WHAT MAKES TRADE POSSIBLE?

Elizabeth Hoffman*, Kevin McCabe† and Vernon Smith†

*University of Illinois at Chicago, 2832 University Hall (MC 105) 601 South Morgan Street, Chicago, IL 60607-7128

†Economic Science Laboratory, McClelland Hall 116, 1130 E. Helen PO Box 210108, University of Arizona, Tucson, AZ 85721-0108

Classification: Social Sciences; Economic Sciences

Character count: 32,974

Corresponding author: Kevin A. McCabe, Economic Science Laboratory, McClelland Hall 116, 1130 E. Helen PO Box 210108, University of Arizona, Tucson, AZ 85721-0108
520-621-3830 phone; 520-621-5642 fax; kmccabe@econlab.arizona.edu

Abstract

This paper presents laboratory results on the comparative dynamics of reciprocity in two economic environments: personal and impersonal exchange. In personal exchange environments subject pairs rely on trust and positive reciprocity to achieve gains from exchange. In contrast, in impersonal exchange environments trust and reciprocity fail in favor of low cost credible assurances of a punishment option for defectors. However, in impersonal exchange environments, when the cost of offering assurances is raised, subject pairs attempt cooperation more often, but also fail more often in comparison to the low cost assurance environments. These results provide support for a cognitive model of exchange that helps explain the observations of historians and anthropologists on the importance of institutions in either promoting or hindering the expansion of trade.

1. Introduction

Trade is a ubiquitous activity and yet, like spoken language, we take it for granted, rarely conscious of the complex interactions taking place between others and ourselves. Consequently our question may seem at first trivial, or maybe unnecessary, since in fact we seem to have no trouble trading. However, the social world in which we live is becoming increasingly complex, and institutions which support trade will likely have to occur more by informed design than by adaptation through spontaneous order from incremental change and selection. For example, with the recent introduction of the Internet, computer and communication technologies allow potential trading partners to be anywhere. Trades can take place at any time, and almost any degree of anonymity can be guaranteed. But, this anonymity has increased the potential for opportunistic behavior, and has created a public outcry for solutions. In this paper we provide a framework for understanding the difference between trade that takes place between partners and trade between anonymous strangers.

There is considerable interest in studying the development of institutions that reduce opportunistic behavior, allowing economic agents to maximize potential gains from exchange. [4] describes a number of social capital infrastructures that facilitate cooperation and [11] asks, why traditional organized forms of social capital formation seem to be in decline today? [10] asks, how do in-groups form the social capital that allows them to benefit from mutual exchange? And, [9] asks, how did northern Europeans in the late medieval and early modern periods develop institutions that allowed the development of relatively anonymous long-distance trade and long-run economic growth?

North makes the case for the development of effective third party enforcement to allow impersonal exchange between groups. His central hypothesis is that deficiencies in economic growth can be attributed in large part to the failure of exchange institutions to develop mechanisms of third party enforcement that are necessary to support long distance (or impersonal) exchange. Drawing on North's [9] insights about the development of long-distance trade, we address the following research questions. Why is third party enforcement necessary for impersonal exchange, but not for personal exchange? And, what makes third party enforcement effective?

To answer these questions we must first understand how humans have solved the problem of personal exchange. Evolutionary psychologists (see [2]) hypothesize that we have evolved mental modules which allow us to readily devise, and enforce, the implicit contracts necessary for personal exchange. These modules include an emotionally regulated response to either the creation of, or the defection from, an implicit contract. They hypothesize that humans have the ability to naturally infer the epistemic states of others, to detect others' intentions, and to autonomically engage in appropriate reciprocity behaviors. [6] use research from evolutionary psychologists to interpret data on cooperation in two-person bargaining games.

In [8] a theory of mental accounting is developed where individuals are postulated to use to solve the problem of social exchange. Goodwill accounting is a reputation scoring mechanism whereby people keep mental accounts of the extent to which potential trading partners can be relied upon to use trust in exchange settings. Subjects then weigh the subjective risk of cooperation against the goodwill of their trading partners to decide whether or not to initiate, or reciprocate, potential exchanges. We hypothesize in this paper that both the subjective risk of trading, as well as the goodwill of potential trading partners, will be updated, but differently, as individuals gain experience in different trading environments. Not only do people keep goodwill accounts, but research by cognitive neural psychologists, [1] and [3], suggests that people are good at reading how much goodwill they have with others in a variety of exchange environments.

However, the modules that govern intentionality detection and reciprocity have been adaptively constructed over evolutionary time to create forms of social capital that support highly personal networks of exchange. See [5] for an analysis of social networks in tribal societies. Economic history, on the other hand, documents that most of the world's sustained economic growth has occurred in the last thousand years. Given this rapid change in our economic environment, mental modules for personal exchange that developed in evolutionary time are likely to be inadequate for modern exchange. So how is modern trade made possible? Most economists would agree that economic growth is sustained by an ever-widening circular flow of goods and services made available through specialization and technological innovation. Furthermore, to take advantage of the gains from exchange made possible through technological innovation, institutions must be invented to augment the mind's natural capacity for personal exchange and create new forms of social capital.

In this paper we consider a two-person, extensive-form "assurance" game that offers players two alternatives for achieving a cooperative exchange: the TRUST sub-game requires mutual trust; while the PUNISH sub-game offers a credible assurance that cheaters will be punished when they fail to reciprocate on an exchange. We postulate that individuals first try to use positive reciprocity responses (TRUST sub-game) that represent adaptations for personal exchange in long-term relationships. If this fails, they then resort to assurances of third party enforcement (PUNISH sub-game) to achieve the gains from exchange. We predict that the form of the economic environment, either personal exchange or impersonal exchange will play an important role in determining what kind of social capital is required.

2. **Experimental Design**

Our experimental design manipulates two variables. The first variable changes the degree to which goodwill accounting can be used to build social capital that sustains cooperation. This variable takes on two values, same pairing (for personal exchange settings), or distinct pairings (for impersonal exchange settings). The second variable changes the amount of subjective risk subjects are predicted to associate with cooperation, and highlights the importance of institutions in building social capital that sustains cooperation. This variable takes on two values that reflect the opportunity cost of offering assurances through third party enforcement.

The Extensive Form Game

The extensive form game we study in this paper is adapted from [7], and illustrated in Figure 1. The low opportunity cost form of the game (LOC), which we discuss first, has symmetric outcomes of 150 points to each player on both sides of the tree. The game is played as follows. Player 1 moves first at node x_1. He or she can either end the game, at a payoff of 0 points to each player, or move down, allowing player 2 to go left or right at node x_2. If player 2 goes left, the next option to player 1 is the same as it is on the right side of the tree: stop the game at 100 points to player 1 and 0 points to player 2 or move down at x_3. The interesting difference between the left and right sides of the tree comes with the next decision on the left side. If player 1 moves down at x_3, player 2 can either end the game at 150 points for each player or move down at x_5, thereby guaranteeing himself or herself 300 points. Thus, on the left side of the tree, player 1 should only move down at x_3 if he or she can trust that player 2 will move left instead of down at x_5.

If player 2 goes right, player 1 then has the option of stopping the game at 100 points to player 1 and 0 points to player 2, or moving down at x_4. Player 2 then has the option of stopping the game at 150 points to each player or moving down at x_6. If player 2 moves down at x_6, player 1 has the option of stopping the game at either 0 points to each player or at 0 points to himself or herself and 300 points to player 1.   The punishment option, down at x_8, we interpret as being made possible by a third party enforcement mechanism. If player 1 plays “steal” (down at x_6), then player 1 can move to have the surplus confiscated by a third party (the experimenter).

Notice that cooperation to split the total possible payoff of 300 points can be achieved on either side of the game tree. However, cooperation on the left can only be achieved if player 1 is sufficiently *trusting* to move down at x_3 and player 2 is sufficiently *trustworthy* to move left at x_5. Cooperation on the right can be achieved by threat of punishment. If player 1 moves down at x_4 and player 2 does not move right at x_6, player 1 can punish player 2 at no cost.

Note, however, that cooperation by trust weakly dominates cooperation by threat of punishment. Comparing the right and left branches of the tree, the payoffs are the same at adjacent nodes except the bottom, where there are 300 more points available at x_7 than at x_8. The game involves assurance because a right move by player 2 at x_2 assures player 1 that it is not in player 2's interest to move down at x_6. No such assurance characterizes defection at x_5 on the left.

In the high opportunity cost (HOC) form of the game, we introduce a payoff benefit associated with cooperation on the left. The payoff to each participant increases from 150 to 200 if they cooperate on the left instead of on the right. Alternatively, this benefit to cooperation on the left can be viewed as an opportunity cost associated with using a third-party mechanism to provide assurance that cheaters will be punished. In these treatments, we operationalize the cost associated with maintaining institutions for cooperation through threat of punishment in impersonal trade.

Experimental Treatments

We repeat each game in two different ways to vary the degree to which goodwill accounting can be used to build social capital that sustains cooperation. In the personal exchange (PE) environment, players are paired with the same partner for 15 trials. In the impersonal exchange (IE) environment, each player plays exactly once with every other player. Thus, the game is repeated 15 times, but on each trial each player plays with a distinct other player. On each trial the role, player 1 or 2, is randomly assigned within each pair. Table 1 describes the number of sessions, pairings, and outcomes for each cell of our 2x2 design.

Hypotheses

We hypothesize that there will be a significant difference in the way bargaining pairs adapt over time, both between the PE and the IE environments and between the LOC and HOC payoff conditions. We further hypothesize that subjects who must move at node x_2 will place a higher subjective risk to moving left, i.e., trusting their counterparts, in the LOC condition than the risk they will assign to moving left in the HOC condition. Goodwill accounting asserts that subjects will move left at x_2 when their counterparts have sufficient goodwill to cover the subjective risks of cooperating. Therefore, for the same initial levels of goodwill we predict that subjects are more likely to begin playing left in the HOC condition than in the LOC condition.

In the IE environment, subjects are distinctly paired in each trial. Based on this meeting experience, we predict they will update their estimates of the subjective risks of cooperation on the left. The less cooperative past counterparts have been, the greater the risks they will assign to playing left with future counterparts. However, in the PE environment, where subjects always meet the same counterparts, they have no new information, and thus we predict will not update the subjective risks of moving left. Moreover, in the PE environment, we predict that subjects will update the goodwill of their counterparts, something they cannot do in the IE environment. The more cooperative a counterpart, the more goodwill they get, while defection reduces goodwill.

Since the left branch of the game has greater built in incentives for defection, we predict that the ability to build goodwill will be important in sustaining cooperation on this side. Thus, we predict greater left branch cooperation in the PE environment than in the IE environment in both the LOC and HOC conditions. Furthermore, since the reward from left branch cooperation is higher in the HOC condition, we predict that within the PE environment, left branch cooperation will be higher in the HOC condition than in the LOC condition. Finally, since the subjective risk of playing left starts out lower in the HOC condition, we predict that left branch play in the IE environment will deteriorate more slowly in the HOC condition than in the LOC condition.

In the IE environment there is no opportunity to develop a trust relationship with one person, making the maintenance of personal exchange difficult. Some player types 2 may go left at first, but they are likely to encounter players 1 who are not trusting enough to move down at x_3, and they will be discouraged from future left branch play. Players 2 who move left, and are paired with players 1 who move down at x_3, will increase the subjective risk of playing left and will become less trustworthy with other counterparts when they are player 1. This will further discourage left branch play. Thus, we expect the IE outcomes to converge to (150, 150) cooperation on the right. The threat of punishment provides assurance to players 1 who are not trusting, and punishment for players 2 who are not trustworthy. In the language of exchange institutions, players will use the assurance of being able to punish cheating to build social capital for cooperation on the right branch of the game.

We note that our hypotheses are all extra game-theoretical. Since the game will only be repeated a finite number of times, Nash equilibrium game theory predicts right branch play for all pairs in both the PE and IE environments and the LOC and HOC conditions. Left branch play, if it occurs at all, should always result in the outcome (100, 0).

Procedures

Experiments were conducted at the University of Arizona's Economic Science Laboratory. Subjects received $5 upon appearing for the experiment and were paid privately their accumulated earnings after the experiment was completed. The instructions and the game tree were displayed on computers. Subjects indicated their choices by using the computer mouse to click on arrows indicating the direction of move at each node.

Each player was seated at an isolated computer terminal. All players were in the same computer laboratory, but each subject knew only that he or she was paired with another player in the same laboratory. The identity of the pairings was never revealed. In the PE environment, each subject was informed that he or she would be matched once at random with some other subject, and would interact with that person repeatedly for the entire experiment. In the IE environment, each subject was told that he or she would be matched exactly once with every other subject in the laboratory, with random assignment of player types on each interaction. In both the PE and IE environments no subject was told the identity of any other subject with whom he or she was paired.

3. **Results**

Figures 2 and 3 display the experimental results by treatment, game, and groups of decision trials. The numbers along the side of the figure represent the outcomes in each of the two treatments' successive groups of trials. Notice that in the (PE, LOC) experiments (Figure 2) left play declines at first, but then stabilizes at approximately 1/3 of total outcomes in trials 6-15. Moreover, whether subjects play right or left, they are likely to end at one of the cooperative outcomes. In the (PE, HOC) experiments (Figure 3) left play starts out high and remains high for the entire experiment. As in the LOC experiments, the outcome is generally cooperative. But, as predicted, increasing the benefit associated with cooperation on the left increases left cooperative play,

Left play in the (IE, LOC) experiments (Figure 2) declines across trial blocks. Of those pairs that do play left, most of the PE pairs end at (150,150). In contrast, most of the IE pairs end at (100,0). Those of the IE pairs who do venture beyond (100,0) generally go to (0,300) instead of (150,150). Thus, for those going left, trust can be maintained in the PE pairings, but not in the IE pairings.

There is a similar, although less pronounced, difference between the PE and the IE environments on the right branch in the LOC condition. A small, but consistent number of IE pairs continue to stop at (100,0), even on the right, while an increasing number do find the cooperative outcome of (150,150). Those that cheat on a move down at (100,0) almost always get punished and end up at (0,0). Comparing by trial block, fewer PE pairings stop at (100,0). Almost all those that move right end up at (150,150). Of the few who try to cheat, all get punished.

As predicted, raising the opportunity cost associated with cooperation through threat of punishment in the HOC experiment (Figure 3) makes the development of cooperation particularly difficult in the IE experiments. While left play declines over the course of the experiments, it is not extinguished, as it is in the LOC experiment. Despite continuing to play left, however, cooperation on the left declines throughout the experiment. An increasing proportion of left play results in either a (100,0) or a (0,300) outcome. The difficulty associated with continued attempts to cooperate on the left also affects the attempts to cooperate on the right. Those that do move right continue to get stopped at (100,0), even though every move down ends at (150,150). Thus, history matters, and the resulting dynamics affects the path to a new stationary equilibrium. [9].

Tables 2-5 display the data in the form of node and branch conditional probabilities for each outcome. They are read as follows. Looking at row 1 for IE, LOC (Table 2), in period 1, of the 23 pairs that got to the top of the tree (one stopped at 0,0) eleven went left and twelve went right. Thus, conditional on getting to the top of the tree, the probability of going left was 0.48 and of going right was 0.52. Of the eleven that went left, five stopped at (100,0) and six went down, for conditional probabilities of 0.45 left and 0.55 down. Of the six that went down, only two stopped at (150,150); the rest went down, cheating on their partners' trust. As the IE, LOC experiments progress, the conditional probability of left play at the top of the tree declines from 0.64 in periods 1-5 (0.48 in period 1) to 0.22 in periods 11-15 (0.08 in period 15). For those pairs that do go left, the conditional probability of stopping at (100,0) rises from 0.47 in periods 1-5 to 0.84 in periods 6-10 and 0.81 in periods 11-15. For those who try to go beyond (100,0), the trusting partner almost always loses.

Turning to the right-hand side of the tree, the conditional probability of stopping at (100,0) falls from 0.33 in periods 1-5 to 0.24 in periods 6-10 to 0.11 in periods 11-15. For those pairs who do go past (100,0), the conditional probability of achieving (150,150) is consistently better than 0.90, with almost all deviations punished with a (0,0) payoff. Thus, IE, LOC pairs can learn to cooperate. But, they must first find the right side of the tree and then be willing to move down at (100,0). Finding (150,150) requires trial and error. First, they may stop at (100,0) on either the left or the right or one player may cheat at (0,300) on the left. If they tried left first, they may eventually move right. Once they have moved right, either at the beginning or later, they may find (150,150). However, some must stop first at (100,0). Those that do venture past (100,0) on the right almost always find (150,150).

In contrast with the IE, LOC results, the conditional probability of left play declines at first (Table 3), but then stabilizes at 0.38-0.39 in the PE, LOC pairings. Of those that go left, only 0.15-0.16 stop at (100,0). The rest go down, with a conditional probability of 0.92-0.97 of achieving (150,150) in the last 10 trials. For those who go right, the conditional probability of stopping at (100,0) stabilizes quickly at 0.10-0.15 and the conditional probability of achieving (150,150) also stabilizes quickly at better than 0.95. Thus, for PE pairings, left and right play quickly becomes equally profitable.

Tables 4 and 5 show the impact of increasing the payoff to cooperation on the left to (200,200) in the conditional probabilities framework. For PE pairs, increasing the payoff makes left play consistently more likely. The conditional probability of left play is 91% in the first trial and 77% in the last trial, with an average probability above 80%. Moreover, the conditional probability of getting to (200,200), once play has proceed left and down, is about 90%, with about 60% of all the trials ending in a (200,200) outcome. This outcome suggests that, in a world of personal exchange and mutual trust and trustworthiness, trading partners are quite adept at maximizing and equally distributing the gains from exchange.

As Table 5 shows, however, increasing the opportunity cost of using punishment to enforce cooperation through impersonal exchange (IE) makes the development of cooperation much harder to achieve. In contrast to the IE, LOC experiments, in which less than half went left on the first trial, more than 91% try left play on the first trial. While left play declines, it still averages over 50% for the last five trials. Thus, at the end of the IE, HOC experiments, subjects are just getting to the point where they start in the IE, LOC condition. Despite continued attempts to go left and a better than 50% conditional probability of going down after going left, they never achieve cooperation to any great extent. Conditional on going left and down, only about 30% cooperate. The rest cheat. Yet, they keep trying, frustrating the development of mechanisms for enforcing cooperation through threat of punishment. The higher payoff on the left is simply too tempting. Averaged over the last five trials, less than 30% of the outcomes can be characterized as cooperative on either the left or the right. This illustrates how difficult it is to develop mechanisms to support impersonal trade when maintaining those mechanisms requires that traders forego gains that could be captured through personal trade or through cheating on attempts to develop personal trading relationships.

If we look at the decision in terms of the expected value of moving left or right and then out or down, we can see how the incentives drive the outcomes. In the IE, LOC experiments, shown in Table 2, the expected value of left play declines from 136 in trial 1 to 0 in trial 15. Once players have gone right, the expected value of playing down is consistently higher than the expected value of any other action, averaging over 140 throughout the experiment.

In contrast, in the IE, HOC experiments shown in Table 5, the expected value of left play is 163 in trial 1 and is still high, 127, in trial 15. Similarly, once players have gone right, the expected value of playing down is 150 throughout the experiment. Thus despite continued cheating on the left and a high conditional expected value associated with cooperation on the right, the expected value of playing left stays sufficiently high to keep players from moving to the right branch of the game.

Turning to the PE environment shown in Tables 3 and 4, the expected value of left play starts high and rises throughout the trials in both the LOC and HOC payoff conditions.

4. Conclusions

The complex organization of the human mind is known to be the product of at least a few million years of evolutionary adaptation to solve the problems of hunting and gathering. Inferring other players' mental states, reciprocity, and the ability to detect and punish cheaters are important elements of a mind adapted to personal exchange in hunter-gatherer environments. The experiments discussed in this paper illustrate how humans use these skills to their advantage in two different environments in which cooperation is possible. In one case, achieving cooperation is relatively easy; in the other, it is considerably more difficult.

The personal exchange (PE) cases illustrate how even anonymous members of a group can form stable pairs, communicate with signals, develop relationships of trust, learn to read one anothers' minds and achieve consistent cooperation. Moreover, when the stakes associated with one kind of cooperation increase relative to another, each easily infers that the other would prefer the higher payoff.

The impersonal exchange (IE) cases illustrate how individuals, who are trying to cooperate, must warily test each new individual. Cooperation through trust is almost impossible in such an environment because no individual has the opportunity to build a reputation for trust. If Player 2 wants to cooperate, he or she must move right at the top of the tree. That provides "assurance" to Player 1 that Player 2 is willing to submit to punishment for cheating. On the left, Player 2 can cheat with impunity. Player 1 may still be wary of Players 2's intentions and go right at (100,0). But, some Players 1 will take the chance and go down at (100,0), allowing Players 2 to go right at (150,150), or to cheat (0, 300). Moreover, both players must go through this elaborate dance each period because each one meets a new "friend" or "foe" each time.

Over time, as a variety of different players in the population interact with one another in the IE, LOC treatment, cooperation with assurance becomes more widespread and the institutional seeds to support impersonal, long-distance trade are planted. What is particularly interesting about this example is that cooperation does develop, despite the strong incentive for Player 1 to take the (100,0) and not run the risk of Player 2 cheating. This provides one more example of the powerful importance of cooperation in social exchange. This propensity is so strong in humans that it emerges even with anonymous same pairings.

It is also interesting, however, that cooperation on either the right or the left does not develop in the IE, HOC treatment. The continued higher return to cooperation on the left encourages enough players 2 to go left, player 1s to go down, and players 2 to cheat. This keeps the left-play returns from opportunistic behavior by players 2 higher than the right-play returns from cooperation with assurance. This suggests that the development of impersonal trading institutions, that provide third-party enforcement, depend critically on creating an environment in which the returns to cooperation with threat of punishment exceed the returns from cheating

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Table 1
Experimental Design

Exchange Environment Type of Repeated Exchange	Opportunity Cost of Third Party Enforcement Low Opportunity Cost (LOC) 150	 High Opportunity Cost (HOC) 200
Personal (PE) Same Pairing	3/24/360*	3/24/360
Impersonal (IE) Distinct Pairing	3/24/360	3/22/352

*a/b/c where a = number of sessions,
b = number of pairs, and
c = number of observations.

Table 2
Low Opportunity Cost (LOC) Payoff Condition
Impersonal Exchange (IE) Environment
Node (Branch) Conditional Outcome Frequencies

Trials	Left Branch	$E(\pi_2 \mid \text{Left})$	100 0	$E(\pi_1 \mid \text{Down})$	150 150	0 300	Right Branch	$E(\pi_2 \mid \text{Right})$	100 0	$E(\pi_1 \mid \text{Down})$	150 150	0 300	0 0
1	11/23 = .478	136	5/11 = .455 (.455)	50	2/6 = .333 (.182)	4/4 = 1 (.364)	12/23 = .522	138	1/12 = .083 (.083)	150	11/11 = 1 (.917)	0	0
1-5	76/118 = .644	138	36/76 = .474 (.474)	37	10/40 = .25 (.132)	30/30 = 1 (.395)	42/118 = .356	100	14/42 = .333 (.333)	150	28/28 = 1 (.667)	0	0
6-10	49/120 = .408	46	41/49 = .837 (.837)	19	1/8 = .125 (.020)	7/7 = 1 (.143)	71/120 = .592	108	17/71 = .239 (.230)	136	49/54 = .907 (.690)	1/5 = .20 (.014)	4/5 = .80 (.056)
11-15	26/119 = .218	58	21/26 = .808 (.008)	0	0	5/5 = 1 (.192)	93/119 = .782	127	10/93 = .108 (.108)	143	79/83 = .952 (.849)	0	4/4 = 1 (.043)
15	2/24 = .083	0	2/2 = 1 (1)	0	0	0	22/24 = .917	136	2/22 = .091 (.091)	150	20/20 = 1 (.909)	0	0

Table 3
Low Opportunity Cost (LOC) Payoff Condition
Personal Exchange (PE) Environment
Node (Branch) Conditional Outcome Frequencies

Trials	Left Branch	$E(\pi_2 \mid \text{Left})$	100 0	$E(\pi_1 \mid \text{Down})$	150 150	0 300	Right Branch	$E(\pi_2 \mid \text{Right})$	100 0	$E(\pi_1 \mid \text{Down})$	150 150	0 300	0 0
1	17/24 = .708	79	8/17 = .471 (.471)	150	9/9 = 1 (.529)	0	7/24 = .292	129	1/7 = .143	150	6/6 = 1 (.857)	0	0
1-5	71/120 = .592	118	23/71 = .324 (.324)	125	40/48 = .833 (.563)	8/8 = 1 (.113)	49/120 = .408	122	7/49 = .143 (.143)	143	40/42 = .952 (.816)	0	2/2 = 1 (.041)
6-10	45/120 = .375	139	7/45 = .156 (.156)	146	37/38 = .974 (.882)	1/1 = 1 (.022)	75/120 = .625	128	8/75 = .107 (.107)	143	64/67 = .955 (.853)	0	3/3 = 1 (.040)
11-15	47/120 = .392	137	7/47 = .149 (.149)	139	37/40 = .925 (.787)	3/3 = 1 (.064)	73/120 = .608	134	7/73 = .096 (.096)	148	65/66 = .985 (.890)	0	1/1 = 1 (.014)
15	8/24 = .333	150	1/8 = .125 (.125)	129	6/7 = .857 (.755)	1/1 = 1 (.125)	16/24 = .667	141	1/16 = .063 (.063)	150	15/15 = 1 (.938)	0	0

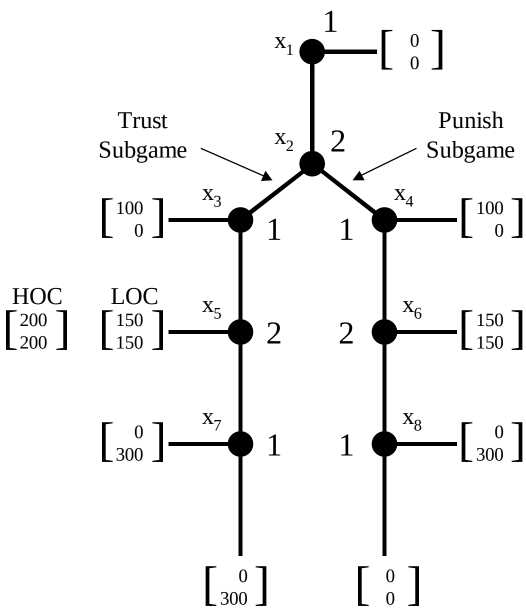
Table 4
High Opportunity Cost (HOC) Payoff Condition
Personal Exchange (PE) Environment
Conditional (Unconditional) Outcome Frequencies

Trials	Left Branch	$E(\pi_2\vert$ Left)	100 0	$E(\pi_1\vert$ Down)	200 200	0 300	Right Branch	$E(\pi_2\vert$ Right)	100 0	$E(\pi_1\vert$ Down)	150 150	0 300	0 0
1	20/22 = .91	140	7/20 = .35 (.318)	169	11/13 = .846 (.50)	2/2 = 1 (.091)	2/22 = .091	150	0	150	2/2 = 1 (.091)		
1-5	98/110 = .891	157	25/98 = .255 (.227)	178	65/73 = .89 (.591)	8/8 = 1 (.073)	12/110 = 0.11	112	3/12 = .25 (.027)	117	7/9 = .778 (.064)	1/2 = .5 (.01)	1/2 = .5 (.01)
6-10	88/110 = .80	150	23/88 = .261 (.209)	194	63/65 = .969 (.573)	2/2 = 1 (.018)	22/110 = .20	102	3/22 = .136 (.027)	118	15/19 = .789 (.136)	0	4/4 = 1 (.036)
11-16	103/13 2 = .780	166	19/103 = .184 (.144)	193	81/84 = .964 (.614)	3/3 = 1 (.025)	29/132 = .220	124	4/29 = .138 (.033)	144	24/25 = .960 (.182)	0 0	1/1 = 1 (.001)
15	17/22 = .773	182	2/17 = .118 (.091)	187	14/15 = .933 (.636)	1/1 = 1 (.045)	5/22 = .227	150	0	150	5/5 = 1 (.227)	0	0

Table 5
High Opportunity Cost (HOC) Condition
Impersonal Exchange (IE) Environment
Conditional (Unconditional) Outcome Frequencies

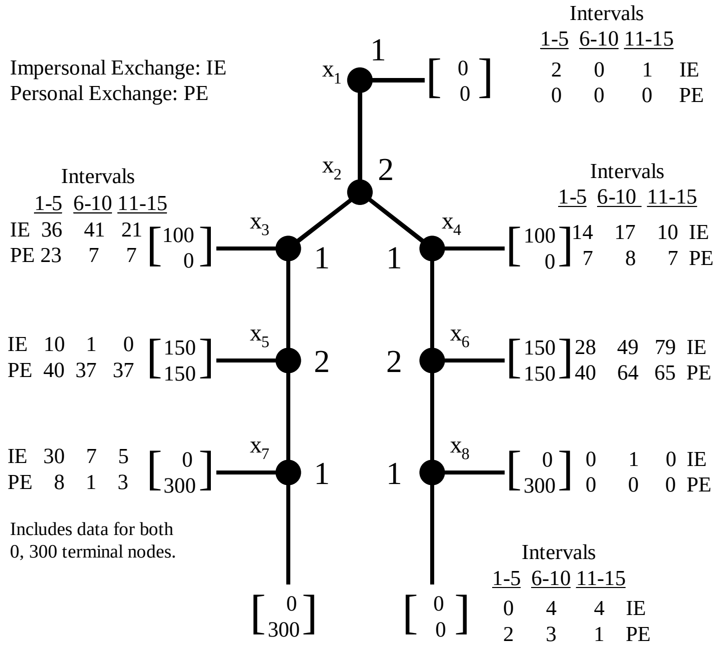
Trials	Left Branch	$E(\pi_2\vert$ Left)	100 0	$E(\pi_1\vert$ Down)	200 200	0 300	Right Branch	$E(\pi_2\vert$ Right)	100 0	$E(\pi_1\vert$ Down)	150 150	0 300	0 0
1	22/24 = .917	163	10/22 = .455 (.417)	100	6/12 = .50 (.25)	6/6 = 1 (.25)	2/24 = .083	75	1/2 = .5 (.041)	150	1/1 = 1 (.041)	0	0
1-5	105/11 9 = .882	129	53/105 = .505 (.445)	77	20/52 = .385 (.168)	32/32 = 1 (.269)	14/119 = .118	75	7/14 = .50 (.059)	150	7/7 = 1 (.059)	0	0
6-10	82/120 = .683	106	50/82 = .610 (.417)	56	9/32 = .281 (.075)	23/23 = 1 (.192)	38/120 = .317	91	15/38 = .395 (.125)	150	23/23 = 1 (.192)	0	0
11-15	68/120 = .567	82	48/68 = .706 (.40)	40	4/20 = .20 (033)	16/16 = 1 (.133)	52/120 = .433	92	20/52 = .385 (.167)	150	32/32 = 1 (.267)	0	0
15	11/24 = .458	127	6/11 = .545 (.25)	40	1/5 = .20 (.042)	4/4 = 1 (.167)	13/24 = .541	104	4/13 = .308 (.167)	150	9/9 = 1 (.375)	0	0

Figure 1
Decision Trees for Assurance Game



The high opportunity cost (HOC) payoff condition makes left branch cooperation more valuable than left branch cooperation in the low opportunity cost (LOC) payoff condition. Otherwise all payoffs remain the same.

Figure 2
Low Opportunity Cost (LOC) Data



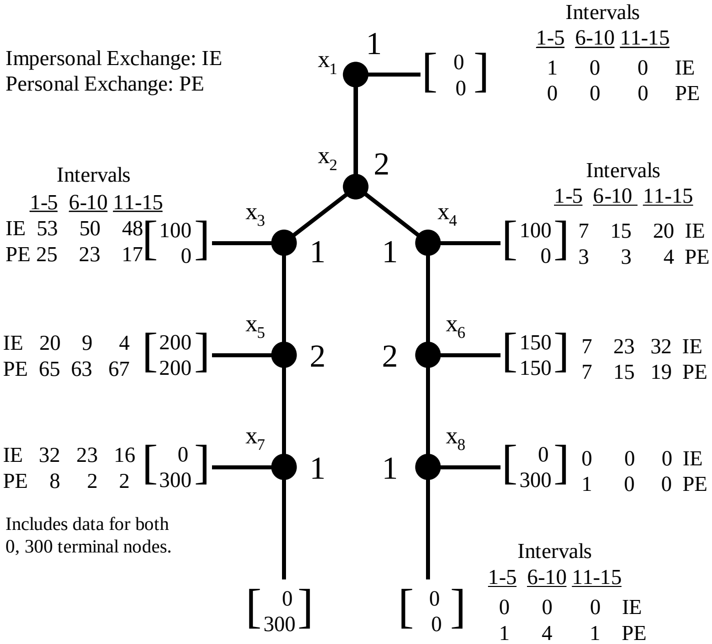
Total Left Branch Play

	Intervals 1-5	6-10	11-15
IE	76	49	26
PE	71	45	47

Total Right Branch Play

	Intervals 1-5	6-10	11-15
IE	42	71	93
PE	49	75	73

Figure 3
High Opportunity Cost (HOC) Data



Total Left Branch Play

	Intervals 1-5	6-10	11-15
IE	105	82	68
PE	98	88	86

Total Right Branch Play

	Intervals 1-5	6-10	11-15
IE	14	38	52
PE	12	22	24