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On Coasean bargaining with transaction costs

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The letter explores how transaction costs affect the efficiency and rationality of Coasian bargaining. Efficiency remained relatively robust with low transaction costs, but was significantly reduced with high transaction costs. A cheap talk protocol increased efficiency. Rationality was dominated by constrained self-interest.

I. INTRODUCTION

The Coase theorem states that given zero transaction costs two disputing parties will bargain until a private and socially optimal agreement is reached, regardless of which party is granted unilateral property rights over the assets (Coase, 1960). While critics complain that Coasean bargaining is a tautology (Bromley, 1989), Coase (1988, p. 15) asserts that he did not champion a zero transaction costs world – '[w]hat my argument does suggest is the need to introduce positive transaction costs explicitly into economic analysis so that we can study the world that does exist'. This letter explores how transaction costs affect the efficiency and rationality of Coasean bargaining.[1]

II. COASEAN BARGAINING WITH TRANSACTION COSTS

As a comparative benchmark, we define a cost-minimizing (CM) equilibrium for a two-player (A and B) Coasean bargain with transaction costs. Let A be the controller, i.e. the player with unilaterial property rights; B is the non-controller. Both players minimize total transaction costs, $C^* = c_A^* + c_B^*$, when one offer is made, evaluated, and accepted. Assume all offers satisfy a player's individual rationality constraint, where the controller's constraint is more binding because his marginal gain from bargaining is relatively more expensive, implying a greater opportunity cost of rejection.[2] Therefore, the controller should wait for the non-controller to make the first offer. Realizing this, the non-controller's offer should be such that the controller will evaluate and accept it. Although not unique, the CM-equilibrium exists when the non-controller makes an offer that the controller evaluates and accepts such that $c_B^* > c_A^* > 0$.

We characterize the distribution of wealth made in the offer by the Nash bargaining problem for a given transaction cost

$$\underset{p_A,\hat{p}_H}{\text{Max}}\,[(Eu_A - Eu^{c-0})(Eu_B - Eu^{nc-0})] \qquad (1)$$

where $Eu_A = p_A u(M + Z - c_A) + (1 - p_A)u(M + z - c_A)$ is A's expected utility; $p_A \in [0, 1]$ and $(1 - p_A)$ are the odds A wins a large or small reward, $Z > z = 0$; M is a monetary endowment; $c_i = \phi^x x_i + \phi^q q_i + \phi^y y_i$ is transaction costs given the number of offers, x_i, evaluations of offers, q_i, and counter-offers, y_i, times the per unit transaction costs, ϕ^x, ϕ^q, and ϕ^y;

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[1] Transaction costs arise from creating and evaluating offers and counter-offers that include meetings, search fees, legal fees, and computation fees (Cheung, 1989; Williamson, 1982).

[2] Assume all offers satisfy a player's individual rationality constraint. The controller's (A) individual rationality constraint is that the expected utility of the offer, Eu_A, times the likelihood, π_A, the non-controller will evaluate and accept the offer cannot be less than the expected returns from exercising his outside option, Eu^{c-0}, $\pi_A Eu_A \geq Eu^{c-0}$. Likewise, the non-controller's individual rationality constraint is that the likelihood, π_B, of the controller reviewing and accepting the offer times her expected utility, Eu_B, of the offer is not less than her expected utility, Eu^{nc-0}, of the outside option, $\pi_B Eu_B \geq Eu^{nc-0}$.

$$Eu^{c-0} = p^0 u(M+Z) + (1-p^0)u(M+z)$$

is the controller's expected utility from taking the outside option with no transaction costs; p^0 is A's odds of winning Z given he takes the outside option;

$$\mathrm{E}u_{\mathrm{B}} = (1 - p_A - \hat{p}_H)u(M + Z - c_B) + (p_A + \hat{p}_H)u(M + z - c_B)$$

is B's expected utility; $\hat{p}_H \in [0, 1]$ is the probability the house wins given an alternative lottery is agreed upon by the bargainers;

$$Eu^{nc-0} = (1 - p^0 - p_H)u(M+Z) + (p^0 + p_H)u(M+z) = u(M+ > z)$$

is B's expected utility given A takes the outside option; and $p_H = 1 - p_A - p_B$.

Since Expression 1 is decreasing in $\hat{p}_H$, the optimal lottery is when $\hat{p}_H = 0$ such that

$$p_A = \left(p^0 + \frac{p_H}{2}\right) + \psi$$

where the first term in brackets represents the transaction cost-independent solution and the second term, ψ, represents the extra transaction costs effect[3]

$$\psi = \frac{1}{2\Delta u(A)\Delta u(B)}[p^0\Theta_1 + p_H\Theta_2 + \Delta u(A)\Theta_3 - \Delta u(B)\Theta_4]$$

Now consider our indicators of efficiency and rationality. We define two measures of efficiency – reward efficiency,

$$R = \{[p_A + p_B][2M + Z - c_A - c_B)] - p^0(2M + Z)\}/[(2M+Z)(1-p^0)],$$

is the improvement in actual expected gain as a percentage of the potential gain due to bargaining;[4] and relative reward efficiency, $RR = [1 - ((R_{\mathrm{cm}} - R)/R)]$, is a constrained efficiency measure, where R_{cm} equals R evaluated at the transaction costs implied by the CM-equilibrium, c_A^* and c_B^*.[5] We also measure the actual transaction costs relative to the predictedcosts, $C_{IF} = (C_{obs} - C^*)/C^*$; as a measure of incomplete information.[6]

Rationality is measured by the distribution of expected wealth based on how the players balance the extremes of pure self-interest and equity. The index of constrained self-interest is

$$\alpha = [p_A - \gamma]u(\mathrm{M} + Z - c_A)/[p^0 u(\mathrm{M} + Z) - \gamma u(\mathrm{M} + Z - c_A)],$$

where $\gamma = [0.5 - (p_H/2)]$. If $\alpha \geq 1$, the controller is strictly self-interested; $\alpha = 0$ strictly equitable, $p_A = \gamma$, or $0 < \alpha < 1$ constrained self-interest. We also examine rationality by considering: whether offers and counter-offers fall as transaction costs rise; who makes the first offer; whether the non-controller suffers more of the total transaction costs, $c_B^* > c_A^*$; and how closely the wealth distribution matches Nash bargaining solution for risk-neutral players.

Table 1. *Lottery schedules*

Schedule 1			Schedule 2			Schedule 3			Schedule 4		
Number	A's chance to win	B's chance to win	Number	A's chance to win	B's chance to win	Number	A's chance to win	B's chance to win	Number	A's chance to win	B's chance to win
1	70	0	1	0	70	1	0	70	1	70	0
2	60	10	2	10	60	2	30	40	2	60	40
3	50	20	3	40	30	3	35	65	3	50	20
4	35	65	4	60	40	4	50	20	4	40	30
5	30	40	5	50	20	5	60	10	5	10	60
6	0	70	6	70	0	6	70	0	6	0	70

[3] Let $\Delta u(A) = u(M + Z - c_A) - u(M + z - c_A) > 0$. $\Delta u(B) = u(M + Z - c_B) - u(M + z - c_B) > 0$, $\Delta u = u(M + Z) - u(M + z) > 0$, $\Theta_1 = [\Delta u(\Delta u(A) + \Delta u(B)) - 2\Delta u(A)\Delta u(B)]$, $\Theta_2 = [\Delta u(A)(\Delta u - \Delta u(B))] < 0$, $\Theta_3 = [u(M + Z - c_B) - u(M + Z)] < 0$, and $\Theta_4 = [u(M + z - c_A) - u(M + z)] < 0$.

[4] Reward efficiency is maximized when $p_H = 0$ and $c_A = c_B = 0$, i.e. $R = 1$. Transaction costs will force reward efficiency to be less than 100% for most bargains because either: (a) the controller takes the outside option to avoid transaction costs $c_A = c_B = 0$, leaving the surplus lottery tickets on the bargaining table ($p_H > 0$); or (b) the players follow the CM-equilibrium such that the bargaining pair come to an agreement that secures all of the surplus lottery tickets above the outside option ($p_H = 0$) but suffer the minimum transaction cost, $c_A^* + c_B^* > 0$.

[5] We also consider probability efficiency, $\Gamma = \{[p_A + p_B] - p^0\}/(1 - p^0)$, to examine whether subjects simply ignore transaction costs and focus on maximizing the joint odds of victory.

[6] Let C_{obs} be the actual total transaction costs observed in bargaining and $C^* = c_A^* + c_B^*$ be the predicted total transaction costs in the CM-equilibrium. See Kennan and Wilson (1993).

[7] The experimental design follows the research thread starting with the original work of Hoffman and Spitzer (1982) that has continued with the boundary experiments exploring the limits to Coasean bargaining in Shogren (1992, 1998).

III. EXPERIMENTAL DESIGN[7]

Contracts and lottery schedules

Each bargain involved two perfectly enforced contracts – the number and transfer contracts. The number contract specifies the initial chances of winning the large reward ($10/round), requiring the bargaining pair to select one of six numbers from a 'Lottery Schedule' (see Table 1). Provided the outside option is not taken, players use the transfer contract to redistribute lottery tickets.

Selection of the controller

A matching game determined the controller in each of the four bargaining rounds. The first player matching three of five card pairs (given one unmatched card) was the controller.

Transaction costs

Each subject had a non-transferable $2.50 endowment per bargain. Subjects kept the remaining endowment after all offers, evaluations, and counter-offers were made. Four transaction cost specifications were considered:

	Zero cost	*$0.20 cost*	*$0.50 cost*	*$0.50 cost–C. talk*
Offer (ϕ^x)	$0.00	$0.20	$0.50	$0.50
Evaluation (ϕ^q)	$0.00	$0.10	$0.25	$0.25
Counter-offer (ϕ^y)	$0.00	$0.10	$0.25	$0.25

Cheap talk protocol

We examine how a two-way 'cheap talk' protocol affects R, RR and C_{IF}. We implemented the cheap talk protocol using an exchange of sealed notes stating a player's maximum and minimum lottery tickets he or she was willing to accept in the bargain. Free communication of threat points can increase information between bargainers (Farrell, 1987).

Procedures

Each subject was randomly assigned a letter designation (A or B), a map to cycle them through the bargaining rounds, and an indentical set of instructions with a comprehension quiz. A monitor read the instructions aloud and answered all relevant questions. Bargains were face-to-face with a monitor separating the pair and handling all offers and counter-offers. The sequencing of offers and counter-offers was endogenous. Prior to each five minute bargaining round, the subjects were given a lottery distribution schedule and the transaction cost specification.[8] Thirty-eight inexperienced subjects were recruited campus wide from the University of Wyoming.

IV. RESULTS AND DISCUSSION

> **Result 1.** Reward and relative reward efficiency remained robust with low transaction costs, but declined significantly with high transaction costs. Total transaction costs were about 100% higher than predicted by the CM-equilibrium. Cheap talk increased efficiency as bargainers took advantage of the free communiction of threat points.

Table 2 shows that transaction costs reduced efficiency – mean reward and relative reward efficiency, R and RR, equalled 0.78 for zero cost; 0.67 and 0.71 for $0.20 cost; 0.53 and 0.63 for $0.50 cost; and 0.62 and 0.74 for $0.50 cost-cheap talk.[9] Median values were larger, R ranged from 0.67 to 1.00, RR ranged from 0.80 to 0.95. Efficiency was low because bargainers did not minimize total transaction costs as predicted – mean C_{IF}, was about 100% higher than predicted for the $0.20 and $0.50 cases; median values ranged from 67 to 100%.

Table 2. *Summary statistics: efficiency and distribution of wealth*

		Transaction costs			
		Zero	$0.20 Offer	$0.50 Offer w/out cheap talk	$0.50 Offer w/ cheap talk
Efficiency					
Reward	Mean	0.78	0.67	0.53	0.62
	Median	1.00	0.89	0.67	0.72
	S.D.	0.43	0.41	0.42	0.37
Rel. Reward	Mean	–	0.71	0.63	0.74
	Median	–	0.95	0.80	0.87
	S.D.	–	0.44	0.51	0.45
Probability	Mean	0.78	0.79	0.83	0.84
	Median	1.00	1.00	1.00	1.00
	S.D.	0.43	0.42	0.38	0.37
Number of $p_H = 0$		14	15	15	16
% cost of incomplete information					
C_{IF}	Mean	–	0.98	0.96	0.42
	Median	–	0.67	1.00	0.00
	S.D.	–	1.02	1.01	0.55
N		18	19	18	19

[8] Four sequences of transaction costs were used to control for order effects.
[9] Probability efficiency, Γ, was relatively constant ranging from 0.78 with Zero costs to 0.84 with $0.50 cost-cheap talk. Median values for Γ equalled 1.00 for all cases.
[10] The restriction that reward efficiency was independent of both round and player, $\gamma_{ROUND2} = \gamma_{ROUND3} = \cdots = \omega_{12} = \omega_{13} = \cdots = \omega_{44} = 0$, was not rejected at the 5% level ($F = 0.649$).

Table 3. *Estimated coefficients, R*

Variable	R
ξ_0	0.778*
	(0.096)
ξ_{20}	−0.113
	(0.230)
ξ_{50}	−0.249**
	(0.135)
$\xi_{50w/CT}$	−0.161
	(0.134)
N	74
F-statistic	0.649

* and ** indicate statistical significant at the 1% and 10% levels. Standard errors are in parentheses.

The following model for the A players tests whether the differences in reward efficiency are due to delay costs or learning and subject effects or some combination

$$R = \xi_0 + \xi_i \sum_{i=2}^{4} TC_i + \gamma_j \sum_{j=2}^{4} r_j + \omega_{1k} \sum_{i=2}^{5} A_{1k} + \omega_{2k} \sum_{i=1}^{5} A_{2k} + \omega_{3k} \sum_{i=1}^{5} A_{3k} + \omega_{4k} \sum_{i=1}^{4} A_{4k}$$

where TC_i are the $(I-1)$ transaction costs (excluding the zero cost), r_j are the $(T-1)$ rounds, and A_{zk} are the $(N-1)$ A players from the four treatments, $z = 1, 2, 3$, or 4. Focusing on the restricted model,[10] Table 3 shows that efficiency was robust with low transaction costs ($0.20), but was significantly reduced with high costs ($0.50).

The results suggest that the full information assumption in the CM-equilibrium is too strict. The cheap talk protocol, however, helped to improve performance. Mean reward and relative reward efficiency, R and RR, increased by 9 and 11 percentage points, and mean and median costs, C_{IF} declined to about 40 and 0% over predicted levels. While Cooper *et al.* (1992) observed that two-way protocol did not increase efficiency in 3 × 3 extensive form coordination games, our results are more favourable to cheap talk even in a game with endogenous offers and numerous potential distributions of wealth. Future reseach exploring how bargaining efficiency can be increased via integrated nonmarket valuation-as-cheap talk is warranted.

> **Result 2.** We observe that (a) the distribution of wealth is best explained by constrained self-interest, (b) the demand for offers and counter-offers declined as transaction costs increased; (c) the non-controller was more likely to make the first offer the greater the transaction costs; (d) the controller bore a smaller

Table 4. *Summary statistics: transaction costs effects*

		Transaction costs			
		Zero	$0.20 Offer	$0.50 Offer w/out cheap talk	$0.50 Offer w/ cheap talk
Distribution of wealth					
α	Mean	0.76	0.78	0.60	0.79
	Median	1.00	0.95	0.69	0.87
	S.D.	0.45	0.50	0.41	0.46
Number of offers					
	Mean	3.06	2.47	2.39	1.63
	Median	2.00	2.00	2.00	1.00
	S.D.	2.01	1.50	1.46	0.83
Who made the first offer?					
	Controller	9	8	5	6
	Non-Controller	9	11	12*	13
Transaction costs					
Controller	Mean	–	0.28	0.67	0.47
	Median	–	0.30	0.63	0.50
	S.D.	–	0.15	0.36	0.22
Non-controller	Mean	–	0.31	0.81	0.59
	Median	–	0.30	0.75	0.50
	S.D.	–	0.18	0.44	0.28
% of risk neutral Nash solution					
Controller	Mean	77	78	77	80
	Median	82	83	80	84
	S.D.	11	15	12	13
Non-controller	Mean	188	186	197	182
	Median	200	181	192	182
	S.D.	118	99	117	102
N		18	19	18	19

* One bargaining dyad made no offers.

Table 5. *Distribution of wealth and Selten's measure of predictive success*

Transaction cost	Wealth distribution	N	Hit rate (#)	Hit rate (%)	Area (%)	Predicted success (%)
Zero	Self-interest	18	11	61.1	21.7	39.4
	Constr. S–I*	18	4	22.2	28.2	−6.0
	Equal splits	18	3	16.7	0.3	16.4
$0.20	Self-interest	19	6	31.6	21.7	9.9
	Constr. S–I	19	10	52.6	28.2	24.4
	Equal splits	19	3	15.8	0.3	15.5
$0.50	Self-interest	18	4	22.2	21.7	0.5
	Constr. S–I	18	10	55.6	28.2	27.4
	Equal splits	18	4	22.2	0.3	21.9
$0.50 w/CT	Self-interest	19	6	31.6	21.7	9.9
	Constr. S–I	19	10	52.6	28.2	24.4
	Equal splits	19	3	15.8	0.3	15.5

* Constr. S–I: Constrained self-interested split of expected wealth.

[11] Selten's measure is $m = hr - ar$, where hr is the relative hit-rate of a theory – the number of observations according to the theory divided by the total number of observations, and ar is the area of the theory divided by the total area. Note that hr is a gross rate of predictive success, while m is a net rate of success.

fraction of the high transaction costs than the non-controller; and (e) the controller only received about 80% of the expected wealth predicted by the risk neutral Nash bargaining solution, while the none-controller received over 180%.

Regarding (a), based on the index of constrained self-interest, α, Table 4 shows constrained self-interest in 45% (33 of 74) of all agreements; pure self-interest in 37% (27 of 74); and pure equity in 18% (13 of 74). Selten's (1991) measure of predictive success, m, tells a similar story.[11] Table 5 shows constrained self-interest m ranged from −6.0 to 27.4%; pure self-interest m ranged from 0.5 to 39.4%; and equity m ranged from 15.5 to 21.9%. Constrained self-interested bargains had the highest prediced success in all but the zero cost treatment.

Regarding (b)–(e), the evidence weakly supports rationality as predicted by the CM-equilibrium. Table 4 shows that the demand for offers and counter-offers fell as transaction costs increased. Mean offers fell from 3.06 with zero cost to a significantly different low of 1.63 with $0.50 cost-cheap talk ($Z = 2.501$); median offers fell from 2 to 1. Also as predicted, larger transaction costs increased the odds the non-controller would make the first offer and would bear a larger fraction of costs – the non-controller moved first in over two-thirds of the $0.50 cost and $0.50 cost-cheap talk bargains, with a mean non-controller cost of $0.81 and $0.59 relative to the mean controller costs of $0.67 and $0.47. Although bearing less costs, the controller only received about 80% of the expected wealth predicted by the risk neutral Nash solution; the non-controller earned between 182 and 197%, suggesting further support for constrained self-interest.

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REFERENCES

Bromley, D. (1989) Entitlements, missing markets, and environmental uncertainty, *Journal of Environmental Economics and Management*, **17**, 181–94.

Cheung, S. (1989) Economic organization and transaction costs, in *The New Palgrave: Allocation, Information and Markets*, J. Eatwell, M. Milgate and P. Newman (eds), W. W. Norton & Co., New York, pp. 77–82.

Coase, R. (1960) The problem of social cost, *Journal of Law and Economics*, **3**, 1–44.

Coase, R. (1988) *The Firm, the Market and the Law*. University of Chicago Press, Chicago.

Cooper, R., DeJong, D., Forsythe, R. and Ross, T. (1992) Communication in coordination games, *Quarterly Journal of Economics*, **107**, 739–71.

Farrell, J. (1987) Cheap talk, coordination, and entry, *RAND Journal of Economics*, **18**, 34–9.

Hoffman, E. and Spitzer, M. (1982) The Coase theorem: some experimental tests, *Journal of Law and Economics*, **25**, 73–98.

Kennan, J. and Wilson, R. (1993). Bargaining with private information, *Journal of Economic Literature*, **31**, 45–104.

Selten, R. (1991) Properties of a measure of predictive success, *Mathematical Social Sciences*, **21**, 153–67.

Shogren, J. (1992) An experiment on Coasian bargaining over ex ante lotteries and ex post rewards, *Journal of Economic Behavior and Organization* **17**, 153–69.

Shogren, J. (1998) Cosean bargaining with symmetric delay costs. *Resource and Energy Economics*, **20**(4), 309–25..

Williamson, O. (1982). Transaction-cost economics: the governance of contractual relations, *Journal of Law and Economics*, **22**, 223–61.