Online Appendix II
Equilibrium properties

In this appendix, we discuss the implications of the data for equilibrium behavior. Clearly, one has to be very careful in making claims that individual subjects are playing equilibrium strategies. Given the multiplicity of equilibria and the heterogeneity of individual behavior, it is unlikely that all subjects coordinate on a single equilibrium. The most that we can claim is that the modal behavior of the subjects bears a striking resemblance to a particular equilibrium, while noting that there are substantial deviations from equilibrium play on the part of some subjects. We have already alluded to the coordination problems found in the pair and star-in networks. We will thus not attempt to reconcile subjects' behavior in these networks with equilibrium behavior. Instead, we focus on the one-link, line, and star-out networks. We begin by considering the line network.

The line network In the line network, the degree of coordination reflected by the efficiency of outcomes appears to be very high. The frequencies of contributions in different positions and information states are tabulated in Table 3. The states 0 and 1 in the table refer to the number of contributions observed by subjects in positions A and B in periods 2 and 3. Note that in order to reduce the number of states, we pool the data corresponding to a given number of contributions, regardless of when the contributions were made. The number in parentheses in each cell represents the number of observations.

[Table 3 here]

The first thing to note is the high contribution rate (0.657) of subjects in position C in period 1. Secondly, subjects in position B contribute mainly after they observe a contribution by the subject in position C. More precisely, the contribution rate in position B, conditional on observing no contribution by C, is 0.120 in period 2 and 0.333 in period 3. By contrast, the contribution rate in position B, conditional on observing a contribution by C, is 0.542 in period 2 and 0.506 in period 3. Finally, the total contribution rate by subjects in position A is only 0.267. This regularity suggests (an equivalence class of) equilibria in which C contributes in period 1, B contributes after observing C contribute, and A does not contribute at all. There are deviations from this equilibrium pattern, notably the contributions by subjects in position B when they have not observed any contribution by the subject in position C. But these deviations are not large and the behaviors of subjects in positions C and A are quite close to those predicted by this class of equilibria. Finally, we note that the overall behavioral tendencies predicted by this class of equilibria are more closely replicated in the Princeton experimental data. In fact, the relative frequencies of contributions in the last two periods are surprisingly close to the corresponding equilibrium predictions (see Online Appendix III).

There are some interesting cases in the data where subjects deviate from the suggested equilibrium behavior. In period 2, position-A subjects are much more likely to contribute if they observe that the subject in position B has contributed in period 1, that is, before he can observe the subject in position C contribute. Subjects in position A may have reasoned that this behavior was intended to encourage them to contribute and, in any case, preempts any possible revelation of the behavior of the subject in position C. Given the high probability that subjects in position C contribute in period 1, such reasoning by subjects is faulty, but it is interesting nonetheless. In period 3, we notice that subjects in position A are less likely to contribute if the subject in position B has contributed in periods 1 or 2; most of these observations are cases in which B contributed in period 2, thus signaling an earlier contribution by C. These observations suggest some rationality, even if they do not correspond exactly to the proposed equilibrium.

The star-out network The next case we consider is the star-out network. The frequencies of contributions in different positions and information states are summarized in Table 4 below. The states 0, 1, and 2 refer to the number of contributions observed by subjects in positions A and B in periods 2 and 3. Again, in order to reduce the number of states, we pool the data corresponding to different histories that lead to the same information state. The number in parentheses in each cell represents the number of observations.

[Table 4 here]

Here we see a good illustration of strategic delay by position-A subjects: out of 575 observations, there are only 119 contributions in the first two periods, of which 55 (46.2% of the time) occur in period 2 after one of the peripheral subjects in positions B or C has contributed. Although further delay would be optimal, the deviation from rational behavior seems small. By contrast, subjects in positions B and C have an incentive to contribute early to encourage the subject in position A, and on average they contribute in the first two periods 51% of the time. In the last period, their contribution rate falls precipitously to 0.066. The patterns here suggest (an equivalence class of) equilibria in which B and C contribute in the first two periods with probability 1/2 and contribute with probability 0 in the last period, while A waits until the last period and contributes only if he observes exactly one contribution by B or C in the preceding periods.

Also notice that the timing of contributions by the subjects in positions B and C matters only to the extent that the total probability of contribution in the first two periods must be 1/2 in equilibrium; the contribution probability in *individual* periods is immaterial. Thus, the fact that subjects contribute in one of the two periods with probability 0.510 is what matters; the contribution rates in period 1 and in period 2 are irrelevant. Position-A subjects match the prescribed behavior very closely in period 1 and period 3. Only in period 2 is there a significant deviation. In three cases, subjects in position A contributed in period 2 after observing two contributions in the previous period. The numbers are very small and should be attributed to the 'trembling hand.'

The one-link network Next, we consider the one-link network. Table 5 below summarizes the frequencies of contributions in different positions and information states in the one-link network. The number in parentheses in each cell represents the number of observations. Note that conditional on observing the subject in position B contribute, the contribution rates of subjects in position A are 0.359 and 0.456 in periods 2 and 3, respectively. It appears that subjects are randomizing, but the contribution rate of subjects in position C (0.367) is too low to make subjects indifferent between contributing and not contributing. Likewise, when subjects in position A do not observe the subject in position B contribute, it cannot be optimal for them to randomize in periods 2 and 3: the contribution rates of subjects in position C and subjects in position B in period 3 are too low.

[Table 5 here]

In conclusion, the data summarized in Table 5 are mixed, with several features that are difficult to reconcile with equilibrium behavior. By analogy with our findings in the line network, one might expect the salient equilibrium to be one in which B contributes first, A contributes after observing B contribute, and C never contributes. The bare facts appear inconsistent with this prediction. Overall, the isolated subjects in position C contribute on average 0.367 of the time. Similarly, subjects in position A contribute 0.233 of the time *without* having observed a contribution by the subject in position B. Even when they have observed a contribution by the subject in position B, the contribution rate of subjects in position A is only 0.406. One anomaly here appears to be the contribution behavior of subjects in position C. Since they can neither observe nor be observed, they have no ability to coordinate and yet they make a significant number of contributions. Since subjects learn the outcome of the game at the end of each round, subjects in position A may become aware of the contribution behavior of subjects in position C and decide to free ride to some extent.

What cannot be ascertained from the information given in Table 5 is whether these anomalies are endemic or caused by a few subjects. To pursue this question, it is necessary to investigate behavior at an individual level. A study of individual behavior in the one-link network shows that the failure to match the predictions of the salient equilibrium cannot be blamed entirely on a couple of outliers. In most experiments, there is evidence of heterogeneity among subjects and this experiment is no different – some subjects have an above-average tendency to contribute to the public good and some are very unwilling to contribute. At any rate, whatever the explanation, it is hard to argue that the average behavior of subjects in position A is optimal.

The complete, star-in and pair networks Overall, the preceding analysis of the line, star-out and one-line networks suggests that the salient equilibria we identify account for much of the large-scale features of the data. The picture is somewhat different for the complete, star-in, and pair networks. In the complete network, where all subjects are symmetrically situated, there is no salient equilibrium, in the sense we have used the term. In the star-in network, as noted before, we observe two kinds of coordination failures, due to the difficulty of position-A subjects (the center of the star) to coordinate with the subjects in positions B and C (the two peripheral subjects). One such difficulty arises if the position-A subject contributes first; because the subjects in positions B and C are symmetrically situated, it results in a game of chicken between those two. The other kind of coordination failure arises when the position-A subject fails to contribute. The pair network is one case where the apparently salient equilibria do not capture the actual behavior of subjects in practice. The data indicate that this arises for two reasons: first, the isolated subjects in position C contribute a significant amount, even though it is impossible for them to coordinate their actions with the other subjects; second, subjects in positions A and B, where coordination is possible in theory, fail to coordinate in practice, possibly because of the significant contribution pattern of the position-C subjects. For the sake of completeness, Tables 6, 7, and 8 below tabulate the frequencies of contributions in the complete, star-in, and pair networks, respectively.

[Table 6 here]
[Table 7 here]
[Table 8 here]

Table 3. The frequencies of contributions at different states in the line network

		A		*B*		*C*
1	State	--		--		--
	Freq.	0.100 (600)		0.187 (600)		0.657 (600)
2	State	0	1	0	1	--
	Freq.	0.023 (444)	0.156 (96)	0.120 (158)	0.542 (330)	0.121 (206)
3	State	0	1	0	1	--
	Freq.	0.204 (250)	0.091 (265)	0.333 (120)	0.506 (170)	0.160 (181)

( ) - # of obs.

Table 4. The frequencies of contributions at different states in the star-out network

		A			*B,C*
1	State	--			--
	Freq.	0.096 (575)			0.395 (1150)
2	State	0	1	2	--
	Freq.	0.033 (183)	0.206 (267)	0.043 (70)	0.191 (696)
3	State	0	1	2	--
	Freq.	0.067 (105)	0.894 (246)	0.038 (105)	0.066 (563)

( ) - # of obs.

Table 5. The frequencies of contributions at different states in the one-link network

		A		*B*	*C*
1	State	--		--	--
	Freq.	0.140 (450)		0.578 (450)	0.244 (450)
2	State	0	1	--	--
	Freq.	0.102 (167)	0.359 (220)	0.432 (190)	0.065 (340)
3	State	0	1	--	--
	Freq.	0.294 (85)	0.456 (206)	0.213 (108)	0.104 (318)

( ) - # of obs.

Table 6. The frequencies of contributions at different states in the complete network

		A,B,C		
1	State	--		
	Freq.	0.179 (825)		
2	State	0	1	2
	Freq.	0.325 (453)	0.126 (206)	0.167 (18)
3	State	0	1	2
	Freq.	0.220 (132)	0.470 (300)	0.072 (69)

( ) - # of obs.

Table 7. The frequencies of contributions at different states in the star-in network

		A	*B,C*	
1	State	--	--	
	Freq.	0.571 (550)	0.165 (1100)	
2	State	--	0	1
	Freq.	0.250 (236)	0.101 (397)	0.234 (522)
3	State	--	0	1
	Freq.	0.175 (177)	0.234 (265)	0.283 (492)

( ) - # of obs.

Table 8. The frequencies of contributions at different states in the pair network

		A,B		*C*
1	State	--		--
	Freq.	0.255 (1100)		0.265 (550)
2	State	0	1	--
	Freq.	0.295 (614)	0.341 (205)	0.064 (404)
3	State	0	1	--
	Freq.	0.252 (310)	0.322 (258)	0.082 (378)

( ) - # of obs.