Chapter 8 Trust and Fairness in Repeated Games

The use of one-shot games has often been justified with the explanation that the motive for self-interest and fairness are confounded in repeated games. Therefore, one-shot games were necessary, so the argument, to demonstrate the influence of concern for others. One-shot games, indeed, have the advantage that they can easily demonstrate individuals' motivation for fair outcomes, but, they have the disadvantage of studying behavior in a rather artificial situation. This may restrict the extent to which the results can be generalized to real life situations reducing the practical significance of the results. Therefore, it would be beneficial if one could test whether a motivation for fair outcomes influences decision making in the less artificial situation of a repeated game. This is the goal of *study 2*.

Study 1 has already shown that individuals' decisions are influenced by a motivation for fair outcomes. How does a motivation for fairness effect behavior in an indefinitely repeated game? Individuals primarily attempt to maximize their monetary payoff, which requires that player A invests the entire endowment in the investment game. Fairness functions as a coordination device on how the surplus produced by the investment is distributed between both players, and thereby, resolves the conflict consisting of two individuals who are primarily interested in obtaining a maximum share of the surplus. However, if individuals have a diverse interpretation on what is a fair allocation, then an agreement may not be found, and the profitable relationship is ruined during the repeated game.

Once more, as for study 1, it can be argued that also in a repeated interaction the equity principle is moderating the distribution decisions. Again, if player A invests the entire endowment, the contribution of both players to the interaction should be regarded as equal, therefore, the equity principle will predict that both players will conclude with equal final payoffs. The equality principle cannot be distinguished from the equity prediction as it also predicts both players earning the same final amount.

An alternative approach, that could be applied to the allocation decisions in the investment game, is the "cooperative bargaining theory," comprising of a negotiation with irrevocable contracts (see Binmore, 1998, pp. 42-49). The underlying idea of the "Nash bargaining solution," which is part of the cooperative bargaining theory, is the observation that if players cannot reach an agreement in a bargaining situation, each player will choose the option that will lead to the maximum amount the player can guarantee, regardless of the other player's decisions. The maximum outcome a player can guarantee is the so-called "conflict point." For the investment game, this implies that, if the players cannot reach an agreement on how to split the trebled investment between them, then player A's conflict point consists of making no investment at all, which guarantees the endowment to player A. In contrast, player B totally depends on player A in obtaining something from a potential trebled investment, therefore, player B's conflict point is a payoff of zero. Player B's endowment is neglected in this deliberation, since, as player B cannot send any of the endowment to player A, it is not part of an agreement. Technically speaking, the endowment for player B is a linear transformation of player B's payoffs. The Nash bargaining solution can be derived by subtracting both players' conflict payoffs from the total distributed amount and then dividing the remaining payoff equally between both players. Therefore, one has to subtract player A's conflict payoff of 10 from the trebled investment of 30, so that the remaining amount of 20 is allocated equally to both players. This solution also predicts equal final payoffs for both players, since player B additionally receives the endowment. Thereby, the Nash bargaining solution yields the same prediction as the equity prediction stated above.

For deriving testable separating predictions for the equity principle and the Nash bargaining solution, the endowment for player B can be varied. The Nash bargaining solution neglects the payoff for player B and predicts that the trebled investment, minus player A's endowment, is divided equally, yielding unequal final payoffs, depending on player B's endowment. For instance, if player B is not provided with an endowment, as will be the case in one condition of the experiment, then the Nash bargaining solution predicts that player A will conclude with a payoff of 20, compared to a payoff of 10 for player B in the condition with no endowment for player B. In contrast, the equity prediction will take the different endowments for player B into account and predict that, finally, the final payoffs of both players should be equal, that is, a payoff of 15 in the condition without endowment for player B and a payoff of 20 for both players in the condition with an endowment. From the equity theory predictions 5.1 follows, whereas from the Nash bargaining solution prediction 5.2 follows:

Prediction 5.1: The return rates of participants in the role of player B will be lower in a condition in which participants in the role of player B receive no endowment, compared to the condition in which participants in the role of player B receive an endowment.

Prediction 5.2: The return rates of participants in the role of player B do not differ between the conditions with and without an endowment for participants in the role of player B.

According to the equity principle, and consistent with prediction 5.1, participants in the role of player B will approximately return 67% of the trebled investment if player B receives an endowment, and only 50% if player B has no endowment for reaching equal final payoffs. Prediction 5.2 implies a return rate of 67% for both conditions.

If individuals are motivated to attain fair allocations, the different endowments for player B should also have an effect on participants' decision in the role of player A. The argument is the following: In the condition with an endowment for player B, both players will conclude with equal final payoffs if no investment whatsoever is made by player A. Although this outcome is inefficient, it could be regarded as fair according to the equity and the equality prediction. However, if player A makes no investment in the condition with no endowment for player B, both players will conclude with unequal final payoffs. If individuals are motivated to attain fair (i.e. equal) payoffs, then participants in the role of player A need to invest their endowment. Thus, if individuals are motivated to reach fair allocations, this yields prediction 6.1:

Prediction 6.1: Participants in the role of player A have a higher investment rate when participants in the role of player B have no endowment, compared to a situation in which participants in both roles receives an endowment.

On the contrary, the different endowments for player B have different implications if individuals are only motivated by their self-interest. Individuals, who only aim to maximize their personal monetary payoffs, invest their endowment merely to increase their payoff. Consequently, they would assume that opponents also merely attempt to maximize their payoffs. The reasons why individuals in the role of player B return substantial or "putative fair" amounts of money is only due to them being fearful that the person in the role of player A will, otherwise, stop the investments. The self-interested opponents return the minimum "fair" amount as a return, which will presumably be regarded as lower in the condition with no endowment for player B than in the condition with an endowment. Following this deliberation, a self-interested individual needs to make a decision between the certain endowment and the uncertain return. Given that the uncertain expected return is lower in the condition with no endowment for player B, compared to the condition with an endowment, it is more liable that individuals in the role of player A will choose to keep their endowment and make no or only small investments:

Prediction 6.2: Participants in the role of player A have a lower investment rate when participants in the role of player B have no endowment, compared to a situation in which participants in both roles receive an endowment.

Prediction 6.2 is supported by the results of the one-shot investment game conducted by Van Huyck et al. (1995). In their experiment, participants in the role of player B received no endowment and the investment rates were lower, compared to the investment rates in the one-shot investment game conducted by Berg et al. (1995) and the investment game reported in the previous chapter, in which both players received an endowment.

How does reciprocity influence decisions in the repeated investment game? Study 1 found only marginal support that positive and negative reciprocity affects participants' behavior in the role of player B. However, since the situation in the present study has changed to a repeated interaction, reciprocity may possess a more important function. If the investments of player A are regarded as the contribution to the investment game, then reciprocity explicated by the equity principle predicts that the return rates depend positively on the investment rates. In contrast, according to the equality principle individuals strive for equal payoffs regardless of another individual's contributions. Therefore, player B, following this principle, will always choose a return rate for obtaining equal final payoffs. If reciprocity has no substantial effect on individuals' behavior in a repeated game, then prediction 7.1 should hold. In contrast, if individuals in repeated games are motivated to behave reciprocally, then prediction 7.2 follows:

Prediction 7.1: The return rates in a repeated game do not depend on the investment rates.

Prediction 7.2: The return rates in a repeated game are positively correlated with the investment rates.

8.1 Method

In the study, 35 men and 61 women, mainly students of the Free University of Berlin, participated in 12 sessions, each with 8 participants. The participants were not acquainted with one another. Players A and B were placed in different rooms and all interactions were performed via personal computers. The player roles were randomly assigned to each participant and fixed for the entire experiment. Hence, only four participants were in the role of player A, the other four participants being player B. Each participant played four indefinitely repeated games against the four various participants who were in the other player role. To acquire comparable data, the lengths of the games were randomly generated prior to the experiment (with a continuation probability of 0.875), hence, in each session the equal lengths were used.

First, the investment game was explained to the participants. They were informed, that subsequent to each period with a probability of 0.875 a new period would follow. They were informed that they needed to play four games in a fixed role against four other participants, whose identity would not be revealed to guarantee anonymity. It was also explained to the participants that in each period, of every game, player A would commence with an endowment of DM 10. Player A could invest any amount of the endowment and player B could (possibly) return any amount of the trebled investment. Subsequent to the players making their choices, both players were informed on the decisions of the opponent, and the corresponding payoffs gained by both players, in the present period, were displayed. However, to avoid reference point effects, participants were not informed on their total gains for all earlier periods and games they had already played during the experiment. They were informed that three percent of the final payoffs were given as payment, yielding a maximum real payoff of DM 29 or DM 38 (ca. $20) depending on the condition for a one-hour session. (For the complete instruction see appendix B.)

According to the between-subject factor *Endowment* ("Endowment" vs. "No Endowment"), in 6 sessions an endowment of DM 10 was provided in every period to the participants in the role of player B (none of this endowment could be returned to player A). In the other 6 sessions, no endowment was provided for player B.

8.2 Results

With an endowment for both players, the participants in the role of player A invested 100% of their endowment in 45% of all 768 periods, compared to 57% of all periods in the condition with no endowment. In the condition with an endowment for player B, participants in the role of player A made an average payoff of DM 15 across all repeated games and participants in the role of player B made on average DM 19. In the condition with no endowment, participants in the role of player A made an average payoff of DM 12 whereas participants in the role of player B gained a payoff of DM 13.

For descriptive purposes, I first analyzed the data across all periods separated for both conditions. Figure 7 shows the frequency distribution of outcomes in the Endowment condition. The modal outcome was an equal split of the final payoffs (20, 20; with a frequency of 13%), which is similar to the outcome where player A receives 21 and player B receives 19 (with a frequency of 7%); joining these almost equal splits together gives a frequency of 20%. An unequal split of the final payoffs was also very frequent (15, 25; with a frequency of 13%) and final payoffs without any surplus (10, 10) were obtained for 5% from all periods. Almost equal final payoffs (20, 20 or 21, 19) were obtained significantly more frequently than equal splits of the trebled investment leading to unequal final payoffs (15, 25). Other outcomes occurred with frequencies lower than 3%.

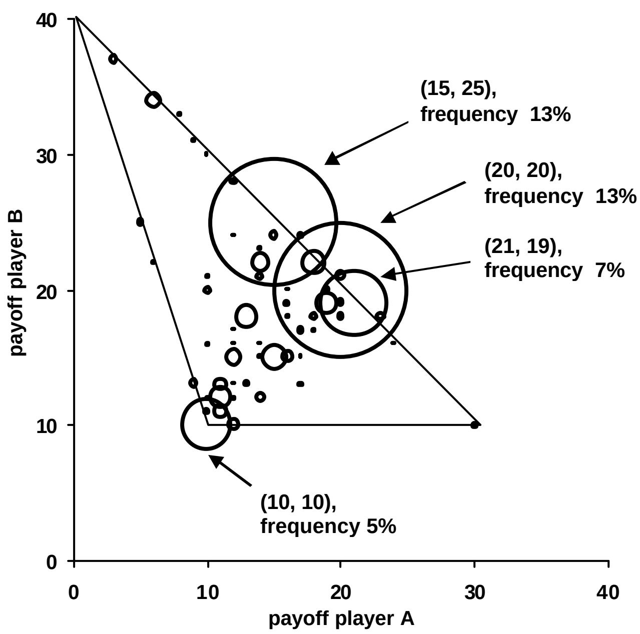

Figure 7. Frequency of outcomes in the condition with an endowment for both players.
The centers of the circles represent the outcomes that are achieved by the participants for all 768 periods. Circles' diameters are proportional to the frequency in which the outcomes occurred in the experiment. (The triangle indicates the possible payoff combinations.)

Figure 8 shows the frequency distribution of outcomes in the condition with no endowment for player B. There is one modal outcome in which both players obtain a payoff of DM 15 (with a frequency of 40%). Final payoffs without any surplus (10, 0) were obtained for 9% of all periods. Other outcomes occurred with frequencies lower than 4%.

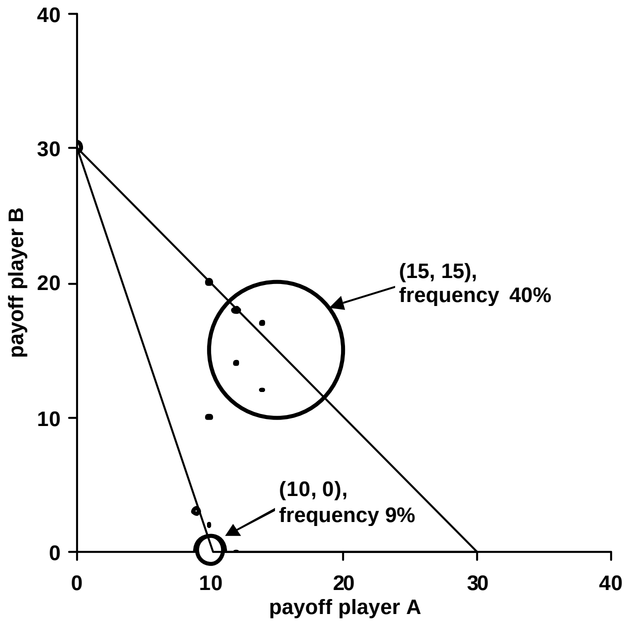

Figure 8. Frequency of outcomes in the condition with no endowment for player B.
The centers of the circles represent the outcomes that are achieved by the participants for all 768 periods. Circles' diameters are proportional to the frequency in which the outcomes occurred. (The triangle indicates the possible payoff combinations.)

In order to test whether the return rates were lower in the condition with an endowment for both players compared to the condition with no endowment, as ascertained by prediction 5.1, or, if no differences in return rates occurred according to prediction 5.2 for each participant in the role of player B, the average return rate across all periods of all repeated games was determined. Finally, the average return rate in each session, across all participants of the session, was determined.[6] Prediction 5.1 could be supported. Participants in the role of player B, in the condition with an endowment for player B, returned on average 54% (*SD*=9) of the trebled investment, compared to an average return rate of 38% (*SD*=6) in the condition with no endowment (t_{10}=3.6, *p*=.005; large effect size of *d*=2.1).

For testing predictions 6, whether the investment varies between the two endowment conditions, the average investment rates were compared.[7] The results provide weak support

[6] Means for sessions were determined, because although the participants in one player role did not interact with participants who were in the same player role, by playing with the same participants in the other player role the data for one participant is in principle not independent from the data of the other participants.
[7] Note because the lengths of the games differed I first computed the average investment rates for the single repeated games and then took the averages across the four games each participant played. Finally the average across all participants of each session were determined.

for prediction 6.1: Participants in the role of player A invested on average 76% (*SD*=15) of their endowment, if player B received no endowment, compared to an average investment rate of 71% (*SD*=15) in the Endowment condition (t_{10}=0.6, *p*=.534; small effect size of *d*=0.37).

For testing prediction 7, whether the return rates correlate with the investment rates, only the decisions in the Endowment condition were analyzed. This was necessary since even someone who constantly strives for equal payoffs for both players, regardless of player A's investment, needed to vary the return rates in the condition with no endowment. For instance, if player A made an investment of 50% (100%), player B needed to return 34% (50%) to obtain equal payoffs for both players. Therefore, in the condition with no endowment, a positive correlation between the investment and return rate would not necessarily support prediction 7.2. On the contrary, in the Endowment condition, participants in the role of player B should always implement the same return rate when striving for equal payoffs for both players, yielding no correlation between investment and return rates. However, if prediction 7.2 is correct, a positive correlation should be observed. In order to determine the correlation, I only used one game per person, proving 24 cases of independent observations. In addition, all periods in which no investment was made, hence no return could be made, were omitted, since these cases would artificially increase the correlation. In the Endowment condition, the correlation between the investment and return rates was *r*=.34 (*p*=.100; medium effect size). This result supports prediction 7.2 and shows that individuals do not strive for equal payoffs if the individuals, with whom they are engaged in an interaction, did not make a high investment.

Finally, in order to scrutinize the dynamic of decision behavior, I compared the investment and return rates in the first and fourth period of the games; the fourth period by chance happened to be the maximum period all games were repeated. In the first period, the average investment rate was 67% in the Endowment condition, compared to an average investment of 71% in the fourth period of the game. In the condition with no endowment, the average investment was 84% in the first period, compared to an average investment of 74% in the fourth period. In the first period, the average return was 57% compared to 54%

in the fourth period of the condition with an endowment for player B. In the first period of the condition, with no endowment for player B, the average return was 43% compared to 45% in the fourth period. This illustrates, that contrary to the return rates, the investment rates changed during the game. In the Endowment condition the investments increased, whereas in the condition with no endowment the investments decreased.

8.3 Discussion

In sum, the treatment of varying the endowments for player B influenced individuals' decisions, and thereby, the distribution of payoffs. Participants in the role of player A made higher investments in the condition with no endowment for player B, compared to the Endowment condition. Participants most frequently strove for equal final payoffs for both players, yielding lower return rates by player B in the condition with no endowment for player B, compared to the Endowment condition. Finally, a substantial correlation between the investment and return rates was obtained. All predictions supported by the results were derived from the equity theory. The goal of the present study was to demonstrate how a repeated game could be implemented to test whether a motivation for fairness effects behavior was reached, as the results illustrate individuals' motivation for reaching fair outcomes according to the equity theory.

If one compares the results of the one-shot game of study 1 with the results of the repeated game, it is most striking that the average investment and return rates were not larger in the repeated game. From a game-theoretical perspective, one would expect no investments and returns in the one-shot situation, compared to the repeated situation where substantial investments and returns can be expected. This result can be interpreted as if individuals do not change their behavior in one-shot games and behave as if they were in a repeated game. However, one important difference between the one-shot game and the indefinitely repeated game is the increase of the correlation between the investment rates and return rates in the repeated game. One could argue, that if repeatedly low investments are made this could easily be interpreted as low trust and as uncooperative behavior, justifying low returns. In line with the interpretation of the results of study 1, I conclude that negative and positive reciprocity is developed by repeated interactions.

Finally, there are still some open questions. The present study showed the influence of fairness in repeated games. However, Figure 7 and Figure 8 also demonstrate the large variance of the obtained outcomes. Often, the participants did not reach an agreement, one participant exploited the other, or an efficient distribution of payoffs contrary to the equity principle was obtained. This large variance cannot be explained by a stable fairness principle. In contrast, as all the different outcomes are a result of the dynamic process of the repeated game, one has to describe the process itself. Therefore, in the second part of the present work I will focus on decision strategies for the indefinitely repeated game.