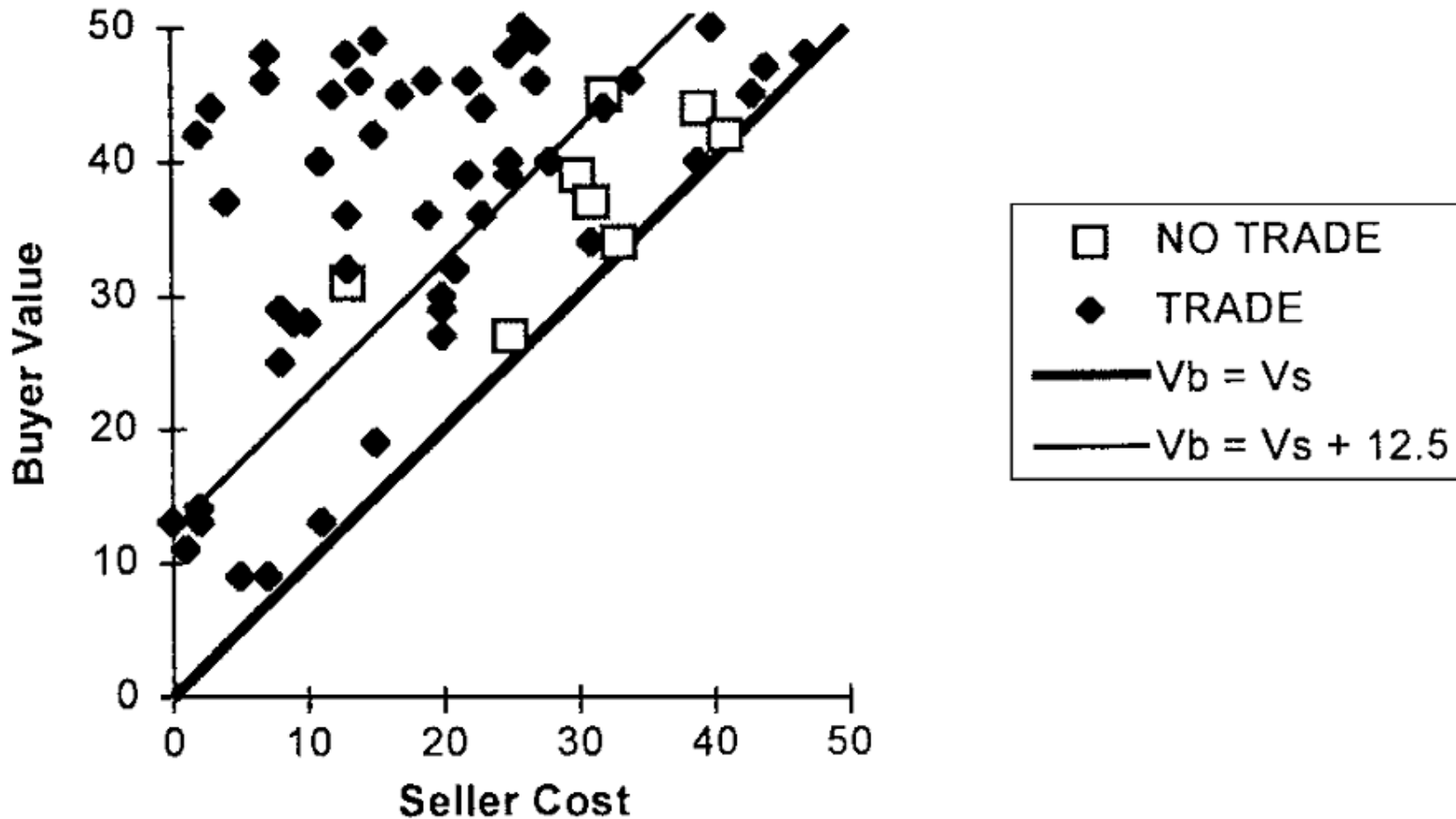
# Communication vs. Sealed-Bid

## B. Written communication



# Communication vs. Sealed-Bid

## C. Face-to-face communication



# Communication vs. Sealed-Bid

- ▶ Empirical bid function slope = 0.7 ( $\sim 0.67$ )
- ▶ 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 mismatch)

# 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  $\delta$  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?

# 致謝

感謝 Management Science 還有以下三位教授讓我們在第47張投影片使用下述論文的圖片：

- ▶ Amnon Rapoport, Ido Erev, and Rami Zwick (1995), "An Experimental Study of Buyer-Seller Negotiation with One-Sided Incomplete Information and Time Discounting," *Management Science*, 41(3), 377-394.

感謝 Games and Economic Behavior 還有以下四位教授讓我們在77, 78, 79 這三張投影片中使用了以下文章的一張圖表：

- ▶ Kathleen Valley, Leigh Thompson, Robert Gibbons, Max H. Bazerman (2002), "How Communication Improves Efficiency in Bargaining Games," *Games and Economic Behavior*, 38(1), 127-155.