

SUPPLEMENTARY APPENDIX

COMMITMENT AND (IN)EFFICIENCY: A BARGAINING EXPERIMENT

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January 29, 2016

This document contains supporting material for the document “Commitment and (In)Efficiency: a Bargaining Experiment,” which herein we refer to as the “main document.”

1 Instructions

1.1 Instructions for Exit Treatment

Welcome. You are about to participate in an experiment on decision-making and you will be paid for your participation in cash privately at the end of the session. Please turn off all electronic devices, especially phones. During the experiment you are not allowed to open or use any other applications on these laboratory computers, except for the interface of the experiment.

Structure of the experiment. The experiment consists of 10 games. Each game consists of several rounds. Before the beginning of each game, you will be randomly divided into groups of 4 people and assigned an ID letter (A, B, C or D). Your group assignment and your ID letter will be the same in all rounds of the same game, but will vary from game to game. In other words, at the end of each game, you will be randomly divided into new groups and you will be assigned new ID letters. The game number, the round number and your ID letter will be clearly displayed on the top of the screen.

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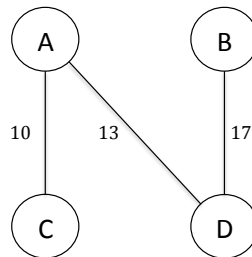
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To determine your payment, at the end of the experiment, the computer will select one game from the 10 games played. Each game is equally likely to be chosen for payment. Your earnings will be equal to your earnings in this randomly selected game. In addition you will receive \$15 for completing the experiment. All the payoffs on the computer screen are in dollars.

What happens in each game. In each game you will engage in anonymous bargaining. A network describes who is connected to whom and how many dollars pairs of players will receive if they are matched at the end of the game. Throughout the game, there will be opportunities for pairs to become matched and reach agreement on how to split the amount of dollars the match will generate. Each person can be matched with at most one other person in her group. We will explain below in details what it means to be matched with another person.

The screen has three main parts: the top-left part depicts the diagram of a network, the top-right part keeps track of matches established in your group in each round and the bottom-right part is where you will make your decisions. We will describe now in details each of these parts and the game.

Here is an example of a diagram of a network that depicts the connections between people and amounts of dollars available for matches between these participants.



This is a 4-person network with each person identified by the letters A, B, C and D. Different people in the network can have different numbers of connections. For instance, A is connected to C and to D, while B is only connected to D. The number next to the line connecting two people represents the surplus (the number of dollars) that pair would generate by matching with each other. For example, if A matched to C, A and C will receive a combined total of 10 dollars.

Each game will consist of several rounds.

First round. At the beginning of a round, each member of the network can choose one of two actions: 1) propose a match or 2) do nothing. Proposing a match means choosing a person in the network with whom you are connected and proposing how to divide available dollars between the two of you. In other words, a proposal of a match is a suggestion of how many dollars you would receive and how many dollars the other person would receive. To make a proposal, please choose the ID letter of the

member you want to propose a split using the drop-down menu. Then underneath that type the number of dollars that you propose to keep to yourself. The remaining dollars will be allocated to the member you chose to propose to if he/she accepts your proposal.

Here is how the interface looks like (bottom-right corner of the screen):

Please propose a match by selecting a player and surplus split below

Player

Keep dollars out of 13.00 dollars

In the example shown in the network diagram above, there are 10 dollars to be divided between members A and C, while there are 13 dollars available for division between members A and D. Therefore, if, for instance, member A makes a proposal to member D and proposes to keep 2 dollars, this means that if member D accepts this proposal she will receive 11 dollars.

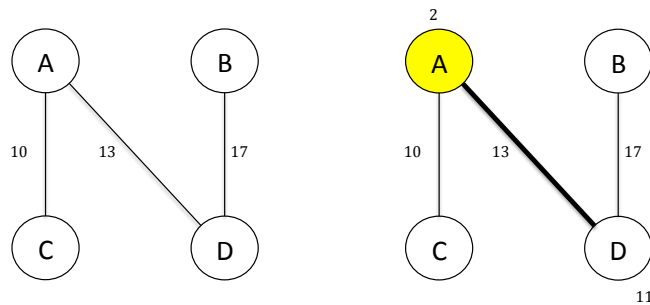
Once you finalize your proposal, please click SUBMIT button. At this moment you won't be able to modify your proposal any more in this round. If you do not wish to make a proposal in this round, you can press DO NOTHING button, located to the right of SUBMIT button.

After all members of the group made their moves (submitted a proposal or done nothing), *the computer will select one participant at random*. Each participant is equally likely to be selected.

Only the move of the selected member will be implemented. If selected member chose to do nothing, then the current round will be over and the group will move on to the next round of the same game. If the selected member proposed a match then the person to whom a match was proposed will be prompted to respond to the proposal. This person may choose to accept or to reject the proposal. If a proposal is accepted, the match is formed. If a proposal is rejected, then we move onto the next round without anything changing; both the selected member and the participant proposed to remain unmatched.

If a match is formed, then it will be displayed in subsequent rounds in top-right diagram located on the screen. Here is an example of what a match between A and D would look like:

This diagram mimics the diagram on the left, indicating the connections between



people in this network with thin lines. It also indicates your position in the network ? this is the yellow circle. A thick line connecting two subjects indicates that a match between these two subjects was formed. The numbers outside the circles indicate the number of dollars each subjects receives according to this agreement. For instance in the example above, in the first round A and D formed a match and agreed to split 13 dollars so that A gets 2 and D gets 11 dollars.

Second and the following rounds. The second, and all the remaining rounds in this game, look very similar to the first round of the except for one feature. At the beginning of each round, all members of the group are asked to choose either to propose a match or to do nothing (just like in the first round). However, while in the very first round all members of the group are unmatched, in the subsequent rounds some members might be matched based on agreements they have reached in the previous rounds. Since any person can be matched with at most one other person in the group, people that formed matches in the previous rounds have no active choice in the subsequent rounds of the game and will be prompted to choose DO NOTHING button. Other people, those that are not matched yet, can either propose a match to someone with whom they have a potential connection (indicated by a thin line on the top-right or top-left diagrams) or DO NOTHING.

History. The right-hand side diagram will keep track of the current status of all members of the network in each round. This right-hand side diagram will also allow people to observe how the matches have evolved over the course of the previous rounds for the current game by clicking arrow buttons below the diagram. Notice there is fast-back button. If pressed, this button will show the very first round of the game. There is also a fast-forward button which if pressed will show the current round of the game. The simple arrows are to go back and forth one round at a time. The number between arrows indicates the round number that the diagram is showing.

When does game end and your payment in a game. There are two possibilities for how a game may come to an end. The first possibility involves chance. At the end of each round, the computer randomly chooses an integer number between 1 and 100 (inclusive), with each number being equally likely. If the chosen number is below 100, then game proceeds to the next round. However, if the computer chose

the number 100, then current game ends. In other words, there is 1% chance that the current round is the last round in this game and 99% chance game is not over and group proceeds to the next round.

The second possibility is the one in which players who proposed new matches cannot form matches without players who chose to do nothing. In other words, there are no possible matches between any two players who are both still proposing. If that is the case, then the current game comes to an end.

When game comes to an end, each member of the group receives the amount of dollars given by the current agreement (last round agreement). The dollars each person will receive from the current agreement are shown on the right-hand side diagram of the network for the current round. If a person is unmatched when the game ends, that participant receives zero dollars.

At the end of each game, you will observe the message that indicates why this game ended.

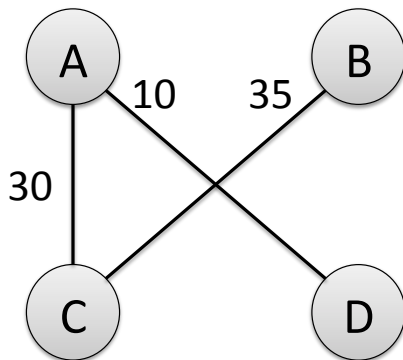
Payment. At the end of the experiment, the computer will randomly choose one of the 10 games that you just played and the number of dollars that you earned in this game will be paid to you together with the participation fee. Each game is equally likely to be selected for payment.

Are there any questions?

1.2 Quiz for Exit treatment

SCREEN 1

Consider the following game:



Question 1: Suppose that in round 1 C makes an offer to A in which C keeps 3 dollars. Suppose this offer is selected. How many dollars each player would get if A accepted

the offer and then the game ended?

1. A gets 3, C gets 27, B and D get 0
2. A gets 27, C gets 3, B and D get 0
3. A gets 27, C gets 3, B gets 35 and D get 10
4. A gets 27, C gets 3, B get 0 and D get 10

Correct answer is 2.

Question 2: Suppose, instead, that in round 1 D makes an offer to A in which D keeps 7 dollars. Suppose this offer is selected. How many dollars each player would get if A rejected the offer and then the game ended?

1. A gets 3, B gets 15, C gets 20 and D gets 7
2. A gets 3, D gets 7, B and C get 0
3. All players get 0
4. Not enough information is given to work it out

Correct answer is 3.

Question 3: How do subjects get assigned to groups?

1. Participants are reshuffled into new groups in each game and in each round
2. Participants stay in the same groups in all games and in all rounds
3. Participants are reshuffled into new groups in each game, but stay in the same group throughout the game

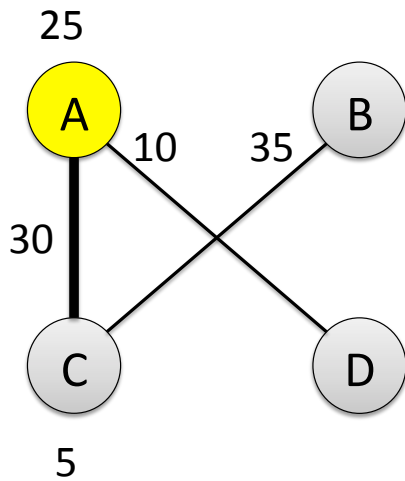
Correct answer is 3.

SCREEN 2

Diagram below shows what has happened in round 1 of the game:

Question 4: Which player are you?

1. A



2. B
3. C
4. D

Correct answer is 1.

Question 5: Which players are currently matched (reached an agreement)?

1. A and D as well as B and C
2. A and C as well as A and D
3. A and C
4. B and D

Correct answer is 3.

Question 6: Can players A and C make new proposals in round 2?

1. No because they are already matched and once matched you cannot make new proposals
2. Yes because both A and C have another link available: A can be matched with D and B with C

Correct answer is 1.

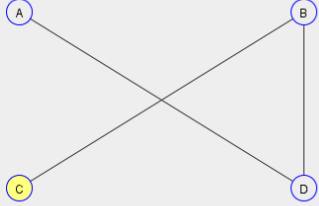
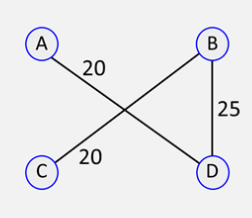
Question 7: Suppose that in round 2, B proposed to C and D proposed to A. Will the game continue to the next round?

1. No because B and D have no link with each other and they can't match
2. Yes because B and C have a link with each other and so are A and D

Correct answer is 1.

1.3 Screenshots from Exit 25 treatment

GAME 1, ROUND 1
You are player C.



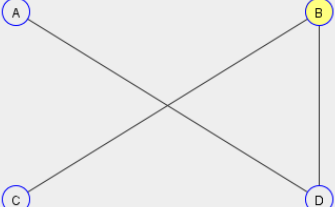
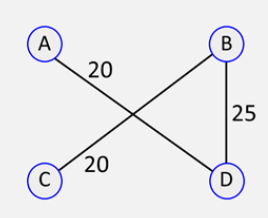
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Please propose a match by selecting a player and surplus split below

Player

Keep dollars out of 20.00 dollars

GAME 1, ROUND 1
You are player B.



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The proposer is player C.
You are the responder.
The proposer chose to keep 10.00 of the possible 20.00 dollars.
That means, if you accept you will get 10.00 dollars.
Please choose by clicking one of the buttons below.

1.4 Instructions for Stay 25 treatment

The instructions for the Stay treatments are the same as the instructions for the Exit treatments except for the description of the second and the following rounds of the game as well as the subjects' payments. We present here only these two parts which are different between the Exit and the Stay treatments.

Second and the following rounds. The second, and all the remaining rounds in this game, look very similar to the first round of the except for one feature. At the beginning of each round, all members of the group are asked to choose either to propose a match or to do nothing (just like in the first round). However, while in the very first round all members of the group are unmatched, in the subsequent rounds some members might be matched based on agreements they have reached in the previous rounds.

If a currently matched person is selected by the computer to be the proposer, and makes an offer to a different player who decides to accept this new offer, then the proposer will incur a separation cost. In this eventuality, the previous match that has been agreed upon will be dissolved and the new match will be formed in its place. If a matched person's proposal is rejected, the separation cost is not paid. If a matched person makes a proposal to another participant, but this proposal is not selected by the computer to be implemented, then the separation cost is also not paid. Finally, if a currently matched person receives a proposal and decides to accept it, that person must pay the separation cost and the previous match this person was involved in will be dissolved.

The separation cost will be subtracted from the final number of dollars earned in the current game. If a person is responsible for dissolving more than one match, that person will pay the separation cost for each such dissolved match. In today's experiment the separation cost is 10 cents in all games. On the top of the screen you will be able to see how many times you have paid the separation cost up until the current round:

In the current game, you have paid separation costs ___ times

If you have already formed a match in a previous round and wish to keep this match as is, you do not need to re-form it. In other words, if both participants involved in the match reject proposals from other participants if such proposals come along and do not propose new matches to other participants themselves, then the previously formed matches remain intact.

All the remaining details of a round are the same as in the first round.

When game comes to an end, each member of the group receives the amount of dollars given by the current agreement (last round agreement) minus the total

separation costs each member has incurred. The dollars each person will receive from the current agreement, not including the separation costs incurred, are shown on the right-hand side diagram of the network for the current round. The number of times each person paid separation cost is indicated on the top of the screen. If a person is unmatched when the game ends, that participant receives zero dollars less the separation costs that participant has incurred.

1.5 Quiz for Stay treatment

The Quiz at the end of the instruction period for the Stay treatments consisted of 8 questions. The first 5 questions were the same as in the Exit treatment. The remaining 3 questions were different and were presented on the second screen of questions following the same picture as in the Exit treatment.

Question 6: Suppose that in round 2, A and C chose DO NOTHING, B proposed to C and D proposed to A. Will the game continue to the next round?

1. No because B and D cannot form a match with each other
2. Yes because D has a link with A and B has a link with C

Correct answer is 1.

Question 7: Suppose instead in round 2, A and D chose DO NOTHING, B proposed to C and C proposed to B. Will the game continue to the next round?

1. No because A and D chose DO NOTHING
2. Yes because B and C have a link with each other and can form a match

Correct answer is 2.

Question 8: Suppose that in round 2, B proposed to C and C proposed to B. B was selected to implement her proposal and C accepted this new proposal. What will happen?

1. Players B and C will form a new match and C will pay the separation cost for breaking the previous match she was involved in
2. Players B and C will form a new match and B will pay the separation cost for breaking the match between A and C
3. The previous match between A and C remain intact, because C cannot form new matches

4. Player C will be matched to both player A and player B.

Correct answer is 1.

1.6 Screenshot for Stay 25 treatment

GAME 1, ROUND 1
You are player D.

The cost of separation is 0.10 dollars.
In the current game you have paid separation cost 0 times up until now.

Please propose a match by selecting a player and surplus split below

Player

Keep dollars out of 20.00 dollars

2 Additional Analysis

2.1 Sessions Conducted at UCI versus UCSB

Here we compare sessions conducted at the two universities: UC Irvine and UC Santa Barbara. Table 1 lists the locations at which we conducted our experimental sessions, by treatment. We will use Game 25 to compare the two subject pools, since this is the only market structure for which we conducted sessions at both locations for both Exit and Stay treatments (3 sessions at UCSB and 1 session at UCI). In Table 2 we report efficiency and players' payoffs in the final outcomes observed in each of these sessions.

Table 1: Locations of experimental sessions

Treatment	UC Irvine		UC Santa Barbara	
	# of sessions	# of subjects	# of sessions	# of subjects
EXIT 15			3 sessions	40 subjects
EXIT 25	1 session	20 subjects	3 sessions	48 subjects
EXIT 30	3 sessions	68 subjects		
STAY 15	1 session	12 subjects	2 sessions	28 subjects
STAY 25	1 session	16 subjects	3 sessions	44 subjects
STAY 30	3 sessions	56 subjects		

While there are some small differences in outcomes observed in the first half of the experiment in different sessions, these differences disappear as subjects gain experience with the game. In particular, in the second half of the experiment we find no significant differences in the frequency of efficient outcomes in any pair of sessions within Exit or Stay treatments (Wilcoxon Ranksum test: $p > 0.10$ in all pairwise comparisons). Moreover, we detect no significant differences in average payoffs of either strong or weak players in the second half of the experiment for any pair of sessions within Exit or Stay treatments (regression analysis: $p > 0.10$ in all pairwise comparisons).

Table 2: Game 25: Efficiency and players' payoffs in final match, by session

	First five repetitions			Last five repetitions		
	efficiency	B and C	A and D	efficiency	B and C	A and D
<i>Exit treatment</i>						
Session 1 (UCSB)	47%	4.63 (0.84)	11.43 (0.34)	45%	4.25 (0.74)	11.50 (0.38)
Session 2 (UCSB)	60%	5.13 (0.93)	11.55 (0.39)	56%	4.77 (0.79)	11.95 (0.26)
Session 3 (UCSB)	50%	4.53 (0.70)	11.60 (0.35)	45%	3.95 (0.71)	11.93 (0.17)
Session 4 (UCI)	68%	6.39 (0.64)	11.22 (0.23)	56%	4.92 (0.80)	11.72 (0.17)
<i>Stay treatment</i>						
Session 1 (UCSB)	44%	3.61 (0.86)	12.25 (0.54)	88%	6.86 (0.81)	11.23 (0.93)
Session 2 (UCSB)	75%	5.70 (0.95)	12.34 (0.34)	88%	6.14 (0.55)	12.43 (0.16)
Session 3 (UCSB)	75%	6.22 (0.66)	11.77 (0.33)	85%	6.35 (0.45)	12.47 (0.16)
Session 4 (UCI)	54%	6.44 (0.88)	10.24 (0.80)	69%	5.41 (0.76)	12.39 (0.15)

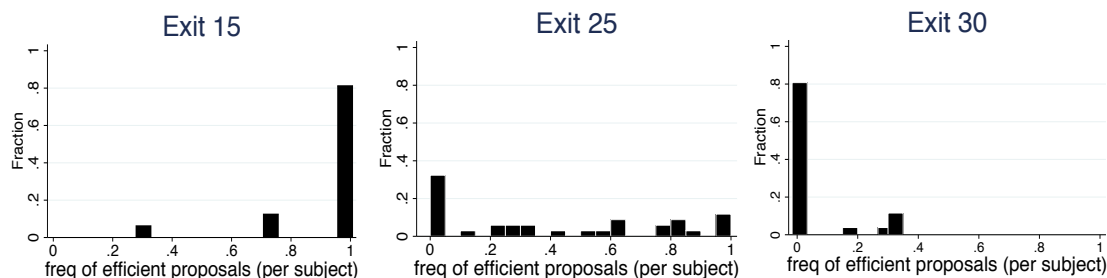
Notes: We focus on the groups that finished playing the game naturally rather than those that were interrupted by random termination. For average payoffs of players, we report robust standard errors in the parentheses, where observations are clustered at the individual level.

Finally, we note that sessions at UCI and UCSB are also very similar in terms of observed individual strategies, market dynamics, and evolution of the players' bargaining power. These results are omitted for brevity and are available from the authors upon request.

2.2 Individual Strategies in Exit and Stay Treatments

Figure 1 depicts the frequency of proposing efficiently in each of our markets by strong players in the second half of the experiment when markets were complete. This figure replicates Figure 4 from the main document, except that here we use all proposals of this type and not only the first round proposals. As is evident from both Figure 1 and Figure 4 from the main document, consistent with the MPE prediction there is a significant shift in strategies used by the strong players as the value of the diagonal link increases, regardless of whether one looks at the first round proposals only (as in Figure 4 from the main document) or at all proposals of this type (as in Figure 1).

Figure 1: Frequency of efficient proposals by strong players when markets were complete, last five repetitions

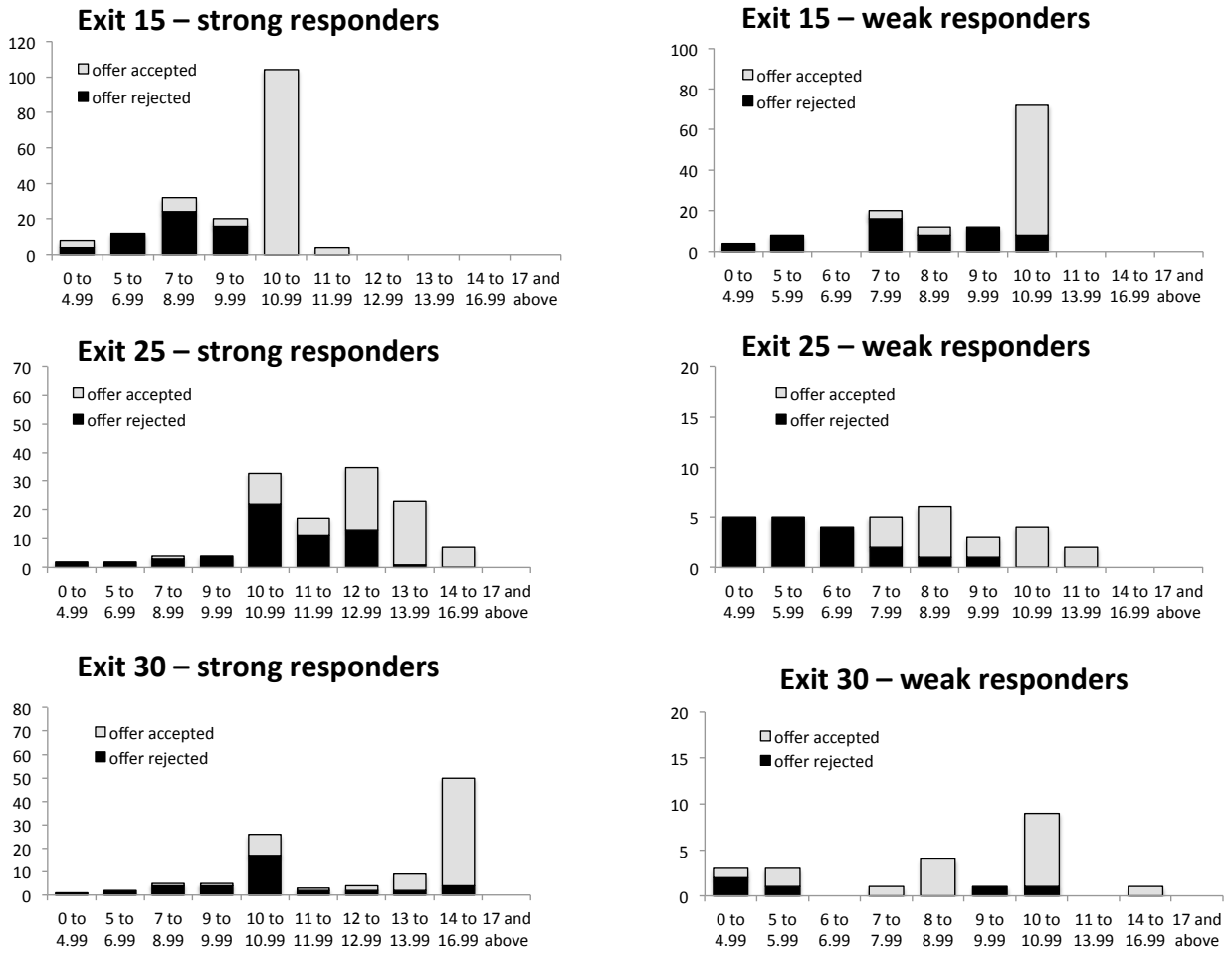


Notes: For each subject, we compute the frequency of proposing efficiently, using data from all rounds in which markets were complete in the last five repetitions of each session, conditional on this player being assigned a strong position.

Figure 2 depicts the acceptance/rejection behavior of our responders in each of the games in the first half of the experiment. We compare this figure to Figure 6 from the main document, where we depict responders' behavior in the second half of the experiment. Comparison of these two figures reveals that there is substantial learning going on with respect to responders' behavior. For instance, while in the first half of the experiment strong players in Games 25 and 30 often accept shares of 10 that come from their efficient partners, by the end of the experiment they learn to reject these shares as they internalize their bargaining power which comes from having a diagonal link. However, we observe that as subjects gain experience with the game, responders' behavior shifts towards behavior predicted by MPE regardless of the network position of responders.

Figure 3 depicts the cumulative distribution functions showing frequencies of proposing efficiently by the strong players when markets were complete in the second half of the experiment. This figure replicates Figure 8 from the main document, except that here we use all rounds in which markets were complete instead of only the first round in each game as in Figure 8 from the main document. The conclusions

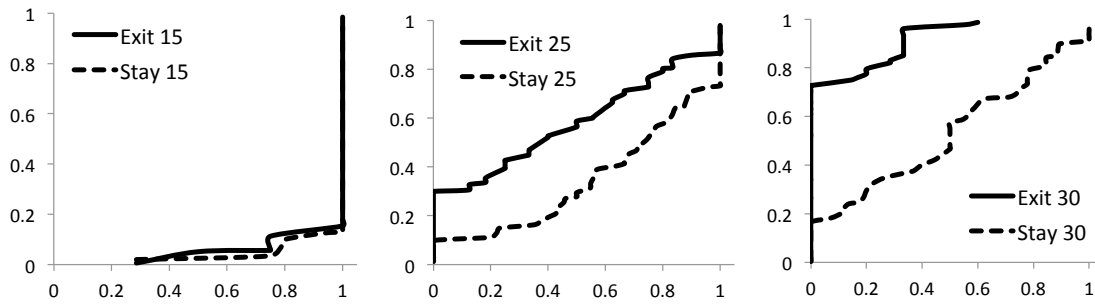
Figure 2: Responders' behavior by network position, first five repetitions



Notes: Offers received by responders are depicted on the horizontal axes. The height of each bar represents the number of observations in each offer range.

reached in Section 8 remain intact. Except for Game 15, in which the vast majority of strong players always propose efficiently in both Exit and Stay treatments, in the remaining Game 25 and Game 30 strong players propose efficiently with higher frequencies when there is a possibility of renegotiation. Regression analysis confirms these results: $p < 0.01$ in both Exit 25 vs. Stay 25 and Exit 30 vs. Stay 30, while $p > 0.10$ in Exit 15 vs. Stay 15.

Figure 3: CDFs of frequency of efficient proposals by strong players when markets were complete, last five repetitions



Notes: We present the cumulative distribution functions summarizing individual frequencies of proposing efficiently in the second half of the experiment when a subject performed a role of strong player and markets were complete. The horizontal axes indicate the likelihood of proposing efficiently, while the vertical axes indicate the values of the CDFs.