Does Bounded Self-interest matter in Coasean Bargaining over Insecure Property?

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28 May 2015

Abstract

We examine whether behavioural economics can provide additional insight into observed behaviour within a classic environmental policy context—the Coase theorem. We investigate whether property owners go beyond their self-interested motive in capital investment and distributing the wealth from production in a Coasean bargaining set up. Our controlled lab experiment considers the trade-off between expected private and social gains from private investment to improve protected assets, given secure property rights and transaction costs. Our results suggest making property rights more secure given positive transaction costs lead to over-capitalization and an unwillingness to bargain. Bargainers in a face-to-face bargaining seem to be concerned about fairness only when private gain is insecure.

Key words: Coasean bargaining, investment, property right security, transaction costs

JEL Codes: C78, C92, H23, Q50

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**Thanks to the Bugas fund for assistance. We thank K. van't Veld, K. Coatney, A. Maala Hussian, and D. Rigby for their constructive comments. We also thank B. Enchelmeyer, C. Kennedy, S. McDermott, and A. Mukherjee for their helpful assistance. Shogren thanks the Rasmuson Chair at the University of Alaska-Anchorage for partial financial support.

1. Introduction

Economists typically rely on rational choice theory to help them sharpen environmental policy. Rational choice theory has people making consistent decisions based on coherent beliefs that arise within active exchange institutions, and these decisions have foreseeable consequences. But for many environmental policy decisions the presumption of rational choice can be problematic—rationality is a social construct based on feedback within an active exchange institution, not an individual one based on isolated introspection that typifies many non-market environmental goods and services (Arrow, 1987; Kahneman and Tversky, 2000). Such isolated introspection can lend itself to *behavioural failures*[1]—systematic deviations from rational choice, examples include people disliking losses, single-mindedly focusing on changes, overweighing small chances, thinking in discrete bundles/mental accounts, valuing the present highly and inconsistently, caring about other people, and how financial incentives crowd out good intentions (see Metcalfe and Dolan, 2012; Weber, 2013). We also know that institutions and the context of choice matters—who gives us the information, social and cultural norms, the default choice and status quo reference point, what draws our attention—uniqueness, access, simplicity—how we are primed to make certain choices, emotional responses to goods and information, and the degree of commitment to overcome bounded will-power.[2]

[1] Shogren and Taylor (2007) lump behavioural weakness and biases together as *behavioural failures* to create a parallel with the idea of market failure as a source of inefficiency. A behavioural failure includes the range of behavior referred to as an anomaly, paradox, bias, heuristic, misperception, fallacy, illusion, or paradigm (also Sunstein, 2000; see Mullainathan et al., 2012).

[2] In environmental policy, people point to a few examples to motivate how "behavioural anomalies" can affect behaviour toward green policy. The classic example is energy efficiency and climate change risk. An "Energy Paradox" is said to exist when people buy less energy conservation than predicted by a present value calculation given say a tax on carbon. Behavioural anomalies that could explain this result include people discounting the future too highly, people who have trouble calculating expected fuel savings, people who focus too intensely on the status quo, and people who rely on heuristic decision making strategies rather than optimizing net benefits. But all these ideas have rarely been tested within the same experimental design. They are a collection of ideas, in which the policy-maker does not know which effect, if any, dominates choices of energy conservation, and why this effect(s) is the key (see Gillingham et al., 2009). Policy options in such case are limited to more education, information, and

Behavioural economics has emerged from within this confluence of choices, motivations, constraints, and institutions as a way to combine insight from psychology with economics to better understand the behavioural underpinnings of cost-effective environmental policy. Exploring how the context of decisions interacts with choice allows us to better understand what non-market institutions accentuate or attenuate behavioural weaknesses and biases within environmental policy. The usefulness of behavioural economics on environmental policy relies on its ability to identify market failure better, to reduce health risks more effectively, to ease environmental conflict, to enhance more cooperation and coordination, to design more cost-effective incentives, and to value environmental quality with more precision. Environmental policy might well be more cost-effective if we expand the rational choice models to include bounded rationality, bounded self-interest, bounded willpower, and unbounded emotions (see, e.g., Mullainathan and Thaler, 2000).

Herein we examine whether behavioural economics can provide additional insight into observed behaviour within a classic environmental policy context—the Coase theorem.[3] Recall, Coase (1960) suggested that self-interested parties could negotiate an efficient solution to an externality problem regardless of initial property right assignment. In the original Coasean bargaining experiments, we observe just that—efficient outcomes generated by either *selfish or selfless* behaviour (Hoffman and Spitzer, 1982; Shogren, 1997). Bargaining behaviour revealed

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standard-setting. If people are not responding rationally to pricing changes, green taxes will not have the intended consequences, either in efficiency or distribution of burden (Galle 2011).

[3] Some policymakers see local collaboration as the future of environmental policy. Examples of devolution in the environmental arena abound (Townsend 2004; Engel et al, 2008; Abildtrup et al 2012). Refinement of the more traditional decision-making processes grew primarily out of dissatisfaction with their costly consequences. Heavy reliance on litigation from both sides in the environmental debate began to escalate legal fees and prompt long delays in enacting changes in the environmental arena. As a result, less adversarial methods of problem solving are attracting considerable attention in the environmental arena. Negotiation, mediation, arbitration and facilitation are just some of the techniques that are now used extensively in resolving environmental disputes and designing natural resource management plans. Furthermore, the use of relatively new decision-making processes—such as regulatory negotiation and collaborative decision-making—that incorporate these techniques is becoming more common.

differing degrees of bounded self-interest (also called constrained self-interest) based on the context or friction of the decision.[4]

In the context of insecure property rights (i.e., when appropriation of property rights is not certain)[5], Cherry and Shogren (2005) observed that *insecure property rights* induced greater efficiency as all players bargained to the efficient frontier since no player could end the bargain unilaterally. Players with secure rights opted out to avoid bargaining with unknown opponents, i.e., they avoided the strategic uncertainty in the game. In addition, bargainers were rational—bargains were mostly self-interested and not selfless (e.g., fairness). More evenly splits were observed with insecure property rights as such moves are "a natural and rational focal point for bargainers facing risky property rights".

In this paper, we address the core role of secure property rights—to induce greater investment in productive capital to increase the size of the overall economic pie (see e.g., Feder 1987; Basely 1995). Institutions with secure property rights lead to market expansion through greater investment. Subjects in a controlled lab might lack incentives to behave optimally with restricted use of property right security when they were unable to increase the size of the economic pie through investments in productive capital.

Our controlled lab experiment considers the trade-off between expected private and social gains from private investment to improve protected assets, given secure property rights and transaction costs. We consider Coasean bargaining with insecure property rights by allowing for commitment and investment into alternative levels of productive capital. Given secure property rights and bargaining transaction costs, our experimental design tests whether a player

[4] Coase (1988) anticipated this by suggesting that the real thorny questions of allocation decisions and behaviour would arise once friction (i.e., transaction costs) was added into this bargaining environment.

[5] In Cherry and Shogren's (2005) bargaining game, secure rights means when a controller can exercise his outside option of any lottery with certainty.

will either (i) invest in the socially optimal level of production and then bargain to a mutually beneficial outcome, or (ii) invest in a second-best level of production to unilaterally secure a larger privately optimal outside option.

Figure 1 illustrates the basic experimental design strategy for two bargainers, Player 1 and 2, and two economic pies X and Y that can be generated and captured through production and bargaining. Assume only player 1 has secure property rights so he can invest in capital to create either pie. Pie X is the socially optimal one—Player 1 invests $x to generate the maximum rent, where point Z_X represents his unilateral outside option if he chooses not to bargain. Pie Y represents a second-best over-investment in capital—Player 1 invests $y ($y > x$) to generate lower overall rents but a larger unilateral outside option, Z_Y relative to Z_X. If player 1 has decided to bargain with 2, he should invest in the efficient pie X and bargain to extract all potential gains (B_X) (i.e., the Nash-Bargaining solution). If he has decided not to bargain, he has greater incentive to invest in the inefficient pie Y in order to lock up his larger private outside option, Z_Y.

Overall, we observe secure property rights induced two levels of inefficiency: the average secure property holder both (1) over-capitalized in production, and then (2) did not bargain to capture the smaller but still positive gains, i.e. the situation illustrated in Pie Y of Figure 1. They created fewer economic rents and then walked away leaving a sizable fraction of these rents on the bargaining table. In contrast, the average insecure property holder produced the largest economic rents and they then bargained to capture these rents—regardless of the bargaining transaction costs.[6] Our result of reduced bargaining efficiency with secure rights and positive transaction costs supports Cherry and Shogren (2005) finding, even when property owners could create greater economic pie through investments. In addition, once we add investment

[6]See Coase (1960), Demsetz (1967), and North (1994); see the case studies in Alston et al. (1996) and Feder (1987).

opportunity in productive capital to the Coasean bargaining mechanism we find property owners over-capitalize in production and avoid bargaining. In the presence of transaction costs, insecure right secures more efficiency and fairness than secure property right. Bargainers in a face-to-face bargaining seem to be concerned about fairness only when private gain is insecure. Players leave money on the table when it is costly to cooperate—even with investment.

2. Benchmark Model

We define our rational benchmark model. Figure 2 shows the sequence of play. First, nature decides whether property rights are secure or insecure[7] (*q = 1 or 0*) and whether bargaining transaction costs exist. Second, the player with property rights—the *controller*—chooses his capital investment level by purchasing one lottery. Property right defines the controller's rights to appropriate his outside option with certainty. In that sense, secure right defines the 'threat point' of the controller in the bargaining. The controller can unilaterally exercise his outside option at any time during the bargain without any consent of the other player. In contrast, insecure rights implies there is a chance that appropriation of property rights may occur, i.e., in the game a property owner may not enjoy her outside option unilaterally.

Capital investment is represented by the purchase of one lottery, either Lottery A, B, C or D (see Table 1). The lotteries differ in two ways: (i) production frontier, and (ii) outside option. For example, lottery C has the largest production frontier and generates to largest joint rents; lottery D has the largest outside option and generates second-best rents. The investment costs increase in lottery type: lottery A is the least expensive, D is the most expensive, L_i^k, where k = A, B, C, D (lottery type) and i = player 1, player 2.

[7] We take *nature* as a player in this game. This is because our design controls for risk preference by normalizing utility between 1 and 0 (see next page).

Third, players then either bargain or the controller ends the game unilaterally by taking his outside option. If the players choose to bargain, they negotiate over *lottery coins*, α_1 and α_2, which define the probability of winning a large monetary reward, S ($10). Normalizing utility so $u(S) = 1, u(0) = 0$, we define player *i*'s expected utility by his final proportion of total lottery coins. If bargaining transaction costs exist, both players incur the cost. A player's bargaining transaction costs are $c_i = \varphi^0 o_i + \varphi^y y_i + \varphi^z z_i, \forall i = 1,2$, where $o_i$represents offers, y_i represents evaluation of offers and z_i are counter offers and $\varphi^0, \varphi^y, \varphi^z$ are the per unit costs. To cover the bargaining transaction costs, each player has an initial *endowment* of coins, λ_1, λ_2. Total number of lottery coins, α_T, is the sum of two players' endowment, the coins after bargaining and coins left on the table (if any), i.e., $\alpha_T = \lambda_1 + \lambda_2 + \alpha_1 + \alpha_2 + \alpha_H$, where α_H denotes the coins on the bargaining table given the property right security.

With secure property right, the controller's expected pay-off from exercising his right unilaterally is $(\alpha_1^0 + \lambda_1)$ and the non-controller's expected payoff is λ_2 . The size of outside option, α_1^0, depends on investment decision by the controller or the lottery he wants to buy. When the right is not unilateral and insecure, both the players obtain their expected payoff from a non-cooperative contest (Dixit 1987).

Given investment choice L^{k^*}, a Nash cooperative bargaining solution is

$$Max_{\alpha_1}\left[\left(\alpha_1(L^{k^*}) - L^{k^*} - c_1 - EP_1^0 + \lambda_1\right)\left(\alpha_2(L^{k^*}) - c_2 - EP_2^0 + \lambda_2\right)\right]$$

$$s.t.\ \ \alpha_T(L^{k^*}) = \lambda_1 + \lambda_2 + \alpha_1(L^{k^*}) + \alpha_2(L^{k^*}) + \alpha_H(L^{k^*}) \qquad (1)$$

where, $EP_1^0 = q\big(\alpha_1^0(L^{k^*}) + \lambda_1\big) + (1-q)EP_1^N$ and $EP_2^0 = q\lambda_2 + (1-q)EP_2^N$, and$EP_1^N$ and EP_2^Nareplayers 1 and 2's expected payoffs at the Nash equilibrium of a contest model.[8]

The Nash bargaining solution yields the controller's optimal tickets:

$$\alpha_1(L^{k^*}) = \left[\alpha_1^0(L^{k^*}) + \frac{\alpha_H(L^{k^*})}{2}\right] - \rho + \vartheta \quad (2)$$

where$\rho = (1-q)[\frac{2\alpha_1^0(L^{k^*})+\alpha_H(L^{k^*})+\lambda_1+\lambda_2-\alpha_T(L^{k^*})}{2}] \geq 0$ represents the impact of insecure property rights (if $1 > q \geq 0, \rho > 0$; if $q = 1, \rho = 0$) ; and$\vartheta = \frac{L^{k^*}-c_1-c_2}{2}$ represents the impact of investment cost and transaction costs for the controller. As expression (2) shows, the controller receives his outside option plus half of the bargaining surplus, adjusted for insecure rights, purchasing costs of lottery and bargaining transaction costs. It also suggests capital investment increases return from bargaining. The non-controller's optimal allocation is $\alpha_2 = \alpha_T - \alpha_1 - [\lambda_1 + \lambda_2]$.

Assuming $(\alpha_1 - EP_1^0) > 0$, $\forall q, L$, the controller prefers bargaining to the outside-option independent of property security (q). The non-controller always prefers to bargain since expected payoffs always exceeds his endowment, λ_i; EP_2^0 reaches maximum when property rights are completely insecure and $EP_1^0 = EP_2^N$.

Table 2 summarizes the lottery parameters. Lottery A and B represent under-investment in capital (e.g., for A, production = 130; cost = 3), C is the social optimum, and D is over-investment. Endowments, λ_i, are 20 tickets per round for all lotteries. When bargaining

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[8] One can solve each player's private and independent expected payoff maximization problem to choose optimal effort level, x, using standard contest-success function (Dixit 1987; Cherry and Shogren 2005), $Max_{x_i} \frac{x_i}{x_i+x_j} \alpha_i^0\big(L^{k^*}\big) - x_i + \lambda_i$, $(i = 1,2;\ j = 1,2;\ i \neq j)$. Assuming the value of the outside option is identical $(i.e.,\ \alpha_1^0 = \alpha_2^0)$ and solving for the players' best functions, we have the Nash equilibrium levels of effort, $(x_1^N, x_2^N) = (\frac{1}{4}\alpha_1^0, \frac{1}{4}\alpha_2^0)$. Player's expected payoff from the contest can be obtained by substituting the Nash equilibrium effort levels into a player's expected payoffs, $EP_i^N = \frac{\frac{1}{4}\alpha_1^0}{\frac{1}{4}\alpha_1^0+\frac{1}{4}\alpha_2^0}\alpha_1^0 - \frac{1}{4}\alpha_1^0 + \lambda_i = \frac{1}{4}\alpha_1^0 + \lambda_i$, $(i = 1,2)$.

transaction costs exists, they are identical for all lotteries and rounds. Our model predicts the social optimum lottery C will be selected and bargaining will always occur.

3. Experimental Design& Experimental Hypotheses

Our experimental design follows earlier Coasean bargaining experiments (e.g., Hoffman and Spitzer, 1982; Rhoads and Shogren, 2003; Cherry and Shogren 2005), and adds in a factorial experimental design by investigating the effects of two factors, property right security and bargaining transaction costs, each at two levels (zero or one), on capital investment and bargaining efficiency. Figure 2 summarizes our design. Forty eight students participated at University of Wyoming in one of four sessions. In each session, there were six rounds of bargaining. Each subject was given instructions of the game and the monitor explained the instructions to the subjects and clarified if they had any confusion. Subjects answered a short quiz to help make sure they understood the instruction.

Each bargain was face-to-face, bilateral negotiation over the chances of winning a reward of $ 10 in each round. Each subject was randomly paired with a different opponent in each round. All bargains were conducted by a monitor acting as an intermediary. No verbal communication was allowed between the players. In the beginning of each round of bargaining, one controller and one non-controller were determined from each pair randomly[9]. Then the monitor decided two things randomly (e.g, random draw): (i) whether full or zero transaction costs to bargaining would be enforced; and, (ii) whether the controller's right to choose outside option would be enforced fully (i.e., q= 1) or not (i.e., q= 0), if selected as the controller. Knowing the information about the transaction costs and property rights, the controller had to

[9]Two options were there to select the controller from the pair, one was based on the "matching card game" following Cherry and Shogren (2005) and the other was based on random draws (e.g., toss a coin). In both cases, it would create a sense among the subjects the controller's outside option was earned and not arbitrarily assigned.

buy a lottery from the Table-1 as initial investment of capital to the monitor, where, she is the one who would enjoy property rights security. For example, suppose the controller chose lottery A. If q = 1, she could go for outside option by choosing #1 at any time and earn 60 additional coins. Consequently, due to this choice by the controller, in this case, the non-controller would get no additional coins.

At the beginning of each round, each player was endowed with twenty (20) coins to cover the bargaining transaction costs and the cost of purchasing the lottery. The bargaining transaction costs arose from making an offer (2 coins), evaluation of the offer (1 coin) and making counter offer (1 coin). These per unit costs were consistent across the sessions, but total costs were endogenous determined by a bargaining pair. The cost of purchasing the lottery—the initial investment on capital was incurred by the controller only (see Table 1). Each lottery contained six (6) different lottery coins distributions numbered 1 to 6. These four lottery types were different in two respects: (i) the additional coins could be earned if outside option is chosen (lottery A and D have the minimum and maximum numbers of coins as outside option, i.e., 60 and 100) and (ii) the total coins available on the bargaining table (lottery C has highest numbers of coins, i.e, 145). Each lottery had one efficient distribution out of six different distributions; the efficient distribution is defined as the highest total coins negotiated over the bargaining table. For example, distribution # 3 was the efficient outcome under lottery B, as it contained maximum number of coins (95) for bargaining. The costs of lottery types also differed, ranging between the minimum cost of purchase of 3 coins for lottery A and maximum purchase cost of 10 coins for lottery D.

After selection of lottery by the controller from the four lottery types, players could earn additional lottery coins by bargaining over the lottery distribution schedule from the chosen lottery type. Either controller or non-controller could initiate the bargaining by making the first offer. For a bargain to reach an agreement over a lottery distribution schedule, two contracts—number contract and transfer contract—were required. Under the number contract, the pairs had to agree on the number from the lottery distribution schedule (1, 2, 3, 4, 5, and 6) from the chosen lottery by the controller before bargaining started. The transfer contract reflected the agreed-upon reallocation of coins between pairs. For example, suppose the pair choose #2 under the lottery D. The controller starts with 90 coins and the non-controller has 20 coins. They might negotiate among themselves so they might ended up with 60 and 50 (controller gets 60 coins and non-controller gets 50 coins). The time-limit for bargaining for each round was 10 minutes. Whatever agreement they reached within this 10-minutes time slot, both of them signed a contract at the end of each round stating the outcome of the round (the agreed-upon number under the chosen lottery and the agreed-upon split among them). Subsequent bargains entailed different pairings of bargainers. Finally, winner of a round was determined by the monitor through a random process[10] (for details, see reviewers' appendix).

We test two hypotheses:

> *Capital Investment Hypothesis*: Secure property rights with or without positivebargaining transaction costs induce property owners to invest in the social optimal level of capital.
>
> *Bargaining Efficiency Hypothesis*: Given the capital investment decision, secure property right with or without positive bargaining transaction costs induces bargainers to negotiate on the global/local optimum.

4. Results& Discussion

[10] A random number is drawn from 1 to 100 to determine the winner. The controller (non-controller) is assigned the numbers from 1 (M+1) to M (M+N), in which M (N) is the agreed upon distribution of coins for the controller (non-controller). If the random lies between 1 (M+1) and M (M+N), the controller (non-controller) wins.

First, we reject the *Capital Investment Hypothesis.* Property rights security induced the typical controller to over-invest in production, irrespective of transaction costs; they focused on private benefit rather than social gain. They selected lottery D about 53-56 percent (q = 1, TC = 0 and, q = 1, TC = 1) (Table 3).[11] In contrast, insecure rights induce controllers to choose the cheapest lottery (A) or the social optimum (C) about 50 percent more frequently. We confirm this using a *multinomial probit model* of capital investment (*k*),

$$k_{it} = \alpha_1 + \alpha_2 q_{it} + \alpha_3 tc_{it} + \alpha_4 interaction_{it} + \alpha_5 \sum_{i=2}^{6} r_i + \varepsilon_{it} (3)$$

Where *interaction* and *round*(*r*) are dummy variables capturing the interaction between *q* and *tc* and the learning effect. Using lottery D as the base, Table 4 shows secured property right reduces investment on lottery A, B, and C significantly (coefficient estimates and marginal effects).Transaction costs, rounds, and interaction effect are statistically insignificant. We also investigate whether people choose social optimum lottery (i.e. lottery C) with secure right using a logit model. A negative but insignificant relationship between secure right and choice of socially optimum lottery is found (see Table 7). A logit regression of choice of lottery D confirms the behavior of choosing second best lottery or overinvestment in capital with secure right (see Table 8).

Second, we reject the *Bargaining Efficiency Hypothesis.* Secured right induced the typical controller to choose OP rather than bargain. Relative Reward Efficiency (E) captures the actual gain as a percentage of the total potential gain due to bargaining:

$$E = \frac{\alpha_1 + \alpha_2 - C_1 - C_2 - L_1^k - \alpha_1^0}{\alpha^S}$$

[11]Capital overinvestment resembles the "fishing derby" problem (e.g., Hackett et al. 2005).

where $\alpha^S$is the potential gain if lottery C were chosen net of investment cost relative to the OP of i^{th} lottery, e.g.,α^Sequals 78 tickets if A is chosen (145-7-60=78). Our measure reaches its highest value at E = 1 when maximum possible surplus is captured from bargaining by choosing lottery C without bargaining transaction costs.

Results show the mean bargaining efficiency decreases from 0.47with q = 0, TC = 0 to -0.004with q = 1, TC = 0 (Table 5). We observed a similar result even when TC is positive—mean bargaining efficiency decreases to -0.08 with q = 1, TC= 1 from 0.44 with q = 0, TC= 1. Efficiency declined as property rights security increased, with or without transaction costs. A random effect panel data model of E confirms this observation. We add a dummy variable, *I*, to account for individual's bargaining capability on E.

$$E_{it} = \beta_1 + \beta_2 q_{it} + \beta_3 tc_{it} + \beta_4 interaction_{it} + \beta_3 \sum_{i=2}^{6} r_i + \beta_6 \sum_{i=2}^{24} I_{it} + \xi_{it} (4)$$

We observe a negative relation between bargaining efficiency and property right security (Table 6). With secure right, controllers maximize private benefit by selecting OP rather than raising the joint social benefit through bargaining. Also, bargaining transaction costs, the interaction between property right and transaction cost, round and individual group effect do not have significant impact on bargaining efficiency. This result supports Cherry and Shogren (2005)—therein property owners with secure right were reluctant to bargain, again they unilaterally exercised the outside option. We find a similar phenomenon even when bargaining is costless.

In addition, our results we cannot reject that bargainers are rational and self-interested. In the presence of transaction costs, insecure right secures more efficiency and fairness than secure property right. Bargainers in a face-to-face bargaining seem to be concerned about fairness only when private gain is insecure. Players leave money on the table when it is costly to cooperate—

even with investment. We observe bargains are *selfish* with secure right and *selfless* with insecure right. Players tend to split the pie evenly, with insecure right and zero transaction costs— Table 9 shows 20% of bargains were equal-splits and mean distance from equal split is 8.10 (with 75% of bargains under were close to equal-split (within 10 coins from equity)). Presence of bargaining transaction costs makes it less equitable (11% of bargains were equal-splits and 63% of bargains were close to equal-split). In contrast, with secure right, bargains were mostly dominated by self-interested motive—property owners captured predicted outside option in 50% of cases with transaction costs and 56% of cases without transaction costs (2% and 0% of bargains were equal-splits with and without transaction costs; and mean distances from equal-split were 60.34 and 64.51 with and without transaction costs).

5. Concluding remarks

Behavioral economics can help us better address how people react to environmental challenges and the creation of new markets given alternative property right rules. We re-examine the link between security property rights and efficient Coasean bargaining by including capital investments. Our results support Cherry and Shogren's (2005) finding that property right security given positive bargaining transaction costs can reduce global efficiency in Coasean bargaining. Property right holders over-invest in capital to secure a larger private outcome relative to the social optimum that can only be reached through bargaining. Less secured property rights caused people to invest in the project that provided the greater social return through bargaining. With insecure right, it becomes more attractive and less risky for property owners to choose a lottery with the largest coins and split it more evenly compared to the secure property right situation when it is their best interest to choose the privately optimum lottery and avoid costly bargaining. They seem to play selflessly when private gain is insecure.

In a recent work, MacKenzie and Ohndorf (2013) show exogenous restrictions on the Coasean bargaining outcomes-which essentially restricts the threat points in the bargaining-results a Pareto improvement when appropriation of property rights is costly. Our work investigates whether this holds if subjects are allowed to choose their threat points (i.e., outside options in different lotteries) endogenously, rather than exogenous restrictions on threat points, with secure rights and transaction costs. Our result supports MacKenzie and Ohndorf (2013) in the sense that some external imposition on bargaining outcomes may be beneficial as property owners tend to maximise their private gain without considering the harmful effects on others.

In summary, property owners with secure rights over-invested in capital and avoided bargaining. Our finding of capital overinvestment is similar but not quite the same as the "fishing derby" results in the commercial fishery literature[12]. Commercial fisheries have now started to promote the idea of Coasean style bargaining within the regulatory framework (see Townsend's, 2004, review of fourteen cases of Coasean bargaining in fisheries)[13]. Our results suggest the Coasean bargain could be more efficient if subgroups of fishers are not assigned unilateral property rights—all the fishers should be allowed to participate in the bargain process, although this might well be qualified by the nature of bargaining transaction costs. In addition, in our experiment, property owners acted as if they were averse to the ambiguity of bargaining with an unknown partner (Ellsberg 1961). Rather they were likely to choose the safe bet (lottery D with 100 tickets with certainty) over the risky bet (lottery C with 85 or 115 tickets). One potential mechanism to reduce the ambiguity over a bargaining partner is *pre-investment bargaining*

[12] As defined by the National Research Council (1999, p. 270), a fishing derby exists when the total allowable catch (TAC) in the fishery is fixed but commercial fishers do not have individual quotas (also see Wilen, 2004). Each commercial fisher has incentive to secure a greater share of the TAC contest before his competitors do—leading to the over-capitalize of the fleet and time compression in a race for fish (see for example Hackett et al, 2005 on the British Columbian halibut fishery; Wilen and Richardson, 2008, on Bering Sea pollock fishery; Costello and Deacon, 2007, on the race for heterogeneous fish stocks).

[13] For the Chignik Salmon fishery, for instance, Deacon et al. (2009) estimated a Coasean-style cooperative institution could generate a 20 percent increase in the value of a fishing permit.

(Schlicht 1996). Anticipating the inefficiencies, one could design the bargaining institution so the non-controller reduces ambiguity by offering an ex ante contract with an ex post payment to cover, say transaction costs, of the controller.

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Table 1. Lottery Types and Distribution of Tickets

Number	Controller's additional tickets	Non-controller's additional tickets	Joint tickets
Lottery A **[Cost: 3 tickets]**			
1	60	0	60
2	55	20	75
3	50	40	90
4	40	45	85
5	25	50	75
6	0	60	60
Lottery B **[Cost: 5 tickets]**			
1	75	0	75
2	65	20	85
3	50	45	95
4	35	55	90
5	15	65	80
6	0	75	75
Lottery C **[Cost: 7 tickets]**			
1	85	0	85
2	80	50	130
3	75	65	140
4	70	75	145
5	55	80	135
6	0	85	85
Lottery D **[Cost: 10 tickets]**			
1	100	0	100
2	90	20	110
3	80	35	115
4	45	65	110
5	25	95	120
6	0	100	100

Table 2. Parameters of the model and predicted outcome of bargain *without* transaction cost

	Parameters	Lottery A	Lottery B	Lottery C	Lottery D
	Total Lottery Tickets (α_T^i)	130	135	185	160
	Unilateral property right (α_A^0)	60	75	85	100
	Endowment (λ_i)	20	20	20	20
	Potential gains from trade (α_H)	30	20	60	20
	Purchasing Cost (L_A^k)	3	5	7	10
(q=1)	Expected Outside Option (OP)	60:0	75:0	85:0	100:0
	Predicted Nash Bargaining Solution (NBS)	75:15	85:10	115:30	110:10
(q=0)	OP	15:15	10:10	30:30	10:10
	NBS	45:45	47.5:47.5	72.5:72.5	60:60

Table 3. Choice of Lottery

Lottery	Treatment 1 q=0, TC=0	Treatment 2 q=1, TC=0	Treatment 3 q=0, TC=1	Treatment 4 q=1,TC=1
A	38.88%	19.44%	38.88%	22.22%
B	11.11%	11.11%	19.44%	8.33%
C	33.33%	16.66%	38.88%	13.88%
D	16.66%	52.77%	2.77%	55.55%

Table 4. Estimated coefficients fora Probit model of capital investment:

	Coefficient	Marginal Effect At Mean
Lottery A		
Property right	-2.708* (0.66)	-0.26(0.10)
Transaction Costs	-0.05 (0.48)	0.03 (0.12)
Interaction	-1.28 (0.83)	-0.12 (0.15)
Constant	1.29 (0.84)	--
Lottery B		
Property right	-2.59* (0.71)	-0.11(0.07)
Transaction Costs	-0.33 (0.56)	-0.04 (0.09)
Interaction	-1.65 (0.91)	-0.11(0.08)
Constant	1.67 (0.90)	--
Lottery C		
Property right	-2.75*(0.67)	-0.25 (0.10)
Transaction Costs	-0.22 (0.50)	-0.03(0.12)
Interaction	-1.46*(0.85)	-0.16(0.13)
Constant	1.77 (0.83)	--
Lottery D Base		

** Significant (5% level); Standard errors in parenthesis.

Table 5. Descriptive Statistics of Reward Efficiency

Reward Efficiency	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Mean	0.471	-0.004	0.441	-0.083
SD	0.364	0.346	0.305	0.316

Table 6.Estimated coefficients for model of reward efficiency:

Variables	Coefficient
Property right	-0.455* (0.08451)
Transaction Costs	0.008 (0.086)
Interaction	0.011 (0.12)
Constant	0.295 (0.175)

Table 7. Logit Regression Results of Choice Lottery C:

Variables	Coefficient	Std. Error	Z	P > $\|Z\|$
q	-1.06	0.722	-1.48	0.140
tc	0.014	0.615	0.02	0.981
Interaction	-0.160	0.935	-0.17	0.864
Constant	-0.773	1.40	-0.55	0.581

Table 8. Logit Regression Results of Choice Lottery D:

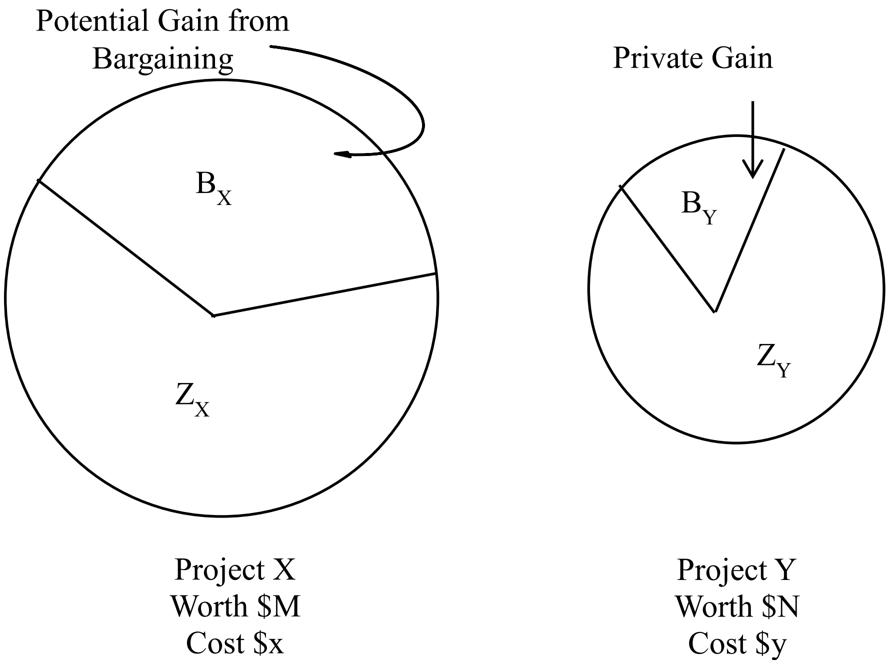
Variables	Coefficient	Std. Error	Z	$P > \|Z\|$
q	1.972098	.8027211	2.46	0.014
tc	-2.283496	1.219488	-1.87	0.061
Interaction	2.88057	1.392346	2.07	0.039
Constant	-2.831522	1.432168	-1.98	0.048

Table 9. Distribution of wealth

Treatments	Number of observations	Self-interest (#)	Equal Split (#)	Mean Distance from Equal Split
q = 0, tc = 0	40	0 (0%)*	8 (20%)**	8.10 (12.80)**
q = 1, tc = 0	32	18 (56%)	0	64.51(32.72)
q = 0, tc = 1	34	0 (0%)	4 (11%)	8.52(9.03)
q = 1, tc = 1	38	19 (50%)	1 (2%)	60.34 (33.46)

*standard deviation; **rate.

Figure 1



Note that, $M>$N and $x<$y

Figure 2. Experimental design