The Effect of Link Costs on the Formation and Outcome of Buyer-Seller Networks

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Abstract

We examine experimentally how link costs affect the formation of links between a single seller and two potential buyers as well as the ensuing bargaining. Theory predicts that link costs lead to less competitive networks, but that link costs do not affect the bargaining outcomes conditional on the network. We find support for the first but not the second prediction. Conditional on the network, link costs have a significant direct impact on bargaining outcomes. In particular, link costs induce the seller to ask a lower price in case she is linked to one buyer, while there is no effect of link costs not in case she is linked to two buyers. The effect of the link costs cannot be explained by social preferences, equity considerations, or loss aversion. The effects seem related to the fact that, compared to the case without link costs, the seller has less bargaining power in the 1-link network with positive link costs.

Keywords: experiments, bargaining, networks, competition, sunk costs,
JEL codes: C7, C9, D4, L1

1. Introduction

Buyers and sellers often have to establish a 'link' between them before they can engage in exchange. The collection of links between buyers and sellers (i.e., the 'network') exerts a strong influence on the outcomes of exchange. Who can interact with whom not only affects the gains from exchange but also how these gains are distributed. Typically, agents with more links and trading opportunities are in a better bargaining position than more isolated agents. For example, Corominas-Bosch (2004) showed that a decomposition of buyer-seller networks allows ‘even’ and competitive sub-networks to be identified; surplus is shared evenly in the even sub-networks, whereas the short side of the market extracts all surplus in the competitive sub-networks. This implies that, similar to market entry, there is a strong strategic element in the formation of links and that the costs of forming a link play a key role.

The present paper uses experiments to analyze behavior in a simple game with endogenous network formation in addition to endogenous interaction within the network. We address two basic questions. First, we ask how network *formation* is affected by the presence of link costs. In particular, we examine whether competitive networks in which the short side of the market is predicted to get the entire surplus are less likely to arise when links are costly.

Our second question is whether the *bargaining* in the network, and not just the *formation* of the network, is affected by the costs of link formation. Because the network formation stage precedes the bargaining in the network, any link costs are sunk at the moment the bargaining in the network commences. Therefore, standard theory would suggest that there is no effect of link costs on the bargaining within the network. It is important to establish the absence of such an effect, as this is a basic assumption in the theoretical literature on network formation. In fact, the assumption is so standard that most papers do not mention it explicitly.

To address the two basic questions we focus on the simplest possible, non-trivial buyer-seller network formation game. We analyze a two-stage game between one seller with one indivisible good and two potential buyers. In the first stage, the seller decides whether or not to form a link with each of the two buyers and the buyers simultaneously decide whether to form a link with the seller. In the second stage, conditional on the network that has been formed in the first stage, the players engage in alternating offers bargaining over a shrinking pie.

The subgame perfect equilibrium prediction of the bargaining stage of the one-shot game is such that all the surplus goes to the seller if a competitive network with two linked buyers is formed, whereas the surplus is shared if the seller is linked to one buyer only. Given the payoff predictions from the bargaining stage, in the first stage it is a weakly dominant strategy for the seller to offer a link to both buyers, irrespective of the link costs. For the buyers it is a weakly dominant strategy to offer a link to the seller if links are costless but not if links are costly. After all, the buyers are fully exploited if the competitive network is formed, so they are better off to unilaterally delete a link in case links are costly. This implies that the competitive network is the unique perfect equilibrium if the links are costless, whereas the competitive network is not an equilibrium if links are costly. Hence, the first basic prediction is that the presence of link costs reduces the occurrence of competitive networks. The second basic prediction is that the presence of link costs does not affect the outcomes of bargaining. Once the network has been formed and bargaining starts, the link costs are sunk and the players treat them as such.

The experimental results indicate that, as predicted, the competitive network is less prevalent in case establishing a link is costly. Contrary to the prediction though, this is due to the seller’s and not the buyers' linking behavior. Remarkably, it is the seller who is more reluctant to establish a competitive network in the presence of link costs, not the buyers. Regarding the second question, we find that the presence of link costs does have an effect on the bargaining outcomes. Interestingly, this effect is observed when the seller is linked to one buyer but not when the seller is linked to two buyers.

We examine various explanations for the effect of sunk costs on bargaining outcomes (e.g., social preferences, equity considerations, loss aversion), but find only one that can explain the pattern that we find in the data. This explanation relies on the fact the bargaining power of the seller in a non-competitive network is reduced due to the presence of link costs, since the competitive network is no longer a viable alternative in this case.

2. Related Literature

Our paper is related to three different strands of experimental literature. The first strand examined the effect of competition on bargaining outcomes. Roth, Prasnikar, Okuno-Fujiwara, and Zamir (1991) examined bargaining between one proposer and one responder as well as bargaining between nine competing proposers and one responder. They found that competition had a dramatic effect on the bargaining outcomes. While bilateral bargaining led to a near equal division of the surplus in as much as 70 percent of the cases, with the introduction of proposer competition the occurrence of the near equal division dropped to less than five percent of the cases and almost all surplus went to the responder.[1] Other papers tested the effect of competition and network structure on outcomes of exchange. In economics, the paper by Charness et al. (2007) tested the implications of Corominas-Bosch's (2004) model. The model identifies buyer-seller networks that are 'even' and those that are 'competitive', where the latter leave almost no surplus to the long side of the market. Charness et al.'s (2007) experiment involved bargaining over a given network structure, in which the network structure was changed exogenously by introducing a link after a certain number of periods. The experimental results indicated that the competitiveness of the network had a strong effect on bargaining outcomes, even though the effect was less extreme than predicted.

Analyzing the effect of competition on bargaining outcomes is also central to our study. In our experiment, however, the competitiveness of the network is not given exogenously, but comes about endogenously. In view of the finding that competitive market structures and networks tend to leave the long side of the market with very little surplus, it is particularly important to analyze whether such

[1] Other experimental studies that examine the effect of competition on bargaining outcomes include Grosskopf (2003), Güth, Marchand and Rulliere (1997), and Fischbacher, Fehr, and Fong (2003).

competitive networks are formed in the first place, especially if the links are costly and as a result some agents may not recover their link costs.[2]

The second strand of related experimental literature focuses on network formation and examines whether behavior in a link formation game is in line with the predictions of various equilibrium concepts (See Berninghaus, Ehrhart, and Ott, 2006; Berninghaus, Ehrhart, Ott, and Vogt, 2007; Callander and Plott, 2005; Deck and Johnson, 2004; Falk and Kosfeld, 2003; Goeree, Riedl, and Ule, 2008).[3] As an example, Falk and Kosfeld (2003) tested the model of Bala and Goyal (2000) in the lab to examine whether the formation of networks was in line with the predictions of strict Nash equilibrium. They found that the predictive power of the strict Nash equilibrium depended strongly on the costs and benefits of establishing a link. Equilibrium worked well if both the costs and the benefits of establishing links were one-sided but often failed if the benefits of establishing links were two-sided while the costs were one-sided, that is, in case of payoff asymmetries. They argued that social preferences might explain such behavioral patterns.

Almost all experimental papers on network formation focused on network formation but did not have endogenous interaction within the network[4]. In our experiment, after the network formation stage, players engaged in bargaining. Investigating both the endogenous network formation and interaction is crucial if one wants to study the effect of link costs on the interaction within the network.

Finally, there exists an experimental literature examining the effect of sunk costs. Some studies found little evidence that sunk costs have a systematic effect on behavior (e.g., Phillips, Battalio, and Kogut, 1991; Friedman, Pommerenke, Lukose, Milam, and Huberman, 2007). Others, however, found a significant effect of the

[2] This question is not just of theoretical interest. During the revision of the new European directive on procurement rules (EU Directive 2004/18/EC), much discussion was addressed at potential hold-up problems and bidder exploitation. The association of construction companies, for example, feared that competing bidders could be exploited to such a degree that they would not be able to earn back the costs of crafting a decent bid.

[3] Also related are papers on market entry, such as Camerer and Lovallo (1999).

[4] One notable exception is the paper by Corbae and Duffy (2008) who studied a two-stage network game in which players first decided with whom to form links and then played the coordination game.

presence and the size of sunk costs. In particular, some studies suggested that sunk entry costs may induce players to coordinate on a better equilibrium in case there are multiple (Pareto-ranked) equilibria (Cachon and Camerer, 1996; Offerman and Potters, 2006). Others found an effect of sunk investment costs that seemed to be better explained by a concern for fairness (Ellingsen and Johannesson, 2005). No study, however, has yet examined the effect of linking or entry costs on bargaining behavior.[5] Nevertheless, the aforementioned studies on sunk cost do suggest that sunk costs cannot always be assumed to be irrelevant for behavior.

3. The Game

The game involves one seller and two buyers who take part in two stages of play. In the first stage, players simultaneously offer links to each other. A link is formed when both players offer it. The two buyers cannot form a link with each other. If no link is formed the game ends and all players obtain a payoff of zero. If at least one link is formed, the linked players proceed to the second stage in which they engage in a three round alternating offers bargaining with a shrinking pie. Bargaining starts with the seller simultaneously offering a share between 0 and 240 to each buyer that he is linked to. An agreement is reached if at least one buyer accepts the offer. If both buyers accept the seller's offer, one of them is randomly chosen to trade. If no agreement is reached the game proceeds to the next round. There are at most three rounds in the bargaining and the side of the market that makes offers alternates: in the second round the buyers make offers and in the third round the seller makes offers again. The pie shrinks each round by 80 points; the first round pie is 240, the second round pie is 160, and the third round pie is 80 points. After each round all players are informed about the offers, and the acceptances. If no offer is accepted in any of the three rounds, all players receive a payoff of zero minus the link costs.

[5] An exception is Güth and Schwarze (1983) who auctioned the rights to play the ultimatum game experiment as either a proposer or a responder; they found that the winning proposers were greedier than was usually the case in standard ultimatum game experiments. It is not clear though whether this is due to a selection of the auction or due to the price paid by the auction winner.

We consider two different cases that correspond to the two treatments implemented in the experiment. In the first case, links are costless; in the second, each link that is formed costs 40. The cost of a link is the same for both sellers and buyers. Costs are incurred once the link is formed, not when the link is offered. All the link offers and the formed links within the group become common knowledge at the end of the first stage.

Three different types of network can be formed. In the empty network no player has a link. In a 1-link network one buyer maintains a link with the seller. In the 2-link network both buyers have a link with the seller. In the empty network each player receives a payoff of 0. The unique subgame perfect equilibrium (SPE) payoffs for the 1-link and 2-link networks are depicted in Figure 1.

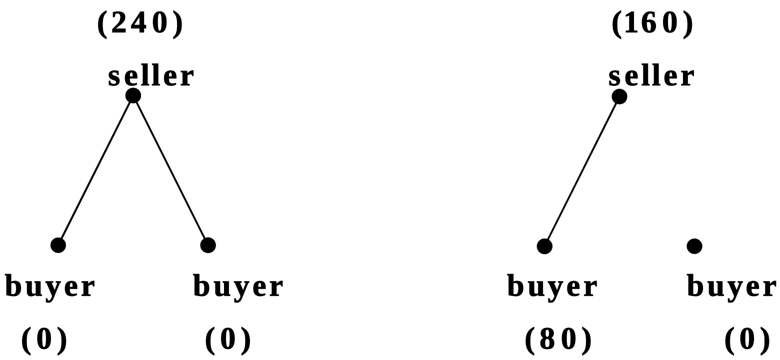

Figure 1. The SPE payoffs in the 2-link and 1-link networks.

In the 2-link network, the unique SPE for the seller is to offer 0 to both buyers in the first round, and for buyers to accept the offer. This can be seen by backward induction. In the third round, the seller offers 0 to both buyers and both buyers accept the offer. So the seller gets 80 and the buyers get 0. In the second round, the (Bertrand) competition between the buyers induces both of them to offer 160 to the seller and the seller accepts one of the offers. In the first round, the seller offers 0 to both buyers, and both buyers accept the offer.

In a 1-link network it is the unique SPE for the seller to propose 80 to the buyer in the first round and for the buyer to accept the offer. Again this follows by backward induction. In the third round, the seller offers 0 to the buyer, and the buyer accepts the offer. In the second round, the buyer has to offer 80 for the seller to accept the offer and hence both get 80. In the first round then, the seller has to offer 80 for the buyer to accept the offer. So, the resulting payoff is 160 for the seller and 80 for the buyer.

Given the SPE payoffs of the bargaining stage, the Nash equilibria of the link formation stage depend on the cost of a link. When links are costless, all networks constitute Nash equilibria.[6] No player has an incentive to unilaterally break a link, in neither the 1-link nor the 2-link network. Moreover, in case a buyer does not offer a link, the seller is indifferent between offering and not offering a link to that buyer. The same holds for the buyers. Hence, any network is a Nash equilibrium. When the link costs are 40, the empty network and the two 1-link networks are Nash equilibria of the link formation stage. The 2-link network, however, is not a Nash equilibrium because a buyer improves his payoffs from -40 to 0 by deleting his link with the seller. There is also a mixed strategy equilibrium if the link costs are 40 in which both buyers offer the seller a link with probability .5, and the seller offers a link to both buyers. The expected payoffs in this equilibrium are 100 and 0 for the seller and buyers, respectively.

Requiring the equilibrium networks to be (trembling hand) perfect eliminates weakly dominated strategies. When links are costless, only the 2-link network is prefect because the seller weakly prefers to offer links to both buyers and both buyers are weakly better off by offering a link to the seller. When the link costs are 40, the empty network is not perfect since the seller weakly prefers to offer a link to both buyers. The two 1-link networks are perfect, as is the mixed strategy equilibrium in which the buyers offer a link with probability .5.

On the basis of this standard equilibrium analysis we formulate the following hypotheses regarding behavior in the first stage (link formation) of the game and the second stage (bargaining) of the game.

1. **Link formation.**

1a. The seller offers two links irrespective of the link costs.

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6 When we refer to networks in this paper, we refer to formed links and disregard unilateral link offers. Obviously, networks in which a buyer offers a link whereas the seller does not offer a link to this buyer do not constitute Nash equilibria.

Offering two links is a weakly dominating strategy for the seller irrespective of whether the link costs are 0 or 40.

1b. The buyers are less likely to offer a link when link costs are 40.

If link costs are 0, it is weakly dominating strategy for the buyers to offer a link to the seller. If the link costs are 40, only one buyer offers a link to the seller, or both do so with probability 0.5.

1c. The 2-link network is formed less often when link costs are 40.

The 2-link network is both a Nash and a perfect equilibrium when the link costs are 0, but the 2-link network is not Nash and hence not perfect when the link costs are 40. Moreover, the only perfect equilibria in pure strategies for the cost 0 and cost 40 cases are the 2-link and 1-link networks, respectively.

2. Bargaining.

2a. Offers do not directly depend on the link costs.

Offers depend on whether a 1-link or 2-link network is formed, but conditional on the network the offers in the bargaining stage are independent of the link costs.

2b. Rejecting an offer does not depend on the link costs.

The decision to accept or reject an offer is not affected by the link costs since the link costs have been incurred once the bargaining stage is reached.

We now show that social preferences might lead the link costs to have a direct effect on the bargaining outcomes contrary to the hypotheses on bargaining formulated above. In particular, we examine the predictions of inequality aversion (Fehr and Schmidt, 1999), and equity theory (Homans, 1961, Selten, 1978).

The model by Fehr and Schmidt (1999) assumes that a player's utility decreases in the absolute difference between his own payoff and the payoffs of other players. The link costs may affect the difference between players' payoffs which in return may affect the bargaining outcomes. It is tedious but straightforward to derive the SPE predictions for the bargaining stage with inequality averse players. The analysis reveals that for a wide range of parameter values the link costs affect the bargaining strategies. In particular, when a 1-link network is formed the seller makes a lower offer to the buyer if there are link costs compared to the case without link costs. If the link costs are 40, the buyer in the link accepts lower offers since he dislikes the fact that his payoff from rejecting an offer (-40) is lower than the payoff of the other buyer (0). Anticipating this, the seller offers less to the buyer in the cost-40 case than in the case without link costs. Link costs have no effect on the bargaining outcome if a 2-link network is formed. The reason is that competition induces the buyers to offer the whole pie to the seller in the second round which in return results in the buyers accepting any offer of the seller in the first round irrespective of the link costs.

Equity theory assumes that the social output is split proportional to players' inputs (e.g., Homans, 1961; Selten, 1978). It is used both as a normative and as a positive theory (Gantner, Güth, and Königstein, 2001). We hypothesize that in the absence of the link costs equity theory would propose an equitable division of the surplus. Since side payments are not possible, an equitable division would imply a 50-50 split between the seller and the contracting buyer. The presence of link costs, however, could imply a different division of output if the link costs are interpreted as inputs. In case a 1-link network is formed, both the seller and the linked buyer incur link costs of 40. So there is little reason to deviate from a 50-50 split. However, in case a 2-link network is formed, the contracting buyer incurs link costs of 40 whereas the seller has link costs of 80. A division of the output proportional to the link costs (i.e., the inputs) would then imply that the seller gets (2/3 x 240) which is more than the buyer’s payoff (1/3 x 240). Likewise, an equal division of the net surplus (240 - 80 - 40) would also imply that the seller gets more (80 + 1/2 x 120) than the contracting buyer (40 + 1/2 x 120). To conclude, equity theory suggests that the seller gets a larger share of the output (i.e., makes lower offers to the buyers) in the presence of link costs only if a 2-link network is formed.

Table 1 summarizes the standard theoretical predictions regarding the effect of link costs on the seller's first round offer along with the alternative predictions based on inequality aversion and equity theory.

Table 1 The effect of link costs on the seller's first round offer

	1 link	2 links
Standard	No effect	No effect
Inequality aversion	Negative	No effect
Equity theory	No effect	Negative

The analysis above is based on the equilibria of the one-shot game. In the experiment, however, the game was played repeatedly by the same three players.[7] We believe the hypotheses formulated above are relevant for the repeated game as well. After all, repeated play of a Nash equilibrium of the one-shot game constitute a Nash equilibrium of the repeated game. We note that the repeated game has additional (subgame perfect) equilibria which involve play that is not part of a one-shot equilibrium. This is because the one-shot game has multiple Nash equilibria with different payoffs, which provides leverage for punishment (Benoit and Krishna, 1985). For example, if links are costless, there are subgame perfect equilibria in which the seller offers more than zero to the buyers in a 2-link network. Such equilibria can be sustained by the buyers' (implicit) threat of not forming a link in the next period (which is after all a Nash equilibrium). A complete equilibrium analysis of the repeated game, however, is beyond the scope of the present paper. Nonetheless, in the analysis of the experimental results we will take into account that the game is repeated.

4. Experimental Design

The experiments were conducted at the CentERlab in Tilburg University, the Netherlands. A total of 105 subjects participated in 6 sessions, and each subject participated only once. Subjects were recruited through email lists of students interested in participating in experiments. There were in total 48 subjects in 3

[7] The main reason to implement a repeated game in the experiment was its close resemblance to most market settings in real life in which buyers and sellers interact repeatedly. Another reason was to retain comparability with Doğan (2009), who analysed the repeated game properties of a simpler version of the game described above, namely one with endogenous network formation but with exogenous bargaining payoffs.

sessions in the cost-0 treatment, and 57 subjects in 3 sessions in the cost-40 treatment. Subjects were at tables separated by partitions, such that they could not see other participants' screens but could see the experimenters in front of the room. Sessions lasted between 90 and 150 minutes, and average earnings were approximately 18.60 Euros including a show-up fee of 7.5 Euros.

First, written instructions were given to the participants and read out loud by the experimenter. A copy of the instructions is included in Appendix A. It was explained in the instructions that each group consisted of 3 players who were randomly selected at the beginning of the experiment and that the group composition stayed the same throughout the experiment. Subjects had no way of knowing which of the other participants were in their group. In the instructions and the experiment, the sellers were denoted as Player 1, and buyers were denoted as Player 2 or Player 3. Player roles remained fixed throughout the experiment. The game was explained as consisting of two parts: the first being about offering links to other players and the second about sharing an amount of points. Subjects were informed that the task would be repeated for 30 periods and that their final earnings comprised of the total points they earned in the experiment converted at a rate of 0.5 (0.7) Eurocents per point in the cost-0 (40) treatment plus the show up fee. In the cost-40 treatment, it was emphasized that offering a link is not costly, but that if a link is formed players who have the link each pay 40 points. After the instructions were finished, subjects played one practice period in order to familiarize them with the procedure and the screens. Subjects' understanding of the task was then assessed by asking them 3 questions to answer at their own pace. Their answers were checked one by one and when necessary the task and the payoff structure were explained again privately.

The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).[8] Each period started with a screen with the three boxes with labels 1, 2, and 3, representing the players of the group. An example of the subject screen is contained in the instructions of the experiment in Appendix A. A player's own box was always presented on top of the screen. Players simultaneously decided

[8] The program of the experiment is available from the authors upon request.

with whom to link, and they offered a link by clicking on the box of another player. Buyers could not link to each other. Subjects saw an arrow pointing to the other player's box when they clicked, and it was possible to undo the link offer by clicking again. When the players moved to the next screen,[9] a line between two players on the screen informed them about the links that formed. If a link was offered unilaterally this was indicated with an arrow pointing to the other player.

If one link or two links were formed, the group proceeded to the bargaining stage in which the seller offered a share between 0 and 240 points to the linked buyer or buyers. If there were two links, the offers could be different for the two buyers. Then, buyers were informed about the offer or offers that the seller made, and buyers simultaneously decided whether to accept or reject the offer. If an offer was accepted, the bargaining ended and the offer was implemented. If both buyers accepted the offer, one of them was randomly chosen by the computer for the payoff realization. If both buyers rejected the seller's offer, the group proceeded to the second round of bargaining in which the buyer(s) offered a share between 0 and 160 to the seller. If the seller rejected the offer(s), they proceeded to the third and final round, in which the seller offered a share between 0 and 80 to the buyer(s). After each bargaining round, all players were informed about the acceptance and rejection decisions of their group members even when they did not have a link. At the end of bargaining, the players were informed about their own payoff in that period, their group members' payoffs in that period, and their own cumulative payoffs. In the cost-40 treatment, their total payoff was the amount of points from an agreement minus the link costs. Note that players could earn negative payoffs in this treatment. All groups in a session started each period at the same time. Thus it was not possible to identify one's group members at any point of the experiment. At the end of the experiment participants were paid privately and separately in an adjacent room.

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[9] The subjects moved to the next phase of the experiment when all group members pressed the OK button. Also, each screen had a binding time limit of 180 seconds in the first 5 periods, and 60 seconds in the later periods.

5. Results

Unless stated otherwise, statistics treated a group of one seller and two buyers interacting over 30 periods as one independent observation. This means that we had 16 independent observations in the cost-0 treatment and 19 independent observations in the cost-40 treatment. The *p*-values reported for between-treatment comparisons were based on the Mann-Whitney test; *p*-values reported for within-treatment comparisons were based on the Wilcoxon matched-pairs signed-ranks test. We used a one-sided (two-sided) test when the corresponding theoretical hypothesis was (was not) directional.

Link formation

Table 2 depicts the average link offers per period as a function of costs and player role. The second column of the table is the average number of links the seller offered to each buyer per period. The third column states the average number of links each buyer offered to the seller. The last row shows the *p*-values from the comparison of the link offers across the two treatments.

In the cost-0 treatment the seller offered an average of 0.87 links to each buyer per period, which was significantly higher than the average 0.61 links to each buyer in the cost-40 treatment. So, contrary to the standard theoretical prediction 1a, the seller offered less than two links in both cost treatments, and the number of links offered by the seller was significantly lower if there were link costs.

Table 2 Average link offers per period[a]

	Seller	Buyers
Cost-0	0.87 (0.17)	0.94 (0.12)
Cost-40	0.61 (0.16)	0.97 (0.03)
P	< .001[b]	.968[c]

[a] Standard deviations are in parentheses. [b] 2-tailed exact test [c] 1-tailed exact test

Table 2 shows that the buyers offered on average 0.94 and 0.97 links to the seller in the cost-0 and cost-40 treatment, respectively. These averages were not significantly different. Hence, contrary to the standard theoretical prediction 1b, both buyers almost always offered a link to the seller in both cost treatments.

Table 3 depicts the relative frequencies of the number of links, and the average number of links in a period per treatment. The '0 links' column shows that there were few periods with no links. The percentage of 2-link networks was, as anticipated in theoretical prediction 1c, significantly higher in the cost-0 treatment (69%) than in the cost-40 treatment (21.4%). Consequently, the percentage of 1-link networks was significantly higher in the cost-40 (76.8%) than in the cost-0 treatment (30.2%). The average number of links per group was 1.68 in the cost-0 treatment and 1.20 in the cost-40 treatment. This result also confirms the direction of change that is predicted by the standard theory.

Table 3 Average frequency and number of links[a]

	0 links	1 link	2 links	Average number of links
Cost-0	0.8 (1.5)	30.2 (32.1)	69.0 (32.9)	1.68 (0.34)
Cost-40	1.8 (1.7)	76.8 (29.8)	21.4 (30.0)	1.20 (0.30)
P	.166[c]	<.001[b]	<.001[b]	.001[b]

[a] Standard deviations are in parentheses [b] 1-tailed exact test [c] 2-tailed exact test

To examine whether the results on the link offers depend on period, we include Figure 2 that depicts the average link offer of the seller and the buyer per period in the cost-0, and cost-40 treatments. Figure 2 shows that in the cost-0 treatment the buyers' link offer was around 0.95 across periods, and the seller's average link offer was smaller than the buyers'. The seller's average link offer in the cost-40 treatment suggests a small downward trend from 0.63 to 0.55. The buyers' average link offer, however, varied between 0.95 and 1 across periods. Overall, the linking strategies do not display a strong development over time.

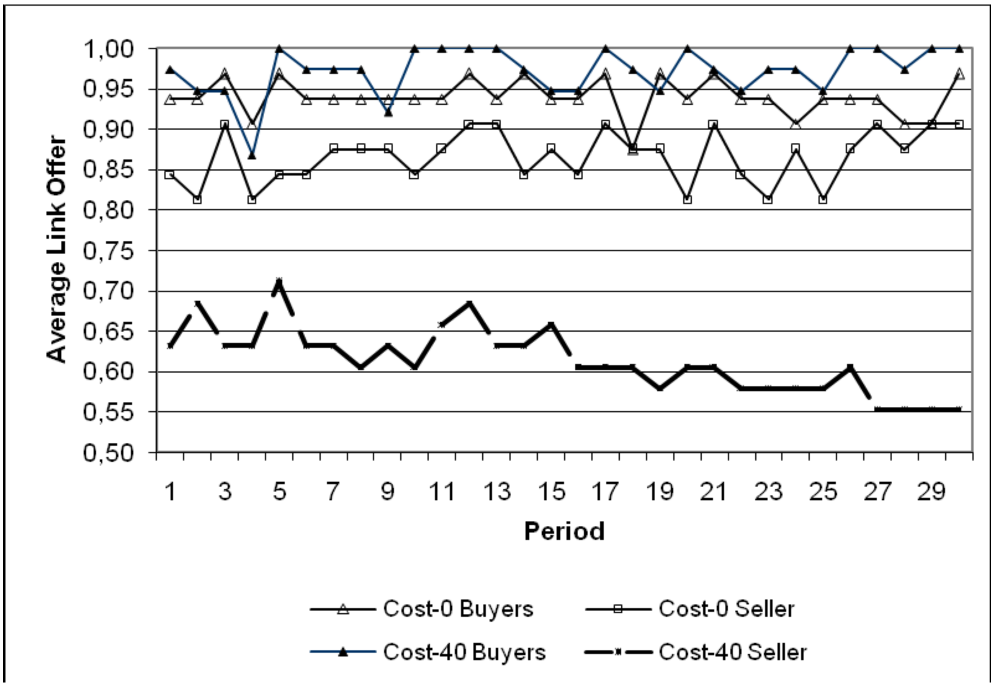

Figure 2. Average link offer in the cost-0 and cost-40 treatments for both buyers and sellers as a function of period

To sum up the results on link formation, the effect of the link costs on the average number of links was as predicted by the standard theory but the predictions on the link offers of the seller and the buyers were not supported. Because the buyers almost always offered a link to the seller in both treatments, it was due to the seller offering fewer links in the cost-40 treatment that the average number of links was lower in the cost-40 treatment. We will come back to this in the discussion.

Bargaining

Table 4 presents average offers of the first, second, and third round bargaining conditional on the network (1 links or 2 links) and conditional on the treatment (Cost-0 or Cost-40). The last row presents statistical tests of the differences between the two treatments. [10]

[10] Although the *p*-values are reported, there were not enough cases to make a statistically powerful comparison

Table 4 Average offer per round [a, b, c]

	First		Second		Third	
	1 link	2 links	1 link	2 links	1 link	2 links
Cost-0	75.60 (21.10) N=15	65.13 (25.20) N=14	66.96 (18.42) N=12	84.80 (11.93) N=4	23.60 (12.71) N=10	11.25 (1.77) N=2
Cost-40	95.15 (22.26) N=19	60.41 (21.29) N=11	59.89 (13.53) N=16	75.18 (19.75) N=9	26.49 (14.80) N=13	20.00 (15.00) N=3
p [c]	.023	.809	.245	.414	.633	.800

[a] Standard deviations are in parentheses [b] The number of observations are indicated with N [c] 2-tailed exact test

First note that the average offer in the first round was higher in the 1-link than in the 2-link network for both cost treatments; 75.6 vs. 65.13 ($p<.001$) for Cost-0 and 95.15 vs. 60.41 ($p=.001$) for Cost-40. Hence, as predicted by standard theory, competition between the buyers reduced the seller's first round offer. Nevertheless, the point prediction was quite far off the mark for the 2-link case. The seller was predicted to offer 0 in the first round, whereas the average observed offer was above 60 in both treatments.

As depicted in the second column of Table 4, the average offer in the first round of the 1-link network was significantly higher in the cost-40 treatment (95.15) than in the cost-0 treatment (75.60), rejecting our theoretical prediction 2a. The difference was smaller and not significant in the 2-link network; 65.13 vs. 60.41, for cost-0 and cost-40 treatments, respectively. The second and third round offers were not significantly different across the treatments, as shown in columns four to seven of Table 4.

To sum up, sunk costs did affect the subsequent bargaining, but only for the 1-link network: the link costs had a positive effect on the first round offer if a 1-link network was formed. Interestingly, this effect is not in line with the alternative

in the case of two links in the second and third rounds of the bargaining stage.

theoretical predictions either (see Table 1). Inequality aversion predicts a negative effect in the 1-link case rather than a positive effect, and equity theory predicts a positive effect of link costs only for the 2-link case.

To check whether the effect of link costs was got weaker over time we plot the average first round offer for 10 different segments of periods (1-3, 4-6,..., 27-30). Figure 3 depicts the average first round offer in the 1-link and 2-link networks for both cost treatments. For the 1-link networks, the average offer was consistently higher in the cost-40 treatment, with a minimum difference higher than 10.29 points for all period segments. Thus, Figure 3 supports the result that the first round offers were significantly different in the 1-link networks across cost treatments. Consider now the offers in the 2-link networks in the two cost treatments. Even though the offers were consistently higher in the cost-0 treatment, the difference between the treatments was not statistically significant in any of the ten segments. Moreover, there was no evidence that over the periods the offers were getting closer to the theoretical prediction that the seller offers zero.

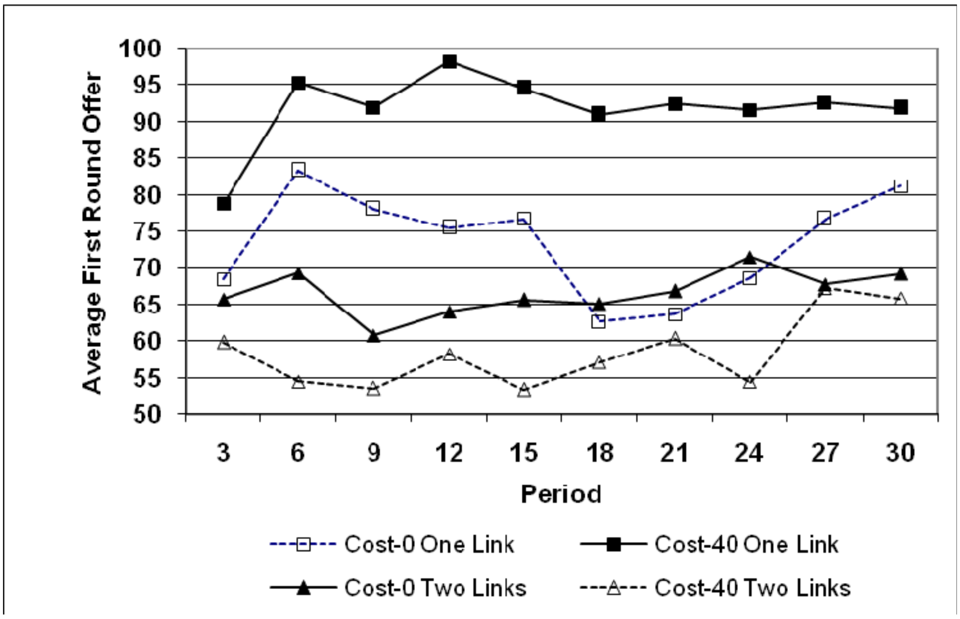

Figure 3. Average first round offers conditional on link costs and number of links

To test our theoretical prediction that rejecting an offer does not depend on the link costs (Hypothesis 2b) we ran logistic regressions for the first round acceptance decisions of the buyers. We report the results of the model in Table 5. The model includes the seller's offer, the link costs, the number of links, the interaction between link costs and number of links, and the period number.[11] The parameter estimates and the significances of Wald tests are reported in the second and third columns of Table 5.

Notice first that the effect of the seller's offer was positive and highly significant; a 10-point increase in offer was associated with an odds ratio of 1.42. The effect of the number of links was positive and significant; the odds of accepting an offer were 2.28 times larger in the 2-link network than in the 1-link network, meaning that buyers were more likely to accept the same offer in the 2-link than in the 1-link network.

The effect of link costs on the probability of accepting an offer was negative but not significantly so. The interaction effect between the link costs and the number of links was negative, indicating that link costs had a smaller effect in case of 2 links, but this effect was not significant either. These results do not refute the Hypothesis 2b.

Summing up the results on bargaining, we found a significant positive effect of the link costs on the seller's first round offer, but only in case a 1-link network was formed. Link costs, however, did not have a significant effect on the buyers' acceptance behavior. So, again it was the seller's behaviour rather than the buyers' that shaped the effect of the link costs.

[11] We also ran regression using a model with interaction effects between the variables and the seller's offer. None of these interaction effects were significant, and hence were not reported in the paper.

Table 5 Buyer decision to accept the seller's first round offer[a,b]

	Coefficient[b]	*P*
Constant	-1.626 (0.609)	0.008
Offer	0.035 (0.006)	0.000
Link costs	-0.217 (0.399)	0.586
Links	0.824 (0.403)	0.041
Link costs × Links	-0.384 (0.497)	0.440
Period[c]	0.033 (0.012)	0.007

[a] The variable Links is 0 if in a dyad, and 1 in a triad; Link costs are 0 in the cost-0 treatment, and 1 in the cost-40 treatment. [b] Robust standard errors at the group level between parentheses. [c] Period is normalized to actual period – 15.5.

Finally, it is informative to examine the average payoffs of the players in the two treatments, both conditional and unconditional on the network. Table 6 shows the average net payoffs of the seller and the buyer as well as the average 1-link and 2-link network payoffs. The *p*-values in the fifth column correspond to the tests comparing the earnings of the sellers in the 1-link network to the earnings of the seller in the 2-link network within each cost treatment. Likewise, the *p*-values in the last column correspond to the tests comparing the earnings of the buyers.

The seller earned on average 151.58 in the cost-0 treatment, which was significantly higher than the average earning of 82.14 in the cost-40 treatment. Note that the average earning of the seller in the cost-0 (cost-40) treatment was 88 (38) points less than the theoretical prediction. The seller also earned less than the predicted 160 (240) points in the 1-link (2-link) network.

Table 6 Average net payoffs per period [a, b]

	Seller				Buyers			
	Average	1 link	2 links	*p*[c]	Average	1 link	2 links	*p*[c]
Cost-0	151.48 (23.44)	113.57 (36.98) N=15	164.99 (22.82) N=14	<.001 N=13	34.60 (10.46)	37.02 (11.52) N=15	33.33 (11.99) N=14	.133 N=13

Cost-40	82.14 (12.45)	80.09 (27.73) N=19	75.87 (24.72) N=11	.700 N=11	18.12 (14.09)	27.97 (14.03) N=19	-7.24 (9.53) N=11	.001 N=11
p^c	<.001	.002	<.001		<.001	.007	<.001	

[a] Standard deviations are in parentheses [b] The number of observations are indicated with N [c] 1-tailed exact test.

There were three reasons why the seller's earnings were substantially lower than those predicted by standard theory. First, contrary to the theoretical predictions, 1-link networks were formed in as much as 30% of the periods in the cost-0 treatment (see Table 3), which decreased the seller payoffs. Second, sellers' first round offers were higher than predicted if there were two links (see Table 4). In both treatments, sellers offered more than 60 in the first round, whereas they were predicted to offer 0. The third reason was the buyers' rejection of the first round offers of the seller. In the cost-0 treatment 42 percent of the offers were rejected in the first round in the 1-link network whereas in the 2-link network both buyers rejected the seller's offer in 7 percent of the cases. In the cost-40 treatment, the percentage of rejections in the first round were 22% in the 1-link and 21% in the 2-link network.

6. Discussion

The standard theory successfully predicts the formation of fewer links with higher link costs and that the rejection of an offer by a buyer is independent of link costs. However, in our experiment we observed two results on the effect of link costs that cannot be easily explained by standard theory: (i) the seller determined which type of network was formed, and (ii) sunk costs did affect the offers of the seller and only so in the 1-link network.

Theory predicts that in both cost treatments the seller offers links to both buyers, and that (on average) only one buyer offers a link to the seller in the cost-40 treatment. However, the formation of a 1-link network was mostly due to the seller, since both buyers almost always offered a link to the seller. Why did the sellers not offer two links more often in the cost-40 treatment? Simply because, on average, it was not profitable to do so. Theoretically, having two links rather than one link is predicted to increase the seller's net payoff from 120 (=160-40) to 160 (=240-80). As can be seen in Table 6, however, in the experiment the average net payoff to the seller was actually lower in a 2-link network (75.87) than in a 1-link network (80.09). Although, the seller usually gets a larger share of the surplus with two links, this was not enough to compensate for the extra link costs.

The other result not in line with the standard model is that the sellers on average offered 20 points more to the buyer in the cost-40 treatment (96) than in the cost-0 treatment (76) in a 1-link network. Interestingly, this finding cannot be explained by inequality aversion or equity theory either. Below we examine four potential explanations. The first two are 'static' while the last two rely on the game being repeated.

First, we explore the assumption that players care about relative payoff shares rather than absolute payoff differences. Such fairness considerations might matter for the predicted impact of link costs. If two sides of a link have to pay link costs of 40, their absolute payoff difference does not change, but their relative payoff shares may. To illustrate, consider a 1-link network in which the seller makes a first round offer of 80 to the buyer. In case the link costs are 0, this offer gives the buyer a share of 1/3 (80/240) of the total payoff. In case the link costs are 40, however, the same offer would give the buyer a share of only 1/4 (40/160). So, in order to give the buyer the same net payoff share, the seller would have to increase her offer (as in fact we observe in the experiment). In a 2-link network this effect is mitigated (or even reversed) by the fact that the seller has to pay the link costs twice. To examine this argument more generally, we analyzed the predictions of the model by Bolton and Ockenfels (2000). This model, however, is only defined for games with non-negative payoffs and adjusting the model in such a way that it allows for negative payoffs is not straightforward. We have experimented with several such adjusted models but the results were not satisfactory. Although there exist model-parameter combinations that predicted an increase in the seller’s offers in the 1-link networks as in the experiment, none of these predictions were close to the experimental data. Furthermore, these models failed to predict that link costs did not have an effect on the seller's offers in the 2-link networks.

Second, prospect theory (PT) might explain the impact of sunk costs (e.g., Offerman and Potters, 2002). Upon paying the cost of establishing a link, players may perceive to be 'in the domain of losses', which may make them more prone to take risks than in the case without link costs. Clearly, for PT to have bite there needs to be some uncertainty in the game. A natural candidate to incorporate such uncertainty is Quantal Response Equilibrium (QRE), which assumes that players make errors, and are more likely to make errors with small costs than errors with large costs (McKelvey and Palfrey, 1995, 1998). Note that the link costs can affect QRE predictions only if the utility function is nonlinear or if it incorporates loss aversion. We calculated the QRE predictions for the bargaining game to examine whether it can predict the difference in the seller's offer across the cost treatments. We assumed that the seller and the two buyers had the same power value function with loss aversion and the same risk parameter for losses and gains[12]. We found that, using QRE, the maximum predicted difference in the seller's first period offers in the 1-link network between the cost-0 and cost-40 treatments was 11, as opposed to the 20 points observed in the experiment. Besides, other predictions such as those on the absolute value of the offers and the net payoffs, were substantially off the mark. So, although a combination of PT and QRE can predict an increase in the first round offers, it fails to explain the pattern observed in the experiment.

Third, there is substantial experimental evidence that agents tend to act fairer towards another agent the more stable the relationship they are in. For example, in Brown, Falk, and Fehr (2004) rents tended to be shared more equally when the trading parties were contracting over longer periods of time. Therefore, a reasonable hypothesis for our game is that on average a seller offers a larger share of the pie to a buyer in the cost-40 treatment because they have more stable bilateral relationships in this treatment than in the cost-0 treatment. To examine

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[12] If x denotes the payoff, the utility of the subjects is $u(x) = x^{\alpha}$ for nonnegative x, and $u(x) = -\lambda(-x)^{\alpha}$ for negative x, where α is the risk aversion parameter, and $\lambda \geq 1$ measures loss aversion. We computed all QRE using values of α between 0.5 to 1, values of λ between 1 and 5, and the rationality parameter ranging from 0 (random behavior) to infinity (full rationality).

this hypothesis we calculated the average number of periods that a 1-link relationship between a seller and a buyer lasted in the two treatments. Indeed, we found that 1-link relationships lasted longer in the cost-40 treatment (2.3 periods on average) than in the cost-0 treatment (1.4 periods on average). However, there was no evidence suggesting that the seller made higher offers to a buyer when their relationship lasted longer. Quite the contrary; on average a seller decreased the offer to the buyer when the 1-link relationship proceeded from one period to the next, and this was true for both treatments. Hence, we can reject the hypothesis that sellers' offers in a 1-link relationship were higher in the cost-40 treatment than in the cost-0 treatment because relationships on average lasted longer in the former than in the latter treatment.

The final explanation for the effect of link costs on the seller's offer in the 1-link case also relies on the game being repeated. This explanation posits that the presence of linking costs reduces the seller's bargaining power in a 1-link network in the cost-40 compared to the cost-0 treatment. If a 1-link network is formed in the cost-0 treatment, the implicit threat by the seller to move to a 2-link network in the next period is very credible. Recall from Table 2 that the buyers almost always offer a link, so essentially the seller decided which network was formed. This enables the seller to extract a relatively large part of the pie in the 1-link network (larger than the SPE predictions); if the buyer does not accept an offer, in the next period the seller can move to the 2-link network in which that same buyer can expect to get a lower payoff. In the cost-40 treatment, it is also feasible for the seller to move to a 2-link network, but such a move is substantially less attractive as the seller has to pay the linking costs twice. The implicit threat to move from a 1-link to a 2-link network in the next period is less credible in the cost-40 treatment and as a result the seller has to offer a larger share of the pie to the buyer.

As can be seen in Table 6 in the cost-0 treatment the seller earns a higher payoff on average in a 2-link network (164.99) than in a 1-link network (113.57). In case a 1-link network forms, an implicit threat to move to a 2-link network in the next period is very credible. In the cost-40 treatment, on the other hand, the seller in fact earned less on average in the 2-link network (75.9) than in the 1-link network (80.1). The threat to move from a 1-link to a 2-link network is not very credible in this treatment. We investigated the rate at which sellers moved from a 1-link network in period *t* to a 2-link network in period *t*+1, in case the seller's offer was rejected by the buyer in the first bargaining round of period *t*. We found that this rate was 0.429 (18/42) in the cost-0 and 0.143 (13/92) in the cost-40 treatment. This suggests that the implicit threat to move to a 2-link network in case the seller's offer was rejected in the 1-link network was executed more frequently in the cost-0 treatment than in the cost-40 treatment.[13] To conclude, the evidence supports the hypothesis that the bargaining power of the seller was increased in the 1-link network in the cost-0 treatment by the seller's attractive alternative (the 2-link network), whereas bargaining power in the cost-40 treatment was not increased since the 2-link network turned out to be no attractive alternative to the seller.

7. Conclusion

The results of this study show that link costs can play a dual role in markets and other settings that require connections to be established between transacting agents. First, link costs shape the competitiveness (power distribution) of the network, which in turn strongly influences the outcomes. Second, link costs have a direct effect on the bargaining within a network. Such costs cannot simply be assumed to be sunk, once a network has been formed. In other words, the interaction within a network cannot be assumed to be independent from the formation of the network.

The direct effect of link costs on the interaction in the network is subtle. There is an effect of link costs if a 1-link network is formed but not if a 2-link network is formed. The data suggest that this is due to a shift in the bargaining power. The link costs reduce the viability of the 2-link network as an alternative, which reduces the bargaining power of the seller in the 1-link network.

In the present paper, an effect of the link costs is found in an experiment in which the game is played repeatedly between the same players, a so-called partners

[13] This difference is somewhat biased though by the fact that overall there were more switches for a 1-link to a 2-link network in the cost-0 treatment than in the cost-40 treatment.

protocol. It would be interesting to examine whether the effect is robust to the game being played repeatedly between different players in a so-called strangers protocol.

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Appendix A. Experimental Instructions for the Cost-0 Treatment

Introduction

Welcome to this experiment on decision making. We will first go through the instructions together. Then there will be a practice period. After the practice period the experiment will start. Talking is strictly forbidden during the experiment. If you have a question, please raise your hand and I will come to your table to answer your question.

The experiment will last about 2 hours. If you follow the instructions carefully you can earn a considerable amount of money. During the experiment your earnings will be denoted in points. After the experiment your earnings will be converted into money at a rate of 1 point is 0.5 Eurocents. In addition, you will receive a show-up fee of 7.5 Euros. Your earnings will be paid to you, privately and in cash, immediately after the experiment.

Instructions for the experiment

In this experiment, you are in a group of 3 persons. Each person has her or his own number; 1, 2, or 3. Your number is randomly determined at the beginning of the practice period and it stays the same throughout the whole experiment. Also, the composition of your group remains the same throughout the experiment. You will not know who is in your group. You and your group members are referred to as player 1, player 2 and player 3.

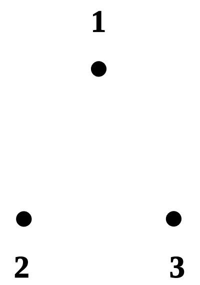
Your group faces the same task for 30 periods. The task has two parts. First, you make a decision about whether to offer links to other players in your group or not. Second, players who form a link to each other try to share an amount of points between them.

In the first part a link is formed between two players if both of them offer a link to each other. Player 1 can have two links; player 2 and 3 can have only one. Hence player 2 and player 3 each have to decide whether they want to offer a link to player

1. Player 1 has to decide whether to offer a link to player 2 and whether to offer a link to player 3. Offering a link is not costly. Also, links that have formed are not costly.

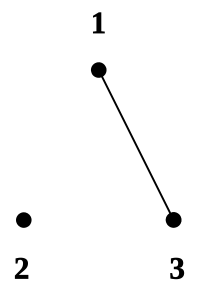
There are 4 different types of situations that can arise from the players' decisions to offer links to other players.

SITUATION A:



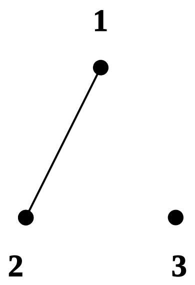
In Situation A there are no links. This occurs when player 1 and player 3 do not both offer a link to each other, and player 1 and player 2 do not both offer a link to each other.

SITUATION B:



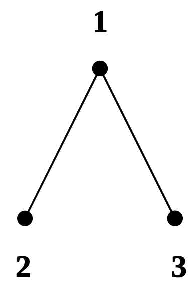
In Situation B there is only one link, namely between player 1 and player 3.
This occurs when both player 1 and player 3 offer a link to each other, while player 1 and player 2 do not both offer a link to each other.

SITUATION C:

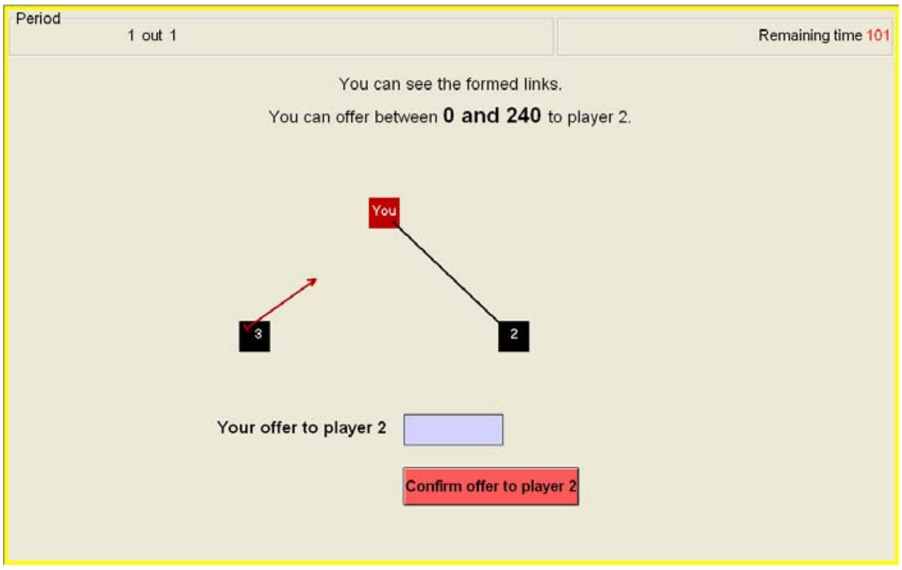


In Situation C there is only one link, namely between player 1 and player 2. This occurs when both player 1 and player 2 offer a link to each other, while player 1 and player 3 do not both offer a link to each other.

SITUATION D:



In Situation D there are two links: one link between player 1 and player 3, and one link between player 1 and player 2. This occurs when both player 1 and player 2 offer a link to each other and also both player 1 and player 3 offer a link to each other.



The figure above illustrates how the results of the first part of the period are displayed to you on the computer screen. A black line indicates that both players offered a link to each other. A red arrow indicates that one player offered a link but the other player did not offer a link to that one player. So, in this example the black line indicates that player 1 (which is "You" in this case) and player 2 offered a link to each other and as a result a link is formed between them. The red arrow indicates that player 3 offered a link to player 1 while player 1 did not offer a link to player 3. Therefore no link is formed between player 1 and player 3.

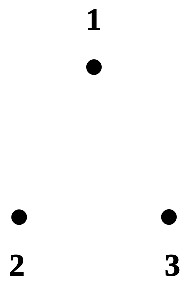
After the first part, if a link or links are formed, your group proceeds to the second part of the period. If no links are formed in the first part all members of your group receive zero points and they proceed to the next period. In the second part, two players who have a link to each other try to share a certain amount of points among the two of them. The second part has at most 3 stages. There are two aspects of the second part that change in each stage; the amount of points to be shared and the player or players that can make an offer.

Let us first focus on the amount of points to be shared in each of the three stages. In the first stage, the amount of points that two players can share is 240. If no two players agree on how to share the 240 points, they proceed to the second stage. In the second stage, the amount of points that can be shared is reduced by 80 points, from 240 to 160 points. If no two players agree on how to share the 160 points in the second stage, they proceed to the third and final stage. In the third stage, the amount of points that can be shared is again reduced by 80 points, from 160 to 80 points. If no two players agree on how to share the 80 points in the third stage, then the period ends and all players earn 0 points in that period.

Let us now focus on which player or players that can make an offer in each of the three stages. In the first stage player 1 offers a share to the players that s/he has links with. In the second stage player 2 and/or player 3 offer a share to player 1. In the third stage player 1 offers a share to the players that s/he has links with.

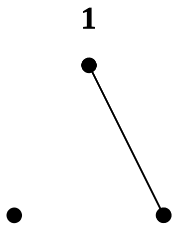
To explain the procedure in the second part in more detail, now we again go through each of the situations that can arise in the first part.

SITUATION A:



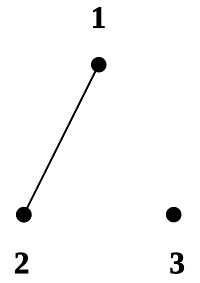
Since no links have formed in Situation A, players cannot share points. Hence, the period is over and all players earn 0 points.

SITUATION B:



2 3

SITUATION C:



Consider first Situation B in which there is one link, namely between player 1 and player 3. Recall that there are at most 3 possible stages.

First stage

- In the first stage player 1 offers between **0 and 240** to player 3.

Keep in mind that an offer always means the amount of points **offered to** the other player. So, player 1 offers an amount of points to player 3; thus, player 1 demands **240 – offer** for herself/himself.

- Player 3 sees player 1's offer and decides to accept or to reject player 1's offer.
    - If player 3 accepts player 1's offer, the period is over and they share the 240 points as offered by player 1.
    - If player 3 does not accept player 1's offer, they proceed to the second stage.

Second stage if reached

- In the second stage player 3 offers between **0 and 160** to player 1.
- Player 1 sees player 3's offer and decides to accept or to reject player 3's offer.
    - If player 1 accepts player 3's offer, the period is over and they share the 160 points as offered by player 3.
    - If player 1 does not accept player 3's offer, they proceed to the third stage.

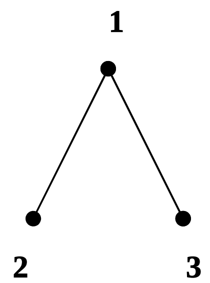
Third stage if reached

- In the third stage player 1 offers between **0 and 80** to player 3.
- Player 3 sees player 1's offer and decides to accept or to reject player 1's offer.
    - o If player 3 accepts player 1's offer, they share the 80 points as offered by player 1.
    - o If player 3 does not accept player 1's offer, they both earn 0 points.

Situation C is similar to Situation B except that instead of player 3, now player 2 has a link to player 1.

Let us now turn to the final situation, Situation D.

SITUATION D:



In Situation D there is a link between player 1 and 3 and a link between player 1 and 2. It is important to realize that at most one pair of players can form an agreement on how to share the points.

First stage

- In the first stage, player 1 offers between 0 and 240 to player 3 and to player 2. The offers to player 3 and player 2 can be different.
- Players 2 and 3 see player 1's offers. Players 2 and 3 decide to accept or to reject player 1's offer.
    - o If both player 2 and player 3 accept player 1's offer, the computer ***randomly chooses*** player 2 or player 3. If player 3 is chosen, then player 1 and player 3 share the 240 points as offered by player 1, and

player 2 earns 0 points. If player 2 is chosen, then player 1 and player 2 share the 240 points as offered by player 1, and player 3 earns 0 points.

  - If either player 2 or player 3 accepts player 1's offer and the other player rejects, then the player that accepts and player 1 share the 240 points as offered by player 1. Let's assume player 2 accepted player 1's offer and player 3 rejected. Then player 1 and player 2 share the 240 points as offered by player 1, and player 3 earns 0 points.
  - If both players 2 and 3 reject player 1's offer, they proceed to the second stage.

Second stage if reached

- In the second stage, player 2 and player 3 offer between 0 and 160 to player 1.
- Player 1 sees player 2's and player 3's offers. Player 1 decides to accept one of the offers, or to reject both offers.
  - If player 1 accepts one of the offers, then the player whose offer was accepted and player 1 share the 160 points as offered. Let's assume player 1 accepted player 3's offer. Then player 1 and player 3 share the 160 points as offered by player 3, and player 2 earns 0 points.
  - If player 1 rejects both offers, they proceed to the third stage.

Third stage if reached

- In the third stage, player 1 offers between 0 and 80 to player 3 and to player 2. The offers to player 3 and player 2 can be different.
- Players 2 and 3 see player 1's offers. Players 2 and 3 decide to accept or to reject player 1's offer.
  - If both player 2 and player 3 accept player 1's offer, the computer ***randomly chooses*** player 2 or player 3. If player 3 is chosen, then player 1 and player 3 share the 80 points as offered by player 1, and player 2 earns 0 points. If player 2 is chosen, then player 1 and player 2 share the 80 points as offered by player 1, and player 3 earns 0 points.

- o If either player 2 or player 3 accepts player 1's offer and the other player rejects, then the player that accepts and player 1 share the 80 points as offered by player 1. Let's assume player 2 accepted player 1's offer and player 3 rejected. Then player 1 and player 2 share the 80 points as offered by player 1, and player 3 earns 0 points.
- o If both players 2 and 3 reject player 1's offer, players 1, 2 and 3 earn 0 points.

To summarize:

You will be in a group of 3 persons. Each person will have her or his own number; 1, 2, or 3. Your number will be randomly determined at the beginning of the practice period and it will stay the same throughout the experiment. Also, the composition of your group will remain the same throughout the experiment. You will not know who is in your group.

There will be 30 periods in the experiment. In every period there will be two parts. First, you will decide with whom to link. Second, at most one pair of linked players shares an amount of points. The important points of the experiment are the following:

- A link is formed between two players if both of them offer a link to each other.
- Player 2 and player 3 cannot form a link with each other.
- Only two players who have a link with each other can try to share a certain amount of points among themselves.
- In the second part of the period, there are at most 3 stages. In the first stage the amount to be shared is 240; in the second it is 160; in the third it is 80.
- In the first stage player 1 can make on offer, in the second stage player 2 and/or player 3 can make an offer, and in the third stage player 1 can make an offer. If there is no agreement in the third stage, everyone gets 0 points.

- At most one pair of players can reach an agreement in a period. When there are two links and if both players 2 and 3 accepts player 1's offer, either player 2 or player 3 is chosen randomly by the computer to form an agreement with player 1.
- In each period you will be informed about all the decisions made by your group members. At the end of each period, you will be informed about your and other players' earnings.
- Your total earnings will be the sum of all points you earn over all periods. For each point you earn in the experiment, you will get 0.5 Eurocents.