

Bargaining

(議價談判)

Joseph Tao-yi Wang (王道一)
EE-BGT, Lecture 6

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 was created to show range of possible bargaining outcomes (原本是用來研究談判的!)
- ▶ **Have you ever bargained with someone?** (你有跟別人談判過嗎?)

Bargaining (議價談判)

- ▶ Nash (1950, 1951):
 1. (Cooperative) Nash Bargaining Solution (奈許談判解)
 2. (Non-Cooperative) Nash Equilibrium (奈許均衡)
- ▶ Nash could have won two Nobel Prizes...
- ▶ **Nash Program:** Is NBS the NE/SPE of a particular game? (奈許大哉問: NBS是否為某賽局的NE/SPE?)
 - ▶ Yes: Binmore, Rubinstein and Wolinsky (1986)
- ▶ References: BGT, Ch.4, HEE, Ch.4, MGSB, 2nd ed., Ch.14 (參考章節)

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 (自由談判實驗)

▶ Free form procedure determined by players (雙方自行決定談判形式過程)

▶ Closer to naturally occurring bargaining (較接近實務上談判)

2. Structured Bargaining Experiments (制式談判實驗)

▶ Procedure specified by experimenter (形式過程由實驗者決定)

▶ Game theory makes specific predictions (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) (應用心理學研究)
- ▶ Negotiate over several issues (ex: price/quantity)
- ▶ Free form communication with fixed deadline (時限內自由溝通討論)
- ▶ Private point schedule (depends on each issue)
 - ▶ 雙方各自知道自己的報酬計分方式，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** (結果:達成的協議不都有效率)
 - ▶ Affected by systematic heuristics and other cognitive variables (unrelated to game) (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? (賽局論假設完全理性)
 - ▶ Solvable games are too simplified (解得出來賽局又太簡單)
 - ▶ Hard to apply to Negotiation games ? (很難用在協商研究)
- ▶ Like the two traditions of experimental economics:
 - ▶ Game experiments are too simplified ? (正如賽局論實驗太過簡單)
 - ▶ Hard to apply to market experiments ? (很難用賽局論預測市場實驗結果)
- ▶ But research questions are the same! (但兩邊面對一樣的研究問題!!)

Unstructured Bargaining (自由談判)

- ▶ Test: Nash Bargaining Solution (NBS) (奈許談判解)
- ▶ The point maximizing the product of utility gains (beyond the disagreement point) (與談判破裂相較讓雙方效用增加量的乘積最大的解)

$$\max_{(x_1, x_2) \in S} (x_1 - d_1)(x_2 - d_2)$$

- ▶ 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) (不受額外無關選項影響)
 4. Independence from affine utility transformation (不受效用平移伸縮影響)

Nash Bargaining Solution (NBS 奈許談判解)

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

Satisfies:

1. **Pareto Optimality:** (效率性) $\forall x \in S^*, \nexists y \in S, y > x \Leftrightarrow y_i \geq x_i \forall i, y_j > x_j$
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 $S^* \subset T \subset S$
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 (雙方談判如何分配100張彩券)
 - ▶ Risk neutral if can reduce compound lottery
 - ▶ 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 (每張=1%機率贏得獎金)
 - ▶ Equal (\$1) vs. Unequal Prize (\$1.25/\$3.75)
 - ▶ Full Information vs. Partial Information (know own prize)
 - ▶ 2x2實驗設計: 獎金相同/不同, 資訊透明/不透明
- ▶ NBS: 50-50 split (NBS預測: 不管獎金相同與否、資訊透明與否都是「50-50對分」)

Unstructured Bargaining (自由談判)

| Information (資訊) | Money Prize (雙方獎金金額) | # of Tickets for Player 2 (成員乙所分得的彩券數目) | | | | | | | % of Dis-agreement (未達成協議的比例) |
|---------------------|-------------------------|--|----|----|----|----|----|----|----------------------------------|
| | | 20 | 25 | 30 | 35 | 40 | 45 | 50 | |
| Full (透明) | 1/1 | 0 | 0 | 1 | 0 | 1 | 0 | 20 | 0% |
| | 1.25/3.75 | 1 | 6 | 3 | 2 | 2 | 1 | 4 | 14% |
| Partial (不透明) | 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
 - ▶ 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(indep. of affine transformation)」公設
- ▶ **Rawlsian Bargaining Solution explains this**
 - ▶ Followup: Roth & Murnighan (ECMA 1982)

Rawlsian Bargaining Solution (羅斯談判解)

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

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

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

$$\underline{x_i \geq y_i \Leftrightarrow u_i(x_i) \geq u_i(y_i)} \quad \underline{x_1 - d_1 \geq x_2 - d_2 \Leftrightarrow u_i(x_1 - d_1) \geq u_i(x_2 - d_2)}$$

Unstructured Bargaining (自由談判)

- ▶ Review earlier studies to find: (回顧先前實驗發現)
 - ▶ Murnighan, Roth and Schoumaker (JRU 1988)
- ▶ Pairs settle @ final minutes (of 9-12 min) (最後幾分鐘才達成協議)
 - ▶ Convey private info (Stubbornness/Delay Cost)? (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 (先跟軟弱電腦談判)
- ▶ Expect and get this later from human players (被訓練該多拿)
 - ▶ Strong Reputation (接下來面對真人態度也會較強硬、並且也真的拿比較多)

Unstructured Bargaining (自由談判)

- ▶ Mehta, Starmer and Sugden (book chapter 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, 總和 ≤ 10 英鎊就會得到所求)
 - ▶ Get their demand If sum $\leq \pounds 10$, 0 otherwise. (不然都得0)
- ▶ **Focal point:** Players split 4 Aces + 4 deuces (兩人抽4張A/4張2)
 - ▶ Before bargain, players were told:
 - ▶ "4 aces worth $\pounds 10$ together, so to earn \$\$ you have to pool your aces and agree on how to divide the $\pounds 10$."
 - ▶ 焦點: 「四張A合起來值十英鎊, 想賺錢就得合作、一起換十英鎊來分」

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**; (另一半要求25-75)

▶ **22% disagree** (22%爆掉)

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

Can BGT Explain This? (行為賽局論的解釋)

- ▶ Roth (1985) explains as **Coordination Game** over allocation focal points 50-50 vs. $h-(100-h)$
 - ▶ Each favoring one ($50 > h$ whenever $50 < 100-h$)
 - ▶ 可用協調賽局解釋: 考慮兩個分配上的協調焦點 50-50 或 $h-(100-h)$
- ▶ Both simultaneously choose to **demand** their favorite or **acquiesce** to the less favorable (兩邊同時選擇「要求有利自己的分配」或「願接受另一個分配」)
 - ▶ If both demand favorite: Both earn 0 (若都「要求」, 兩邊報酬皆為0)
 - ▶ If only one demands favorite: Play focal point (只有一方「要求」, 則按「要求」分)

Can BGT Explain This? (行為賽局論的解釋)

- ▶ If both acquiesce: Earn average of the two focal points

$$x_1 = (50+h)/2, x_2 = (150-h)/2$$

- ▶ 若都「接受另一個」則獲得兩分配平均 $x_1 = (50+h)/2, x_2 = (150-h)/2$

- ▶ MSE: Players demand with probability

(混合策略均衡)

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

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

(未達成協議的比例)

Can BGT Explain This? (行為賽局論的解釋)

- ▶ Roth (book chapter 1985)
- ▶ Disagreement rate = $\frac{(h - 50)^2}{(150 - h)(50 + h)}$
(未達成協議的比例)
- ▶ Predicted to be 0% → 7% → 10% (過去結果預測隨 h ↑)
 - ▶ for $h = 50, 75, 80$ by pervious experiments
- ▶ Data: 7% → 18% → 25% (Direction is right!) (比較靜態正確!)
- ▶ Murnighan et al. (JRU 1988) (理論預測未達協議比例應該隨 h ↑)
 - ▶ $h = 60, 70, 80, 90$ predict 1%, 4%, 10%, 19%
- ▶ Actual data not as good: Constant across h (但實驗結果持平)

Cause of Disagreement: Self-Serving Bias

- ▶ "What is better for me" = "Fair" (對我有利才叫公平)
- ▶ Add to coordination game explains more disagreement in data (上述協調賽局加入自利偏誤可解釋結果)
- ▶ Same in Kagel, Kim and Moser (GEB 1996):
 - ▶ Ultimatum over 100 tickets (P/R value differently)
 - ▶ 用最後通牒談判分配100張(對雙方價值不同)的彩券
 - ▶ If R unaware of H/L, P_H/P_L propose to give 45%/30%
 - ▶ 回應者不知對方價值高低時, 提議者在價值高時會給45%, 但價值低時只給30%
 - ▶ If aware of H, R will want $>50\%$ (Rejection rate = 40%)
 - ▶ 回應者知道對方價值較高會拒絕40%、要求比平分更好, 使得40%提議被拒絕

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:機車騎士告車主)
 - ▶ 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
 - ▶ 30分鐘談判和解(訴訟金額\$100k), 每延遲5分鐘須付\$5k律師費(和解不成則由退休法官裁定)
 - ▶ **First Guess what judge would award** (事先預測和解不成法官會如何判)
 - ▶ US\$1 (or 1 Grade Point) for every \$10,000 (實驗中1萬元=1美元/加1分)

(和解不成來自預期判決結果的落差)

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)
 - ▶ 70%的控制組在第3-4回合達成和解(總共6回合); 雙方預期判決結果落差在2萬元左右(訴訟金額的20%)

| Settlement Statistics (和解結果) | | | | E(judgment) Gap (預期判決落差) | | |
|-------------------------------|----|----|--------------|--------------------------|-----------|---------|
| Group (實驗組別) | N | % | periods | (s. e.) | mean (平均) | (s. e.) |
| Control: Babcock 95' (控制組) | 47 | 72 | 3.75 (回合) | (0.28) | \$18,555 | (3,787) |
| Control: Babcock 97' (控制組) | 26 | 65 | 4.08 (回合) | (0.46) | \$21,783 | (3,956) |

(提高和解率、更快和解的辦法)

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

- ▶ Don't know role @ reading: 94% (in 2.51 pds)
- ▶ But you know own role in reality!
 - ▶ 閱讀前不知自己是哪一方: 94%在2.51回合和解(但現實雙方立場已知!)

| Settlement Statistics (和解結果) | | | | E(judgment) Gap (預期判決落差) | | |
|------------------------------|----|----|---------|--------------------------|----------------------|---------|
| Group (實驗組別) | N | % | periods | (s. e.) | mean (平均) | (s. e.) |
| Control: Babcock 95' | 47 | 72 | 3.75 | (0.28) | \$18,555 | (3,787) |
| Didn't know roles | 47 | 94 | 2.51 | (0.21) | - \$6,275 $\doteq 0$ | (4,179) |
| Control: Babcock 97' | 26 | 65 | 4.08 | (0.46) | \$21,783 | (3,956) |

(提高和解率、更快和解的辦法)

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

- ▶ Or, tell subjects the bias before bargaining and ask them to
- ▶ **List Weakness of own case: 96%** (in 2.39 periods)
 - ▶ 談判前告知有此偏誤，並請其列出己方立場弱點: 96%在2.39回合和解

| Settlement Statistics (和解結果) | | | | E(judgment) Gap (預期判決落差) | | |
|-------------------------------|----|----|---------|--------------------------|----------------------|---------|
| Group (實驗組別) | N | % | periods | (s. e.) | mean (平均) | (s. e.) |
| Control: Babcock 95' | 47 | 72 | 3.75 | (0.28) | \$18,555 | (3,787) |
| Didn't know roles | 47 | 94 | 2.51 | (0.21) | - \$6,275 $\doteq 0$ | (4,179) |
| Control: Babcock 97' | 26 | 65 | 4.08 | (0.46) | \$21,783 | (3,956) |
| 1 st List Weakness | 23 | 96 | 2.39 | (0.34) | \$4,676 $\doteq 0$ | (6,091) |

Summary for Unstructured Bargaining (小結: 自由談判實驗)

- ▶ **Focal points** affect bargaining outcome (「焦點」會影響談判結果)
- ▶ **Chip value** affect bargaining outcome (籌碼/彩券的價值影響談判結果)
 - ▶ Violate IAT Axiom of NBS (違反奈許談判解的IAT公設, 受效用平移伸縮影響)
- ▶ **BGT Explanation:** Bargainers may fail to coordinate under multiple focal points (行為賽局論: 在多重「焦點」下協商不易達成協議)
- ▶ **Self-serving bias** predict costly delay/settle (自利偏誤解釋不和解、^{延遲})
 - ▶ "Outcome favoring me more likely/fair" (對我有利更公平/更可能發生)
 - ▶ Caused by knowing my role when reading case (來自閱讀卷宗時已經知道自己是哪一方)

Structured Bargaining (制式談判)

- ▶ 2-Period Finite Alternating-Offer Game (有限回交互提案)
 - ▶ **Binmore, Shaked & Sutton (1985)**
 - ▶ 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 (經濟系大學生結果不同)
 - ▶ Are they taught backward induction? Also, (因為學過倒推法?)
- ▶ **Binmore:** (還是實驗說明? Binmore請學生極大化自己的報酬)
 - ▶ "YOU WOULD BE DOING US A FAVOR IF YOU SIMPLY SET OUT TO MAXIMIZE YOUR WINNINGS."
- ▶ **Neelin (=Janet Currie):** (Neelin說上課會討論相關理論)
 - ▶ "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

Random Termination vs. Discounting

- ▶ **Zwick, Rapoport and Howard (T&D 1992)**
- ▶ Divide \$30 with random termination
 - ▶ 兩人分配\$30，無限回合但可能隨機結束。還有下一回合的機率如下：
- ▶ Continuation probabilities 0.90, 0.67, 0.17
- ▶ **SPE prediction: (均衡預測) 14.21, 12, 4.29**
 - ▶ Accepted final offers: 14.97, 14.76, 13.92
 - ▶ 最後接受分配與金額縮水的結果類似(50-50平分&均衡)
- ▶ Close to discounting results (50-50 & SPE)
 - ▶ 14.90, 14.64, 13.57

Fixed Delay Cost in Bargaining (固定延遲成本)

- ▶ **Lost wages, profits, etc.** (利潤, 薪資損失)
- ▶ **SPE: Strong side (lower delay cost) gets all**
 - ▶ 均衡預測: 強勢者(延遲成本低)會全拿
- ▶ **Rapoport, Weg and Felsenthal (T&D 1990)**
 - ▶ Divide 30 shekels (pseudo-infinite horizon)
 - ▶ 談判分配30舍克勒 (「假裝」無窮期)
 - ▶ Fixed Cost: 0.10 vs. 2.50 or 0.20 vs. 3.00
(固定延遲成本)

Fixed Delay Cost in Bargaining (固定延遲成本)

- ▶ **Strong support for SPE:** In the 1st round,
 - ▶ 實驗結果支持均衡預測: 在第一回合
 - ▶ Strong P offer 4.4-7.9, weak R accept 60-80%
 - ▶ 強勢者提議給對方4.4-7.9, 且60-80%弱勢者會接受
 - ▶ Weak P offer low, strong R accept 30%, but later quickly settle in 2nd (35%) or 3rd-4th (22%)
 - ▶ 弱勢者提議70%會被強勢者拒絕, 但很快修正, 故35%(22%)的組第2(3-4)回合達成協議

Outside Option and Threat Points (威嚇點)

- ▶ **Binmore, Shaked and Sutton (QJE 1989)**
 - ▶ 2 players bargain over £7, discount factor $\delta = 0.9$
 - ▶ 雙方談判如何分配£7, 折現率=0.9
 - ▶ Rubinstein-Stahl solution is $\left(\frac{1}{1+\delta}, \frac{\delta}{1+\delta}\right)$ (談判解)
 - ▶ Player 2 has outside option of £0, £2, or £4
 - ▶ 若不達成協議成員乙仍可獲得£0, £2, 或£4
- ▶ **Split-the-difference (NBS; 平分差額的預測): 47%, 64%, 76%**
 - ▶ Divide surplus beyond the threat points
 - ▶ 雙方會平方超出威嚇點以外的部分

Outside Option and Threat Points (威嚇點)

- ▶ Deal-me-out (SPE; 來真的才算數的預測): 47%, 47%, 57%=4/7
- ▶ Ignore non-credible options below $\left(\frac{\delta}{1-\delta}\right)$ (只有當威脅可信時才影響結果, 所有更小的威嚇點通通不算數)
- ▶ **Result** (BGT, Figure 4.4): Deal-me-out wins
 - ▶ £0, £2: spike around 50% / £4: cluster @ 57%
 - ▶ 結果符合來真的才算數 (£0, £2: 50%附近特別多 / £4: 集中在57%)
- ▶ Follow-ups:
 - ▶ Binmore, Proulx, Samuelson & Swierzbinski (EJ98)
 - ▶ Forsythe, Kennan and Sopher (book chapter 1991)

Incomplete Information (資訊不透明)

- ▶ Add Asymmetric Information to bargaining
 - ▶ 在談判實驗中加入資訊不透明的情形
- ▶ More realistic, but (更符合真實)
 - ▶ Hard to bargain for a bigger share AND convey information at the same time (但是很難同時傳遞訊息又獅子大開口)
- ▶ Might need to turn down an offer to signal patience or a better outside option
 - ▶ 可能必須要用拒絕某一方案來展示自己有更好的外部選項

Seller Make Offer to Informed Buyer

- ▶ Rapoport, Erve, and Zwick (MS 1995)
- ▶ Seller: Own item (worthless to herself) (賣方: 擁有1單位商品留著沒用)
- ▶ Buyer: Private reservation price is uniform $[0,1]$
 - ▶ (買方: 保留價格為均勻分配, 實際價值只有自己才知道)
- ▶ Seller makes an offer each period (每回合賣方提議價格)
- ▶ Common discount factor δ (相同的折現率 δ)
- ▶ Unique Sequential Equilibrium (唯一的序列均衡)
- ▶ Seller Offer: $p_t = p_0 \cdot \gamma^t$ (賣方提議)
- ▶ Buyer Accepts if $p_t \leq v \cdot \frac{1 - \delta}{1 - \gamma \cdot \delta}$ (買方接受底線為)

Seller Make Offer to Informed Buyer

- ▶ Unique Sequential Equilibrium: (唯一的序列均衡)
- ▶ Seller Offer: (賣方提議)

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

- ▶ Subsequently: $p_t = p_0 \cdot \gamma^t$
 - ▶ (接下來)

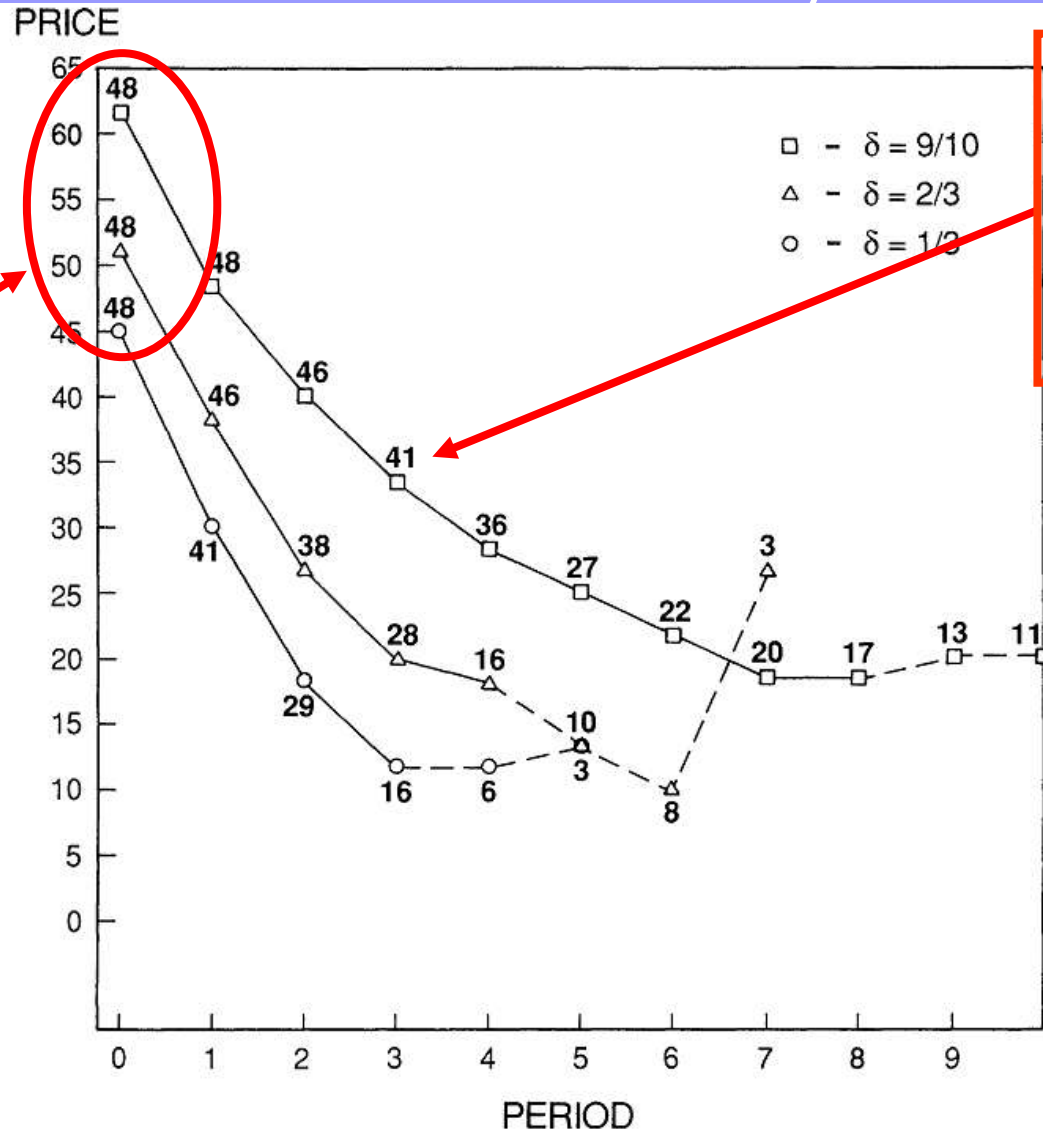
- ▶ Buyer Accepts if $p_t \leq v \cdot \frac{1 - \delta}{1 - \gamma \cdot \delta}$
 - ▶ (買方接受底線為)

Seller Make Offer to Informed Buyer

- ▶ Complicate Strategy: Depend on δ (均衡策略很複雜且跟 δ 有關)
 - ▶ Price discriminate high/low-value buyers
 - ▶ Price declines slow enough so high-value buyers will not want to wait (對保留價格不同的買方實施價格歧視，價格下降速度慢到讓高保留價格者不願意等待。但受試者做得到嗎?)
- ▶ Can subjects get these in experiments?
 - ▶ Different δ : H (0.90), M (0.67), L (0.33) (不同折現率)
 - ▶ Opening p_0 : H (0.24), M (0.36), L (0.45) (初始出價)
 - ▶ Discount γ : H (0.76), M (0.68), L (0.55) (降價幅度)

(賣方對保留價格未知的買方提議)

Seller Make Offer to Informed Buyer



Decline Rate
Amazingly Close!

(但降價幅度很接近理論預測)

Initial offer
too high!
(初始出價太高!)

Seller Make Offer to Informed Buyer

- ▶ Can subjects get these in experiments?
 - ▶ Different δ : H (0.90), M (0.67), L (0.33) (不同折現率)
 - ▶ Opening p_0 : H (0.24), M (0.36), L (0.45) (初始出價)
 - ▶ Discount γ : H (0.76), M (0.68), L (0.55) (降價幅度)
- ▶ Buyers accept the 1st or 2nd offer below v (出價 $< v$ 一兩回合就接受)
 - ▶ Accept offers too soon (買方接受得太早/應該再等一會兒)
- ▶ Sellers ask for higher prices (than equilibrium)
 - ▶ 跟均衡相比，賣方初始出價太高，但實際降價幅度非常接近理論預測
 - ▶ But empirical discount γ : H (0.81), M (0.68), L (0.55)

Strikes and 1-Sided Information (資訊不透明與罷工)

- ▶ Forsythe, Kennan and Sopher (AER 1991)
 - ▶ Only Informed bargainer I sees pie size π_g or π_b (只有一方 I 知道總金額)
- ▶ Uninformed U can strike to shrink pie by γ (不知情的一方 U 可罷工使金額縮水 γ)
- ▶ What happens in free-form bargaining? (自由談判的實驗結果會如何?)
- ▶ Myerson (1979): Revelation Principle (顯示真實原則)
 1. I announces true state (I 宣布真實狀況)
 2. U strikes to shrink pie by γ_g or γ_b (U 罷工會讓金額變成 γ_g 或 γ_b)
 3. I gives U (based on true state) x_g or x_b (根據真實狀況 I 給 U x_g 或 x_b)

Strikes and 1-Sided Information (資訊不透明與罷工)

- ▶ IC requires: (誘因符合限制式)

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

- ▶ Interim Incentive Efficiency requires: (中間誘因效率)

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

- ▶ Strike ($\gamma_b < 1$) if and only if $p\pi_g > \pi_b$

- ▶ 罷工 ($\gamma_b < 1$) 的充分必要條件

- ▶ Deriving this is complicated... (解出這些條件很複雜...)

- ▶ Could ANY subject get close to this? (會有人解出來嗎?)

Strikes and 1-Sided Information (資訊不透明與罷工)

- ▶ Random Dictator (RD) Axiom: (隨機獨裁分配公設)
 - ▶ Agree fair mix between each being dictator to propose mechanism (同意隨機決定由誰獨裁決定分配機制)
- ▶ Then: (則)

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

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

Strikes and 1-Sided Information (資訊不透明與罷工)

- ▶ This is a win-win experiment: (這是一個雙贏實驗)
 - ▶ Success if theory predictions are close (如果結果符合理論預測就驗證了理論)
 - ▶ If not, will point to which assumption fails (不符合可看出哪個假設出問題)
- ▶ Forsythe et al. (AER 1995): (文字溝通10分鐘)
 - ▶ 10 minute sessions; written messages
- ▶ Is Myerson (1979) confirmed? (顯示真實原則是否被驗證?)
 - ▶ Surprisingly yes, though not perfect... (出乎意料地正確，但是還不夠完美...)

Strike Condition Off (罷工條件不成立)

$$p\pi_g < \pi_b$$

| Game (賽局) | p | State (狀況) | π | π_U | π_I | Total (加總) | Strike (罷工) |
|-----------|------|------------|-------|---------|---------|------------|-------------|
| 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 | 2.40 | | | | |
| | | 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 Off (罷工條件不成立)

$$p\pi_g < \pi_b$$

| Game (賽局) | p | State (狀況) | π | π_U | π_I | Total (加總) | Strike (罷工) |
|-----------|------|------------|-------|---------|---------|------------|-------------|
| 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 (罷工條件成立)

$$p\pi_g > \pi_b$$

| Game (賽局) | p | State (狀況) | π | π_U | π_I | Total (加總) | Strike (罷工) |
|-----------|------|------------|-------|---------|---------|------------|-------------|
| 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% |

Strike Condition On (罷工條件成立)

$$p\pi_g > \pi_b$$

| Game (賽局) | p | State (狀況) | π | π_U | π_I | Total (加總) | Strike (罷工) |
|-----------|------|------------|-------|---------|---------|------------|-------------|
| 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 (密封投標的雙邊談判)

- ▶ Both buyers and sellers have private information (買賣雙方都各自知道自己的成本/保留價格)
- ▶ Sealed-Bid Mechanism (密封投標機制)
 - ▶ Both write down a price (雙方都寫下一個價格)
 - ▶ Trade at the average if $p_b > p_s$ (當 $p_b > p_s$ 則以均價成交)
 - ▶ Call Market: Many buyers vs. many sellers (公開喊價: 許多買方 vs. 賣方)
- ▶ Two-Person Sealed-Bid Mechanism
 - ▶ One form of bilateral bargaining (雙人密封投標機制: 一種特定的雙邊談判)

Two-Person Sealed-Bid Mechanism (雙人密封投標機制)

▶ Buyer V : uniform[0,100]; Seller C : uniform[0,100]

▶ 買方價值 V

賣方成本 C

▶ Piecewise-linear Equilibrium: (not unique)

▶ Chatterjee and Samuelson (1983) (一個分段線性均衡)

▶ Myerson and Satterthwaite (1983): Maximize ex ante gains

(極大化事前報酬)

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

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

Two-Person Sealed-Bid Mechanism (雙人密封投標機制)

- ▶ Radner and Schotter (JET 1989): 8 sessions
- ▶ 1, 2, 8: Baseline as above (場次1,2,8為對照組/如上所述)
- ▶ 3: Trade at price $(v + c + 50) / 3$ if $v > (c + 25)$
 - ▶ Should bid their values $v = V, c = C$ (場次3改變交易價格決定方式, 讓誠實下標買方價值/賣方成本為上策)
- ▶ 4: Price = v , (Buyers should bid $v = V/2$) (場次4價格為買方出價; 買方出價應為價值之半/場次5,6改分配增加學習)
- ▶ 5,6: Alternative distribution for more learning
 - ▶ Distribution w/ more trade (for learning): $m=0.438$
- ▶ 7: Face-to-face bargaining (場次7為面對面談判)

Below Cutoff (前段)

Above Cutoff (後段)

Estimated Buyer Bid Function Slope (用資料估計買方出價函數斜率)

| Session (場次) | β | $\hat{\beta}$ | t-stat (t值) | β | $\hat{\beta}$ | t-stat (t值) |
|--------------|---------|---------------|-------------|---------|---------------|-------------|
| 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 (用資料估計賣方出價函數斜率)

Below Cutoff (前段)

Above Cutoff (後段)

| Session (場次) | β | $\hat{\beta}$ | t-stat (t值) | β | $\hat{\beta}$ | t-stat (t值) |
|--------------|---------|---------------|-------------|---------|---------------|-------------|
| 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) |

Face-to-face Yields 110% Efficiency (面對面可達到110%效率)

- ▶ Some **truthfully reveal**; others do not (因部分人講真話)
- ▶ 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. (如果面對面談判的成功可重複驗證，那也許就不必再費心尋找資訊不全下、更好的制式談判方式了)
 - ▶ 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. (反而需要更好的制式談判理論來解釋為什麼面對面的方式這麼成功)

Follow-up Studies (後續研究)

- ▶ Schotter, Snyder and Zheng (GEB 2000)
 - ▶ Agent bargains face-to-face for you (派代表幫你談判)
- ▶ Rapoport and Fuller (1995)
 - ▶ Strategy method; asymmetric value distribution
 - ▶ 詢問完整策略、買方價值/賣方成本分配不對稱

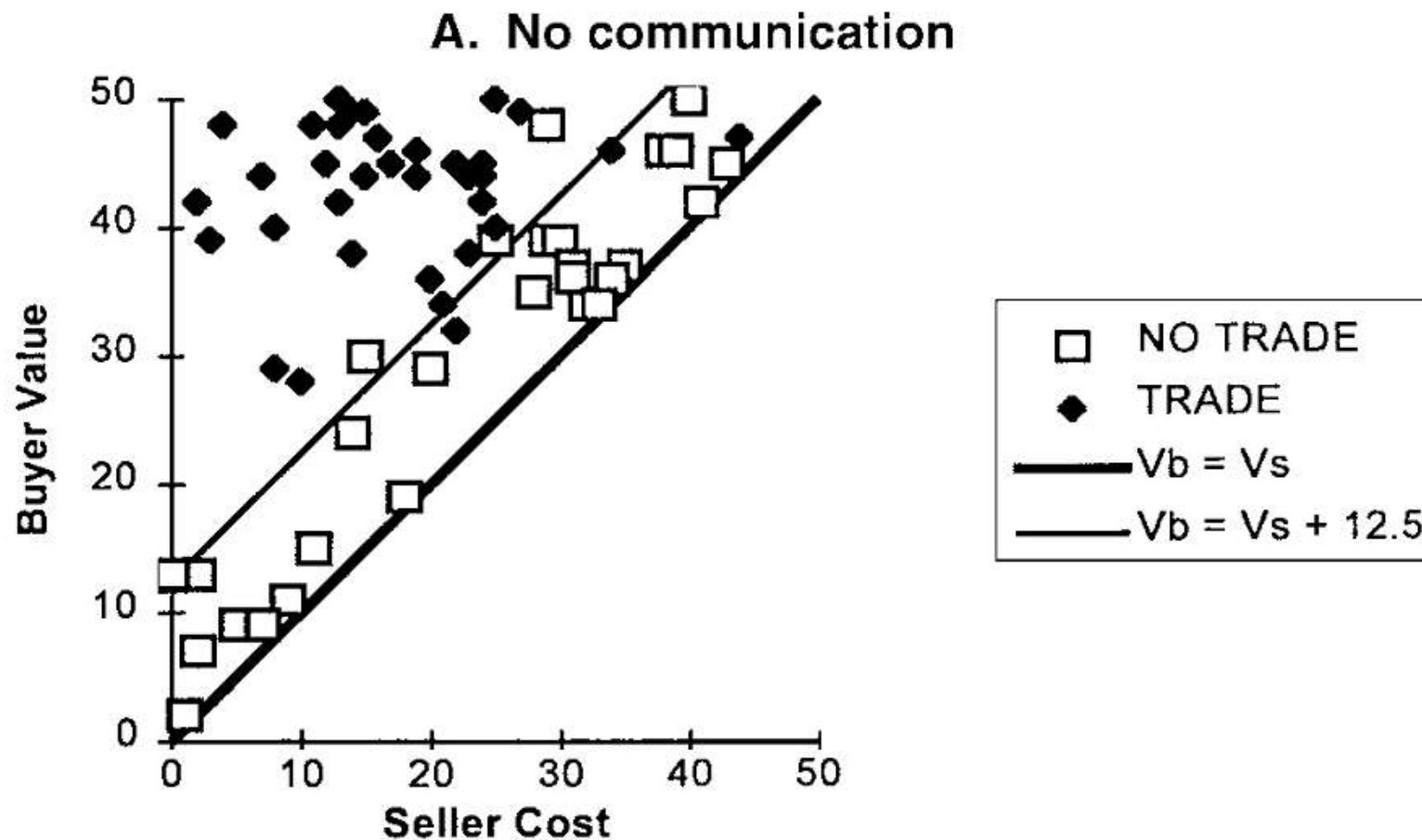
Follow-up Studies (後續研究)

- ▶ Daniel, Seale and Rapoport (1998)
 - ▶ Asymmetric value distribution (20 vs. 200)
 - ▶ 買方價值/賣方成本分配不對稱 (0-20 vs. 0-200)
- ▶ Rapoport, Daniel and Seale (1998)
 - ▶ Flip buyer-seller asymmetry; fixed pairing
 - ▶ 買方價值/賣方成本的分配不對稱反過來、固定配對

Communication vs. Sealed-Bid (溝通 vs. 密封投標)

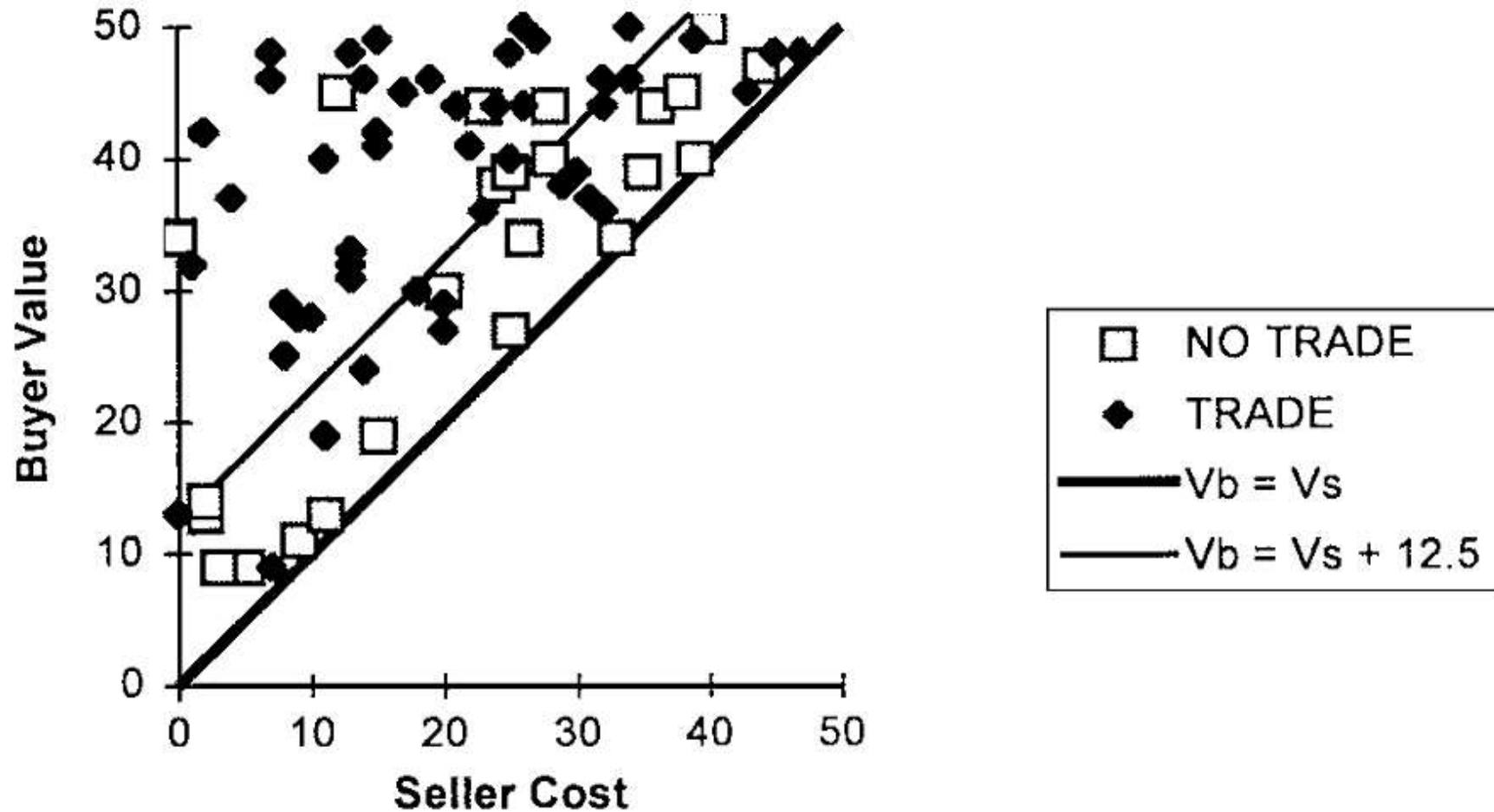
- ▶ **Valley et al. (GEB 2002):** Communication (溝通)
- ▶ Buyer/Seller Values/Costs: uniform[0, \$50]
 - ▶ 買方價值/賣方成本的分配都是 uniform[0, \$50] (透過出價來談判)
 - ▶ Bargain by stating bids; 7 periods; no rematch
 - ▶ Half had no feedback (七回合不重複配對/一半沒有看結果)
- ▶ **No communication:** Sealed-bid in 2 minutes (沒有溝通: 2分鐘內密封投標)
- ▶ **Written communication:** Exchange messages for 13 minutes before final bid (文字溝通: 13分鐘傳紙條交換意見)
- ▶ **Face-to-face:** Pre-game communication (當面: 事前溝通)

Communication vs. Sealed-Bid (溝通 vs. 密封投標)

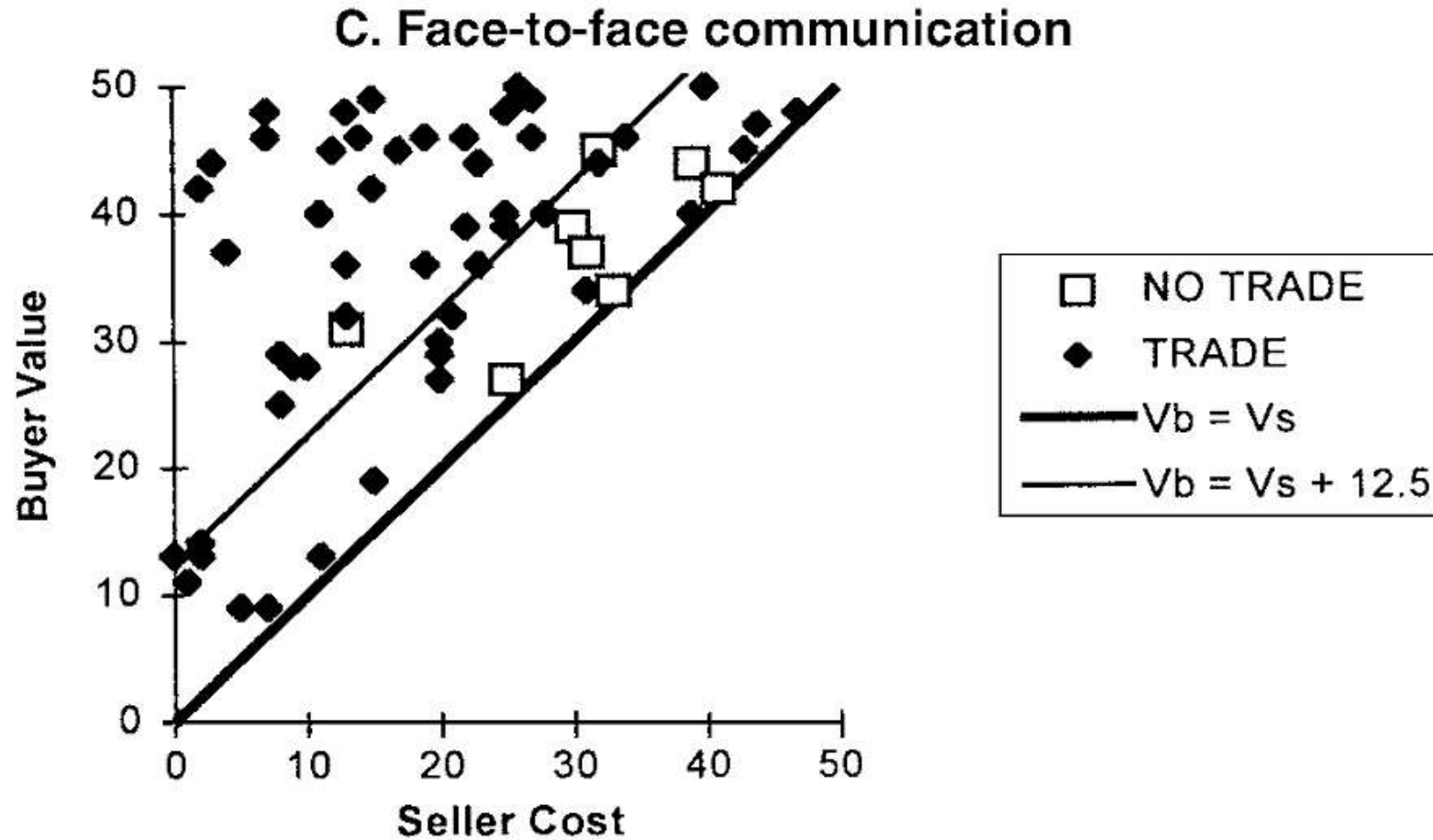


Communication vs. Sealed-Bid (溝通 vs. 密封投標)

B. Written communication



Communication vs. Sealed-Bid (溝通 vs. 密封投標)



Communication vs. Sealed-Bid (溝通 vs. 密封投標)

- ▶ Empirical bid function slope = 0.7 (near 2/3)
 - ▶ 實驗資料估計出來的出價函數斜率(=0.7)接近三分之二
- ▶ Why are there "gains of communication" ?
 - ▶ 「溝通的好處」哪來?
- ▶ Slope of buyer bids against seller bids=0.6
- ▶ Buyers bid higher when seller bids higher
 - ▶ 賣家出價約為買家的六成且賣家出價愈高、買家出價愈高
 - ▶ Mutual bidding of values (common in students)
 - ▶ Mutual revelation of values (common in students)
 - ▶ (學生受試者更傾向)一起用真實價值/成本出價或一起揭露

Communication vs. Sealed-Bid (溝通 vs. 密封投標)

- ▶ Coordinating on a price (40%文字/70%當面協調相同出價)
 - ▶ Happens 40% in written, 70% in face-to-face
- ▶ Not truth-telling (only 1/3) (講真話只有1/3且未協調)
 - ▶ TT not coordinated (4% written, 8% face)
- ▶ Feel each other out; give enough surplus
 - ▶ Modal – equal split of surplus (彼此試探後給足交易好處)
- ▶ Variance of surplus doubles (by mismatch)
 - ▶ (大多平分交易好處，但交易好處的變異數倍增，因為協調不成)

Conclusion (結論)

- ▶ **Unstructured Bargaining** (自由談判: 焦點/競爭的焦點)
 - ▶ Focal divisions; competing focal points
 - ▶ Self-serving bias (erased by veil of ignorance or stating weakness of own case) (自立偏誤可以無知之幕或找己方弱點抗衡)
- ▶ **Structured Bargaining** (制式談判)
 - ▶ Deviate toward equal splits (朝平分偏離均衡預測/因社會偏好?)
 - ▶ Social preference models could explain this
 - ▶ But Johnson et al. (JET 2002) suggest deviation due to limited look-ahead (但MouseLAB結果顯示也可能來自無法「無限往前看」的有限理性)

Conclusion (結論)

- ▶ Outside options affect bargaining divisions only if threats are credible (威嚇點來真的才算數)
- ▶ Lower fixed cost player gets everything (延遲成本低全拿)
- ▶ Information Asymmetry: One-Sided (單邊資訊不對等)
 - ▶ Revelation Principle + Random Dictator: Good
 - ▶ 顯示真實原則+隨機獨裁者公設的預測被實驗結果證實
 - ▶ Bazaar mechanism: (檢驗賣家一再降價直到買家接受的機制)
 - ▶ Offers decline as theory predicts, but start too high and respond to δ wrongly since buyers accept too early (降價幅度符合預測，但是初始開價太高，因買家會太快接受)

Conclusion (結論)

- ▶ Bilateral Bargaining: Two-Sided (雙邊資訊不對等談判)
 - ▶ Sealed-bid mechanism (密封投標機制) : between truthful revelation & piecewise-linear equilibrium
- ▶ Players over-reveal values in face-to-face
 - ▶ Too honest, but "more efficient" (當面太誠實/超效率)
 - ▶ Communication → agree on a single price (溝通→合意單一價格)
- ▶ Why theory does better in sealed-bid than alternative-offer bargaining? (為何密封投標比反覆提議更合乎理論?)
 - ▶ Is sealed-bid cognitively more transparent?