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Abstract

Who should own public projects? We report data from a laboratory experiment with 480 participants that was designed to test Besley and Ghatak's (2001) public-good version of the Grossman-Hart-Moore property rights theory. Consider two parties, one of whom can invest in the provision of a public good. The parties value the public good differently. Besley and Ghatak (2001) argue that more investments will be made if the high-valuation party is the owner, regardless of whether or not this party is the investor. While our experimental results provide support for the Grossman-Hart-Moore theory, they cast some doubts on the robustness of Besley and Ghatak's (2001) conclusion.

JEL Classification: D23, D86, H41, L33, C92

Keywords: Property rights, Public Goods, Incomplete Contracts, Investment incentives, Laboratory experiments

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Government versus Private Ownership of Public Goods: Experimental Evidence

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Abstract

Who should own public projects? We report data from a laboratory experiment with 480 participants that was designed to test Besley and Ghatak's (2001) public-good version of the Grossman-Hart-Moore property rights theory. Consider two parties, one of whom can invest in the provision of a public good. The parties value the public good differently. Besley and Ghatak (2001) argue that more investments will be made if the high-valuation party is the owner, regardless of whether or not this party is the investor. While our experimental results provide support for the Grossman-Hart-Moore theory, they cast some doubts on the robustness of Besley and Ghatak's (2001) conclusion.

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1 Introduction

Who should be the owner of public projects? Should control rights over the delivery of public goods and services be allocated to the state or to the private sector? Should government agencies at the local or at the federal level own the facilities needed to provide local public goods? These are among the most fundamental questions in public economics. To discuss these questions in a formal model, Besley and Ghatak (2001) have applied the Grossman-Hart-Moore property rights theory (Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995) to a setup where the involved parties care about the benefits of a public good. In the present paper, we report about the first laboratory experiment that was explicitly designed to test Besley and Ghatak's (2001) predictions.

In the Grossman-Hart-Moore theory contracts are incomplete, so ownership matters.[1] Specifically, consider two parties, A and B, who at some future date 2 can use a physical asset to generate a surplus. At date 0, it is not yet possible to contractually specify the decisions to be taken at date 2. Thus, the parties will negotiate about these decisions at date 2. However, at date 0 it can be stipulated who owns the asset, i.e. who will have the right to make the date-2 decisions if the parties will not reach an agreement. Now suppose that at date 1, one of the parties can make a non-contractible investment to enhance the date-2 surplus. According to the Grossman-Hart-Moore theory, ownership should reside with the investor.[2] Ownership improves investment incentives, since the owner can appropriate a larger part of the date-2 surplus. The reason is that at date 2 the owner is in a better bargaining position, because if the negotiations fail the owner can make the decisions that are best for him. In the Grossman-Hart-Moore private-good setup, the decisions preferred by party A are different from the decisions that party B would prefer.

Besley and Ghatak (2001) have applied the Grossman-Hart-Moore theory in a public-good context where both parties value the benefits generated by a public project. In their lead example, party A is the government and party B is a non-governmental organization. In this case, we can discuss the pros and cons of public and private ownership. Yet, party A and party B could also be two different government agencies, so we could for example discuss whether the federal level or the local level should be in control. In any case, Besley and Ghatak's (2001) central

[1] See Segal and Whinston (2013) for a comprehensive review of the literature on property rights. For a discussion of the incomplete contracting methodology, see Tirole (1999).

[2] More generally, if both parties have investment opportunities, then the key investor should be the owner (cf. Hart, 1995). In what follows, we focus on the case in which only one of the parties can invest. In this case, the differences between the private-good setup and the public-good setup stand out most clearly (cf. also Francesconi and Muthoo, 2011, section 4).

conclusion is that in order to maximize investment incentives, the party that values the public good most should be the owner, regardless of whether or not this party is the investor.[3]

To see this, suppose party A is the investor. Assume that party B has a very large valuation of the public good, while party A's valuation is relatively small. The public good cannot be provided without party A or without the physical asset. Under B-ownership, the public good can hence be provided only if party A and party B reach an agreement. Thus, they will split the surplus in the date-2 negotiations. As a consequence, since party B has a very large valuation, party A's date-2 payoff and hence his investment incentives will be relatively large. In contrast, under A-ownership party A can provide the public good even when no agreement with party B is reached. Now party B is unwilling to make a payment to party A in the date-2 negotiations, since party B anticipates that after a bargaining breakdown party A will provide the public good anyway (i.e., both parties now prefer the same date-2 decision). Since party A's valuation of the public good is relatively small, his incentives to invest are small. Therefore, B-ownership is optimal, even though party A is the investor.

In our experimental test of Besley and Ghatak's (2001) theory we employ a straightforward 2x2 design. Specifically, we have conducted treatments with A-ownership and B-ownership in two different parameter constellations. In each of the four treatments, party A is the investor.

In parameter constellation 1, party A has a larger valuation of the public good than party B. Hence, in this case Besley and Ghatak's (2001) conclusion is in line with the usual Grossman-Hart-Moore finding that party A's investment incentives are larger under A-ownership than under B-ownership. Our data support this prediction. The fact that ownership matters as predicted by the Grossman-Hart-Moore theory is not self-evident, since the A-ownership and B-ownership treatments differ only if the date-2 negotiations are broken off. Thus, if the parties were only interested in maximizing the total surplus and achieving a fair division, ownership would not matter at all. However, it should be noted that under B-ownership investments are made substantially more often than predicted by standard theory, and the parties do not seem to treat the investment costs incurred at date 1 to be completely

[3]For example, the public project may involve designing and running schools or a health care system, the physical assets could include buildings and locations, and the investments might be specialized training and acquisition of specific knowledge. Besley and Ghatak (2001) conclude that even though the (federal) government may be the key investor, ownership should reside with a non-governmental organization (or a local government agency) when the latter values the public good more. For more detailed discussions of these and other real-world applications, see Besley and Ghatak (2001) and Francesconi and Muthoo (2011).

irrelevant in the date-2 negotiations. Hence, apparently fairness concerns do play an important role.

In parameter constellation 2, it is party B who has the larger valuation of the public good. Thus, Besley and Ghatak (2001) predict that party A's investment incentives are larger under B-ownership than under A-ownership. Our data do not support this prediction, as the investment frequencies turn out to be equally high under both ownership structures. To better understand where the theory goes wrong, in addition to our four main treatments we have conducted a control treatment. Recall that Besley and Ghatak (2001) assume that under A-ownership the public good would always be provided by party A when the negotiations are broken off. Therefore, in our control treatment we exogenously impose this date-2 decision. Indeed, in the control treatment investments are made less often than under B-ownership. Hence, the Grossman-Hart-Moore property rights approach works as predicted for the disagreement payoffs that Besley and Ghatak (2001) have taken as granted. Yet, when under A-ownership the negotiations are broken off, the subjects in the role of party A behave differently from Besley and Ghatak's (2001) presumption. They often do not provide the public good, even though this ex post inefficient decision is costly for them. Apparently, the subjects in the role of party A feel entitled to a suitable payment from party B to reimburse them for their investment costs. If party B is not willing to make such a payment, party A often opts for costly punishment of party B by not providing the public good.[4]

To conclude, our experimental findings offer support for the Grossman-Hart-Moore theory according to which the disagreement payoffs in the date-2 negotiations translate into investment incentives at date 1. Yet, Besley and Ghatak's (2001) analysis neglects the willingness of the parties to engage in ex post inefficient punishment behavior at date 2, so our experimental findings suggest that the disagreement payoffs that they have taken as granted may not be the ones that are actually relevant. Therefore, Besley and Ghatak's (2001) central message according to which more investments can be stimulated by making the non-investing party owner when it has a larger valuation of the public good deserves more scrutiny in future empirical research.

The remainder of the paper is organized as follows. In the next section, we discuss the related literature. In Section 3, we present a bare-bones version of

[4]The fact that subjects may be aggrieved and willing to engage in ex post inefficient punishment when they do not get what they feel entitled to has also been emphasized in Hart and Moore's (2008) theory of contracts as reference points. Note however that they consider a rather different setting where a decision between flexible and rigid contracts has to be made. See Fehr et al. (2009, 2011, 2015), Bartling and Schmidt (2015), Brandts et al. (2015), and Erlei and Reinhold (2016) for experimental evidence in this line of research.

Besley and Ghatak's (2001) model on which our experimental study is based. The experimental design is introduced in Section 4. Predictions based on Besley and Ghatak's (2001) analysis are derived in Section 5. In Section 6, we report and analyze our experimental results. Concluding remarks follow in Section 7. In the Appendix, the bargaining behavior is analyzed in greater detail.

2 Related literature

Besley and Ghatak's (2001) application of the Grossman-Hart-Moore theory was the first contract-theoretic investigation of optimal ownership arrangements in a setting where the involved parties care about the benefits generated by a public good.[5] Some authors have theoretically studied the robustness of Besley and Ghatak's (2001) insights. For instance, Rasul (2006) considers an application in the context of child custody. He assumes that there is a positive probability with which it is ex post efficient for a married couple to divorce. In his setting, allocating custody to the spouse with the larger valuation does not necessarily provide the best investment incentives. Francesconi and Muthoo (2011) consider impure public goods; i.e., they generalize Besley and Ghatak's (2001) work by introducing the possibility that the public good may be excludable. They find that even if the degree of impurity is very low, there are situations in which the control rights should always be given to the main investor in order to maximize the incentives to invest.[6]

To the best of our knowledge, the present paper presents the first experimental test of Besley and Ghatak's (2001) theory.[7] While there is by now a vast literature

[5]Hart et al. (1997) have also used the incomplete contracting approach to study privatization. Yet, in their model the private party does not directly care about the good to be provided. Starting with Hart (2003), several contract-theoretic papers have studied public-private partnerships (see Iossa and Martimort, 2015, for a recent survey). This literature is about the pros and cons of bundling different tasks in a partnership, while Hart (2003, p. C71) explicitly ignores ownership considerations. See Hoppe et al. (2013) for experimental evidence in line with Hart's (2003) theory.

[6]There are some further papers studying the robustness of Besley and Ghatak's (2001) finding that ownership by the high-valuation party is always optimal in a public-good context. Specifically, Halonen-Akatwijuka (2012) assumes that a party's investment may have a stronger impact on the other party's disagreement payoff than on its own disagreement payoff. Schmitz (2015) allows for ex post inefficiencies due to frictions in the bargaining process. Halonen-Akatwijuka and Pafilis (2016) study a repeated relationship. Müller and Schmitz (2017) suppose that the ex post negotiations are restrained by transaction costs in the spirit of Anderlini and Felli (2006).

[7]Contract-theoretic models are notoriously difficult to test using field data. After all, if the relevant variables could be verified by researchers, then the parties could contract on these variables, so there would be no contract-theoretic problem in the first place. For this reason, as has also been pointed out by Landeo and Spier (2009) and Huck et al. (2011), testing hypotheses in laboratory

in experimental economics that deals with the free-rider problem in the provision of public goods,[8] we are not aware of any experimental studies that have explored the role of property rights in a public-good context.

Since Besley and Ghatak's (2001) model is based on the seminal work by Grossman and Hart (1986) and Hart and Moore (1990), our paper also adds to the still relatively scarce literature that experimentally tests the Grossman-Hart-Moore property rights theory. Starting with Hackett (1993), several experiments have been conducted to explore hold-up problems (where a party may underinvest because in future negotiations it does not get the full returns of its investment). It turns out that the total surplus is usually split more evenly and the underinvestment problem is less severe than suggested by standard theory. The players do not seem to consider the sunk investment costs as irrelevant in the ex post bargaining stage, which can be explained by fairness concerns (cf. Fehr and Schmidt, 2006).[9] Our data are in line with these findings.

Closer to the property rights theory are Sonnemans et al. (2001) and Erlei and Siemer (2014), who study Grossman-Hart-Moore variants in order to investigate the impact of different bargaining games that are played ex post. They consider settings in which the split-the-difference-rule (where the default payoffs constitute the threatpoint of the Nash bargaining solution) and the deal-me-out-solution (where the default payoffs are outside options, i.e. constraints on the bargaining set) lead to different bargaining outcomes.[10] In contrast, we consider a setup in which it does not matter whether the default payoffs are treated as threatpoints or as outside options. Fehr et al. (2008) experimentally confirm that a party's incentives to invest are affected by the way in which the investment's return will be divided ex post. However, in their experiment there is no ex post bargaining; instead, the division of the ex post surplus is stipulated ex ante.[11] In our public-good setup it turns out that it can be important not to reduce the ex post stage to an exogenous division of the surplus, as becomes evident when we compare the control treatment in our parameter constellation 2 with the corresponding A-ownership treatment (in which

experiments is a particularly valuable approach in the context of contract-theoretic problems.

[8]For literature reviews, see Ledyard (1995) and Chaudhuri (2011). In particular, see Ostrom et al. (1992) and Fehr and Gächter (2000) for experiments demonstrating subjects' willingness to engage in costly punishment.

[9]For experimental studies of hold-up problems, see also Ellingsen and Johannesson (2004a,b), Hoppe and Schmitz (2011), Dufwenberg et al. (2013), Morita and Servátka (2013), and Erlei and Roß (2014).

[10]See Chiu (1998) and DeMeza and Lockwood (1998) for a theoretical analysis.

[11]See Hart (1995, p. 30 and p. 63) for a discussion of the relationship between ownership (i.e., residual rights of control) and profit sharing agreements.

party A often makes an ex post inefficient decision). Finally, Kusterer and Schmitz (2017) have experimentally explored Aghion and Tirole's (1994) management-of-innovation theory, which is also based on the Grossman-Hart-Moore approach. Yet, Aghion and Tirole (1994) consider a private-good framework with uncertainty and bounded payments, which is quite different from Besley and Ghatak's (2001) public-good setting.

3 The theoretical framework

Our experimental study is motivated by Besley and Ghatak's (2001) public-good application of the Grossman-Hart-Moore property rights theory. In this section, we present a stripped-down version of their model. The central question is: Who should be owner of the nonhuman assets that are required to provide a public good?

Consider two parties, A and B. At date 1, party A can invest $i \in \{0, I\}$ in its human capital. The investment decision is observable but non-contractible. If party A does not invest ($i = 0$), the payoffs of both parties are zero. If the investment is made ($i = I$), party A can provide a public good at date 2.[12] In line with the Grossman-Hart-Moore approach, it is assumed that provision of the public good is non-contractible before date 2. Let $q \in \{0, 1\}$ denote whether or not the public good is provided. Following Besley and Ghatak (2001), we assume that the benefits generated by the public good are non-rival and non-excludable. Specifically, in the absence of transfer payments between the parties, the date-2 payoffs of party A and party B are given by qv_A and qv_B, respectively. We assume that $v_A > 0$, $v_B > 0$, and $v_A + v_B > I$. The latter assumption means that making the investment is the first-best decision which maximizes the parties' total surplus.

At date 2, the two parties can bargain with each other in order to divide the benefits generated by the public good. In the Grossman-Hart-Moore property rights theory, ownership matters because the date-2 bargaining outcome depends on the ownership structure. Specifically, the ownership structure determines the parties' default payoffs that will be attained in the case of disagreement.

Suppose first that party A is the owner and the investment has been made. In this case, when at date 2 no agreement with party B is reached, party A is free to choose $q \in \{0, 1\}$. Since $v_A > 0$, party A prefers to provide the public good (recall that the investment costs are sunk at date 2, so they are no longer relevant for party A's decision). Thus, the parties' default payoffs are v_A and v_B, respectively. Next, suppose that party B is the owner and the investment has been made. When party

[12]Note that the public good cannot be provided in the absence of party A's human capital; i.e., party A is *indispensable* in Hart and Moore's (1990) wording.

A does not reach an agreement with party B at date 2, then the public good cannot be provided. Hence, in this case the default payoffs are 0 for both parties.

In the Grossman-Hart-Moore property rights theory it is usually assumed that the outcome of the negotiations is given by the regular Nash bargaining solution, where the default payoffs constitute the threatpoint.[13] Therefore, at date 2 each party gets its default payoff plus half of the gains from trade (where the gains from trade are given by the maximum date-2 surplus $v_A + v_B$ minus both parties' default payoffs).[14] In the case of A-ownership, the gains from trade are $v_A + v_B - v_A - v_B = 0$, so party A's date-2 payoff is $v_A + \frac{1}{2} \cdot 0 = v_A$ and party B's date-2 payoff is $v_B + \frac{1}{2} \cdot 0 = v_B$. In the case of B-ownership, the gains from trade are $v_A + v_B - 0 - 0 = v_A + v_B$, so party A's date-2 payoff is $0 + \frac{1}{2}(v_A + v_B)$ and party B's date-2 payoff is $0 + \frac{1}{2}(v_A + v_B)$.[15]

Applying backward induction, we can now analyze party A's investment incentives at date 1. Under A-ownership, party A will invest whenever $v_A - I \geq 0$. Under B-ownership, party A will invest whenever $\frac{1}{2}(v_A + v_B) - I \geq 0$. Besley and Ghatak's (2001) central insight is that party A's investment returns are larger under A-ownership than under B-ownership (i.e., $v_A \geq \frac{1}{2}(v_A + v_B)$) whenever party A has a larger valuation of the public good than party B (i.e., whenever $v_A \geq v_B$). Hence, if $v_B > v_A$, then B-ownership can yield a larger total surplus than A-ownership, even though only party A has to make an investment decision, which is in contrast to the private-good case that is usually studied in the Grossman-Hart-Moore property rights theory. In particular, in our binary investment setting A-ownership is strictly better than B-ownership when $\frac{1}{2}(v_A + v_B) < I < v_A$, while B-ownership is strictly better than A-ownership when $v_A < I < \frac{1}{2}(v_A + v_B)$.

[13] In a Rubinstein (1982) alternating offers game, the date-2 bargaining powers depend on the parties' time preferences. If the time interval between offers goes to zero and both parties are equally patient, then they have equal bargaining powers, as it is assumed in the regular Nash bargaining solution (cf. Muthoo, 1999, for a comprehensive exposition of bargaining theory).

[14] Hart (1995, p. 39) emphasizes that in the property rights theory the date-2 bargaining *process* does *not* depend on the ownership structure. Instead, ownership matters because it determines the parties' date-2 default payoffs.

[15] Most papers in the Grossman-Hart-Moore literature apply the split-the-difference rule. Chiu (1998) and DeMeza and Lockwood (1998) have instead considered the deal-me-out solution. According to this bargaining solution, each party gets half of the date-2 total surplus, except when a party's default payoff would be larger (this party then gets its default payoff and the other party gets the date-2 total surplus minus the first party's default payoff). Note that in the present setup, the deal-me-out solution yields the same date-2 payoffs as the split-the-difference rule (cf. also Schmitz, 2014).

4 Experimental design

Our experiment consists of five treatments. Each treatment was run in six sessions with 16 participants each. Thus, in total 480 subjects took part in the experiment. No subject was allowed to participate in more than one session. All subjects were students of the University of Cologne from a wide variety of fields of study.[16] All interactions were anonymous; i.e., the subjects did not learn the identities of the subjects with whom they were matched.

In each session, half of the participants were randomly assigned to the role of player A and the others to the role of player B. The participants kept their role throughout the whole session. In order to give the subjects the opportunity to gain experience, each session consisted of 16 periods, using a random matching protocol. Hence, we have six independent matching groups per treatment.[17]

At the beginning of each session, written instructions were handed out to each participant.[18] Before the experiment started, each subject had to answer several comprehension questions. A session lasted between 40 and 90 minutes, with an average of 60 minutes. We made use of the experimental currency unit ECU. At the end of each session, one of the 16 periods was randomly selected for payment. The participants' earnings were then converted into euros and paid out to them in cash.

The main part of our experiment consists of four treatments. We employ a 2x2 design, comparing A-ownership to B-ownership in two different parameter constellations. In *parameter constellation 1*, party A has a larger valuation of the public good. Specifically, $v_A = 100$, $v_B = 40$, and $I = 95$. Hence, the condition $\frac{1}{2}(v_A + v_B) < I < v_A$ is satisfied, so according to standard theory A-ownership would be optimal. In *parameter constellation 2*, it is party B who has a larger valuation of the public good. Specifically, $v_A = 40$, $v_B = 100$, and $I = 65$, so $v_A < I < \frac{1}{2}(v_A + v_B)$ holds, which means that B-ownership would be optimal according to standard theory.

In addition to the four main treatments, we have conducted a control treatment in order to throw more light on the players' behavior in parameter constellation 2. In each of the five treatments, each period consists of up to two stages.

A-ownership treatment $A1$. In the first stage, player A decides whether to invest 95 ECU. If player A does not invest, the period is over and both players' profits are

[16]The computerized experiment was programmed and conducted with oTree (Chen et al., 2016), and subjects were recruited using ORSEE (Greiner, 2004).

[17]Throughout, when we report the results of Wilcoxon signed-rank tests or Mann-Whitney U tests, matching group averages are used as units of observations.

[18]The instructions for all five treatments and screenshots of the main decision screens are in the Supplementary Material.

0 ECU. If the investment is made, the second stage is reached, in which a public good can be provided. Player A's benefit from the public good is 100 ECU, while player B's benefit is 40 ECU. The players can divide the benefits in an alternating offers bargaining game. Specifically, one player is randomly drawn to make an offer X, where X can be any integer between -40 and 100. If the other player accepts the offer, the public good is provided, player A's second-stage profit is 100 ECU $-$ X ECU, and player B's profit is 40 ECU + X ECU. If the other player rejects, he can either make a counteroffer (so a new round of negotiations is reached) or break off the negotiations. In the latter case, since player A owns the production technology, he is free to decide whether to provide the public good. If the public good is provided, player A's second-stage profit is 100 ECU and player B's profit is 40 ECU, while otherwise both players' second-stage profits are zero.

B-ownership treatment $B1$. This treatment is identical to treatment $A1$, except for the case in which the negotiations in the second stage are broken off. Since player B owns the production technology, the public good can be provided only if the players reach an agreement to do so. Hence, if the negotiations are broken off, both players' second-stage profits are zero.

A-ownership treatment $A2$. In the first stage, player A decides whether to invest 65 ECU. If player A does not invest, the period is over and the players' profits are 0 ECU. If player A invests, the second stage takes place, in which a public good can be provided. Player A's benefit from the public good is 40 ECU, while player B's benefit is 100 ECU. The players can divide the benefits in an alternating offers bargaining game. One player is randomly drawn to make an offer X (which can be any integer between -40 and 100). If the other player accepts the offer, the public good is provided, player A's second-stage profit is 40 ECU + X ECU, and player B's profit is 100 ECU $-$ X ECU. If the other player rejects, he can either make a counteroffer (so a new negotiations round is reached) or break off the negotiations. In the latter case, as player A owns the production technology, he can decide whether to provide the public good. If the public good is provided, player A's second-stage profit is 40 ECU and player B's profit is 100 ECU, while otherwise both players' second-stage profits are zero.

B-ownership treatment $B2$. This treatment is identical to treatment $A2$, except for the case in which the negotiations in the second stage are broken off. As player B is the owner, the public good can be provided only if the players agree to do so. Thus, if the negotiations are broken off, both players' second-stage profits are zero.

Control treatment $A2C$. This treatment is also identical to treatment $A2$, except for the case in which the negotiations in the second stage are broken off. In treatment

$A2C$, when the negotiations are broken off the public good is always provided, so player A's second-stage profit is 40 ECU and player B's profit is 100 ECU. Note that treatment $A2C$ is an artificial benchmark which is not meant to capture a feasible ownership allocation in the public-good problem.

In addition to the main experiment, we elicited subjects' social value orientation (SVO) using the SVO Slider Measure (Murphy et al., 2011). The SVO measures subjects' preferences over different allocations of money between themselves and another subject. The SVO elicitation task was run after the main experiment took place and the instructions made it clear that subjects were randomly matched with another subject that had the same role (A or B) during the main experiment, ensuring that they had not interacted before. Subjects had to choose allocations in six dictator games corresponding to the six primary items in Murphy et al. (2011) on a single screen.[19] Two main SVO types can be distinguished: prosocials, who maximize joint surplus and/or reduce payoff inequality, and individualists, who maximize only their own payoff.[20] Overall, 61% of subjects are individualistic and 38.3% are prosocial.[21]

The subjects obtained 0.99^R euros per 7 ECU, where $R \geq 1$ is the number of rounds that the negotiation stage lasted (when the second stage was not reached, the conversion rate was 0.99 euros per 7 ECU).[22] This way of converting ECU into euros gave the subjects an incentive to finish the negotiations in early rounds. The minimum, median, maximum, and average earnings in the experiment were 4.00, 18.25, 38.50, and 17.78 euros, respectively.

5 Predictions

Table 1 summarizes the implications of Besley and Ghatak's (2001) analysis for the parameter constellations that were implemented in our experiment.

[19] Across all six decisions, subjects could choose points for themselves between [50,100] and for the matched subjects between [15,100] (40 points = 1 euro). See the Supplementary Material for a screenshot of the decision screen.

[20] There are also two further but empirically less relevant types: Altruists, who maximize the other subject's payoff, and competitive subjects, who maximize the difference in payoffs, with themselves ahead, even if it comes at a cost. See Murphy et al. (2011) for the mapping of decisions in the six dictator games into SVO types.

[21] Besides the aforementioned prosocial and individualistic subjects, 1 subject is classified altruistic, and 2 as competitive. We include them in the prosocial and individualistic categories, respectively. SVO does not differ significantly between treatments, roles, or gender.

[22] In addition, the subjects received an endowment of 100 ECU in parameter constellation 1 and 70 ECU in parameter constellation 2 in order to ensure non-negative payoffs.

	$A1$	$B1$	$A2$	$B2$
A invests	100%	0%	0%	100%
A and B reach agreement		[100%]		100%
X if agreement	0	[30]	[0]	30
Provision if no agreement	100%	-	[100%]	-
A's second-stage profit	100	[70]	[40]	70
B's second-stage profit	40	[70]	[100]	70
A's profit if investment	5	[-25]	[-25]	5
A's profit	5	0	0	5
B's profit	40	0	0	70
Total surplus	45	0	0	75

Table 1. Point predictions according to Besley and Ghatak's (2001) analysis. Note that if the second stage is reached under A-ownership, the negotiations might be broken off or the parties might agree on $X = 0$, yielding the same second-stage profits. Recall that under B-ownership the public good cannot be provided in the absence of an agreement. The entries in square brackets show the predictions for the second stage in the cases in which it would not be reached on the equilibrium path. The predictions for treatment $A2C$ are identical to those for treatment $A2$.

Specifically, consider A-ownership. If the negotiations are broken off in the second stage, player A will always make the ex post efficient decision to provide the public good. Hence, in the second-stage negotiations the players simply get their default payoffs. Therefore, in parameter constellation 1 player A will invest, while in parameter constellation 2 player A will not invest. Note that in the control treatment $A2C$ when the negotiations are broken off the provision of the public good is exogenously fixed, so the same outcome is predicted as in treatment $A2$.

Next, consider B-ownership. The players' default payoffs in the second-stage negotiations are zero, so they agree on $X = 30$, yielding a second-stage profit of 70 for each player. As a consequence, in parameter constellation 1 player A will not invest, while in parameter constellation 2 player A will invest.

We do not expect the point predictions to be borne out by the data, as it has been documented in many experimental studies that subjects sometimes make mistakes and they may well be guided by motives different from expected profit maximization. Instead, it is our primary goal to investigate whether the central predictions of Besley and Ghatak's (2001) model hold qualitatively. Do the treatment variations lead to the predicted changes in the subjects' behavior? In particular, is it true that in order to maximize investment incentives, ownership must always reside with the party that has a larger valuation for the public good, regardless of whether this party is also the one that has to make an investment decision?

Hypothesis 1. *Investments are made more frequently in treatment $A1$ than in treatment $B1$.*

In parameter constellation 1, the player who can make an investment decision (player A) is also the one who has a larger valuation of the public good. In this case, Besley and Ghatak's (2001) conclusion is in line with the usual prediction of the Grossman-Hart-Moore property rights theory, according to which investment incentives are maximized when ownership resides with the party that has to make an investment decision. Hence, if Hypothesis 1 were violated, the data would not only contradict Besley and Ghatak's (2001) analysis, it would also cast doubts on the empirical relevance of the underlying Grossman-Hart-Moore property rights approach.

Note that it is not self-evident that the data will be in support of Hypothesis 1. Recall that if the players wish to do so, they can attain the same payoffs regardless of the ownership structure. If the players were only interested in maximizing the total surplus and achieving an equal division, ownership would not matter at all.

Hypothesis 2. *Investments are made more frequently in treatment $B2$ than in treatment $A2$.*

In parameter constellation 2, player B has a larger valuation of the public good, while player A has to make an investment decision. Thus, Besley and Ghatak's (2001) prediction is that player A's investment incentives are larger under B-ownership than under A-ownership, which is in contrast to the usual Grossman-Hart-Moore conclusion. If Hypothesis 2 were violated, the data would challenge the empirical relevance of Besley and Ghatak's (2001) central insight. In this case, it would be important to understand where the theory goes wrong. In particular, in treatment $A2$ it may happen that player A engages in costly punishment by not providing the public good when no agreement with player B is reached in the second stage. Therefore, we have conducted the control treatment $A2C$, where the public good is always provided, so the design of the treatment rules out the possibility of punishment. According to standard theory, the players' behavior should not differ between the treatments $A2$ and $A2C$. Hence, we can state the following hypothesis.

Hypothesis 3. *Investments are made more frequently in treatment $B2$ than in treatment $A2C$.*

If the data violated Hypothesis 2 but were in support of Hypothesis 3, we would have clearly identified a reason for Besley and Ghatak's (2001) specific application of the Grossman-Hart-Moore approach to fail. In contrast, if Hypothesis 3 were also violated, then the data would call into question the underlying Grossman-Hart-Moore theory itself, according to which investment incentives depend on the parties' bargaining positions in future negotiations.

6 Results

6.1 Overview

Table 2 shows the main descriptive statistics of all treatments. Note that the table is separated into descriptive statistics for all periods and for the last eight periods, where the players have already gained some experience. In the table we also indicate whether behavior between unexperienced and experienced subjects differs. In what follows, unless otherwise stated we focus on behavior in the periods 9–16.[23]

Comparing the results in Table 2 to the corresponding point predictions in Table 1, it is obvious that there are substantial deviations. However, recall that our main interest is in comparisons between the treatments.

6.2 The investor is the high-valuation party

Consider first parameter constellation 1, where player A is the high-valuation party. In treatment $A1$, the subjects in the role of player A invest in almost 95% of the cases, while in treatment $B1$ they do so in only around 60% of the cases. The difference in the players' investment behavior between the two treatments is statistically significant (see Table 3). Hence, the data are in support of Hypothesis 1.

Result 1. *In line with Hypothesis 1, investments are made more frequently in treatment* $A1$ *than in treatment* $B1$.

Figure 1 shows how the players' investment decisions developed over the 16 periods. Observe that in all five treatments, the investment behavior is quite stable in the final eight periods. The left panel depicts the relative frequencies with which the subjects in the role of player A decided to invest in the treatments $A1$ and $B1$. It is evident that ownership matters for the investment decision, which corroborates the central claim of the Grossman-Hart-Moore property rights theory.

Now let us take a closer look at the players' behavior in parameter constellation 1. Observe that in treatment $A1$, all entries in Table 2 are reasonably close to the point predictions made in Table 1. In particular, in the second stage the negotiations are

[23] In the Supplementary Material, we also report the corresponding p-values that are obtained when all 16 periods are considered, which leads to qualitatively similar conclusions.

broken off in the majority of the cases, and otherwise the parties agree on a relatively small payment. As a consequence, player A's and player B's second-stage profits are close to their predicted levels. In particular, when the negotiations are broken off, player A almost always decides to provide the public good. Investing was the profit-maximizing strategy of player A, since his payoff conditional on investment was strictly positive (while the profits are always zero when the investment is not made).

	$A1$	$B1$	$A2$	$B2$	$A2C$
	Periods 1 - 16				
A invests	92.58%	64.71%	88.8%	90.89%	62.76%
A and B reach agreement	40.86%	83.35%	76.65%	88.14%	51.56%
Mean of X if agreement	-3.28	-2.59	49.35	50.85	37.75
Provision if no agreement	93.93%		44.88%		[100%]
Mean of A's second-stage profit	97.88	85.4	72.93	80.03	59.27
Mean of B's second-stage profit	37.56	31.29	49.03	43.37	80.73
Mean of A's profit if investment	2.88	-9.6	7.93	15.03	-5.73
Mean of A's profit	2.69	-7.52	7.14	13.31	-3.31
Mean of B's profit	34.96	20.78	43.61	39.36	50.38
Mean of total surplus	37.65	13.26	50.74	52.67	47.07
	Periods 9 - 16				
A invests	94.27%*	60.16%	86.46%	89.58%	54.43%*
A and B reach agreement	38.65%	85.17%	81.95%*	91.25%*	53.41%
Mean of X if agreement	-5.5	-6.23**	49.17	51.35	36.3**
Provision if no agreement	98.83%		47.5%		[100%]
Mean of A's second-stage profit	101.43**	90.42**	76.36**	83.30**	59.45
Mean of B's second-stage profit	37.35	28.81*	49.49	44.45	80.55
Mean of A's profit if investment	6.43**	-4.58**	11.36**	18.30**	-5.55
Mean of A's profit	5.98**	-3.62**	10.07**	16.12**	-2.77
Mean of B's profit	35.35	17.93**	42.74	39.77	43.59*
Mean of total surplus	41.33*	14.31	52.81	55.89	40.82*

Table 2. Descriptive statistics. All profits are in ECU. Recall that under B-ownership the public good cannot be provided when no agreement is reached, and in the control treatment $A2C$ the public good is always provided by design. The asterisks indicate whether behavior in periods 9–16 differs significantly (* at the 10% level, ** at the 5% level) from behavior in periods 1–8 according to two-tailed Wilcoxon signed-rank tests.

However, in treatment $B1$ we observe strong deviations from the point predictions. When the investment was made, an agreement is reached in only around 85% of the cases. In contrast to the theoretical prediction, when an agreement is reached, then on average a positive payment is made from player B to player A. Player A thus manages to recoup a part of his sunk investment costs and player B's second-stage profit is much smaller than predicted. Yet, in line with the theoretical prediction not investing was player A's profit-maximizing strategy. When player A decided to invest, then average profit was negative. It is remarkable that nevertheless around 60% of the subjects in the role of player A made the investment.

	$A1$ vs. $B1$	$A2$ vs. $B2$	$A2$ vs. $A2C$	$A2C$ vs. $B2$
A invests	0.005	0.572	0.019	0.013
A and B reach agreement	0.002	0.026	0.002	0.002
X if agreement	0.818	0.818	0.015	0.004
Provision if no agreement			0.002	
A's second-stage profit	0.009	0.041	0.004	0.002
B's second-stage profit	0.093	0.180	0.002	0.002
A's profit if investment	0.009	0.041	0.004	0.002
A's profit	0.004	0.132	0.004	0.002
B's profit	0.015	0.589	1.000	0.937
Total surplus	0.002	0.937	0.240	0.132

Table 3. p-values for pairwise comparisons between treatments in periods 9–16 (two-tailed Mann-Whitney U tests).

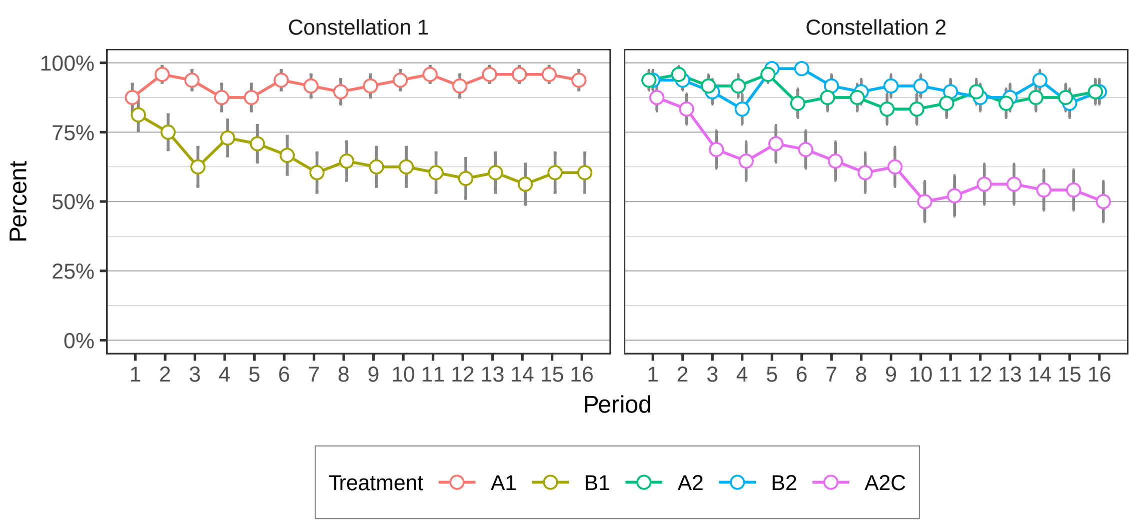

Figure 1. The figure shows for each treatment the relative frequencies of the cases in which player A decided to invest. The left panel refers to parameter constellation 1, while the right panel refers to parameter constellation 2.

	B1		A2		A2C	
Periods	1–16	9–16	1–16	9–16	1–16	9–16
Investment in all 16 periods						
Prosocial player A	41.87%		58.33%		36.67%	
Individualistic player A	10.83%		61.87%		18.89%	
p-value	0.005		0.936		0.365	
Investment in current period						
Prosocial player A	63.28%	56.77%	57.81%	43.75%	41.93%	33.33%
Individualistic player A	49.29%	39.86%	70.14%	68.75%	48.61%	35.21%
p-value	0.262	0.423	0.517	0.330	0.688	0.872
Provision						
Prosocial player A			24.51%	21.19%		
Individualistic player A			55.66%	57.04%		
p-value			0.016	0.065		
Player B breaks off						
Prosocial player B	13.94%	13.61%	16.86%	21.93%	19.47%	18.98%
Individualistic player B	7.40%	9.57%	22.52%	26.22%	55.90%	58.40%
p-value	0.109	0.297	0.337	0.631	0.010	0.006
Investment in current period						
Lagged loss	65.68%	61.50%	62.20%	72.67%	52.66%	63.76%
No lagged loss	84.93%	87.22%	92.28%	96.15%	85.72%	80.34%
p-value	0.046	0.035	0.225	0.090	0.028	0.345
Player B breaks off						
Lagged provision			56.55%	54.17%		
Lagged non-provision			36.31%	37.78%		
p-value			0.028	0.196		

Note: Data for the tests regarding the investment in the current period are restricted to subjects who did not invest in at least one period. The p-values for comparisons between prosocial and individualistic subjects are derived from Mann-Whitney U tests, p-values for the remaining comparisons are derived from Wilcoxon signed-rank tests.

Table 4. Investment, provision, and break-off decisions conditional on player's SVO, lagged loss, and lagged provision for treatments $B1$, $A2$, and $A2C$.

Looking more closely at investment behavior in treatment $B1$, we see that 25% of the subjects invest in all 16 periods.[24] Prosocial subjects (according to their SVO classification) in the role of player A are significantly more likely to invest in all

[24]In this paragraph, we report averages and p-values from all 16 periods to capture learning and individual-difference effects over the complete experiment. Table 4 reports these values and also the corresponding values for the data from periods 9–16.

periods: 42% of prosocials exhibit this behavior, while only 11% of individualists do so (cf. Table 4). The investment behavior of subjects who do not always invest does not differ by SVO. However, these subjects react to previous experience: if they invested in the previous period and made a loss, they are less likely to invest in the current period than when they made a non-negative profit (66% vs. 85%). In the Appendix, we look in greater detail at the subjects' bargaining behavior with regard to break-off decisions and the value of X.

6.3 The investor is the low-valuation party

Now consider parameter constellation 2, where player B is the high-valuation party. As illustrated in the right panel of Figure 1, the investment decisions in treatment $A2$ and treatment $B2$ do not differ significantly (cf. Table 3). In both treatments, the investment is made in almost 90% of the cases. Hence, the data clearly contradict Hypothesis 2.

Result 2. *Contradicting Hypothesis 2, the relative frequencies with which investments are made do* not *differ significantly between treatment $B2$ and treatment $A2$.*

In order to understand why Hypothesis 2 is violated, let us again compare the results in Table 2 to the corresponding point predictions in Table 1. In treatment $B2$, there are some notable deviations. In particular, in more than 8% of the cases the parties fail to reach an agreement in the second stage. On average player B makes a larger payment to player A than predicted, so player A's investment costs are not simply considered to be sunk. Thus, player B's profit is smaller than predicted. In line with theory, investing clearly was the profit-maximizing strategy for player A.

The deviations from the point predictions are much stronger in treatment $A2$. The parties reach an agreement in the second stage in around 82% of the cases, and then they agree on a payment that does not differ significantly from the payment in treatment $B2$. Thus, player A's second-stage profit is much larger than player B's second-stage profit, which is in stark contrast to the theoretical prediction. As a consequence, investing was player A's profit-maximizing decision.

The fact that in contrast to the theoretical prediction player A was able to extract a large payment from player B can be explained by player A's behavior when the negotiations were broken off. In this case, player A decides to provide the public good in less than 50% of the cases, while Besley and Ghatak (2001) assume that the public good will always be provided. In parameter constellation 2, the investing party (i.e., player A) seems to expect to be compensated by the high-valuation party (i.e., player B). When player A does not get the payment that he feels entitled to, he may be willing to punish player B by not providing the public good (which hurts player B more than it hurts player A). In contrast, recall that when the negotiations were broken off in treatment $A1$, the public good was indeed almost always provided. In parameter constellation 1, player A is the high-valuation party, so not providing the public good would hurt himself more than player B.

Player A's social value orientation affects the willingness to employ this costly punishment strategy:[25] While individualistic subjects provide the public good in 56% of the cases in which negotiations were broken off, prosocials only provide in 25% of the cases (cf. Table 4). Although bargaining breakdowns occur only rarely and random matching was used so that individual player reputations do not play a role, the use of the punishment strategy influences player B's decision to break off the negotiations: when A did not provide the public good after B broke off the bargaining process, player B is less likely to break off in the following period than when A chose to provide the public good (36% vs. 57%). A loss for player A in the previous period does not significantly affect the investment probability in the current period.

However, the fact that Hypothesis 2 is violated does not mean that the Grossman-Hart-Moore property rights approach itself fails. Instead, by assuming that the public good will always be provided by player A even when player B is the high-valuation party, the analysis is based on misspecified default payoffs. To disentangle Besley and Ghatak's (2001) specification of the default payoffs from the mechanics of the Grossman-Hart-Moore approach, we have conducted the control treatment $A2C$. In this treatment, we exogenously impose that indeed the public good is always provided when the negotiations are broken off, as it was taken for granted by Besley and Ghatak (2001). Indeed, it turns out that in treatment $A2C$ the investment is made only in around 55% of the cases, which is significantly less often than in treatment $A2$ and in treatment $B2$.

Result 3. *In line with Hypothesis 3, investments are made more frequently in treatment $B2$ than in treatment $A2C$.*

Observe that in treatment $A2C$, the players reach an agreement in the second stage in about half of the cases. When the negotiations are broken off, it is typically player B who does so, as he can now rely on the public good being provided (see Figure 2). When an agreement is reached, the payment is significantly smaller than in treatment $A2$. Player A still manages to extract a larger payment from player B than theoretically predicted, so again the sunk investment costs are not completely disregarded by the players. Yet, player A's second-stage profit is now much smaller than player B's second-stage profit. In line with the theoretical prediction, not

[25] Note that in this paragraph we refer to all 16 periods (cf. footnote 24).

investing was player A's profit-maximizing decision. Note that similar to treatment $B1$, it is remarkable that nevertheless slightly more than half of the subjects in the role of player A decided to invest.

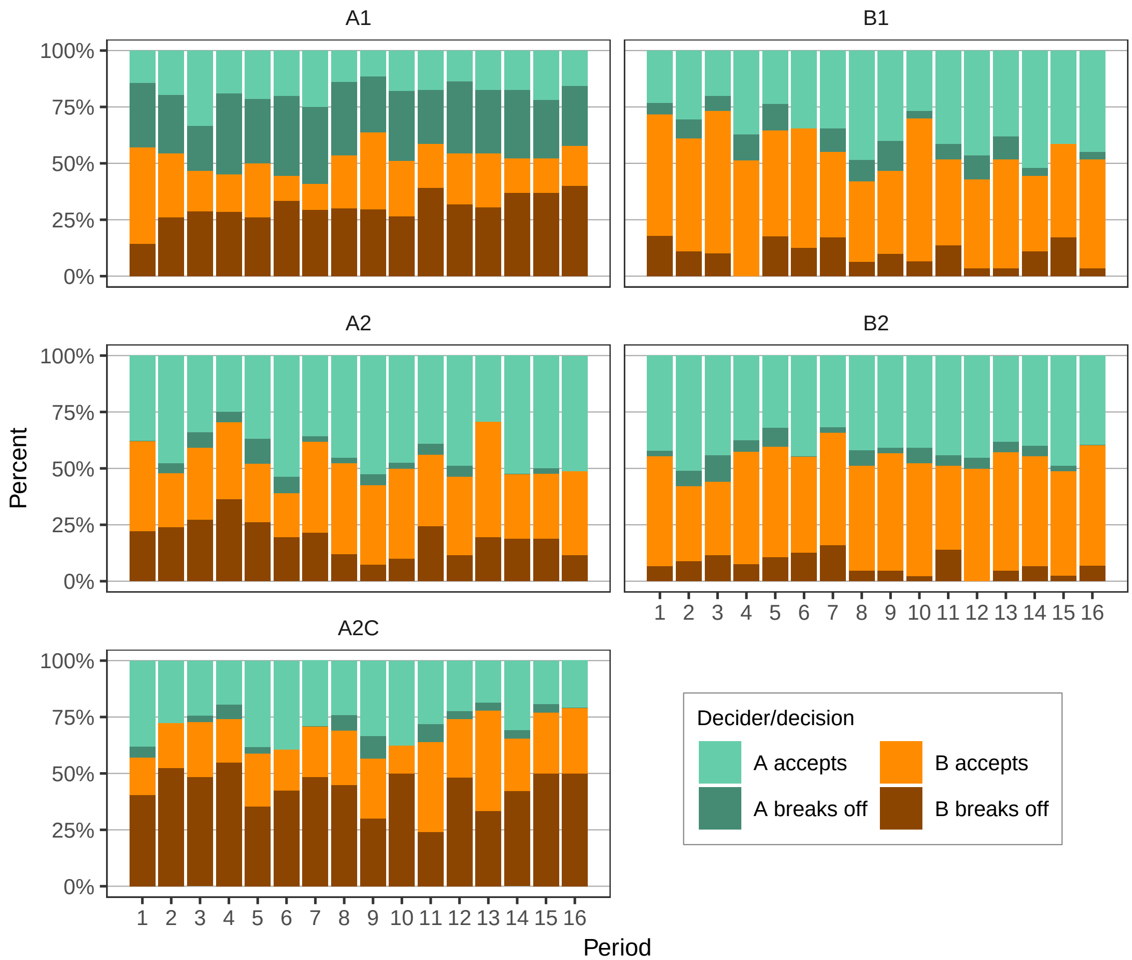

Figure 2. The figure illustrates for each treatment how often an agreement was reached in the bargaining stage. The figure also shows whether it was player A or player B who broke off the negotiations or who accepted an offer made by the other player.

However, unlike in treatment $A2$ and comparable to $B1$, player A learns from past experience regarding the investment decision.[26] Player A is less likely to invest again in the current period in $A2C$ if investing in the previous period resulted in a loss (53% for lagged losses vs. 86% for lagged non-negative profits, cf. Table 4). As mentioned before, player B breaks off the negotiations more often in $A2C$ compared to $A2$. This results in more frequent losses for A when investing, which likely speeds up learning about the value of investing. It is noticeable that the treatment effect regarding

[26]As above, in this paragraph we refer to all 16 periods (cf. footnote 24).

break-offs between $A2$ and $A2C$ is driven by individualistic Bs (see Figure 3). In particular, individualistic Bs break off more often in $A2C$ than in $A2$ (23% vs. 56%, $p = 0.004$, Mann-Whitney U test), while the break-off rates of prosocials do not differ (17% vs. 19%, $p = 0.854$, Mann-Whitney U test). Within treatments, break-off rates do not depend on SVO in treatment $A2$, while individualistic Bs break off more often than prosocial Bs in treatment $A2C$ (see Table 4). Moreover, in treatment $A2C$ prosocial Bs also are willing to give player A a larger value of X in case there is an agreement (41 vs. 33, $p = 0.045$, Mann-Whitney U test). Hence, only individualistic subjects react to the treatment change and exploit the guaranteed provision in treatment $A2C$.

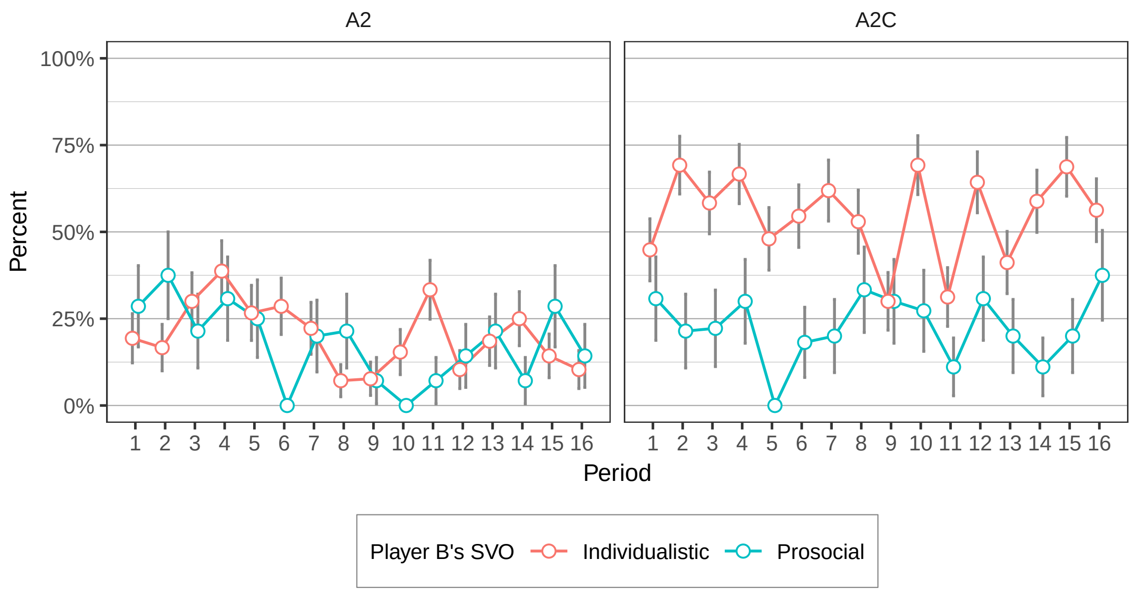

Figure 3. Break-off decisions of player B for treatments $A2$ and $A2C$, conditional on their social value orientation.

7 Concluding remarks

Besley and Ghatak (2001) have applied the Grossman-Hart-Moore property rights theory to discuss the optimal allocation of ownership rights in settings where the involved parties care about the benefits generated by a public good. In particular, their framework allows us to think systematically about "how the private sector can be involved in the provision of public goods, a process that has proceeded apace in the real world without any underpinning model to understand it" (p. 1367). In the meantime, some authors such as Francesconi and Muthoo (2011) have theoretically explored the robustness of Besley and Ghatak's (2001) findings when some of the modeling assumptions are changed, e.g. by allowing the public good to be impure. Our study is complementary to this line of research, as we stay within the original pure public-good framework, but we investigate real human behavior in a controlled laboratory experiment. Our study yields mixed results.

If the investor is the high-valuation party, then indeed substantially more investments are made when this party is the owner than under ownership by the low-valuation party. This result is in line with the usual Grossman-Hart-Moore conclusion that the key investor should be the owner.

Yet, when the investor is the low-valuation party, then ownership by the high-valuation party does not lead to more investments, contradicting Besley and Ghatak's (2001) main novel insight. In particular, they have taken as granted that when the low-valuation party is owner, it will provide the public good when the negotiations are broken off. However, in the experiment it turns out that the low-valuation party often makes the ex post inefficient decision not to provide the public good in this case. In our control treatment where we exogenously impose provision of the public good after the negotiations are broken off, investments are indeed made less often than under ownership by the high-valuation party.

Taken together, our data are in support of the Grossman-Hart-Moore property rights approach. When the disagreement payoffs are correctly specified, then qualitatively ownership matters for the investment incentives as theoretically predicted.[27] The fact that our data do not support Besley and Ghatak's (2001) central new insight is due to the fact that their specification of the disagreement payoffs neglects the parties' willingness to make ex post inefficient decisions in order to punish the other party for unfair behavior.

Tadelis (2016, p. 29) has recently pointed out that in Grossman and Hart's (1986) seminal paper, the ex post decisions (the "q's") played a very prominent role, while later in the follow-up work the ex post decisions have often been suppressed altogether. Indeed, in many papers such as Besley and Ghatak (2001), the ex post decisions that lead to the disagreement payoffs are not modeled explicitly. Our experiment shows that in future research on the property rights approach it may be worthwhile to have a closer look at the ex post decisions that are taken when the negotiations are broken off. Since a party may well be aggrieved when it did not get what it felt entitled to in the bargaining stage, the ex post decision that it then

[27] However, quantitatively the effect of changing the ownership structure is smaller than standard theory predicts, since sunk investment costs are not treated as completely irrelevant in the bargaining stage and hence more investments than predicted occur under the suboptimal ownership structure. This observation is in line with earlier laboratory experiments showing that the hold-up problem is less severe than predicted by standard theory (see e.g. Hackett, 1993).

takes may well be guided by the desire to punish the other party.[28]

We hope that our paper will spur further experimental work on the choice of ownership structures in the context of public-good provision. For instance, conducting experiments to explore impure public goods, repeated interactions, and the role of asymmetric information could be interesting avenues for future research.[29]

[28]Ex post inefficient behavior played a major role in the older literature on transaction cost economics (cf. Williamson, 2000). See also Hart (2017, p. 1744), who has recently stressed the relevance of ex post inefficient decisions and who emphasizes that "ideas of fairness and reasonable behavior" must not be neglected when studying incomplete contracts and control. In Hart and Moore's (2008) contracts-as-reference-points theory, which is focused on the choice between rigid and flexible contracts, a party engages in ex post inefficient shading activities when it feels shortchanged.

[29]Experiments on impure public goods and on repeated interactions in the provision of public goods could be guided by the theoretical studies by Francesconi and Muthoo (2011) and Halonen-Akatwijuka and Pafilis (2016), respectively. See Schmitz (2006) and Goldlücke and Schmitz (2014) for theoretical studies that introduce asymmetric information into the Grossman-Hart-Moore framework.

A Appendix

In the Appendix we study subjects' behavior in the bargaining stage in greater detail. We separately analyze the offers regarding X and the decisions made in reaction to an offer. As additional notation, we refer to an offer a player makes in a bargaining round t as X_t. We start with an overview of the decisions and the duration of bargaining. After that, we look at opening offers and finally conclude with an analysis of bargaining dynamics.

A.1 Bargaining decisions

Figure 4 shows the decisions within each bargaining round t for all five treatments. As either player A or player B was randomly selected to make the opening offer, the figure shows the decisions for groups where player A started in the positive domain of the ordinate, while decisions with player B starting are shown in the negative domain. It is noticeable that the negotiations between the treatments differ not only in decisions, as we have seen in the main body of the paper, but also in duration: Generally, bargaining ends faster and there are more break-offs in treatments with A-ownership compared to treatments with B-ownership (see also Table 5). In the treatments with B-ownership, an agreement between the players was necessary to avoid zero second-stage profits. Hence, neither of the players wanted to break off, but apparently they had different ideas about the appropriate division of the surplus. There were few final decisions per bargaining round, and negotiations carried on for a larger number of rounds than in the A-ownership treatments.

In treatment $A1$, where A has no monetary incentive to accept offers above 0 and B has no incentive to accept offers below 0, in $t = 1$ about half of the negotiations with a final decision in that round are broken off, regardless who makes the opening offer. In $t > 1$, break-off rates among final decisions are even higher. In $A2C$ and to a smaller extent also in $A2$, we see that the role of the player making the opening offer affects the timing of break-offs: A substantial fraction of the break-offs occurs in the first round in which B can make a decision. In particular, in treatment $A2C$, if A started bargaining, a large percentage of negotiations is broken off already in the first bargaining round. Conversely, if B started, break-offs by A in $t = 1$ occur only rarely, while in $t = 2$ in the majority of the cases the negotiations are broken off by player B.

	Mean	Maximum	Median
A1	2.12	13	2
B1	4.52	55	3
A2	3.64	53	3
B2	5.86	58	4
A2C	1.76	13	1

Table 5. Number of bargaining rounds t during the negotiation stage. Data from periods 1–16.

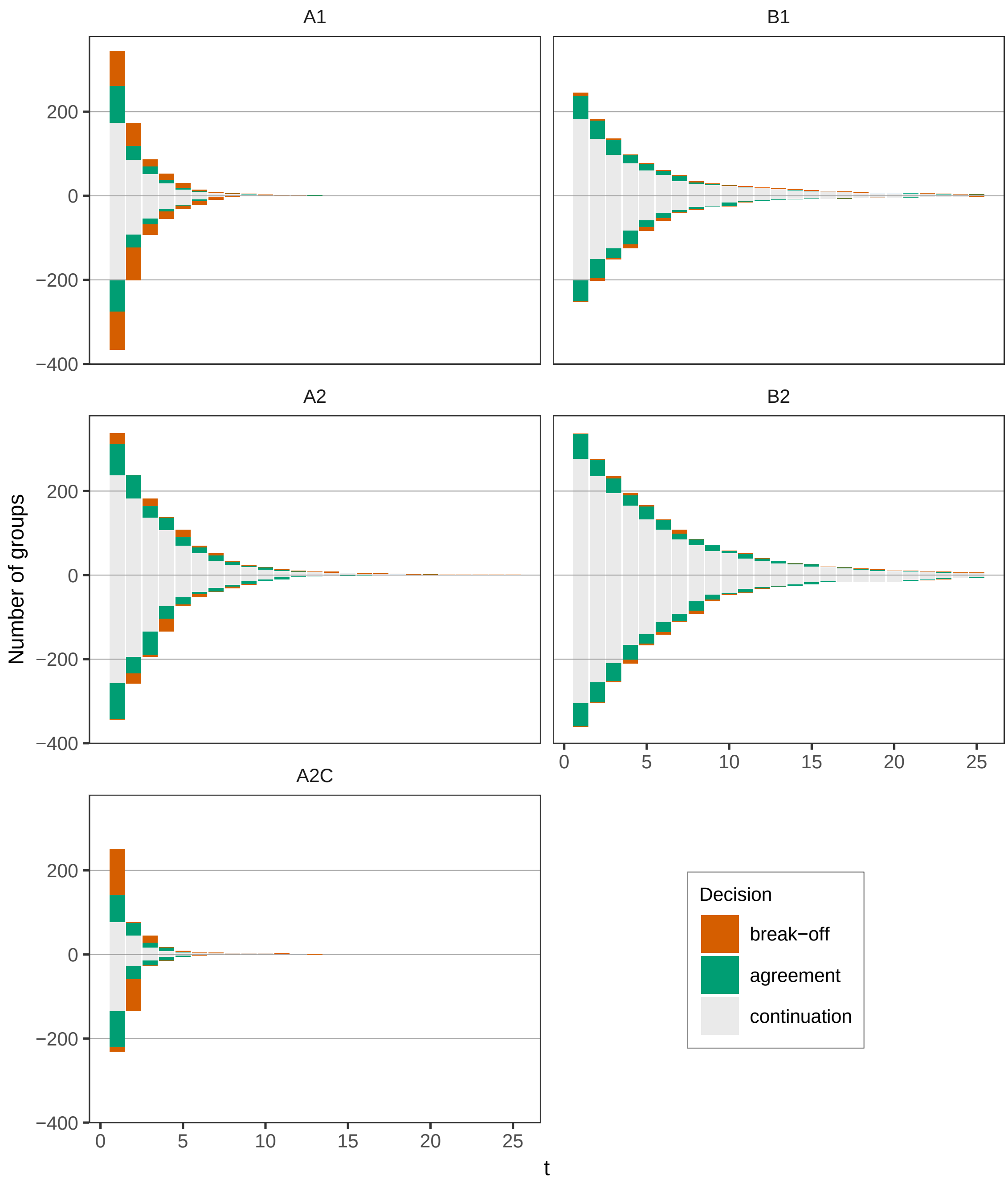

Figure 4. Decisions within each bargaining round. Bars in the positive (negative) domain represent decisions when player A (B) started bargaining. Data from periods $1-16$ and cut off at 25 bargaining rounds.

A.2 Opening offers

We now take a closer look at the opening offers. The behavioral economics literature has shown that subjects tend to exhibit fairness concerns and apply the 50-50 norm where they split the surplus equally (see e.g. Roth and Malouf, 1979, and Andreoni and Bernheim, 2009). However, what exactly constitutes the surplus to be bargained about might be open to debate for our subjects.[30] Observe that the bargaining results do not lie close to the Nash bargaining solution in our treatments except in treatment $A1$. Besides the standard theoretical solution displayed in Table 1, two other benchmarks are useful for organizing our data. As we already mentioned in the main body of the paper, some subjects might not view the investment as sunk and might thus bargain over the ex ante surplus, $v_A + v_B - I$, with an equal split that we call X^a. The subjects might also simply take into account the pie they are currently bargaining over, $v_A + v_B$, without considering the default payoffs, resulting in an equal split X^p. Note that $X^p = 30$ in all treatments, while $X^a = -17.5$ in constellation 1 and $X^a = 62.5$ in constellation 2.[31]

In order to better understand which benchmark our subjects have in mind, in Figure 5 we look at the opening offers X_1. While the offers cover a wide range, it is noticeable that in all four main treatments, player A's modal offer is equal to X^a, the ex ante surplus equal split. In all treatments but $A1$, the modal offer of player B is the equal split of the pie, X^p. In the treatments with B-ownership, this benchmark coincides with the theoretical value of $X = 30$, so we cannot make a clear statement what the subjects have in mind in these treatments.

[30]Note that subjects may have self-serving subjective entitlements regarding their fair share of the surplus, affecting their opening offers and concessions during bargaining (Karagözoğlu and Riedl, 2015; see also Babcock and Loewenstein, 1997, and Konow, 2000).

[31]We use the two closest integers for coding the indicator variable whether a subject's offer was equal to X^a.

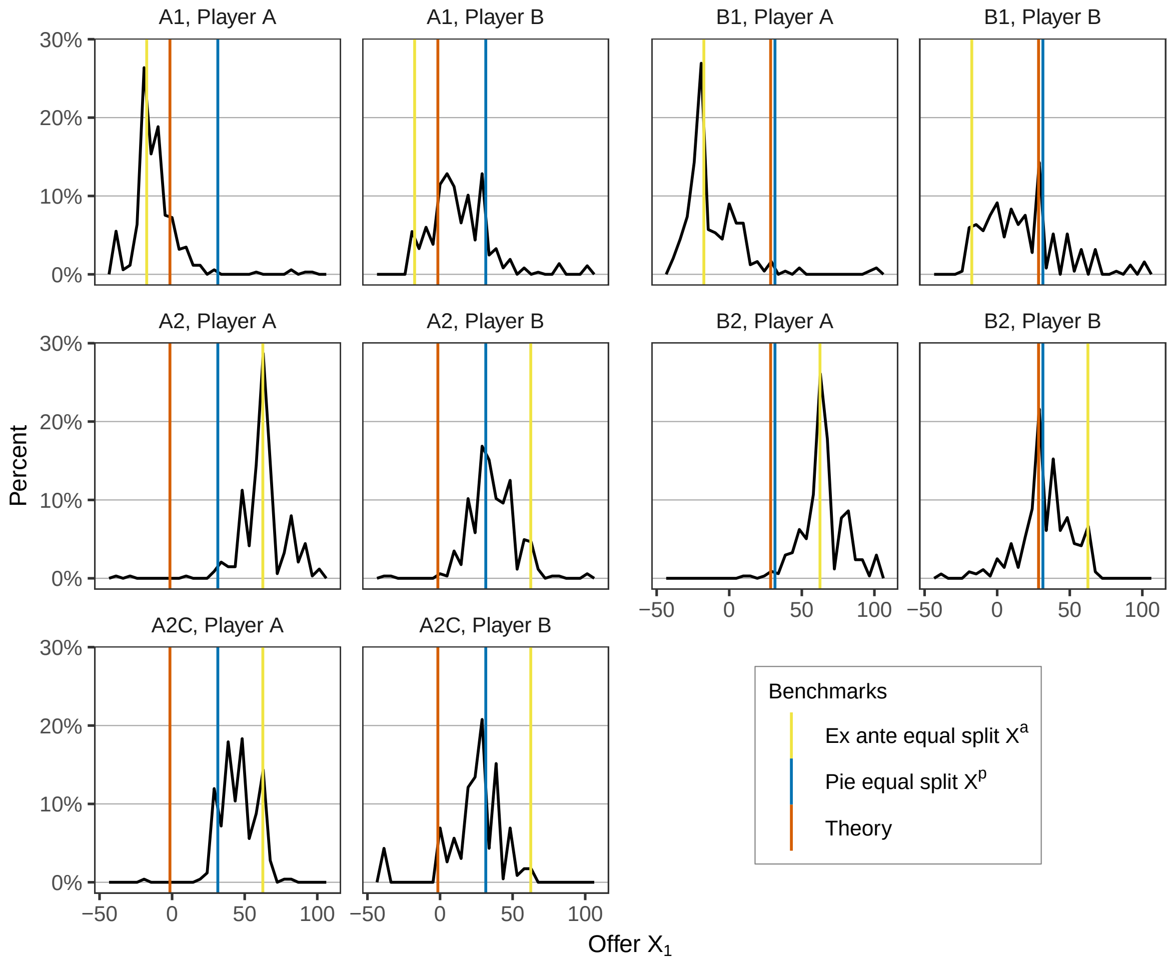

Figure 5. Opening offers conditional on the type of the player who made the opening offer. For each treatment, the left (right) panel shows groups where player A (B) started bargaining. Data from periods $1-16$.

A.3 Bargaining dynamics

Having seen that players A and B start with different ideas about a fair bargaining outcome, a natural question is how they proceed, come to an agreement, or break off the negotiations. Figure 6 displays the progression for negotiations started by player A (the corresponding figure when player B started can be found in the Supplementary Material). For each treatment, the left panel shows negotiations that ended with agreement, while the right panel gives the progression for negotiations that were finally broken off. The different colors correspond to the round t the final decision was made. Solid lines connect offers by player A, while dashed lines refer to offers from B. The point size is proportional to the fraction of decisions that ended in a given t per treatment. As A made the opening offer, B decides in odd bargaining rounds, while A is the decider in even ones.

Let us for example look at successful negotiations in $A2$ that ended in $t = 5$ (green). A starts with an offer of 62.4, the ex ante equal split. B counters with 32.2, an offer close to the simple pie split benchmark of 30. This is in turn countered with 53.5 by A and 39.6 by B. The next offer of 47.6 by A is then accepted by B. Compare this to the progression of negotiations that end in a break-off after 5 bargaining rounds: The initial offers are further apart, and the concession, at least of player A, is smaller. Again looking at negotiations that ended in agreement, an extrapolation of the dashed line connecting offers by B meets the solid line connecting offers by A at the offer where the agreement was made. This is not the case when extrapolating offers that resulted in disagreement. Two observations can generally be made in all the treatments: Successful negotiations exhibit opening and first responding offers that are closer to one another, and have bargaining trajectories that are more concessive. Similar findings were recently also made by Backus et al. (2018), who analyze offers on eBay's Best Offer platform, where buyers and sellers can bargain over the price of a good.

In order to analyze the effect of the bargaining trajectories on decisions and to examine how offers relate to previous offers, it is useful to treat the current offer as a weighted average of the two previous offers analogous to Backus et al. (2018). Think of the two previous offers as opening a space in which the next offer is made. Formally, $X_t = \gamma_t X_{t-2} + (1 - \gamma_t) X_{t-1}$. Larger values of γ_t imply that the player puts more weight on his own previous offer, and that he is less willing to make a concession.[32] Naturally, there exists no γ_1. For calculating γ_2, we use either the lower or upper bound of admissible offers as the value for X_{t-2}, depending on the constellation and which player type made the offer, as this together with the previous offer X_{t-1} defines the reasonable bargaining space in $t = 2$.[33] This implies that values of γ_2 and γ_t for $t > 2$ are not comparable in size, only direction, and hence the following analysis treats them separately.

[32] Note that γ_t is also related to the relative concession measure used by Gächter and Riedl (2005) and Karagözoğlu and Riedl (2015).

[33] The calculation of γ_2 in constellation 1 uses $X_{t-2} = -40$ if player A made the offer and $X_{t-2} = 100$ if player B made the offer. This is reversed in constellation 2.

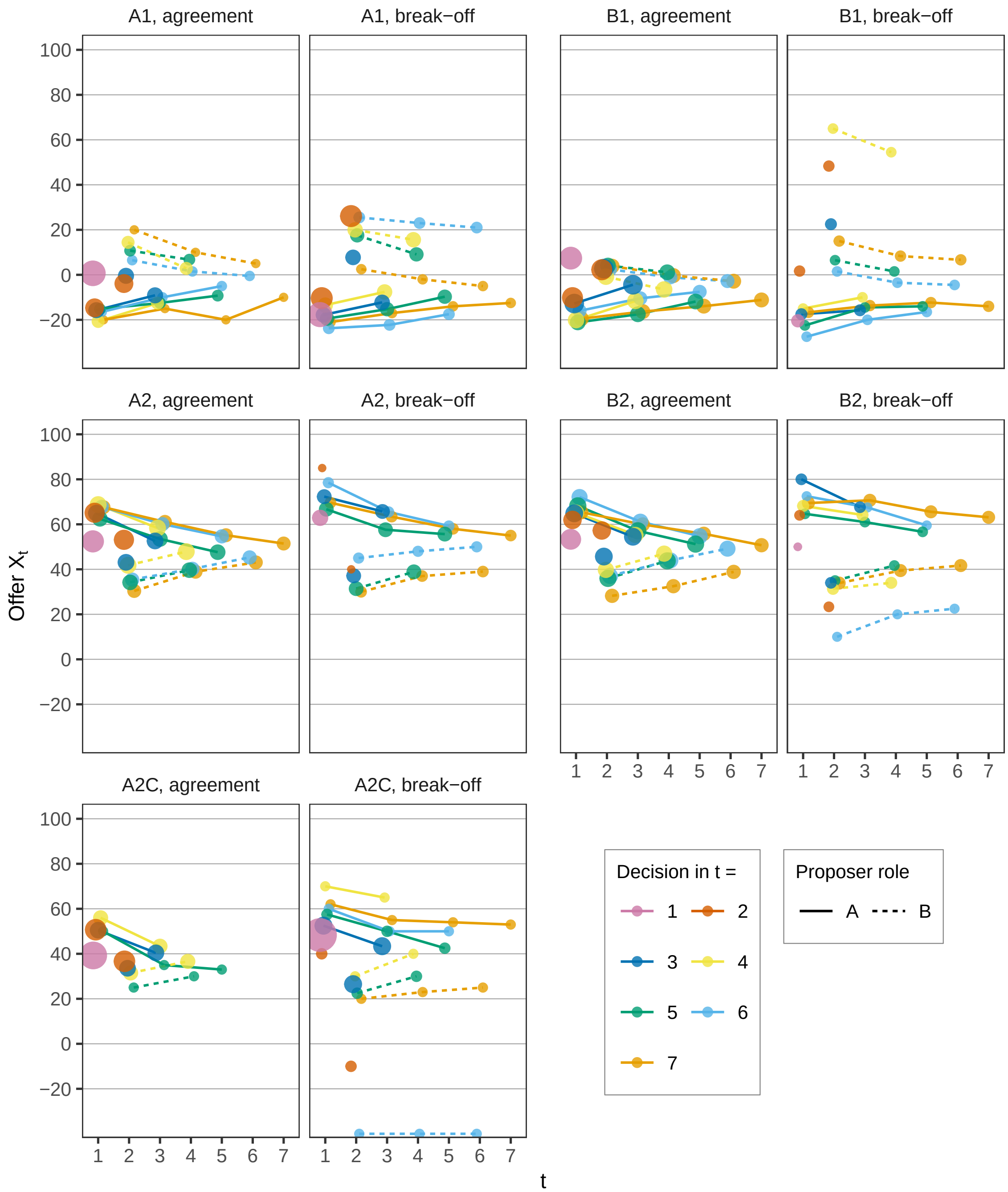

Figure 6. Offer convergence conditional on decision round for bargaining stages ending in $t < 8$. Solid (dashed) lines connect average offers from player A (B). Point size is proportional to the number of offers. Only groups where player A started bargaining. Data from periods $1 - 16$.

Backus et al. (2018) show that on eBay's Best Offer platform, more concessive offers increase the probability of an agreement. Table 6 presents a similar analysis for treatment $A2$ (the results for the other treatments can be found in the Supplementary Material). The first three columns present regression results when player A decides, separately for the first, the second, and the remaining bargaining rounds, the last three columns repeat this for player B as the decision maker. For $t = 1$, the agreement probability increases in X_1 when player A decides and decreases in X_1 when player B decides, as one would intuitively expect. The coefficients of γ_t are negative in the models for $t = 2$ and for $t > 2$ for both players. This implies that more concessive counteroffers increase the acceptance probability, in line with Backus et al.'s (2018) results, and mirroring what we saw in Figure 6. We also include a dummy variable indicating whether the current offer was exactly between the two previous offers, and find that this also increases player A's acceptance probability. In other words, if B splits the difference between offers (not surplus), the likelihood of an agreement increases.

In addition, we also look at reciprocal behavior between the subjects regarding their choice of X_t. Table 7 follows the layout of Table 6, with three columns for each player. Columns 1 and 4 show that players' first counteroffers do not correlate significantly with X_1. The next counteroffer in $t = 3$, however, significantly increases in γ_{t-1} for player A and significantly decreases in γ_{t-1} for B. This is evidence for reciprocity in offers: The smaller the concession the other player made with his previous offer, the stronger the current player moves his offer in his preferred direction (upwards for A and downwards for B). For the remaining rounds, this can also be seen for player B, while the coefficient is not significant for player A for $t > 3$. The significant coefficient of X_{t-1} can be interpreted as a level effect: the previous offer determines to some extent the location of the space between the last two offers in the admissible range between -40 and 100.

Summing up the the analysis of the subjects' bargaining behavior in our experiment, we saw that the two player roles have different subjective entitlements about what is their fair share, reflected in their opening offers. The behavior during the negotiation affected outcomes in that more concessive offers triggered more concessive offers from the other player, and made agreements more likely.

	A, $t=1$	A, $t=2$	A, $t>2$	B, $t=1$	B, $t=2$	B, $t>2$
Offer X_t	0.096***	0.006	0.069***	-0.096*	-0.050	-0.068***
	(5.26)	(0.20)	(6.48)	(-2.10)	(-1.52)	(-7.52)
γ_t		-20.051***	-3.266***		-9.620**	-4.304**
		(-4.89)	(-5.87)		(-3.03)	(-2.76)
Split the difference			1.312***			0.800
			(3.41)			(1.60)
Period	-0.052	-0.032	0.069	-0.064*	-0.003	-0.007
	(-1.33)	(-0.75)	(1.70)	(-2.57)	(-0.06)	(-0.23)
t			0.036			0.020
			(0.97)			(0.63)
Constant	-4.736***	2.522	-2.630***	5.023	3.689**	4.910***
	(-5.84)	(1.41)	(-3.34)	(1.80)	(2.83)	(5.05)
N	344	238	650	338	258	657

t statistics in parentheses

Random effects logistic regression, standard errors clustered on matching group level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6. Probability of acceptance by player A (columns 1-3) and by player B (columns 4-6), regressed on X_{t-1} and γ_t. Treatment $A2$, data from periods 1–16.

	A, $t=2$	A, $t=3$	A, $t>3$	B, $t=2$	B, $t=3$	B, $t>3$
Offer X_{t-1}	0.084	1.106***	0.176**	0.030	1.037***	0.451***
	(1.11)	(16.54)	(2.72)	(0.74)	(43.50)	(8.66)
γ_{t-1}		112.011***	2.041		-63.778***	-12.947***
		(16.38)	(1.05)		(-13.81)	(-4.09)
Period	-0.242	-0.063	-0.539***	0.016	-0.090	0.488
	(-1.91)	(-0.77)	(-3.78)	(0.08)	(-1.16)	(1.54)
t			0.027			-0.416
			(0.15)			(-0.85)
Constant	59.030***	-12.526**	51.685***	39.398***	4.576**	23.498***
	(16.69)	(-3.16)	(19.50)	(6.80)	(3.23)	(4.09)
N	258	182	475	238	195	455

t statistics in parentheses

Random effects regression, standard errors clustered on matching group level.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7. Offer X_t regressed on X_{t-1} and γ_{t-1}. Treatment $A2$, data from periods 1–16.

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Supplementary Material

"Government versus Private Ownership of Public Goods: Experimental Evidence"

David J. Kusterer and Patrick W. Schmitz

Contents

I Additional analyses

I.I Pairwise treatment comparisons over all 16 periods

Table S1 reports the p-values for the pairwise treatment comparisons for the main variables of interest including data from all 16 periods.

	$A1$ vs. $B1$	$A2$ vs. $B2$	$A2$ vs. $A2C$	$A2C$ vs. $B2$
A invests	0.002	0.699	0.009	0.009
A and B reach agreement	0.002	0.009	0.004	0.002
X if agreement	0.818	0.818	0.026	0.041
Provision if no agreement			0.002	
A's second-stage profit	0.002	0.180	0.009	0.002
B's second-stage profit	0.180	0.132	0.002	0.002
A's profit if investment	0.002	0.180	0.009	0.002
A's profit	0.002	0.310	0.026	0.002
B's profit	0.026	0.310	0.485	0.132
Total surplus	0.002	1.000	0.485	0.394

Table S1. p-values for pairwise comparisons between treatments in periods 1–16 (two-tailed Mann-Whitney U tests).

I.II Regressions for acceptance probabilities

Tables S2 to S4 report the regressions for the probability that a player accepts an offer during the bargaining stage for treatments $A1$, $B1$, and $B2$. Regressions for treatment $A2C$ are omitted, since due to the small number of investments and negotiation rounds in this treatment the coefficients could not be estimated reliably.

	A, $t=1$	A, $t=2$	A, $t>2$	B, $t=1$	B, $t=2$	B, $t>2$
Offer X_t	-0.123***	-0.038	-0.021	0.098***	0.019	-0.004
	(-5.39)	(-1.21)	(-0.57)	(3.82)	(0.50)	(-0.08)
γ_t		-16.756***	-5.377		-3.601	-9.739***
		(-4.04)	(-1.61)		(-0.83)	(-5.47)
Split the difference			1.096*			2.031*
			(1.98)			(2.57)
Period	-0.028	-0.085	-0.052	0.037	-0.053	-0.138
	(-0.75)	(-0.70)	(-0.89)	(1.41)	(-0.47)	(-1.52)
t			0.065			0.314
			(0.26)			(1.00)
Constant	-0.562*	1.682	1.305	-0.486	0.313	4.337
	(-2.09)	(1.42)	(0.69)	(-1.42)	(0.14)	(1.78)
N	366	174	211	345	201	211

t statistics in parentheses

Random effects logistic regression, standard errors clustered on matching group level.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table S2. Probability of acceptance by player A (columns 1-3) and by player B (columns 4-6), regressed on X_{t-1} and γ_t. Treatment $A1$, data from periods 1–16.

	$A, t = 1$	$A, t = 2$	$A, t > 2$	$B, t = 1$	$B, t = 2$	$B, t > 2$
Offer X_t	-0.055***	0.048*	-0.021	0.087*	0.018	0.027**
	(-3.49)	(2.09)	(-1.33)	(2.54)	(0.71)	(2.83)
γ_t		-16.720*	-4.198***		-7.239***	-4.354***
		(-2.33)	(-8.53)		(-3.91)	(-7.64)
Split the difference			0.931**			0.347
			(3.19)			(0.99)
Period	-0.058	0.048	0.090***	0.032	0.050	-0.056*
	(-1.70)	(0.70)	(3.74)	(0.33)	(1.07)	(-2.30)
t			-0.060**			-0.035
			(-3.20)			(-1.54)
Constant	-0.706	0.579	0.559	-0.894	1.157*	2.834***
	(-1.09)	(0.43)	(1.38)	(-1.14)	(2.39)	(7.70)
N	252	182	674	245	202	692

t statistics in parentheses

Random effects logistic regression, standard errors clustered on matching group level.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table S3. Probability of acceptance by player A (columns 1-3) and by player B (columns 4-6), regressed on X_{t-1} and γ_t. Treatment $B1$, data from periods 1–16.

	A, $t=1$	A, $t=2$	A, $t>2$	B, $t=1$	B, $t=2$	B, $t>2$
Offer X_t	0.118***	0.048	0.058**	-0.097***	-0.040***	-0.036*
	(7.48)	(0.86)	(3.12)	(-5.33)	(-3.32)	(-2.30)
γ_t		-31.405***	-3.701***		-10.592***	-4.867***
		(-4.09)	(-8.77)		(-3.46)	(-14.78)
Split the difference			1.522***			0.876**
			(5.84)			(3.13)
Period	-0.063	-0.090*	-0.033	0.007	0.020	-0.034*
	(-1.19)	(-2.22)	(-1.07)	(0.11)	(0.44)	(-2.02)
t			0.001			0.026
			(0.02)			(1.17)
Constant	-6.357***	1.300	-1.492*	4.326***	3.598***	3.814***
	(-14.36)	(0.41)	(-2.06)	(6.19)	(3.95)	(4.87)
N	361	277	1399	337	305	1411

t statistics in parentheses

Random effects logistic regression, standard errors clustered on matching group level.

${}^{*}p < 0.05$, ${}^{**}p < 0.01$, ${}^{***}p < 0.001$

Table S4. Probability of acceptance by player A (columns 1-3) and by player B (columns 4-6), regressed on X_{t-1} and γ_t. Treatment $B2$, data from periods 1–16.

I.III Regressions for offers X_t

Tables S5 to S7 report the regressions with the offers X_t as the dependent variable during the bargaining stage for treatments $A1$, $B1$, and $B2$. Regressions for treatment $A2C$ are omitted, since due to the small number of investments and negotiation rounds in this treatment the coefficients could not be estimated reliably.

	A, $t = 2$	A, $t = 3$	A, $t > 3$	B, $t = 2$	B, $t = 3$	B, $t > 3$
Offer X_{t-1}	0.028	1.098***	-0.065	0.013	1.247***	-0.183
	(0.44)	(13.62)	(-0.77)	(0.10)	(7.44)	(-1.70)
γ_{t-1}		-131.373***	-8.398*		89.166***	13.110***
		(-23.12)	(-2.37)		(6.06)	(6.76)
Period	0.131	0.105	0.189	-0.869*	-0.128	-0.826**
	(0.43)	(0.68)	(0.76)	(-2.53)	(-0.53)	(-2.87)
t			1.606***			-0.753
			(15.87)			(-1.24)
Constant	-13.227**	6.509*	-13.408***	18.934***	-17.416**	4.433
	(-3.00)	(2.57)	(-3.38)	(4.78)	(-2.77)	(0.79)
N	201	86	125	174	93	118

t statistics in parentheses

Random effects regression, standard errors clustered on matching group level.

${}^{*}p < 0.05$, ${}^{**}p < 0.01$, ${}^{***}p < 0.001$

Table S5. Offer X_t regressed on X_{t-1} and γ_{t-1}. Treatment $A1$, data from periods 1–16.

	A, $t = 2$	A, $t = 3$	A, $t > 3$	B, $t = 2$	B, $t = 3$	B, $t > 3$
Offer X_{t-1}	0.089	1.114***	0.001	0.175**	1.370***	0.406***
	(1.23)	(12.08)	(0.05)	(2.58)	(9.83)	(4.18)
γ_{t-1}		-129.010***	-0.141		82.155***	11.786***
		(-18.52)	(-1.40)		(4.39)	(4.23)
Period	-0.552	0.076	-0.182	-0.866***	0.142	-0.712
	(-1.91)	(0.48)	(-1.45)	(-3.37)	(0.22)	(-1.91)
t			0.150			-0.301
			(1.16)			(-1.60)
Constant	-6.696	6.609***	-6.084	16.684***	-17.142	8.518***
	(-1.22)	(5.16)	(-1.64)	(6.84)	(-1.40)	(3.53)
N	202	136	556	182	151	523

t statistics in parentheses

Random effects regression, standard errors clustered on matching group level.

${}^{*}p < 0.05$, ${}^{**}p < 0.01$, ${}^{***}p < 0.001$

Table S6. Offer X_t regressed on X_{t-1} and γ_{t-1}. Treatment $B1$, data from periods 1–16.

	A, $t=2$	A, $t=3$	A, $t>3$	B, $t=2$	B, $t=3$	B, $t>3$
Offer X_{t-1}	0.015	0.753***	0.063	-0.203	1.008***	0.123*
	(0.29)	(8.05)	(1.22)	(-1.85)	(12.36)	(2.03)
γ_{t-1}		86.948***	0.454*		-73.107***	-13.510***
		(9.40)	(2.15)		(-15.69)	(-5.27)
Period	0.409***	0.254	0.037	0.103	-0.049	0.063
	(3.60)	(1.35)	(0.23)	(0.44)	(-0.94)	(0.38)
t			-0.477**			0.383***
			(-3.02)			(7.00)
Constant	57.582***	5.506	55.443***	50.306***	8.133**	42.025***
	(23.42)	(1.04)	(35.14)	(6.12)	(2.68)	(21.81)
N	305	235	1176	277	255	1144

t statistics in parentheses

Random effects regression, standard errors clustered on matching group level.

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table S7. Offer X_t regressed on X_{t-1} and γ_{t-1}. Treatment $B2$, data from periods 1–16.

I.IV Offer convergence

Figure S1 presents the convergence of offers during the bargaining stage when player B started bargaining.

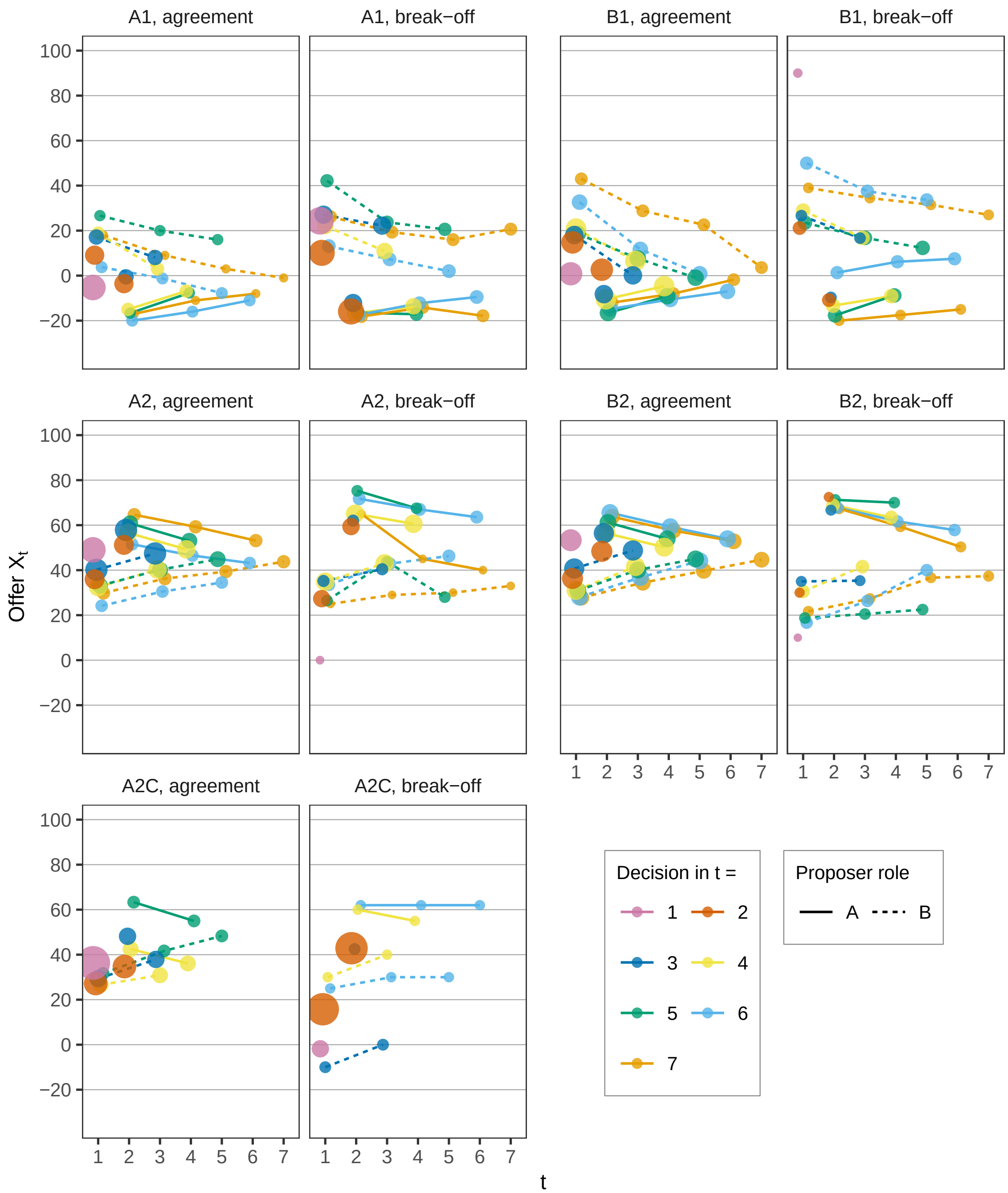

Figure S1. Offer convergence conditional on decision round for bargaining stages ending in $t < 8$. Solid (dashed) lines connect average offers from player A (B). Point size is proportional to the number of offers. Only groups where player B started bargaining. Data from periods $1 - 16$.

II Screenshots from the experiment

Figures S2 to S6 present screenshots of the main decision screens of the experiment for treatment $A1$.

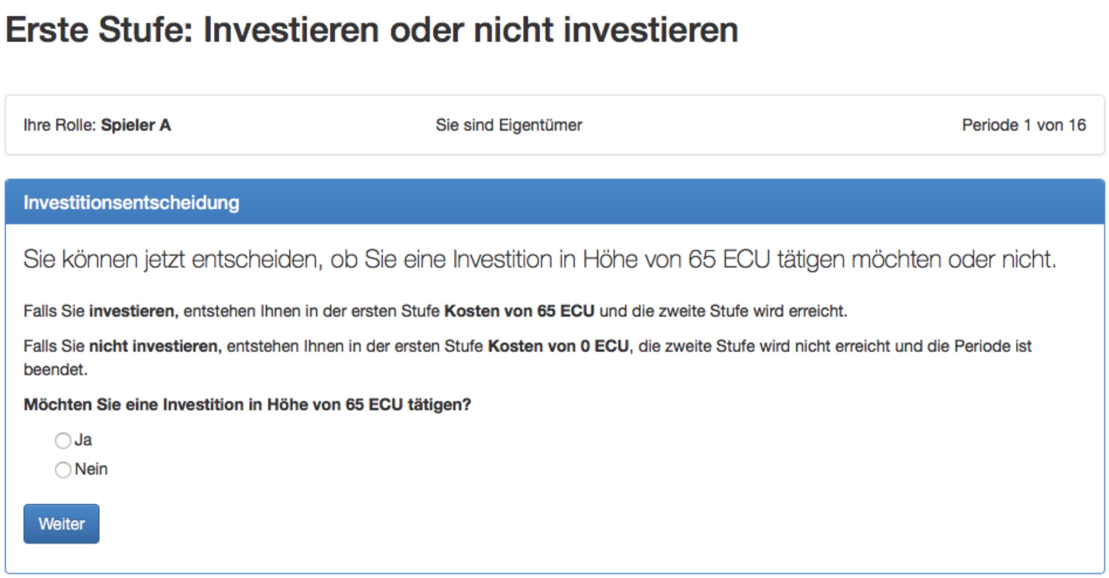

Figure S2. Screenshot of the investment decision in treatment $A1$.

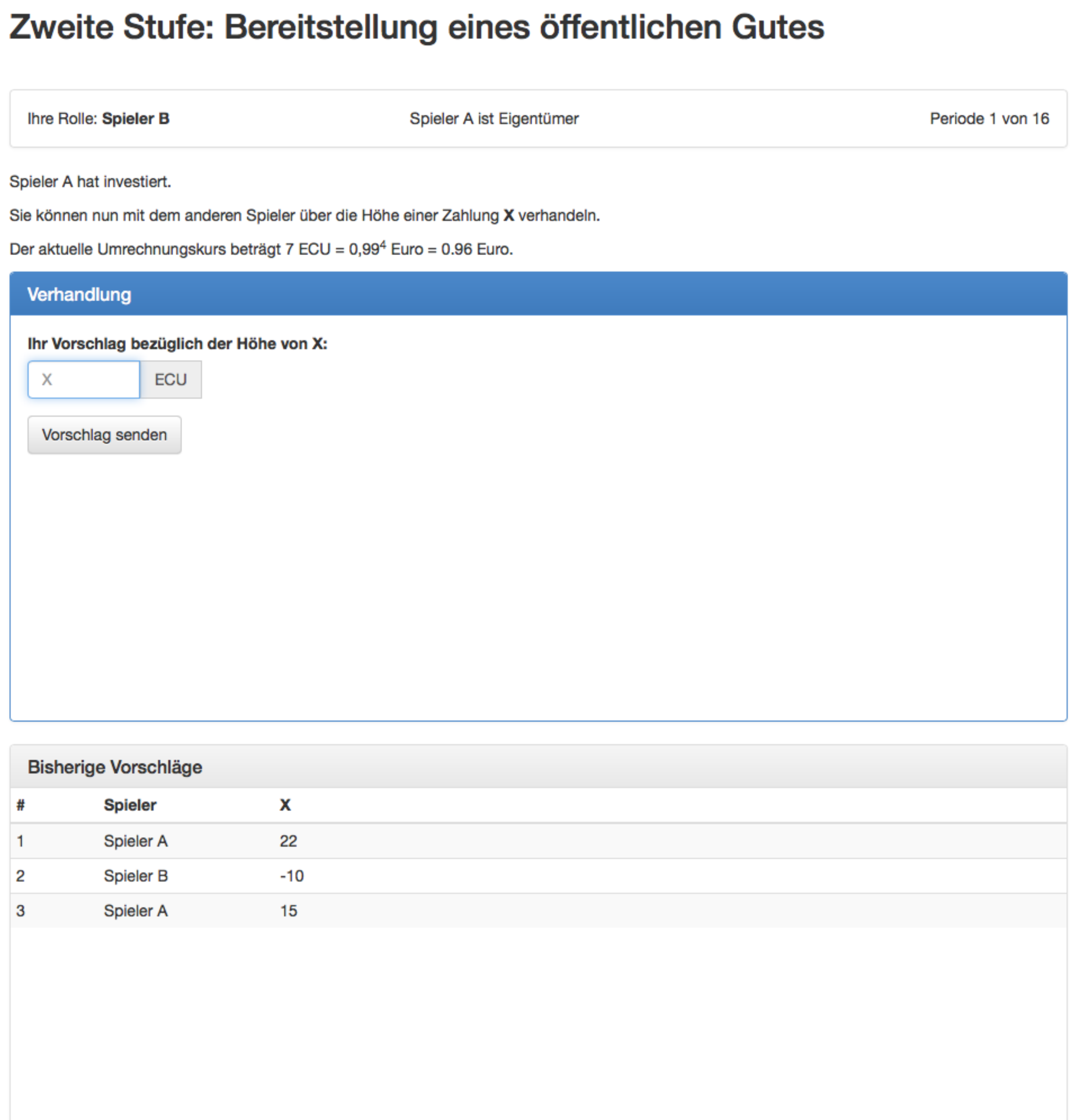

Figure S3. Screenshot of the bargaining interface for making an offer regarding X in treatment $A1$.

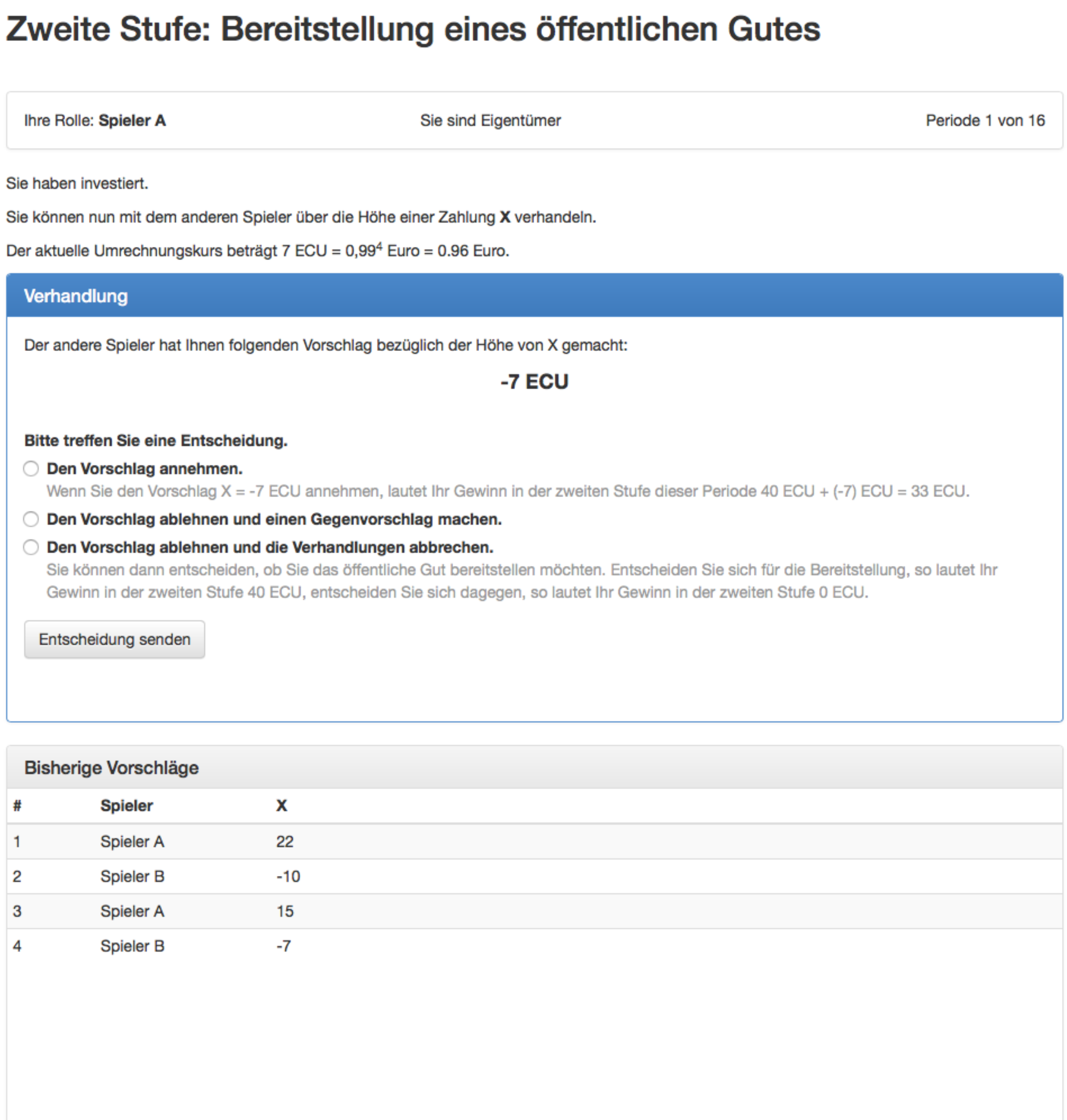

Figure S4. Screenshot of the bargaining interface for making a decision in response to an offer X in treatment $A1$.

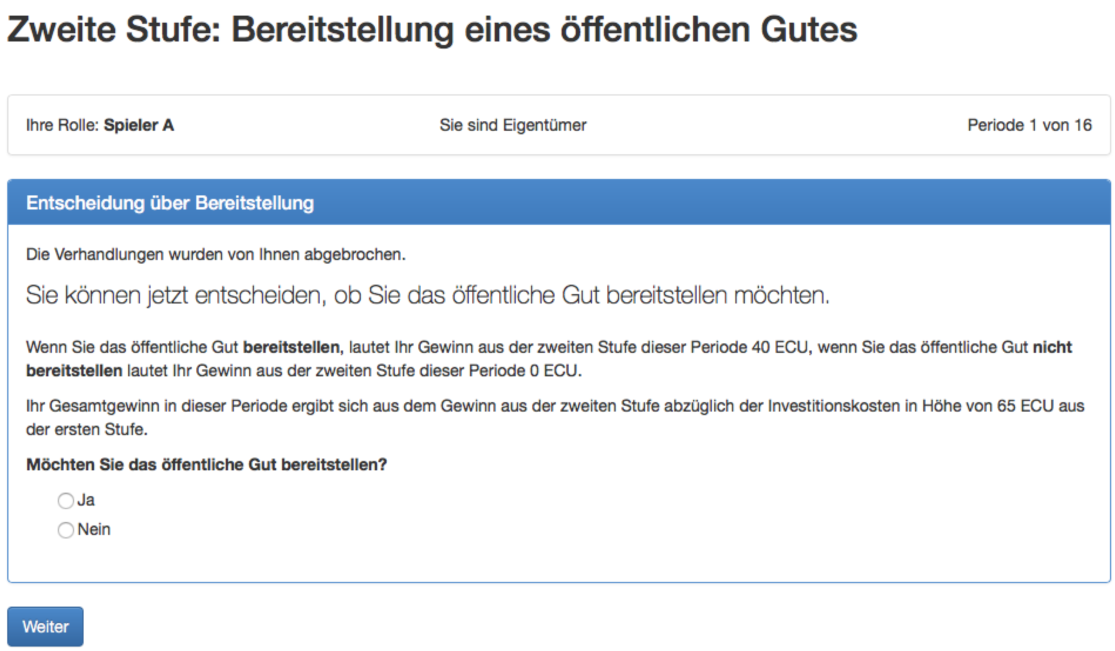

Figure S5. Screenshot of the provision decision after a bargaining break-off in treatment $A1$.

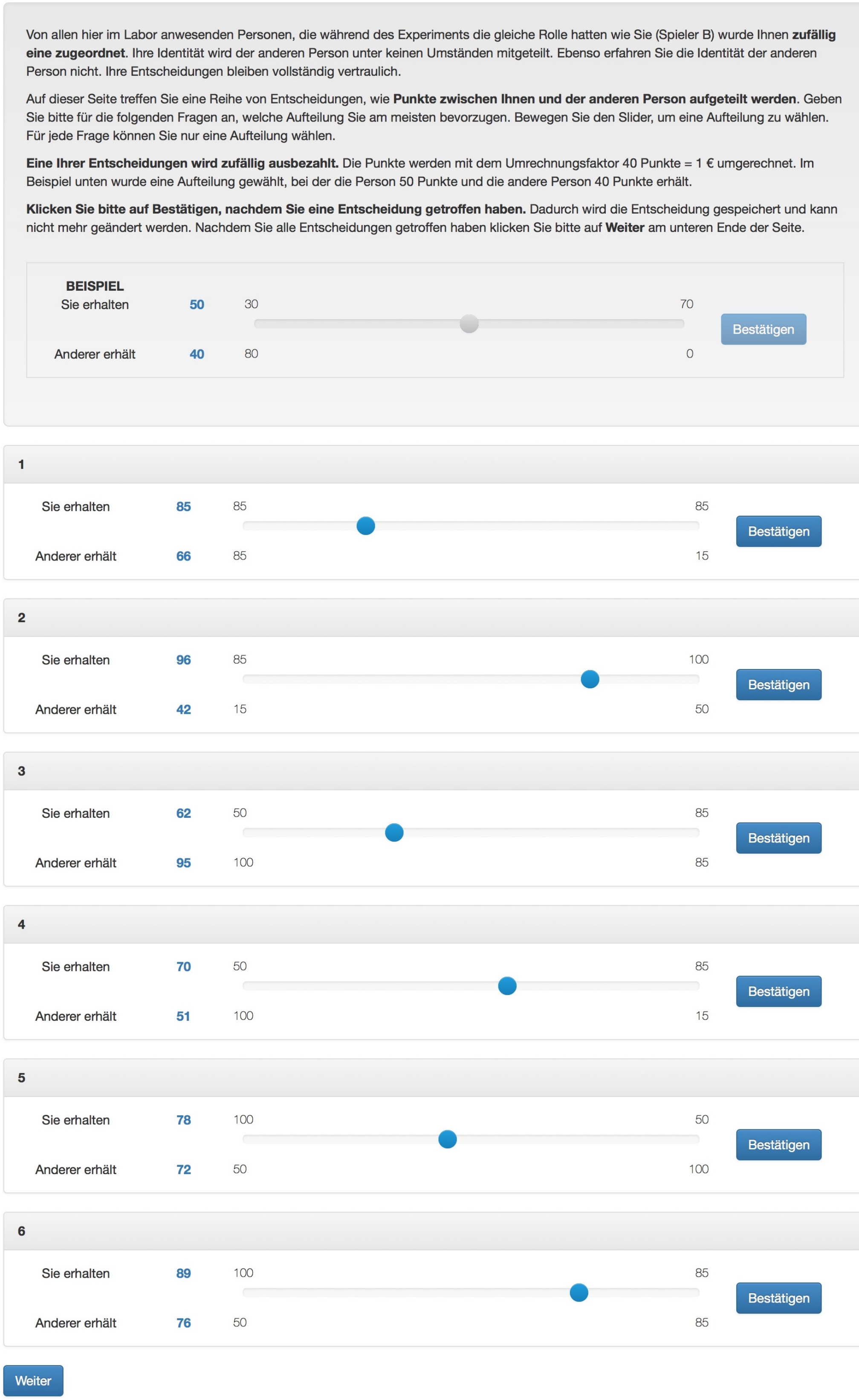

Figure S6. Screenshot of the Social Value Orientation (SVO) task with random values selected. Initially, the sliders are blank.

III Instructions

The following pages contain the instructions that were handed out to the participants in the five treatments of our experiment (translated from German).

Instructions for the treatment A1

Experimental instructions

In this experiment, participants interact within groups of two. You will be randomly assigned to the role of Player A or Player B.

The experiment consists of 16 periods.

You will keep your role (Player A or Player B) in all 16 periods.

At the beginning of each period, you will be randomly matched with a participant with whom you will play in this period.

The currency used in the experiment is called ECU (“Experimental Currency Unit”).

Each period consists of up to two stages:

First stage: To invest or not to invest

In the first stage, Player A decides whether he wants to make an investment of 95 ECU.

If Player A **does not invest**, the second stage will not be reached and the period is over. In this case, the players’ profits are:

Player A: 0 ECU
Player B: 0 ECU

If Player A **invests**, he incurs costs of 95 ECU and the second stage is reached.

Second stage: Provision of a public good

If the second stage is reached, Player A can provide a public good. The value of the public good is 100 ECU for Player A and 40 ECU for Player B.

Player A is the **owner** of the production technology for the public good; i.e., Player A can provide the public good also when no agreement with Player B is reached.

Player A and Player B bargain over a payment X. If the players reach an agreement, Player A makes the payment X to Player B and the public good is provided. The players can alternately send offers about the amount of X to the respective other player. The player to make the first offer is randomly determined.

A player can respond to the other player’s offer X in the following ways: (1) Accept the offer. (2) Reject the offer and make a counteroffer, so a new round of negotiations begins. (3) Reject the offer and terminate the negotiations.

If a player accepts another player's offer X, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 100 ECU - X ECU
Player B: 40 ECU + X ECU

If a player terminates the negotiations, Player A decides subsequently whether or not to provide the public good. Then the period is over and the players' profits in the second stage of the period are as follows:

If Player A provides the public good:

Player A: 100 ECU
Player B: 40 ECU

If Player A does not provide the public good:

Player A: 0 ECU
Player B: 0 ECU

Note that Player A's total profit in the period is given by his profit in the second stage minus his investment costs of 95 ECU incurred in the first stage.

Remark:
In the second stage, only integers between -40 ECU and 100 ECU can be entered as offers for X.

After period 16, the experiment is over.

Your payment:
One of the 16 periods is selected randomly. The profit you made in this period is relevant for your payment. Please note that the profit can be negative.
Your final balance is calculated as follows: 100 ECU are added to your (possibly negative) profit. The resulting amount is paid to you in cash. The exchange rate is as follows:
7 ECU = 0.99^R Euro, where R is the number of negotiation rounds in the second stage of the selected period. Thus, the fewer negotiation rounds have taken place, the more favorable is the exchange rate for you: 7 ECU = 0.99 Euro in case of one round, 7 ECU ≈ 0.98 Euro in case of two rounds, 7 ECU ≈ 0.97 Euro in case of three rounds, 7 ECU ≈ 0.96 Euro in case of four rounds, and so on. If the second stage was not reached, the exchange rate is 7 ECU = 0.99 Euro.

Please note:
Throughout the experiment, all communication is forbidden. Please raise your hand if you have a question. All decisions are **anonymous**, i.e., no participant learns the identity of another participant who has made a particular decision. The payment is also conducted **anonymously**, i.e., no participant learns the payment of another participant.

Instructions for the treatment B1

Experimental instructions

In this experiment, participants interact within groups of two. You will be randomly assigned to the role of Player A or Player B.

The experiment consists of 16 periods.

You will keep your role (Player A or Player B) in all 16 periods.

At the beginning of each period, you will be randomly matched with a participant with whom you will play in this period.

The currency used in the experiment is called ECU ("Experimental Currency Unit").

Each period consists of up to two stages:

First stage: To invest or not to invest

In the first stage, Player A decides whether he wants to make an investment of 95 ECU.

If Player A **does not invest**, the second stage will not be reached and the period is over. In this case, the players' profits are:

Player A: 0 ECU
Player B: 0 ECU

If Player A **invests**, he incurs costs of 95 ECU and the second stage is reached.

Second stage: Provision of a public good

If the second stage is reached, Player A can provide a public good. The value of the public good is 100 ECU for Player A and 40 ECU for Player B.

Player B is the **owner** of the production technology for the public good; i.e., in order to provide the public good Player A must reach an agreement with Player B.

Player A and Player B bargain over a payment X. If the players reach an agreement, Player A makes the payment X to Player B and the public good is provided. The players can alternately send offers about the amount of X to the respective other player. The player to make the first offer is randomly determined.

A player can respond to the other player's offer X in the following ways: (1) Accept the offer. (2) Reject the offer and make a counteroffer, so a new round of negotiations begins. (3) Reject the offer and terminate the negotiations.

If a player accepts another player's offer X, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 100 ECU - X ECU
Player B: 40 ECU + X ECU

If a player terminates the negotiations, the public good is not provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 0 ECU
Player B: 0 ECU

Note that Player A's total profit in the period is given by his profit in the second stage minus his investment costs of 95 ECU incurred in the first stage.

Remark:
In the second stage, only integers between -40 ECU and 100 ECU can be entered as offers for X.

After period 16, the experiment is over.

Your payment:
One of the 16 periods is selected randomly. The profit you made in this period is relevant for your payment. Please note that the profit can be negative.
Your final balance is calculated as follows: 100 ECU are added to your (possibly negative) profit. The resulting amount is paid to you in cash. The exchange rate is as follows:
7 ECU = 0.99^R Euro, where R is the number of negotiation rounds in the second stage of the selected period. Thus, the fewer negotiation rounds have taken place, the more favorable is the exchange rate for you: 7 ECU = 0.99 Euro in case of one round, 7 ECU ≈ 0.98 Euro in case of two rounds, 7 ECU ≈ 0.97 Euro in case of three rounds, 7 ECU ≈ 0.96 Euro in case of four rounds, and so on. If the second stage was not reached, the exchange rate is 7 ECU = 0.99 Euro.

Please note:
Throughout the experiment, all communication is forbidden. Please raise your hand if you have a question. All decisions are **anonymous**, i.e., no participant learns the identity of another participant who has made a particular decision. The payment is also conducted **anonymously**, i.e., no participant learns the payment of another participant.

Instructions for the treatment A2

Experimental instructions

In this experiment, participants interact within groups of two. You will be randomly assigned to the role of Player A or Player B.

The experiment consists of 16 periods.

You will keep your role (Player A or Player B) in all 16 periods.

At the beginning of each period, you will be randomly matched with a participant with whom you will play in this period.

The currency used in the experiment is called ECU ("Experimental Currency Unit").

Each period consists of up to two stages:

First stage: To invest or not to invest

In the first stage, Player A decides whether he wants to make an investment of 65 ECU.

If Player A **does not invest**, the second stage will not be reached and the period is over. In this case, the players' profits are:

Player A: 0 ECU
Player B: 0 ECU

If Player A **invests**, he incurs costs of 65 ECU and the second stage is reached.

Second stage: Provision of a public good

If the second stage is reached, Player A can provide a public good. The value of the public good is 40 ECU for Player A and 100 ECU for Player B.

Player A is the **owner** of the production technology for the public good; i.e., Player A can provide the public good also when no agreement with Player B is reached.

Player A and Player B bargain over a payment X. If the players reach an agreement, Player B makes the payment X to Player A and the public good is provided. The players can alternately send offers about the amount of X to the respective other player. The player to make the first offer is randomly determined.

A player can respond to the other player's offer X in the following ways: (1) Accept the offer. (2) Reject the offer and make a counteroffer, so a new round of negotiations begins. (3) Reject the offer and terminate the negotiations.

If a player accepts another player's offer X, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 40 ECU + X ECU
Player B: 100 ECU - X ECU

If a player terminates the negotiations, Player A decides subsequently whether or not to provide the public good. Then the period is over and the players' profits in the second stage of the period are as follows:

If Player A provides the public good:

Player A: 40 ECU
Player B: 100 ECU

If Player A does not provide the public good:

Player A: 0 ECU
Player B: 0 ECU

Note that Player A's total profit in the period is given by his profit in the second stage minus his investment costs of 65 ECU incurred in the first stage.

Remark:
In the second stage, only integers between -40 ECU and 100 ECU can be entered as offers for X.

After period 16, the experiment is over.

Your payment:
One of the 16 periods is selected randomly. The profit you made in this period is relevant for your payment. Please note that the profit can be negative.
Your final balance is calculated as follows: 70 ECU are added to your (possibly negative) profit. The resulting amount is paid to you in cash. The exchange rate is as follows:
7 ECU = 0.99^R Euro, where R is the number of negotiation rounds in the second stage of the selected period. Thus, the fewer negotiation rounds have taken place, the more favorable is the exchange rate for you: 7 ECU = 0.99 Euro in case of one round, 7 ECU ≈ 0.98 Euro in case of two rounds, 7 ECU ≈ 0.97 Euro in case of three rounds, 7 ECU ≈ 0.96 Euro in case of four rounds, and so on. If the second stage was not reached, the exchange rate is 7 ECU = 0.99 Euro.

Please note:
Throughout the experiment, all communication is forbidden. Please raise your hand if you have a question. All decisions are **anonymous**, i.e., no participant learns the identity of another participant who has made a particular decision. The payment is also conducted **anonymously**, i.e., no participant learns the payment of another participant.

Instructions for the treatment B2

Experimental instructions

In this experiment, participants interact within groups of two. You will be randomly assigned to the role of Player A or Player B.

The experiment consists of 16 periods.

You will keep your role (Player A or Player B) in all 16 periods.

At the beginning of each period, you will be randomly matched with a participant with whom you will play in this period.

The currency used in the experiment is called ECU (“Experimental Currency Unit”).

Each period consists of up to two stages:

First stage: To invest or not to invest

In the first stage, Player A decides whether he wants to make an investment of 65 ECU.

If Player A **does not invest**, the second stage will not be reached and the period is over. In this case, the players’ profits are:

Player A: 0 ECU
Player B: 0 ECU

If Player A **invests**, he incurs costs of 65 ECU and the second stage is reached.

Second stage: Provision of a public good

If the second stage is reached, Player A can provide a public good. The value of the public good is 40 ECU for Player A and 100 ECU for Player B.

Player B is the **owner** of the production technology for the public good; i.e., in order to provide the public good Player A must reach an agreement with Player B.

Player A and Player B bargain over a payment X. If the players reach an agreement, Player B makes the payment X to Player A and the public good is provided. The players can alternately send offers about the amount of X to the respective other player. The player to make the first offer is randomly determined.

A player can respond to the other player’s offer X in the following ways: (1) Accept the offer. (2) Reject the offer and make a counteroffer, so a new round of negotiations begins. (3) Reject the offer and terminate the negotiations.

If a player accepts another player's offer X, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 40 ECU + X ECU
Player B: 100 ECU - X ECU

If a player terminates the negotiations, the public good is not provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 0 ECU
Player B: 0 ECU

Note that Player A's total profit in the period is given by his profit in the second stage minus his investment costs of 65 ECU incurred in the first stage.

Remark:
In the second stage, only integers between -40 ECU and 100 ECU can be entered as offers for X.

After period 16, the experiment is over.

Your payment:
One of the 16 periods is selected randomly. The profit you made in this period is relevant for your payment. Please note that the profit can be negative.
Your final balance is calculated as follows: 70 ECU are added to your (possibly negative) profit. The resulting amount is paid to you in cash. The exchange rate is as follows:
7 ECU = 0.99^R Euro, where R is the number of negotiation rounds in the second stage of the selected period. Thus, the fewer negotiation rounds have taken place, the more favorable is the exchange rate for you: 7 ECU = 0.99 Euro in case of one round, 7 ECU ≈ 0.98 Euro in case of two rounds, 7 ECU ≈ 0.97 Euro in case of three rounds, 7 ECU ≈ 0.96 Euro in case of four rounds, and so on. If the second stage was not reached, the exchange rate is 7 ECU = 0.99 Euro.

Please note:
Throughout the experiment, all communication is forbidden. Please raise your hand if you have a question. All decisions are **anonymous**, i.e., no participant learns the identity of another participant who has made a particular decision. The payment is also conducted **anonymously**, i.e., no participant learns the payment of another participant.

Instructions for the treatment A2C

<u>Experimental instructions</u>

In this experiment, participants interact within groups of two. You will be randomly assigned to the role of Player A or Player B.

The experiment consists of 16 periods.

You will keep your role (Player A or Player B) in all 16 periods.

At the beginning of each period, you will be randomly matched with a participant with whom you will play in this period.

The currency used in the experiment is called ECU ("Experimental Currency Unit").

Each period consists of up to two stages:

First stage: To invest or not to invest

In the first stage, Player A decides whether he wants to make an investment of 65 ECU.

If Player A **does not invest**, the second stage will not be reached and the period is over. In this case, the players' profits are:

Player A: 0 ECU
Player B: 0 ECU

If Player A **invests**, he incurs costs of 65 ECU and the second stage is reached.

Second stage: Provision of a public good

If the second stage is reached, a public good can be provided. The value of the public good is 40 ECU for Player A and 100 ECU for Player B.

Player A and Player B bargain over a payment X. If the players reach an agreement, Player B makes the payment X to Player A and the public good is provided. The players can alternately send offers about the amount of X to the respective other player. The player to make the first offer is randomly determined.

A player can respond to the other player's offer X in the following ways: (1) Accept the offer. (2) Reject the offer and make a counteroffer, so a new round of negotiations begins. (3) Reject the offer and terminate the negotiations.

If a player accepts another player's offer X, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 40 ECU + X ECU
Player B: 100 ECU - X ECU

If a player terminates the negotiations, the public good is provided. Then the period is over and the players' profits in the second stage of the period are as follows:

Player A: 40 ECU
Player B: 100 ECU

Note that Player A's total profit in the period is given by his profit in the second stage minus his investment costs of 65 ECU incurred in the first stage.

Remark:
In the second stage, only integers between -40 ECU and 100 ECU can be entered as offers for X.

After period 16, the experiment is over.

Your payment:
One of the 16 periods is selected randomly. The profit you made in this period is relevant for your payment. Please note that the profit can be negative.
Your final balance is calculated as follows: 70 ECU are added to your (possibly negative) profit. The resulting amount is paid to you in cash. The exchange rate is as follows:
7 ECU = 0.99^R Euro, where R is the number of negotiation rounds in the second stage of the selected period. Thus, the fewer negotiation rounds have taken place, the more favorable is the exchange rate for you: 7 ECU = 0.99 Euro in case of one round, 7 ECU ≈ 0.98 Euro in case of two rounds, 7 ECU ≈ 0.97 Euro in case of three rounds, 7 ECU ≈ 0.96 Euro in case of four rounds, and so on. If the second stage was not reached, the exchange rate is 7 ECU = 0.99 Euro.

Please note:
Throughout the experiment, all communication is forbidden. Please raise your hand if you have a question. All decisions are **anonymous**, i.e., no participant learns the identity of another participant who has made a particular decision. The payment is also conducted **anonymously**, i.e., no participant learns the payment of another participant.