Costly Coasean Bargaining and Property Right Security

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Abstract

This paper examines how transaction costs affect Coasean bargaining with secure and insecure property rights in the lab. Consistent with the theory that secure property rights lowers the cost of non-cooperation, we find that bargaining efficiency is inversely related to property right security. Less secure property rights increased economic efficiency twofold. Property owners with secure rights are more likely to opt for their riskless outside option rather than pay the costs of bargaining.

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1. Introduction

Recall Coase's (1960) classic attack on the Pigovian mindset of many post-war, neo-classical economists. If, as Pigou proposed and followers promoted, a regulator could set an efficient Pigovian tax to remedy a negative externality between two disputing parties, Coase reasoned it must be only because the transaction costs to collect all the necessary information were either nil or very low. Otherwise, how could the regulator have gathered all the private details on the marginal benefits and marginal costs underlying these citizens' preferences to set the tax accurately? But if transaction costs were so low, Coase argued that the citizens did not need the regulator to intervene with a new tax – rather they could resolve the problem themselves. The regulator could simply assign secure property rights to one party or the other, and the two citizens could then bargain – costlessly – until they found an efficient agreement. Coasean bargaining with *secure property rights* and *zero transaction costs* avoided the need for government interference in the price system. This is the Coase theorem.

If one looks at the Coase theorem from a Nash bargaining perspective, however, we see that efficiency should be exactly the same regardless of whether unilateral property rights are secure or insecure. By property right *inse-*

curity, we mean a person who thinks he has secure individual or unilateral property rights to a resource is at risk of relinquishing these individual rights to the group as common property. One could interpret "insecurity" here as also meaning "secure but differently allocated" property rights, e.g., joint property rights. That said, a rational pair of bargainers who negotiate costlessly should reach the efficient bargaining frontier – secure rights or otherwise. The only ingredient that should differ is the final distribution of the total wealth.

Figure 1 illustrates. Suppose the regulator gives player A the secure unilateral property rights. Point x represents A's outside option, or threat point, with these secure rights. Player A can exercise his outside option at any time, thereby ending the bargain. Bargaining, however, can allow players A and B to achieve a mutually advantageous deal. Assuming equal bargaining ability, point y shows the efficient Nash–Coasean bargaining solution – A and B split equally the additional wealth above the outside option, with A earning more total wealth than B.

In contrast, point z is a new threat point when A's unilateral property rights are perfectly insecure, e.g., joint property rights. If player A chooses to exercise his outside option, both parties go to court to determine the final outcome. Point zz is the Nash–Coasean solution to the insecure property problem, which is again on the efficient bargaining frontier. Assuming equal bargaining power, players A and B should now share total wealth equally. So we see that a Nash–Coase bargaining solution with secure (pt. x) or insecure

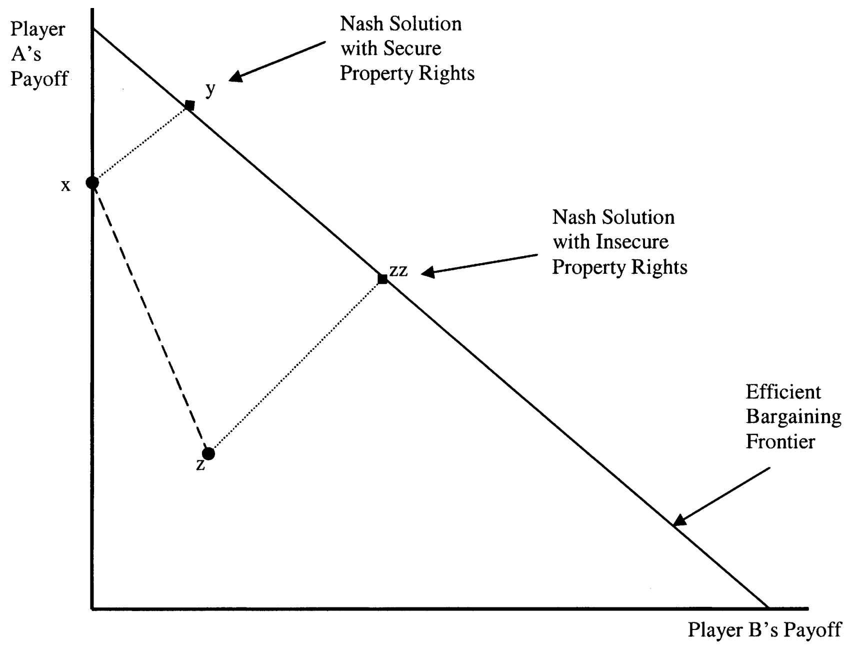

Figure 1. Efficient bargaining with and without secure property rights.

property rights (pt. y), or any combination of these two poles (the line connecting pts. x and y) should be equally efficient in this zero transaction cost world.

But Coase did not promoted a world of zero transaction costs; rather he "pushed the fiction of zero transaction costs reasoning to limit" (Williamson 1994). His Noble–prize winning work 23 years earlier on transaction costs within the firm demonstrates that without doubt (Brunner 1992; also see Coase 1936). What Coase said was, since a zero transaction costs world does not exist, what we need to study was the world that does – the one with transaction costs (Coase 1998). In our current context, the open question we address is how transaction costs work with property right security to affect bargaining efficiency. The answer is not *a priori* obvious given two competing hypotheses: a *backsliding* argument which says security enhances efficiency because it avoids a costly battle in court; and the *non-cooperation* counter-argument which says security reduces efficiency because the cost of non-cooperative behavior is relatively cheap.

Our results suggest the *non-cooperation* theory does a better job at organizing observed bargaining behavior in the lab. We see that Coasean bargaining with transaction costs is more efficient when property rights are *less secure*, *not more secure*. Bargaining efficiency increases as property right security decreases. The reason is insecure rights increase the costs of non-cooperative behavior. A property right holder who otherwise might want to avoid transaction costs by taking his outside option now must bargain. And while bargaining is costly, it is not as socially expensive as the alternative – leaving potential wealth on the table by avoiding the bargain as is permitted with secure property rights. We find that the net gains from bargaining with transaction costs under insecure rights exceed the losses incurred from property owners choosing not to bargain at all. We cannot dismiss these results arising from irrational bargainers – nearly all agreement were rationally self-interested and people valued security more the less secure their rights, as predicted.

These results alter the nature of the Coase theorem. Before, the argument was *without transaction costs and weak property rights*, a regulator makes property rights *more secure* to increase the odds citizens will bargain to an efficient outcome. Now we find *with transaction costs and strong property rights*, a regulator could consider making property rights *less* secure to increase the odds citizens will bargain to a more efficient outcome. Within our frame of costly Coasean bargaining, less security drives people to the bargain table, and consequently, to greater bargaining efficiency.

2. A Benchmark Model

We start by defining the benchmark model for rational Coasean bargaining with and without secure property rights in four steps – (1) the bargaining environment; (2) property rights security; (3) Nash bargaining solution; and (4) the controller's valuation of reducing the risk of insecure rights. First, consider the basic bargaining environment. A Coasean bargain consists of two players (A and B) negotiating over *lottery tickets*, α_A and α_B, defining the likelihood of winning a large monetary payoff, Z. For simplicity, we normalizing utility, $u(Z) = 1$ and $u(0) = 0$, such that player i's expected utility is defined by his or her final proportion of total lottery tickets.

All bargaining has some transaction costs, $C = c_A + c_B$, where $c_i = \varphi^o o_i + \varphi^y y_i + \varphi^z z_i (i = A, B)$ represents a player's costs defined by the number of (a) offers, o_i, (b) evaluation of offers, y_i and (c) counter offers, z_i, times the per unit costs,φ^0,φ^y, and φ^z. Each player also has an initial *endowment* of lottery tickets, λ_A and λ_B, to help cover transaction costs. Therefore, the total number of lottery tickets is $\alpha_T = \lambda_A + \lambda_B + \alpha_A + \alpha_B + \alpha_H$, where (α_H/α_T) denotes the probability the *house* retains the larger payoff. Here α_H represents the lottery tickets on the bargaining table given the property right security, i.e., the potential gains from bargaining. If $\alpha_H = 0$, no lottery are left on the bargaining table, and either player A or B will win the payoff, Z – the house has zero chance to retain the payoff. If $\alpha_H > 0$, some lottery tickets are left on the table and the house has a chance to keep Z.

Second, consider property right security. Assume player A is the *controller* – the player with property rights such that he can unilaterally exercise his unilateral *outside option* at any time during the negotiations, i.e., the controller's threat point. Given his initial endowment λ_A, let $\alpha_A^o + \lambda_A$ denote the controller's probability of winning the large payoff, Z, when he exercises the outside option. Let $0 \leq q \leq 1$ represent the probability that his unilateral property right is upheld when challenged. *Secure* property rights exist when $q = 1.0$ – no risks to unilateral rights; *no* unilateral rights exist when $q = 0$; and *insecure* unilateral rights arise when $0 < q < 1$, i.e., there is a chance the property rights are joint.

Secure property rights implies that the controller's expected payoff from unilaterally exercising his rights is the sum of his outside option and endowment lottery tickets, $\alpha_A^0 + \lambda_A$; whereas the non-controller's expected payoff is just her endowment, λ_B. But for the cases of *no unilateral* and *insecure* rights, both players' expected payoffs from the outside option are derived from a non-cooperative contest (see Dixit 1987). Let x_i represent player i's observable and irreversible effort invested to win the property rights. Assume both player have equal ability in the contest.

Using the standard contest–success function (see Dixit 1987; Tullock 1980), assume each player privately and independently selects his level of effort to maximize his expected payoff, EP_i^N,

$$\underset{x_i}{\text{Max}} \frac{x_i}{x_i + x_j} \alpha_i^0 - x_i + \lambda_i, \quad (i = A, B; \ j = A, B; i \neq j). \tag{1}$$

For simplicity, assume the value of the outside options is identical, $\alpha_{\rm A}^0 = \alpha_{\rm B}^0$. Solving (1) for the players' best functions, the Nash equilibrium levels of effort:

$$(x_{\rm A}^N, x_{\rm B}^N) = \left(\frac{1}{4}\alpha_{\rm A}^0, \frac{1}{4}\alpha_{\rm A}^0\right),$$

Substitute the Nash equilibrium effort levels into a player's expected payoffs to determine the expected payoff from the contest:

$$\mathrm{EP}_i^N = \frac{1/4\alpha_{\rm A}^0}{1/4\alpha_{\rm A}^0 + 1/4\alpha_{\rm A}^0}\alpha_{\rm A}^0 - 1/4\alpha_{\rm A}^0 + \lambda_i = 1/4\alpha_{\rm A}^0 + \lambda_i. \quad (i = {\rm A}, {\rm B}) \tag{2}$$

Therefore, with property rights insecurity, the controller's and non-controller's expected payoffs when the controller takes his insecure outside option are:

$$\mathrm{EP}_{\rm A}^0 = q(\alpha_{\rm A}^0 + \lambda_{\rm A}) + (1 - q)\mathrm{EP}_{\rm A}^N \tag{3}$$

$$\mathrm{EP}_{\rm B}^0 = q\lambda_{\rm B} + (1 - q)\mathrm{EP}_{\rm B}^N. \tag{4}$$

Third, we now define the Nash bargaining solution given the non-cooperative threat points. In a Nash cooperative bargain, each player negotiates to realize the gains from trade over the existing unilateral property right. The Nash bargaining solution is the product of player A and B's potential gains from bargaining:

$$\begin{aligned} &\underset{\alpha_{\rm A}}{\mathrm{Max}}[\alpha_{\rm A} - c_{\rm A} - \mathrm{EP}_{\rm A}^0 + \lambda_{\rm A})(\alpha_{\rm B} - c_{\rm B} - \mathrm{EP}_{\rm B}^0 - \lambda_{\rm B})] \\ &\text{s.t. } \alpha_T = \lambda_{\rm A} + \lambda_{\rm B} + \alpha_{\rm A} + \alpha_{\rm B} + \alpha_H. \end{aligned} \tag{5}$$

Assuming efficient bargaining (i.e., the house gives up all lottery tickets), solving the first order conditions for Expression (5) yields the optimal number of lottery tickets for player A:

$$\alpha_{\rm A} = \left[\alpha_{\rm A}^0 + \frac{\alpha_H}{2}\right] - \rho + \vartheta \tag{6}$$

where

$$\rho = \left[\frac{2\alpha_{\rm A}^0 + \alpha_H + \lambda_{\rm A} + \lambda_{\rm B} - \alpha_T}{2}\right](1 - q) \geq 0,$$

represents the impact of insecure property rights on player A's tickets ($\rho > 0$, if $q > 0$, $\rho = 0$, if $q = 1$), and

$$\vartheta = \left[\frac{c_{\rm A} - c_{\rm B}}{2}\right]$$

shows the affect of transaction costs – players share these costs equally. Expression (6) says player A receives his outside option plus half the bargaining surplus, adjusted for insecure property rights and transaction costs. Note if property rights are secure ($\rho = 0$) and transaction costs are zero ($\vartheta = 0$), player A earns the standard Nash solution: his outside option plus half the surplus. The optimal allocation for player B is $\alpha_B = \alpha_T - \alpha_A - [\lambda_A + \lambda_B]$.

Player A, the controller, should always prefer bargaining to not bargaining. Comparing expressions (3) and (6) shows $[\alpha_A - EP^o_A > 0]$ for any value of q, which implies the controller prefers bargaining to taking the outside option regardless of the uncertainty associated with the outside option, q. Opting for the outside option becomes an attractive alternative only when the transaction costs effect is too large. Player B, the non-controller, also should prefer bargaining. Given expression (2) always exceeds the endowment λ_i, EP^o_B reaches the maximum when q equals zero and $EP^o_B = EP^N_B$. While the non-controller's expected payoff increases in insecurity, with the greatest payoff arising with no rights, he should bargain because he always benefits from an efficient agreement.

Finally, if unilateral property rights are valuable, the controller should be willing to pay to reduce the risk of insecurity. Using expression (3), the ex ante option price, WTP_A, for secure property rights given the bilateral lottery is determined by

$$\alpha^0_A + \lambda_A - WTP_A = EP^0_A$$

which can then be rearranged and rewritten as

$$WTP_A[(3/4)\alpha^0_A](1 - q)$$

The option price is inversely related to the likelihood of secure property rights. A rational controller pays less as property rights become more secure, i.e., if $q = 1$, then $WTP_A = 0$.

Table I summarizes the efficiency Nash solution predications of the benchmark model given our parameter set. We set total lottery tickets at $\alpha_T = 200$; outside option with secure property rights at $\alpha^o_A = 120$; endowments at $\lambda_i = 10$; potential gains from bargaining from secure rights at $\alpha_H = 60$; and transaction costs: offer $\varphi^o = 2$, evaluate $\varphi^y = 1$, and counter-offer $\varphi^z = 1$. We consider five levels of security, $q = [1.0; 0.9; 0.75; 0.5; 0.0]$. We see predicated Nash solutions range from a 150:30 split with secure property rights to a 90:90 split with no rights. The predicated option prices of the corresponding outside options range from 0 to 90 tickets.

In principle, rational bargainers should always find the efficient Nash solution at the least transaction costs. In reality, however, these costs can significantly reduce bargaining efficiency in the lab (see for example Rhoads and Shogren 1999, 2003). The open question is how transaction costs and property right security intertwine to affect efficiency. Consider two competing

Table I. Parameters and predictions

A. Parameters			
Total lottery tickets (α_T)	200		
Unilateral property rights ($\alpha^o{}_A$)	120		
Player endowment (λ_i)	10		
Potential gains from trade (α_H)	60		
Transaction Costs:			
Offer (φ^o)	2		
Evaluate (φ^y)	1		
Counter-offer (φ^z)	1		
B. Predictions (Player A: Player B)			
	Outcome of bargain		
Probability of secure property rights (q)	Predicted Nash solution* (in lottery tickets)	Expected outside option (in lottery tickets)	Predicted controller's option price (in lottery tickets)
1.00	150:30	120:0	0
0.90	144:36	111:3	9
0.75	135:45	97.5:7.5	22.5
0.50	120:60	75:15	45
0.00	90:90	30:30	90

*Payoffs are for additional lottery tickets (α_i) and does not incorporate endowment (λ_i) and transaction costs (c_i). Endowment is 10 lottery and minimum transaction costs is 3 lottery tickets (2/1 split between the two parties depending on which player makes the initial offer).

hypotheses. The *backsliding* argument says security enhances efficiency. If bargainers cannot agree to an efficient outcome given economic friction, a secure outside option avoids a costly and unproductive conflict over who has rights to the resource. The property owner simply exercises his outside option and the only efficiency loss is the money left on the bargaining table. Insecure rights, however, would trigger even greater waste as the parties would both leave the money on the table and expend valuable resources fighting over the rights, i.e., a rent seeking contest.

The *cost-of-non-cooperation* counterargument says security can cause efficiency to fall. Secure property rights reduce the cost of non-cooperative behavior, which therefore leads to less cooperation. The property owner who worries about economic friction can avoid it all by taking his outside option, again the efficiency loss is money left on the table. Whereas bargainers with high costs of non-cooperation – money left and costly conflict over rights – have a lot to lose when they disagree. They will work together to find the cooperative outcome even with transaction costs. The odds they will find the cooperative outcome are also increased because the rational and efficient outcome is an equal split of resources – a natural focal point for any bargaining pair as experimental evidence has shown repeatedly over the years. We now consider which hypothesis holds under our experimental design.

3. Experimental Design

Our designed follows earlier Coasean bargaining experiments (e.g., Rhoads and Shogren 1999, 2003; Shogren 1998). Forty-eight students were recruited at the University of Wyoming to participate in one of four sessions. Each session had 12 subjects participate in five rounds of bargaining. Upon entering the lab, subjects were randomly assigned identification numbers used in assigning bargaining pairs. Each subject was provided instructions to follow as a monitor read them aloud. Subjects answered a set of questions to help them understand the experiment. The monitor then reviewed the answers to the questions and addressed any remaining questions.

Each bargain was a face-to-face, bilateral negotiation over lottery tickets reflecting chances to win a $10 reward. Subjects had a different opponent in each round, and all bargains had a monitor acting as the intermediary. No verbal communication was allowed between players or pairs. A monitor sat between each pair and all transactions were directed through the monitor.

Prior to each round of bargaining, the monitor endowed each subject with 10 lottery tickets to cover the transaction costs that arose from offers, $\varphi^o = 2$, evaluations $\varphi^y = 1$, and counter-offers, $\varphi^z = 1$. These per unit transaction costs were consistent across sessions, but total costs were endogenous determined by a bargaining pair.

Subjects could earn additional lottery tickets by bargaining over a *lottery distribution schedule*, which presented six different lottery ticket totals distributions. Table II provides the five schedules used in our experiment. For a bargain to reach an agreement, two contracts were required. First, the *number contract* required bargaining pairs to agree on the number from the lottery distribution schedule (1, 2,…, 6). This established the initial level and distribution of lottery tickets for each person. Each schedule had one efficient number which allocated 180 lottery tickets (e.g., #4 of Schedule 5 from Table II) and five other inefficient numbers which allocated 140 tickets or less.

Second, the *transfer contract* reflected the agreed-upon reallocation of tickets between the pair. For instance, suppose the pair choose #4, player A starts with 80 tickets and player B has 100. The pair might agree to

Table II. Experimental design: lottery schedules

Number	A's additional lottery tickets	B's additional lottery tickets
Schedule 1		
1	120	0
2	110	20
3	100	40
4	90	90
5	30	110
6	0	120
Schedule 2		
1	120	0
2	110	30
3	100	80
4	50	90
5	30	100
6	0	120
Schedule 3		
1	120	0
2	110	20
3	65	75
4	80	100
5	25	115
6	0	120
Schedule 4		
1	120	0
2	115	25
3	95	85
4	45	95
5	25	105
6	0	120
Schedule 5		
1	120	0
2	105	25
3	90	50
4	80	100
5	30	110

redistribute the tickets, say B gives 10 tickets to A, such that both have 90 tickets. There was a 10-minute time limit for bargaining pairs to sign both contracts. Subsequent bargains entailed different pairings of bargainers and different lottery distribution schedules.

Before each bargain, a game of skill between the two bargainers determined which would be the controller. A matching card game attempted to create a sense that the *controller's outside option* was earned and not arbitrarily assigned. The controller could exercise his right to take his outside option at any time by unilaterally choosing a number from the schedule, without input from the non-controller. For example, from Schedule 5 in Table II, player A as the controller could choose #1 at any time and earn 120 tickets; B would get no tickets.

We introduce property right insecurity by varying the level of certainty the outside option will be realized if selected by the controller. We consider five treatments of property right security, $q = [0.00, 0.50, 0.75, 0.90, \text{and} 1.00]$. Bargainers knew the odds of security before each round of bargaining. If bargainers reach an agreement, the mutually agreed upon payoffs are realized. If the controller unilaterally exercises his or her outside option, a random draw determines whether the option's payoffs are realized. If the controller's outside option is not enforced, bargainers realize payoffs that correspond to disagreement or conflict (each receiving 1/4 of outside option – 30 tickets).

Table III provides an overview of the level of property right security in each round for each session. A single level of property right security was predetermined for all subjects in the first, second and fifth bargains of each session. Prior to the third and fifth rounds of bargaining, we elicited the value of property right security with the demand-revealing, Vickrey fourth-price auction (see Shogren et al. 1994; Vickrey 1961). The auction worked as follows. All 12 players submitted a sealed bid to buy secure property rights in an upcoming bargain with insecure rights. Each bargaining pair then played the game of skill to determine the controller in that pair. The monitor then ranked from high to low the bids of the six controllers. The three controllers with the highest bids paid the fourth-highest bid, and thereby secured property rights in the next bargaining session ($q = 1.00$). The other three controllers paid nothing, and then bargained insecure property rights at a level set by the treatment ($q = 0.50$, 0.75, or 0.90).

4. Results

Result 1. Given transaction costs, bargaining efficiency is inversely related to property right security. Relative to the no security baseline ($q = 0.0$), results suggest that efficiency decreases about 5 percent when security is 50 percent certain, a 20 percent drop at 75 percent, nearly a 50 percent drop at 90 percent, and over a 50 percent drop with secure property rights.

Table III. Experimental design: property rights security by and session

Session	Round				
	1	2	3[a]	4	5[a]
1	0.5	1.0	0.5 or 1.0	0.0	0.0 or 1.0
2	0.0	1.0	0.0 or 1.0	0.5	0.5 or 1.0
3	0.75	1.0	0.75 or 1.0	0.9	0.9 or 1.0
4	0.9	1.0	0.9 or 1.0	0.75	0.75 or 1.0

[a] Indicates an auction preceded the bargaining round with the 6 of the 12 highest bidders receiving certain property rights ($q = 1.0$) and the six lowest bidders receiving the indicated level of property right insecurity.

We show this result by considering two measures of efficiency – reward (R) and relative reward (RR). Reward efficiency captures the improvement in actual gain as a percentage of the potential gain due to bargaining:

$$\mathrm{R} = \frac{\alpha_{\mathrm{A}} + \alpha_{\mathrm{B}} - \mathrm{C_A} - \mathrm{C_B} - \alpha^{o}_{\mathrm{A}}}{\alpha^{s}.}$$

where α^s equals 60 lottery tickets ($=180-\alpha^o_{\mathrm{A}}$) for secure property rights ($q = 1$), 66 tickets for $q = 0.90$, 75 tickets for $q = 0.75$, 90 tickets for $q = 0.50$, and 120 tickets for $q = 0.0$ (see Table I). Reward efficiency is maximized at $\mathrm{R} = 1$ when all possible surplus is gained from bargaining ($\alpha_H = 0$) without transaction costs ($C = 0$). The presence of transaction cost forces reward efficiency to be less than 1.00 because either (1) the outside option is taken to avoid transaction costs ($C = 0$) leaving the surplus of lottery tickets unclaimed ($\alpha_H > 0$), or (2) the players arrive at an agreement that secures all the surplus of lottery tickets ($\alpha_H = 0$) incurring the minimum transaction costs ($C > 0$).

We account for the efficiency loss from transaction costs by also considering a constrained efficiency measure of relative reward (RR):

$$\mathrm{RR} = \frac{1 - (\mathrm{R_{CM}} - \mathrm{R})}{\mathrm{R}}$$

where $\mathrm{R_{CM}}$ equals R evaluated at the cost-minimizing bargain. Relative reward is maximized ($\mathrm{RR} = 1$) when all possible surplus of lottery tickets are obtained ($\alpha_H = 0$) while incurring the minimum transaction costs, $min\text{-}C = 2 + 1$, one offer/one evaluation and acceptance.[1]

Table IV summarizes the descriptive statistics, suggesting insecure property rights have a strong *inverse* relationship with efficiency. With no enforcement ($q = 0.0$), parties captured all potential gains in every bargain ($\alpha_{\mathrm{H}} = 0$) such that $\mathrm{R} = 0.963$ and $\mathrm{RR} = 0.988$. Efficiency decreased about 4 percent when property right security increased to $q = 0.5$, in which 94.4

percent of the bargainers captured all potential gains. When security rose to $q = 0.75$, efficiency fell further: R = 0.754 and RR = 0.782. The potential gains were captured in 72.2 percent of bargains. At $q = 0.9$, the mean relative reward measure approached 0.500, and over half of the bargains left potential gains on the table. With secure property rights ($q = 1.0$), mean reward and relative reward efficiency were 0.427 and 0.450, and potential gains were captured in only 45.6 percent of the bargains.[2]

Table IV. Efficiency by property rights security

Efficiency measure		Probability of secure property rights (q)					
		1.00	0.90	0.75	0.50	0.00	Total
Reward	Mean	0.427	0.480	0.745	0.920	0.963	0.638
	Median	0.233	0.349	0.939	0.967	0.958	0.928
	S.D.	0.477	0.421	0.322	0.155	0.014	0.430
Relative reward	Mean	0.450	0.502	0.782	0.952	0.988	0.663
	Median	0.246	0.364	0.975	1.000	0.983	0.970
	S.D.	0.502	0.441	0.334	0.160	0.014	0.447
Probability	Mean	0.486	0.541	0.812	0.963	1.000	0.692
	Median	0.333	0.420	1.000	1.000	1.000	1.000
	S.D.	0.486	0.428	0.317	0.157	0.000	0.431
# of $\alpha_H = 0$		22	8	13	17	18	78
% of $\alpha_H = 0$		45.8%	44.4%	72.2%	94.4%	100.0%	65.0%
Lottery tickets captured							
Total tickets (both A&B) (180 tickets possible)	Mean	149.2	148.3	164.4	176.7	180	
	Median	140	135	180	180	180	
	S.D.	29.2	29.6	26.2	14.1	0.0	
Total tickets + Endowment − transaction costs (200 tickets possible)	Mean	165.5	164.1	179.6	192.8	195.6	
	Median	153.5	149	194.5	196	195	
	S.D.	28.7	29.1	26.7	14.0	1.6	
N		48	18	18	18	18	120

We address the robustness of these summary statistics by estimating the following model:

$$E = \beta_0 + \beta_k \sum_{k=2}^{5} q_k + \beta_n^i \sum_{n=2}^{24} s_n + \beta_t \sum_{t=2}^{5} r_t + \beta_m \sum_{m=2}^{5} l_m + \varepsilon$$

where E represents one of the efficiency measures (R, RR), q_k are dummy variables representing property right security, s_n captures individual subject effects for players A or B ($i = $ A, B), r_t captures round effects, and l_m captures lottery schedule effects. Tests reveal individual subject, round and lottery effects were insignificant.[3]

Table V presents the estimates of the restricted model. The empirical results correspond to the descriptive statistics indicating that property right security *reduces* efficiency. Relative to the no property right security baseline ($q = 0.0$), estimated coefficients indicate efficiency decreases less than 5 percent when property right security is a 50–50 prospect, approximately 20 percent when security is 75 percent probable, nearly 50 percent when security is 90 percent probable, and over 50 percent when property when rights are secure with certainty.

Decreased property right security increases the cost of non-cooperative outcomes and therefore, property owners are led to the bargaining table by the insecurity. People who had to bargain paid the transaction costs because it was in their private interest to do so; those who could opt out avoided them because it also was in their private interest. A property owner's lack of interest in bargaining is magnified by the positive transactions costs, and the potential for those costs to erode the property owner's initial position if the bargain does not go well. Property owners therefore perceive the potential

Table V. Estimated coefficients for models of reward efficiency*

Variable	Reward efficiency	Relative reward efficiency	Probability efficiency
β_0	0.963 (0.000)	0.988 (0.000)	1.000 (0.000)
$\beta_q = 0.50$	−0.043 (0.728)	−0.036 (0.781)	−0.037 (0.769)
$\beta_q = 0.75$	−0.209 (0.094)	−0.206 (0.116)	−0.189 (0.136)
$\beta_q = 0.90$	−0.483 (0.000)	−0.486 (0.000)	−0.459 (0.000)
$\beta_q = 1.00$	−0.536 (0.000)	−0.538 (0.000)	−0.514 (0.000)
N	120	120	120
F-statistic	11.14	10.37	10.08
P-value	(0.0000)	(0.0000)	(0.0000)

* Individual, round and lottery schedule effects were not significant. P-values are reported in parentheses.

gains from the bargain will not compensate for the costs of bargaining. This result corresponds to previous studies showing transaction costs decrease efficiency in the presence of secure property rights (Rhoads and Shogren 1999), and potential gains may not suffice to induce self-interested bargaining (Shogren 1998). And while forgoing potentially mutually advantageous outcomes does not appear rational, the result corresponds to evidence relative outcomes matter as much as absolute outcomes.

Just as first-movers in an ultimatum game understand rejection is likely if they offer a significant uneven split, bargainers understand mutual advantageous, but uneven, outcomes may be difficult to achieve and choose not to face certain costs on an uncertain outcome. And as the security of the property right is diminished, the more attractive and less risky cooperation is for the property owner – i.e., more gains relative to the threat point and more evenly split outcomes that increase the likelihood of agreement. We have not considered the expected private and social gains that arise from the personal investment to improve protected assets that arise from secure property rights. Secure property rights promote investment in capital and create sweat-equity that is an obvious gain to society. What our results suggest is these gains would have to be worth the costs from inefficient bargaining due to lower costs of non-cooperative behavior.

Result 2. Mean ex ante option price is inversely related to the level of increased property right security. The average option price falls considerably short of the predicted value of a secure property rights – the average bidder only paid 20–60 percent of the predicted valuation.

Rational choice theory suggests a person's willingness to pay should be inversely related to property right security – the option price to increase security from 50 to 100 percent, $WTP_{0.50}$, should exceed the option price from 90 to 100 percent, $WTP_{0.90}$. Table VI provides the descriptive statistics for the bids by auction (WTP_p where $p = 0.00$, 0.50, 0.75, and 0.90). Six bidders in eight auctions yielded 48 total bids – 12 bids for auctions. As theory predicts, mean willingness to pay is inversely related to the level of increased property right security. Tests of equality confirm the relationship is significant. Bargainers therefore were rational with their sealed bids for increasing the security of their property rights.

While bargainers were rational in submitting higher bids for greater increases in security, they also were conservative relative to the predicted option price for secure property rights. The average bidder underbid relative to the theoretic predicted option price for all auctions. For instance, the mean bid to go from no rights to secure rights was only about 20 percent of the predicted option price (17.82 vs. 90 tickets). Overall, average bids ranged

Table VI. Option prices: tests of rationally in the auction

Treatment auction	Number of bids	Option price mean	Option price sd	Option price min–max	Predicted option value	Empirical option value
Descriptive statistics by treatment						
$WTP_{0.90}$	12	5.67	4.03	0–15	9.0	−0.8
$WTP_{0.75}$	12	6.83	4.63	2–20	22.5	5.9
$WTP_{0.50}$	12	14.08	6.36	8–21	45.0	24.2
$WTP_{0.00}$	12	17.92	3.06	15–21	90.0	28.6
Combined	48	11.75	7.60	0–21		
The Null	*t*-statistic	*P*-value	Reject?			
Tests of equality						
H_o:$WTP_{0.00} = WTP_{0.50}$	−1.8817	0.0366	Yes			
H_o:$WTP_{0.50} = WTP_{0.75}$	−3.1929	0.0021	Yes			
H_o:$WTP_{0.75} = WTP_{0.90}$	−0.6585	0.2585	No			

from 20 to 60 percent of the theoretical value of secure property rights. Examining the empirical value of secure property rights, we observe bargainers failed to realize the predicted gains from possessing secure property rights. Therefore the conservative nature of bidders may have been warranted. Relative to the empirical value of secure property rights, subjects overbid in the $WTP_{0.90}$ and $WTP_{0.75}$ auctions and underbid in the $WTP_{0.50}$ and $WTP_{0.00}$.

Result 3. Self-interest and Nash self-interested best organized observed bargaining behavior, regardless of the property right security.

Table VII presents the distribution of wealth by *Nash self-interest* – the controller captures the level predicted by the Nash solution; *self-interest* – the controller at least his expected outside option; and *equity* – the controller splits the tickets with the non-controller. The definitions of self-interest and equity become blurred as property rights become less secure. With secure rights ($q = 1$), over 70 percent of the controllers (34 of 48) earned at least outside option – which supports the idea of rational bargaining. A mild risk to security ($q = 0.9$) does not change this result – nearly 90 percent (16 of 18) of controllers were rationally self-interested. With even more risk ($q = 0.75$), controllers remained rational – over 70 percent (13 of 18) earned at least their outside option.

The nature of the distribution of wealth changes once we consider even odds of security risk ($q = 0.5$) or no security ($q = 0.0$). Now it is rational for the controller to accept an equal split of lottery tickets. Equal splits are a natural and rational focal point for bargainers facing risky property rights. And in fact this is just what we observed. For even odds, over 80 percent (15 of 18) of the agreements were efficient and equitable. This was also the case for no security – about 95 percent (17 of 18) of the bargains split tickets equally and efficiently. We therefore cannot reject the hypothesis that our average bargainer was rational.

5. Conclusion

Coase (1988, p. 15) explained his theorem nearly three decades later by noting; "[w]hat my argument does suggest is the need to introduce positive transactions costs explicitly into economic analysis so that we can study the world that does exist." Herein we see that transaction costs created an inverse relationship between property right security and bargaining efficiency. As the certainty of property rights increased, the degree of self-interested behavior

Table VII. Distribution of wealth

Probability of secure property rights	*N*	Wealth distribution	Hits (#)	Rate (%)
1.00	48	Nash self-interest	4	0.083
		Self-interest	30	0.625
		Equal splits	6	0.125
0.90	18	Nash self-interest	3	0.167
		Self-interest	13	0.722
		Equal splits	2	0.111
0.75	18	Nash self-interest	2	0.111
		Self-interest	11	0.611
		Equal splits	4	0.277
0.50	18	Nash self-interest	0	0.000
		Self-interest	3	0.167
		Self-interest equal splits	15	0.833
0.00	18	Nash Self-interest equal splits	17	0.944
Total	120	Nash self-interest	26	0.217
		Self-interest	98	0.817

increased – but at a cost of less efficiency. Less security actually generated more efficient agreements. This occurred because the property right owner found it more profitable to bargain even with transaction costs rather than unilaterally exercise his inefficient and risky outside option. Once at the table, bargainers capture all the potential gains from exchange. In contrast, many property owners with secure property rights concluded the potential bargaining gains were not worth the private transaction costs, and left the social gains behind.

We recognize and appreciate secure property rights create other social gains that go well beyond simply providing an outside option for Coasean bargaining. Secure property rights create privacy and provide the incentive to make new improvements to capital. Perceived threats to these broader purposes that support hard work and sweat equity can affect a property owner's willingness to cooperate in a bargain, even if positive gains are to be had. For instance, policy to protect endangered species on private land is moving toward new compensation schemes that will require some form of cooperative bargaining. But some landowners will reject the extra compensation if they believe in the end their privacy will not be respected, their prior stewardship efforts will not be acknowledged, and their ability to protect their investment will be restricted. Future work on efficient Coasean bargaining in the lab could take this broader perspective. Let bargainers choose between private and socials gains from protecting new investments in capital that create wealth versus the social losses that arise from the ability to avoid the bargaining table when it is costly.

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Notes

1. For completeness, we examine whether bargainers focus on maximizing the joint odds of winning – ignoring the magnitude of transactions costs – by considering *probability efficiency*:

$$P = \frac{\alpha_{\mathrm{A}} + \alpha_{\mathrm{B}} - \alpha_A^o}{\alpha^s}.$$

Though expected utility assumes people evaluate probabilities and consequences comprehensively, subjects dealing with choices under uncertainty frequently focus on probabilities and neglect consequences, or visa versa. In such a case, the bargain yields outcomes with relatively high probability efficiency and low reward efficiency.

2. An alternative measure of efficiency is the nearness to the efficient frontier. This measure still leads to the same conclusion. For instance, we know from Table II that bargainers start at 120 lottery tickets for secure rights, which means they have 60 tickets to bargain over to hit the efficient frontier (ignoring the 20 ticket endowment and transaction costs for simplicity); and they have 60 tickets for totally insecure rights, which means they have 120 tickets to bargain over to hit the frontier. From Table IV, we see bargains with secure rights only captured 149.2 of the 180 tickets on average, which means they captured 29.2 tickets out of the 60 (about 50 percent). In contrast, bargains with totally insecure rights captured 180 of 180 tickets on average, or 120 of the 120 available (100%). By either measure – Reward Efficiency or nearness to the efficient frontier – insecure rights induced greater economic efficiency.
3. Given the dependent variable is based on bargaining pairs, individual subject effects for A and B players were estimated separately. In each case, individual effects were insignificant ($F = 1.30$ when $i = \text{A}$, and $F = 0.93$when $i = \text{B}$). Results for round and lottery effects were also insignificant ($F = 0.47$ and $F = 0.78$). Results therefore are consistent across the full and restricted models.

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