Endogenous Claims and Collective Production: An Experimental Study on the Timing of Profit-Sharing Negotiations and Production

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Abstract

We explore the efficiency and distributive implications (theoretically and experimentally) of a multilateral bargaining model with endogenous production of the surplus under two different timings: ex ante and ex post bargaining. Both timings are commonly observed in business partnerships and alliance formations. The theoretical predictions confirm an intuitive economic tenet: in ex post bargaining, effort is considered sunk and opportunistic bargaining behavior will dissuade players from producing. On the other hand, ex ante bargaining entails an allocation of ownership shares that induces at least certain members to invest in the common fund because their return is guaranteed. Experiments show opposite results: ex ante bargaining yields almost fully efficient outcomes while the reverse timing entails near zero efficiency.

1. Introduction

Whenever two or more persons, countries, or firms engage in a mutually beneficial activity it is quite common that they will negotiate how to divide the benefits resulting from their joint effort. For example, certain medical groups, law firms, and other partnerships have been reported to hold end-of-year meetings to redistribute profits (or at least a portion of them) while others assign profit shares at the beginning of the year.[1] In fact, multiple management consulting firms offer advice to partnerships on how to design an optimal partner compensation plan in order to induce effort and maximize profits.[2] One particular question that partners must ask regarding their profit-sharing scheme is: "Will the distribution be prospective (distribution percentages or units of participation determined in advance of the year) or retrospective (distribution percentages or units of participation determined when year-end results are known)?" (Rose 2011).[3] In this article we make use of a laboratory experiment to examine how the timing of profit-sharing negotiations with respect to productive decisions affects both the distribution of profits and the efficiency levels that partnerships can achieve.

Several studies have been concerned with whether a firm should be jointly or individually owned (Hart and Moore 1996; for an experiment see Fehr, Kremhelmer, and Schmidt 2008), why partnerships and other joint ownership structures exist (Levin and Tadelis 2005; Alchian and Demsetz 1972), compensation systems in partnerships (Gilson and Mnooking 1985; Lang and Gordon 1995), and even on how to dissolve partnerships (Morgan 2004).[4] Here,

[1] In a lock-step system partners are assigned ownership shares based on their status or seniority within the firm. Such profit-sharing scheme is an example of a compensation plan in which partners know their shares of the profits prior to engaging in productive activities. This system is most widely spread in European law firms but not so common in U.S. and Canadian firms according to a three surveys by Edge International (Wessman and Kerr, 2015).

[2] See the report on partner compensation systems in law firms by Edge International (Anderson, 2001), Altman and Weil (Cotterman, 2014), and surveys by the consulting firms Edge International (Wessman and Kerr, 2015) and Major, Lindsey, and Africa (Lowe, 2014).

[3] Another setting in which the timing of bargaining with respect to production is essential is the choice of technological standards (see Llanes and Poblete 2014). Setting a standard creates rents which are to be divided among the firms of an industry. How these rents are divided and the timing of rent-sharing with respect to the choice of the standard will likely impact the outcome of negotations to choose a standard.

[4] Levin and Tadelis argue that "[p]rofit sharing leads individuals to be particularly selective as to whom

partnerships are broadly represented as a group of players who posses voting rights and must agree on how to share profits which are endogenously determined via individual voluntary efforts or investments.[5] We focus on the interaction between profit-sharing agreements and rent-generating incentives in a setting in which (1) partners can propose and vote on profit-sharing agreements, (2) no partner has total control over the agenda of negotiations, and (3) all engage in production voluntarily.

The bargaining game and corresponding experiments consist of a negotiation phase and a production stage. Generally speaking, our model is a game of alternating offers and voting in which the surplus to divide is endogenously determined; the latter is an important feature that the standard divide-the-dollar models have typically abstracted from.[6] We explore the efficiency implications by providing a theoretical benchmark and an experimental test of two different timings: ex post bargaining, which we call *redistribution*, and ex ante bargaining, which we call *pre-distribution*. Under pre-distributive bargaining, partners negotiate how to divide equity (percentage shares of ownership) among themselves and once an agreement is reached, they proceed to a simultaneous game of investments. With redistributive bargaining, investments take place prior to profit-sharing negotiations.[7]

Our theoretical framework can be interpreted as the merging of two influential models in economics: the Baron and Ferejohn (1989) model of multilateral bargaining and the linear public goods game.[8] While the canonical linear public goods game exogenously establishes

they take on as partners. This feature of partnerships assures clients of quality service" (131). Fehr, Kremhelmer, and Schmidt (2008) show that subjects in an experiment were more likely to choose a joint ownership structure (partnership) over a single ownership. Moreover, partnerships implemented efficient outcomes more often, findings which go against the predictions of Hart and Moore (1996).

[5]We have abstracted from the partnership formation process, which can be an essential component in determining efficiency.

[6]See Rubinstein (1982) for bilateral bargaining and Osborne and Rubinstein (1990) for a comprehensive analysis of such games. See Baron and Ferejohn (1989), Krishna and Serrano (1996) for multilateral bargaining. Bataglinni and Coate (2005, 2008) consider a dynamic model of taxing and spending in which a nation's budget is determined endogenously through labor decisions which are a function of the taxing schemes agreed in the bargaining game. For cooperative (Nash) bargaining with an endogenous fund and subjective claims see Gächter and Riedl (2006) and Karagözoğlu and Riedl (2015).

[7]In both cases, the production technology that we consider is linear, additively separable, and symmetric. In keeping the productive setting as simple as possible, we can focus on the interaction between the institutional constraints given by the bargaining protocol and the productive technology.

[8]In the standard linear public goods game all players simultaneously choose an investment level which is

an equal share of the common fund to every player, both redistributive and pre-distributive bargaining allow to exclude some players from consumption of the joint surplus. In spite of the non-excludability violation, the redistribution game can be conceived of as public goods game with *a priori* undefined claims and the pre-distribution game as one in which claims are endogenously determined via bargaining. A wealth of theoretical and experimental studies exists in the fields of Public Economics, Political Science, and Political Economy that build on the aforementioned games. Thus, our model and experiments provide a bridge between these streams of literature which are discussed in Section 2.

The theory predicts that in the redistribution game, investments are considered sunk and opportunistic bargaining behavior will dissuade players from investing in the joint project. In contrast, the equilibrium prediction under pre-distributive bargaining entails a distribution of shares that induces at least certain members to invest in the common fund because their return is guaranteed and the hold-up problem is absent.[9,10]

Our experimental results contradict unequivocally the theoretical predictions. The treatments of pre-distribution entail very low levels of efficiency while redistribution gives rise to almost full investments. The large difference in investment levels is surprising because the equity shares received in the pre-distribution treatment are not significantly different from the shares (as a percentage of the total fund) received in the redistribution game. Our analysis shows that the reason for the sustained difference in investments between treatments is because subjects largely tend to condition the division of the common fund on each member's investment in the redistribution treatment, a strategy that is not possible when determining shares ex ante. A strong norm of investment-based fairness is enforced

multiplied times a productivity parameter greater than one but smaller than the number of players. The total fund is divided in equal parts. Even though it is socially optimal for every player to invest in the common fund, the individually optimal choice is to not invest and appropriate a portion of what others invest. As a consequence, the Nash equilibrium yields the most inefficient outcome. The Baron and Ferejohn (1989) game is described in detail in Sections 2 and 3.

[9] In both models we use the solution concept of stationary subgame perfect equilibrium, a standard refinement in the bargaining literature.

[10] For an experiment on how renegotiation (after investments) in a bilateral exchange setting can improve efficiency see Hoppe and Schmitz (2011), a result which is contrary to the predictions of standard contract theory.

via the bargaining outcomes in which low contributors are offered smaller shares and high contributors are rewarded with higher shares. This is particularly striking in a setting where partners are not fixed and reputation concerns play a negligible role. As the data show, a player's contribution to the common project also serves the purpose of acting as a credible behavioral commitment to reject low offers (those below her contribution) and to not allow for the proposer to extract excessively inequitable shares. In other words, contributions create *implicit property rights* which are largely enforced in the bargaining stage.

In the pre-distribution treatments, subjects implement ownership agreements in which no one finds it profitable to invest, and free-riding predominates. A generalized downward trend in investments is observed throughout the experimental sessions which is reminiscent of the stylized behavior reported in standard public goods games (Ledyard 1995). One of our initial conjectures was that subjects could feel compelled to invest whenever they voted in favor of a proposal and could perceive others' favorable voting decisions as signals of good will. In turn, these signals would elicit a collective reciprocal behavior in the investment stage. A similar argument has been set forth to explain the findings in experiments with *endogenous institutional choice* in which subjects tend to act more cooperatively and attain efficient outcomes more often when they have a say, by choice or vote, in creating or modifying the environment (see Kosfeld, Okada, and Riedl 2009 and Dal Bó, Foster, and Putterman 2010). However, we did not find strong support for the effectiveness of endogenous ownership agreements in fostering economic efficiency.

Theories of inequality aversion (Bolton and Ockenfels 2000; Fehr and Schmidt 1999) are not useful in explaining our experimental results. Inequality of outcomes is quite prevalent in the game of redistribution since a member who invests a small amount would generally be offered a low share thus receiving smaller payoffs compared to a high investor. Instead, we find that the theory of inequity aversion (Adams 1963; Selten 1987) is more useful in describing our bargaining outcomes in both redistributive and pre-distributive bargaining. Inequity is broadly construed as a feeling perceived from a discrepancy between one's proportion of rewards to costs relative to others in the comparison group. We extend this theory to apply to cases where rewards are assigned ex ante and costs bourne ex post as in pre-distribution. If all partners are expected to invest the same amount inequity theory helps account for the even distribution of shares among partners in ex ante bargaining. We elucidate upon this issue in Section 7.

The consistently inefficient outcomes observed in the pre-distribution experiments led us to analyze the effect of group size by considering a treatment with smaller partnerships while maintaining the voting rule (simple majority) and productivity constant. Our theory poses a trade-off between productive and appropriation incentives. With larger committees, too much equity must be used to *buy* votes in order to implement the agreement and too little is used to incentivize production compared to smaller committees. The experimental results provide qualitative support in this direction as we observe that average investments increase when committees are smaller but efficiency is nowhere near the levels attained in the redistributive partnerships.

The article proceeds as follows. In Section 2, we provide a brief literature review, mainly focused on bargaining games and efficiency-enhancing mechanisms in public goods games. In Section 3, we present the model and theoretical results. In Section 4 we describe the experimental design and in Section 5 we present the results from the main experiments. Section 6 analyzes the experiments for smaller committees in pre-distribution. Section 7 discusses the results and Section 8 concludes the article.

2. Related Literature

The leading models of structured bargaining, Rubinstein (1982), Baron and Ferejohn (1989), and Krishna and Serrano (1996) all assume the existence of an *exogenous fund* which is to be divided between the parties. Our model builds on the Baron and Ferejohn game of multilateral bargaining as the negotiations protocol through which the *endogenous fund* is split once it has been created (redistribution) or through which equity shares are determined prior to making investments (pre-distribution).[11]

The canonical Baron and Ferejohn bargaining game under the closed amendment rule is quite simple. In a group of people (3 or more), anyone has equal chance of being selected as the proposer to set forth a distribution of the common fund. Proposals are voted up or down according to the majority rule. In case there is a rejection, the fund is discounted by $\delta \in [0,1]$ (a measure of the cost of delay or players' impatience) and a new round of proposing and voting takes place. The process continues until a proposal is approved.

The equilibrium predictions of the game are intuitive.[12] Regarding the equilibrium distribution of rents, proposers should form minimum winning coalitions (MWCs) by assigning a positive share of the fund only to the number of voters required for approval. The shares offered to coalition partners are such that each member is indifferent between accepting or rejecting. The offered shares yield the discounted continuation value of the game, which in equilibrium, is equal to the average fund. Moreover, there is a favorable payoff differential for the proposer who is able to extract the rents that non-coalition partners would earn if their votes were required for approval.[13] Finally, regarding the time horizon of approval, committees adjourn in the first session which implies that equilibrium outcomes are efficient. The vast experimental evidence[14] provides strong qualitative evidence to support these predictions: MWCs are the modal allocations, most committees reach an agreement in the first round, and proposers earn a larger share than coalition partners (with the caveat that the

[11] A series of articles have aimed at generalizing the Baron and Ferejohn game and extending it to new settings. Eraslan (2002) considers a setting in which players differ in their probability of being the proposers and their impatience levels. One of the most important results in the literature is that, even if multiple stationary subgame perfect Nash equilibria exist, they all yield the same payoff vector. See Eraslan and McLennan (2007) for a further generalization of Baron and Ferejohn (1989) with different voting weights. The model has also been extended to include policy choices (Jackson and Moselle, 2012), a contest for proposal rights (Yildirim, 2007), and risk sharing in the context of the firm (Britz, Herings, and Predtetchinski, 2012).

[12] When δ is large enough, any proposal can be sustained as a subgame perfect Nash equilibrium. See Baron and Ferejohn (1989) for the details. The literature has focused on the stationarity refinement, which yields a unique outcome up to a permutation of the payoff vector.

[13] The proposer's share also increases as δ becomes smaller because included coalition members have a lower continuation value.

[14] See Frechette, Kagel ,and Lehrer (2003), Frechette, Kagel, and Morelli (2005a), Frechette, Kagel, Morelli (2005b), Bradfield and Kagel (2015), and Baranski and Kagel (2015).

proposer's share is not as high as predicted).

Baranski (2016) introduced an investment game to determine the common fund that subjects divide *a posteriori* via bargaining, which corresponds to the redistributive partnership developed here. Based on the previous bargaining experiments with an exogenous fund, one could have conjectured that players would not invest in the common account because of the likelihood of being excluded from the winning coalition. However, with endogenous production of the fund, this prediction was wrong and most subjects actually conditioned the shares offered on the investments made by partners giving rise to a virtuous cycle that fostered almost full efficiency. Our present experimental treatment on redistribution replicates this finding with a different subject pool and incentive structure, further confirming the previous results.

The game of equity bargaining with endogenous production is based on Baranski (2017). In this article we present a simplified version because we are focused on providing a tractable theory for a restricted set of parameters pertinent to the experimental design. A general framework is presented in Baranski (2017) where the model is solved for any voting rule, committee size, discount factor, and a larger range of productivity values. The main finding in the general framework is that, when productivity is large enough, the proposer will form minimum winning coalitions with two types of partners: Some partners will receive a share that induces them to produce and others will receive a lower share that only buys their vote. Productive members earn a payoff higher than the ex ante value of the game. Hence, the need to provide productive incentives mitigates the proposer's rent extraction abilities in pre-distribution compared to redistribution bargaining games. In the main treatments of this article we have focused on a lower range of productivity values that result in only one productive member (the proposer). In our pre-distribution treatment with smaller committees two members are incentivized in equilibrium.

Our experiments are also related to the literature on public good provision and the free-rider problem because the productive technology we implement is exactly the one used in linear public goods game for which dozens of experimental studies exist. Comprehensive reviews may be found in Ledyard (1995) and Chaudhuri (2011). The investment pattern observed in the pre-distribution experiments are quite similar to those observed in the standard linear public goods games with random rematching over several rounds: mean investments start close to 50% of endowment and quickly unravel towards zero.

It should be noted that endogenously determined equity agreements often induce differences among partners in valuations for the public good which implies that the marginal return of investing differs for each member. Several experiments have investigated the effect of valuation heterogeneity in public goods games.[15] Fisher et al. (1995) conducted an experiment in which two members had a small return and two other members had a large return. They compared investment decisions with the benchmark cases in which all members had low or all had high returns and found that average investments in heterogeneous groups are at an intermediate level compared to homogeneous groups. Their finding is driven by the fact that low return members invested less than high return members, both in heterogeneous and homogenous groups. In this sense, there is no "seeding effect" in heterogenous groups since the presence of members with a higher return does not induce those with a lower return to invest more.

Reuben and Riedl (2009) studied heterogenous groups of three members in which one of the member's benefit from investing is large enough that she should fully invest out of self-interest, even if others reap part of the benefits. They report that the contributions of low benefit members quickly unravel towards zero regardless of group composition. High benefit members contributed all their endowment in the last period of play, which reveals that subjects are learning to play the dominant strategy. Heterogeneous groups performed better than homogeneous groups (with only low benefit members) from an efficiency standpoint,

[15] See Buckely and Croson (2008) for exogenous endowment heterogeneity. They report that experimentally wealthier subjects contribute less as a proportion of their income to the common fund compared to poorer subjects, contrary to what models of inequality aversion would predict. See Cherry, Kroll, and Shogren (2005) for earned endowments (endogenous heterogeneity). They find no effect on contributions between the earned endowment and exogenous endowment treatments.

but this result reverses with the introduction of an ex post punishment stage.[16]

Redistributive bargaining allows for players to condition shares based on investments, which largely explains the efficiency levels observed in the experiments. Our findings resonate with those of the decentralized sanctioning experiments of Fehr and Gächter (2000), sanctioning and reward mechanisms (Sefton, Shupp, and Walker, 2007), and institutional sanctioning via voting (Ertan, Page, and Putterman, 2009) which show that the possibility to diminish others' payoffs after the investment stage helps overcome the free-rider problem. A recent experiment by Dong, Falvey, and Luckraz (2016) allows for each member to assign payoffs to other members after investments have been made, but each player does not have a say over how much to keep for herself. This mechanism provides a substantial increase in efficiency with almost 80 percent of subjects fully investing because peers abide mainly by a proportionality standard in assigning payoffs.

3. Theoretical Models

We first describe the elements that are common to both bargaining timings. Let there be $n \geq 5$ players (odd) labeled by the superscript i, each endowed with E amount of wealth. Players are assumed to be risk neutral and concerned only about their own payoff. Thus, we have that the stage profit is given by $u^i(\mathbf{x}) = x^i$ for any vector of payoffs $\mathbf{x}$. The production technology is linear and additively separable. Specifically, for a given vector of investments $\mathbf{c} \in [0, E]^n$ where c^i represents player i's investment, total production is given by

$$F := \alpha \sum_{i=1}^{n} c^i \tag{1}$$

[16]Homogeneous groups attain higher efficiency levels than heterogeneous ones mainly because low benefit members in heterogeneous groups have a weaker response to previous punishment experiences than members of a homogeneous group. Also, punishment behavior in heterogenous groups reveals that low benefit members are likely to punish high benefit members even when the high benefit members has contributed a substantial amount to the public good.

where $\alpha \in (1, 2]$.[17]

3.1 Redistributive Partnership

The timing of the game is as follows. In stage 1, players simultaneously and independently choose $c^i \in [0, 1]$. In stage 2, bargaining takes place according to the Baron and Ferejohn (1989) bargaining procedure. At the beginning of a bargaining round, a randomly chosen player proposes an allocation of the available fund to distribute. The allocation is publicly known and all players proceed to cast a vote. If a majority approves, the allocation is binding, if not, another round of bargaining takes place and the fund is discounted by δ.[18]

In each round of bargaining, a proposal $\mathbf{s}_t = (s_t^1, ..., s_t^n)$ satisfies $\sum_{i=1}^n s_t^i = F$. The payoffs resulting from a vector of investments $\mathbf{c}$ and a distribution of the fund $\mathbf{s}$ approved in round τ are given by

$$u^i(\mathbf{c}, \mathbf{s}) = \delta^{\tau-1}\left(s^i - c + E\right) \tag{2}$$

Proposal and voting strategies[19] are formally defined to be functions of the history of play up to the moment of a proposal or voting decision being made. However, since we will focus on stationary equilibria, we omit the extra notation for the sake of a clear exposition.

Proposition 1 (Baron and Ferejohn (1989), Baranski (2016)) The stationary subgame perfect equilibrium outcome of the redistributive partnership game is as follows: (i) No one invests ($c^i = 0$); (2) If there are any investments, the proposer assigns $\delta F/n$ to $\frac{n-1}{2}$ members and keeps the rest, the remaining partners receive nothing; (3) All those receiving $\delta F/n$ vote in favor and the proposal is approved without delay.

The proof can be found in Baranski (2016) and here we provide the economic intuition which relies simply on the same free-riding notion as in the linear public goods games. Note

[17] In principle α can be larger and this poses potential changes in the equilibrium predictions, but for our experiments this is the range that matters.

[18] If there is no agreement, $s = 0$ for each player.

[19] It is commonly assumed that players only vote in favor if the offered share is greater than or equal to the continuation value of the game.

that the ex ante value of the bargaining game (in equilibrium) prior to any player being designated as the proposer, is equal to the average fund (F/n). This implies that for each unit contributed, a player appropriates in expectation only α/n which is smaller than the cost of investing. As such, no one should invest in equilibrium.

3.2 Pre-distributive Partnership

The timing of the game is as follows. In stage 1, players bargain over the distribution of equity shares. A randomly selected member proposes an equity scheme, and if it is not approved by a simple majority, a new round of bargaining and voting starts.[20] Once an allocation is approved, investments take place and the total fund is then split according the agreed-upon equity scheme.

A bargaining proposal in round t is given by $\mathbf{s}_t = (s_t^1, ..., s_t^n)$ and satisfies $\sum_{i=1}^n s_t^i = 1$ such that each $s_t^i \in [0,1]$. The payoffs resulting from an equity agreement $\mathbf{s}$ in round τ and a vector of investments $\mathbf{c}$ is given by

$$u^i(\mathbf{s}, \mathbf{c}) = \delta^{\tau-1}\left(s^i F - c^i + E\right) \ . \tag{3}$$

For this section we will assume that $\delta = 1$ for simplicity.[21]

Proposition 2 The stationary subgame perfect equilibrium outcome of the pre-distributive partnership game is as follows: (1) The proposer assigns $s = \frac{\alpha-1}{\alpha n}$ to $\frac{n-1}{2}$ coalition partners and keeps the rest; (2) Coalition partners including the proposer vote in favor and there is no delay in approval; (3) The proposer invests all the endowment and no one else invests.

We provide a sketch of the proof to give an economic intuition and relegate the formal arguments to the Appendix. Starting in stage 2 after an equity agreement has been reached

[20] If no agreement is ever reached, players earn zero.

[21] Very low values of δ could give rise to equilibria with unanimous approval. This is because the discounted continuation value of the game would be so small, that a player is willing to accept a zero share as long as bargaining is not delayed. With acceptance, the player guarantees a payoff of 1 (her endowment) which may be higher than δV where V is the ex ante value of the game.

in round τ we have that a member finds it optimal to invest if and only if the return of doing so is larger than the cost. Formally, the equilibrium investment strategy in any subgame is

$$c_i^*(\mathbf{s}^\tau) = \begin{cases} 0 & \text{if} \quad \alpha s_i^\tau < 1 \\ E & \text{if} \quad \alpha s_i^\tau \geq 1 \end{cases} . \tag{4}$$

Now we partition the set of subgames into three possible disjoint sets and show that equilibrium can only occur in one of those subsets. We define

$$S_k := \left\{ (s^1, ..., s^n) \in [0,1]^n : \sum_{i=1}^{n} c_i^* = k \right\} \tag{5}$$

where the S_k determines all equity agreements in which k members receive a share that induces investments. It is straight forward to show that the sets S_k are pair-wise disjoint and that $S_0 \cup S_1 \cup S_2 = [0,1]^n$. Moreover, $S_k = \emptyset$ for $k > 2$. If $\alpha < 2$, then $S_2 = \emptyset$ also. This is a consequence of the equity constraint which requires that the sum of shares must add to 1.

In Lemmas 4 and 5 we show that there is no equilibrium in which $\mathbf{s} \in S_0$ or $\mathbf{s} \in S_2$. In the first case, if there were no productive members, every player would earn exactly his endowment and there would be a profitable deviation in which one member keeps all equity shares and invests. All other members' payoffs would remain unchanged and the deviator would increases his earnings.

The fact that $\mathbf{s} \in S_2$ is not an equilibrium is due to two constraints: one given by the production technology and the other by the voting requirement. For the highest productivity level ($\alpha = 2$), at most two players could be incentivized by receiving a share of 50% each and all equity is exhausted. Hence, in a committee of 5 members with a majority rule (3 votes) there would be no equity left to offer to a third partner which implies that the proposal would not be approved. The details can be found in Lemma 5.

It is straightforward to show that only the proposer invests in equilibrium and forms a minimum winning coalition because including additional members is not needed for approval and any additional equity assigned to redundant members is wasteful. The equity share offered to each coalition partner, $\frac{\alpha-1}{\alpha n}$, is such that the associated payoff matches the ex-ante value of the game in equilibrium, as defined in equation (8) developed in the Appendix.[22]

4. Experimental Design

In the experiments we implemented a productivity parameter $\alpha = 2$. Committees were composed of five members and three votes were required for approval. The discount factor was set at $\delta = 1$. Subjects were endowed with 50 tokens (equivalent to 5 euros). The theoretical predictions for this parameter configuration can be found in Table 1.

Subjects participated in ten games (or periods) and were randomly reassigned into new groups in each game (strangers matching protocol). Within each game we observed an investment for each subject and a bargaining stage which could entail as many bargaining rounds as necessary to reach an agreement.[23] In each bargaining round, all subjects were asked to submit a proposal (partial strategy method), but only the chosen one was observed publicly by group members and voted on.

Subjects were compensated for only one of the playing periods which was randomly selected and revealed at the end. A small show-up fee of 4 euros was offered in order to keep the investment decision as meaningful as possible. Six sessions (three for each treatment) were conducted between March 1 and 15 of 2016. Participants were bachelor students recruited from the Maastricht University subject pool and only took part in one session.[24]

[22]Intuitively, the ex ante value of the game is the average expected payoff, which corresponds to the endowment plus the surplus net of investments divided by the number of members.

[23]Our software automatically stopped in round 15. A group bargaining for 15 rounds would take approximately 25 minutes, which would not allow us to conclude the experiment within our time frame. Subjects were told that, if they failed to approve an allocation and too much time had passed, the experimenter would move them to the next game in order to continue with the experiment. Payoffs for that round would not count if it was selected for payment. No one reached the limit.

[24]Recruitment was done via ORSEE developed by Greiner (2015) and the experiments were programmed in z-Tree (Fischbacher 2007). Sessions lasted between 45-50 minutes and average payments were 14.9 euros

The instructions were written without mentioning business partnerships or firms to avoid priming subjects in any direction. A dry run was conducted to ensure a complete understanding of the screen layouts and software capabilities. Instructions and screenshots may be found in the Supplementary Materials. Given that the investment task entailed assessing the profitability of different scenarios, we provided a payoff calculator in the main screen. Subjects could enter any combination of shares and investments to compute the resulting payoffs. It was important to us that subjects were able evaluate alternatives in an easy and transparent way.

5. Experimental Results

We first present a comparison of investment dynamics and efficiency levels between treatments and then proceed to analyze how bargaining behavior explains the observed investment decisions.

5.1 Investments and Efficiency

Figure 1 shows the evolution of average investments throughout the ten games. In the first game of play, investments for the pre-distributive bargaining game start at 15 tokens (out of 50) and quickly unravel to almost zero on average. For redistributive bargaining, average investments start at 32 tokens and quickly to rise to almost full endowment, averaging 49.5 in the last five games of play.

Conclusion 1 Contrary to the theoretical predictions, redistributive bargaining induces higher investments than pre-distributive bargaining. When subjects have gained experience in the game (last five games) nearly full productive efficiency is attained under redistribution while pre-distribution entails almost no investments.

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in redistribution treatments and 10.1 euros in pre-distribution.

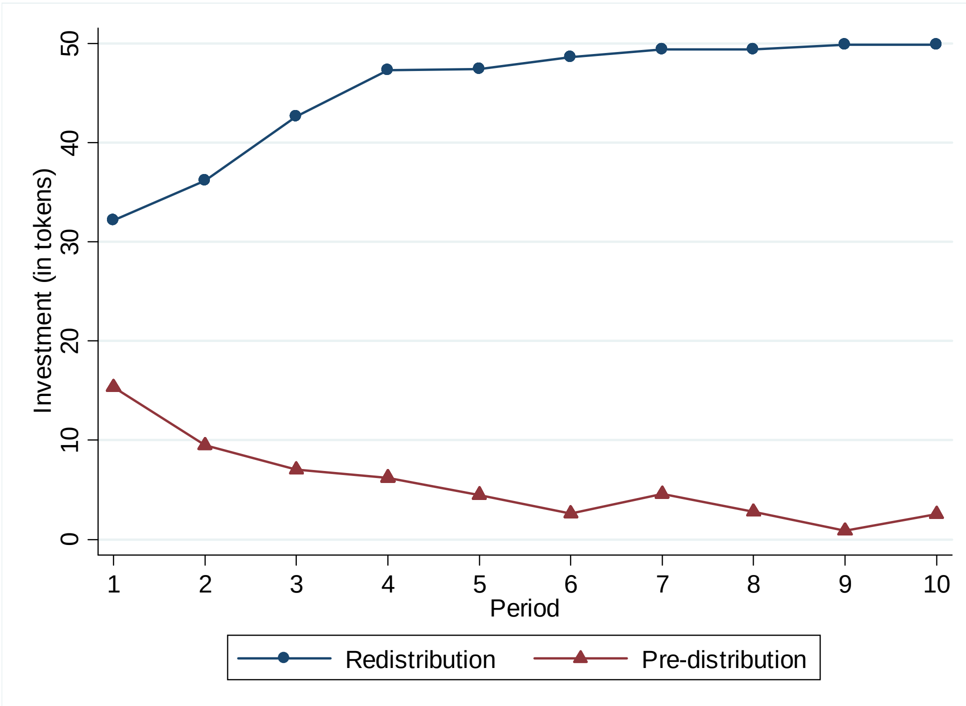

Figure 1: Average Investments

The evolution of investments in the redistributive bargaining game is similar to those reported in Baranski (2016), while the pattern observed in the pre-distributive bargaining game is more in line with the unravelling that occurs in the standard linear public goods games where free-riding quickly prevails. What is striking from the redistribution treatment, is that efficiency is so high in a strangers matching protocol where reputation concerns are minimized. Compared to experiments with sanctioning, bargaining and voting as an institution presents a substantial improvement in terms of social welfare.[25]

We now proceed to take a close look at bargaining dynamics to shed light on why investments are reinforced in the redistributive bargaining game and not in the pre-distributive game.

[25] Average investments in a strangers matching protocol of the sanctioning games in Fehr and Gachter (2000) are around 50 percent of endowment.

5.2 Bargaining Outcomes

In this section, our analysis will focus on approved allocations of the second half of the experiment (games 6-10) once subjects have gained experience. In both treatments, the SSPE prediction is that equity or funds should be disbursed only to three out of five members (MWC). Instead, we find that allocations in which shares are disbursed to all members are modal in both treatments. For the games of pre-distribution, 46 percent of approved proposals disburse equity to every member and 33 percent are MWCs. In redistributive bargaining 71.1 percent of allocations include payments to all members and only 20 percent are MWCs.[26]

The theoretical prediction in the pre-distributive bargaining game is that proposers keep a share of 80 percent. However, the average share is only 25.6 percent which is significantly larger than the voter's average share of 18.6 percent (p-value$\approx$ 0).[27] The difference between proposers' and non-proposers' shares is smaller in the redistributive bargaining game, 22.3 percent compared to 19.4 percent for non-proposers, but it is still significant (p-value$=0.015$). Focusing on MWCs, we find that there is virtually an equal split between coalition partners in both treatments.[28]

Conclusion 2 Bargaining behavior does not conform to the equilibrium predictions. In both treatments, allocations in which shares are distributed to all members are modal and not minimum winning coalitions. The proposer's average share is very small compared to the theoretical benchmark, even when focusing on minimum winning coalitions.

Our findings for the redistribution game are similar to those reported in Baranski (2016) and contrast starkly with the findings from multiple Baron and Ferejohn (1989) experimental studies in which the fund to distribute is exogenously given, mainly because in those studies

[26]If a member receives less than 5 percent (equity or percentage of the fund) she is considered to be excluded. For example, the proposal (50%,20%,20%,5%,5%) is counted as a minimun winning coalition.

[27]P-value obtained from an OLS regression controlling for session and period effects, were non of the controls reached significance at conventional levels.

[28]In fact, 17.8 percent of allocations are an equal split MWC for the redistribution treatment and 26.7 percent for pre-distribution.

Table 1: Bargaining Outcomes[1]

	Pre-distribution		Redistribution	
	Predicted	**Observed**	**Predicted**	**Observed**
Proposals[2]				
3-way split (MWC)	100%	33.3	100%	20.0
4-way split	0%	20.0	0%	8.9
5-way split	0%	46.7	0%	71.1
Shares[3]				
Proposer's Share	80%	25.6 (1.123)	60%	22.3 (0.826)
Proposer's Share in MWC	80%	32.6 (1.233)	60%	31.0 (0.756)
Voter's Share	10%	18.6 (0.751)	20%	19.4 (0.528)
Voter's Share in MWC	10%	31.9 (0.469)	20%	30.9 (0.310)
Timing of Approval				
Round 1	100%	80.0	100%	86.7
Round 2	0%	13.3	0%	6.7

[1] Outcomes are reported for accepted allocations of games 6-10.
[2] Members receiving 5% of less are counted as excluded from the allocation.
[3] Shares of the redistribution treatment are computed as a percentage of the total fund.

MWCs are modal and the proposer has a substantial advantage compared to other members.

5.3 Productive Incentives and Bargaining Behavior

From Table 1 we can see that the difference between the average proposers' shares in the pre-distribution and redistribution games is small, and the same for the average shares for included non-proposers. An member is denoted as *included* when she receives more than 5 percent of shares. To test for whether or not the small differences are significant, we present the results from a regression with the player's share as the dependent variable in Table 2. The independent variables are the timing of bargaining (Pre-distribution equals 1 when negotiations take place before production), and dummies for the allocation type, whether the proposal is a 3,4, or 5-way split (3-way split is the omitted category).

In columns (1) and (2) of Table 2 one can observe that the treatment dummies are not significant and that the differences in the proposer (and voter) average shares correlate

Table 2: OLS Regression for Proposer and Voter Shares [1]

	(1) Proposer's Share [2]	(2) Included Voter's Share [2]
Predistribution	0.0620	-0.0155
	(0.04)	(-0.03)
4-way split	-7.125*	-7.000***
	(-2.12)	(-5.50)
5-way split	-12.13***	-12.00***
	(-7.08)	(-18.38)
Constant	32.06***	32.02***
	(16.35)	(44.43)
N	88	301
R^2	0.760	0.831
F-statistic	13.02	81.94

***,**,* denote significance at 1%,5%, and 10% respectively. t-statistics reported in parentheses below coefficient values. Regression included session dummies and interaction with allocation type (3,4,5-way splits). None of the controls were significant at standard levels.

[1] Only accepted proposals of games 6-10.

[2] Only shares greater than 5% included.

negatively and significantly with the number of included members as expected.

Conclusion 3 Controlling for the number of members in a proposal that receive a positive share, the average proposer share (in percentage) does not differ significantly between pre-distribution and redistribution treatments and neither does the average share offered to a voter included in the coalition.

But then, if shares are so similar in percentage terms, why do we observe such a large difference in average investments between treatments? In what follows we analyze redistributive and pre-distributive bargaining strategies separately to understand how profit-sharing negotiations translate into productive incentives in the redistribution treatment but not in the pre-distribution treatment.

5.3.1 Pre-distributive Bargaining Behavior

According to our theoretical prediction, a player should only invest in the common fund if she receives an equity share greater than or equal to 50 percent, however there are no approved allocations in which a member obtains this amount or more. Hence, the investment outcomes can be considered to be a best response given the subgames reached after bargaining.

Table 3 presents the payoffs that result from different investment levels. In the first half of the experiment we observe that the highest mean payoffs are obtained by members contributing between 0 and 20 tokens.[29] In the second half of the experiment, almost all investments are concentrated between 0 and 10 tokens and deviations from those levels yield lower payoffs on average. This pattern resembles closely the findings of the standard public goods experiments which lead to unravelling of contributions (Ledyard 1995, Chaudhuri 2011).

[29] Average non-proposer payoffs in games 1-5 for those investing more than 20 tokens are significantly lower than for those investing less (p-value≈ 0 for a two-sided t-test), but we find no difference for proposers (p-value$= 0.422$). Pooling over all periods, those who contribute 10 tokens or less obtain a higher payoff on average than those contributing more (p-value$= 0.013$).

Table 3: Proposer and Voter Average Payoffs by Investment in Pre-distributive Bargaining

	Games 1-5		Games 6-10	
Investment	Voter	Proposer	Voter	Proposer
0-10	59.02	60.95	53.49	54.25
	(1.042)	(2.385)	(0.489)	(1.081)
11-20	61.97	64.37	41.43	49.6
	(2.507)	(4.109)	(1.367)	(1.314)
21-30	55.93	55.33	37.4	42
	(3.722)	(6.936)	(4.6)	(0)
31-40	53.58	69.4	–	–
	(7.964)			
41-50	33.99	–	25	–
	(6.216)		(5)	

Standard errors of the mean are reported in parentheses.

Prior to reaching the investment stage, players have voted and also received feedback on how others in their group voted. Based on the literature on endogenous institution formation we ask the two following questions. Can it be that groups with higher agreement rates reach higher contributions? And, does a member's favorable voting decision signal a higher willingness to contribute?

To answer these questions we estimated a random effects tobit model (accounting for subject-specific effects) in which the invested amount was the dependent variable. As explanatory variables we included the share received, the player's voting decision (accept or reject), an interaction between the previous two variables, the player's role (proposer or voter), dummies for the number of votes in favor excluding one's vote, and a period trend variable.[30]

The estimation results are presented in Table 4.[31] We find that voting in favor of a proposal is positively correlated with the amount a player will invest. At mean levels in

[30]Session dummies were also included and were not significant at the 10 percent level. Since all proposers vote in favor of their proposals, the interaction dummy for role and vote was omitted due to collinearity.

[31]We considered four subsamples: all approved allocations, all approved allocations for members with a share greater than 5%, and the same subsamples restricted to the last five games. Here we report the results for all approved allocations (column 1).

game one, voting in favor increases investments by 14.8 tokens, but the marginal effect decreases gradually to only 6.2 tokens in game 10. The coefficient for own share is positive as expected. However, for non-proposers –conditional on voting in favor– an increase in equity shares does not affect investments.[32] In short, voting in favor is an indicator of a member's investment intention. This finding echoes what Dal Bó, Foster, and Putterman (2010) report in a prisoner's dilemma game in which subjects can vote to implement a tax on non-cooperative behavior, because the voting decision is strongly correlated with willingness to cooperate.[33] However, the strength of the effect is rather low in our setting and rapidly fades with experience.

We also find that the proposer role dummy and its interaction with own equity share are insignificant individually and jointly (Wald test p-value$= 0.591$) which means that the agenda setter does not feel compelled to produce more or less than non-proposing members.

The reason we included dummies for the number of votes in favor was because we conjectured that higher agreement rates could be a signal of good faith and thus create trust among the committee members. Nevertheless, we do not find evidence supporting our conjecture. We also conducted the same specification as in Table 4 including an interaction between own share and number of votes in favor. The coefficients were not significant individually or jointly (Wald test p-value$= 0.981$).

Finally, we find that the period trend variable is negative and significant as one would expect based the evolution of investments presented in Figure 1. On average, investments fall by 1 token with each successive game.

Conclusion 4 In the pre-distributive bargaining game, the approved equity agreements induce free-riding behavior and the average payoffs resulting are reminiscent of the behavior reported in standard public goods games with predefined equal shares. Subjects are more likely to invest when they have voted in favor, but as they gain experience in the game,

[32] We test $OwnShare + Vote \times OwnShare = 0$ and obtain a p-value$= 0.628$.

[33] This holds for the case when the implementation of the tax took place endogenously.

Table 4: Random Effects Tobits for Investments in Pre-distribution

	All Shares		Shares > 5%	
	All Games	Games 6-10	All Games	Games 6-10
Constant	-23.22***	-107.6*	-46.25**	-107.9*
	(-3.68)	(-2.00)	(-3.02)	(-1.97)
Vote (= 1 if yes)	40.08***	131.9*	59.10***	132.7*
	(4.89)	(2.44)	(3.69)	(2.40)
Proposer (= 1 if yes)	-7.957	-22.56	-4.956	-16.68
	(-0.88)	(-1.57)	(-0.53)	(-0.96)
Own Share	1.236***	5.075*	2.450***	5.061*
	(4.27)	(2.18)	(3.36)	(2.14)
Vote × Own Share	-1.402***	-5.546*	-2.470**	-5.550*
	(-3.67)	(-2.35)	(-3.24)	(-2.31)
Proposer × Own Share	0.341	0.929	0.255	0.717
	(0.99)	(1.69)	(0.72)	(1.11)
Period	-3.747***	-3.616**	-3.626***	-3.650**
	(-10.25)	(-3.23)	(-10.55)	(-3.13)
Votes in favor (dummies)[1]				
4 Votes	0.811	6.391	1.503	6.191
	(0.34)	(1.73)	(0.65)	(1.65)
5 Votes	0.571	1.726	1.297	1.109
	(0.19)	(0.33)	(0.45)	(0.20)
Session (dummies)[2]				
2	4.902	4.918	4.340	4.705
	(0.87)	(0.74)	(0.77)	(0.68)
3	7.804	2.956	7.840	3.062
	(1.40)	(0.45)	(1.39)	(0.45)
Observations	450	225	375	186
χ^2	136.4	23.43	121.9	20.09
Correlation (predicted and observed)	0.459	0.313	0.442	0.273
ρ (Subject-Level Var/Total Var)	0.469***	0.541***	0.537***	0.557***
χ^2 (LR test for $\rho = 0$)	47.32	24.31	50.12	23.88

***,**,* denote significance at 1%,5%, and 10% respectively. *t*-statistics reported in parentheses below coefficient values. Investments are censored from below at 0 and from above at 50. Interaction between Vote and Role is excluded because of collinearity.

[1] Dummy variables for the number of votes in favor excluding oneself. 2 votes in favor is the omitted category.

[2] Session 1 is the omitted category.

investments unravel toward zero regardless of whether one is a proposer or not, and regardless of how many other partners have voted in favor.

In the experiments by Reuben and Riedl (2009), group members have different returns from investing in the common fund and one of the member's return is large enough such that in equilibrium she should invest fully. In their benchmark experiment, subjects' investments converge to the theoretical predictions: those with a low return do not invest and those with a large return invest fully. Our experiment shows that subjects are not able to solve the public good provision problem by bargaining to reassign shares, i.e. "privileged groups" do not form voluntarily and endogenously. Since we implemented a partial strategy method, we have data on all proposals even those that did not take the floor for voting. We only observe 13 shares out of 645 (1.7 percent) in which some subject receives $s \geq 50\%$.

5.3.2 Redistributive Bargaining Behavior

Investments are likely to yield a high return in redistributive bargaining: 90 percent of shares to non-proposers in approved allocations are greater than or equal to members' investments and in 81 percent of the cases the share received is at least twice as large. Proposers always retrieve their investments.[34] In stark comparison with the payoffs arising in pre-distributive bargaining, Table 5 shows that the highest average payoffs are obtained by members who contribute above 40 tokens (out of 50).

What is clear from analyzing the data and the scatter plot displayed in Figure 2, is that shares and investments are positively correlated. In fact, 52 percent of all shares in approved allocations are proportional to the members' investments. This implies that subjects largely follow a norm of investment-based fairness in the allocation of shares. In the first five periods of play, we observe a wide dispersion in investments (standard deviation=11.98) compared to the second half of the experiment in which investments are clustered at 50 tokens (standard

[34] We find one proposer in the first game that assigned herself 0. The subject then voted against perhaps because this was a mistake.

Table 5: Proposer and Voter Average Payoffs by Investment in Redistributive Bargaining

	Games 1-5		Games 6-10	
Investment	Voter	Proposer	Voter	Proposer
0-10	55.83	90	–	–
	(7.791)	(30)		
11-20	64.77	70	–	–
	(5.316)			
21-30	74.17	78	80	–
	(5.018)	(4.163)		
31-40	83.09	96.667	58	90
	(4.591)	(2.764)	(19.596)	(0)
41-50	97.86	113.5	97.87	111.65
	(2.886)	(4.363)	(2.580)	(4.262)

Standard errors of the mean are reported in parentheses.

deviation=2.31). Panel A (game 1-5) in Figure 2 shows a clear positive correlation between the amount invested (as a percentage of the sum of investments of group members) and the share that one receives (as a percentage of the total fund). In Panel B (games 6-10) we see less variation, but a significant clustering of observations around the point $(0.2, 0.2)$ which indicates a proportional redistribution strategy.

In order to better describe the nature of such correlation, we regressed the share received (in tokens) on a member's contribution, the period of play (trend), her role (proposer or voter), and pairwise interactions of all the previous variables.

The results are presented in Table 6 and our discussion will focus on the estimations obtained from the full sample (first column). The coefficient for investment is positive and significant. Thus, increasing investments by one token yields an increase of 1.6 tokens in the share received. Controlling for the amount invested, proposers do not have a significant advantage over other members. Moreover, the interactions of the proposer dummy with investments and with the period of play are not significant at standard levels.[35]

[35] The experiments in Baranski (2016) yielded a positive and significant coefficient for the proposer dummy. Since committees were endowed with an initial exogenous fund of 30 tokens, one possible explanation is that proposers claimed a larger share of the exogenous fund. However, this is just a conjecture that would require

Table 6: Tobit for Approved Shares in Redistribution

	All Periods	Periods 1-5	Periods 6-10
Investment	1.661***	1.661***	-8.479
	(0.305)	(0.357)	(7.038)
Proposer (=1 if Proposer)	24.42	16.24	37.34
	(21.40)	(19.64)	(131.9)
Proposer × Investment	-0.371	-0.334	-1.327
	(0.508)	(0.480)	(2.726)
Period	-16.75**	-14.74*	-96.35
	(5.592)	(6.382)	(51.65)
Period × Investment	0.328**	0.292*	1.904
	(0.113)	(0.141)	(1.038)
Proposer × Period	1.334	4.498	5.237
	(1.438)	(3.527)	(4.052)
Session dummies[1]			
1	-1.927	-1.784	-1.965
	(3.590)	(4.464)	(5.553)
2	-0.210	-0.0759	-0.0523
	(3.572)	(4.474)	(5.495)
Constant	18.21	16.58	532.1
	(13.70)	(14.32)	(349.4)
N	450	225	225
χ^2	191.8	155.5	26.68
Correlation (Predicted vs Observed)	0.595	0.722	0.327

***,**,* denote significance at 1%,5%, and 10% respectively. Standard errors reported in parentheses below coefficient values.

[1] Session 3 is the omitted category.

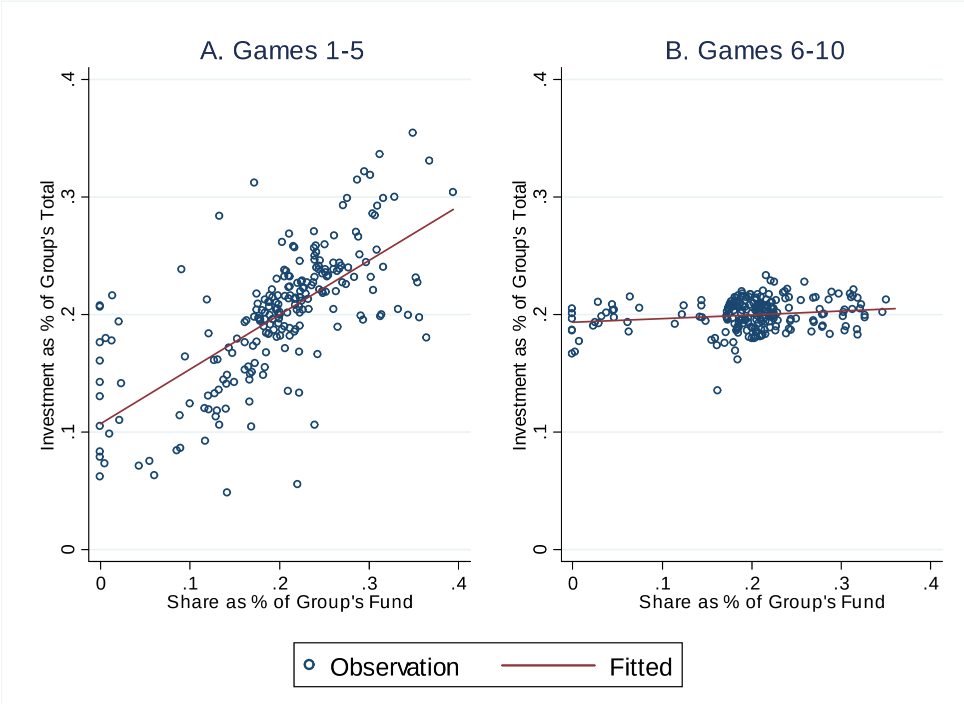

Figure 2: Investments and Approved Shares in Redistributive Bargaining

The negative coefficient for the period variable indicates that investing at mean levels would result in a lower share next game. The interaction between period and investment is positive, increasing one's investment above mean levels in each subsequent game counteracts the negative effect captured by the period trend coefficient.

A careful inspection of the rejected proposals and voting behavior also helps explain why subjects find it optimal to invest in the common fund because rejected proposals are more unfair than accepted ones. In the last five games, 70 percent of rejected proposals were 3-way splits while only 20 percent of accepted proposals follow such strategy. In rejected allocations, proposers were attempting to keep almost 31 percent of the fund, significantly more than the 22 percent that they effectively keep on average in approved allocations (p-value$=0.009$).[36]

We informally mentioned that approved allocations are more fair, yet different notions

an appropriate experimental test.

[36] P-value obtained from a OLS regression with Session dummies clustering standard errors at the subject level.

of fairness could be envisioned.[37] Here we focus on *investment-based fairness* and calculate a fairness index as follows:

$$FI = \sqrt[2]{\sum_{i=1}^{5}\left(\frac{Share_i}{Fund} - \frac{Investment_i}{\sum_{j=1}^{5} Investment_j}\right)^2} \quad . \tag{6}$$

The FI is simply a measure of how far an allocation is from the allocation that yields to each member the share of the fund that she produced. Thus, a perfectly fair allocation yields an FI of 0. We find that approved allocations have a lower mean FI compared to rejected allocations (p-value= 0.014).[38]

An analysis of voting decisions reveals why proposers cannot extract a large share as predicted in the stationary equilibrium: the probability of voting against a proposal is positively correlated with the proposer's share. As expected, subjects are more likely to vote in favor as their own earnings increase. Both of the previous voting results were robust to different measures of own gain and the proposer's gain.[39] In our probit voting models we also incorporated the FI (excluding the proposer and voter in question) to account for overall fairness of the proposal, however the estimated coefficients were not significant at conventional levels. The estimation results are reported in Table 8 in the Appendix.

CONCLUSION 5 Redistributive bargaining is used as a mechanism to assign shares proportionally based on investments, and as a consequence, full efficiency attains. Minimum winning coalitions are predicted in equilibrium and ubiquitously observed in experiments with an exogenous fund, but these entail very low chances of acceptance in the game of redistribution with an endogenous fund.

[37] See Capelen et al. (2007) for a study on the pluralism of fairness ideals. One could consider minimizing final payoff inequality as another measure of fairness.

[38] P-value obtained from an OLS regression with session dummies clustering standard errors at the subject level. The difference is mainly driven by the larger proportion of 3-way splits in rejected allocations. If one introduces a dummy variable for 3-way split, the difference is no longer significant (p-value=0.294).

[39] For example, we considered $\frac{Share-Contribution}{Fund}$ as normalized measure of return to investment. Another measure we used was $\left(\frac{Share}{Fund} - \frac{Investment}{\sum_{j\in Group} Investment_j}\right)$.

6. Pre-distribution with Smaller Groups

In this section we present the theoretical predictions and experimental results of a treatment with committees composed of three members.[40] Can it be that smaller committees provide a better environment to incentivize production? The theory and experiments provide a positive answer.

Reducing the committee size has important economic implications which we summarize in the following proposition.

PROPOSITION 3 Let $\alpha = 2$, $n = 3$, and $\delta = 1$. Then, the equilibrium outcome of the pre-distributive bargaining game is as follows: (1) The proposer keeps 50 percent of the shares and assigns 50 percent to another partner; (2) Both the proposer and included partner vote in favor and invest fully; (3) there is no delay in approval.

The intuition behind this result is that, if the proposer attempts to keep a larger equity share, he must give up one productive partner which would decrease the total fund. The proposer would still need to compensate at least one partner in order to obtain her vote for approval. Hence, being the sole producer is suboptimal. The formal proof can be found in the Appendix.[41] One aspect we should highlight is that the proposer has no payoff advantage over the coalition partner, which evidences the difference between the payoffs that can arise in the standard Baron and Ferejohn game with an exogenous fund and the pre-distributive partnership game.

In Figure 3 we can see that average contributions in groups of three are significantly larger than in groups of five by 7.3 tokens which implies efficiency is higher in per capita terms in smaller groups. Nevertheless, the rate of decay in contributions over the ten games is not significantly different between group sizes.

[40] We conducted three sessions with 12-15 subjects each for a total of 39 participants that had no previous experience in the bargaining game.

[41] Notice that the proposer does not hold any advantage compared to the member included in the winning coalition, a stark difference with the standard Baron and Ferejohn (1989) game. For a general discussion see Baranski (2017).

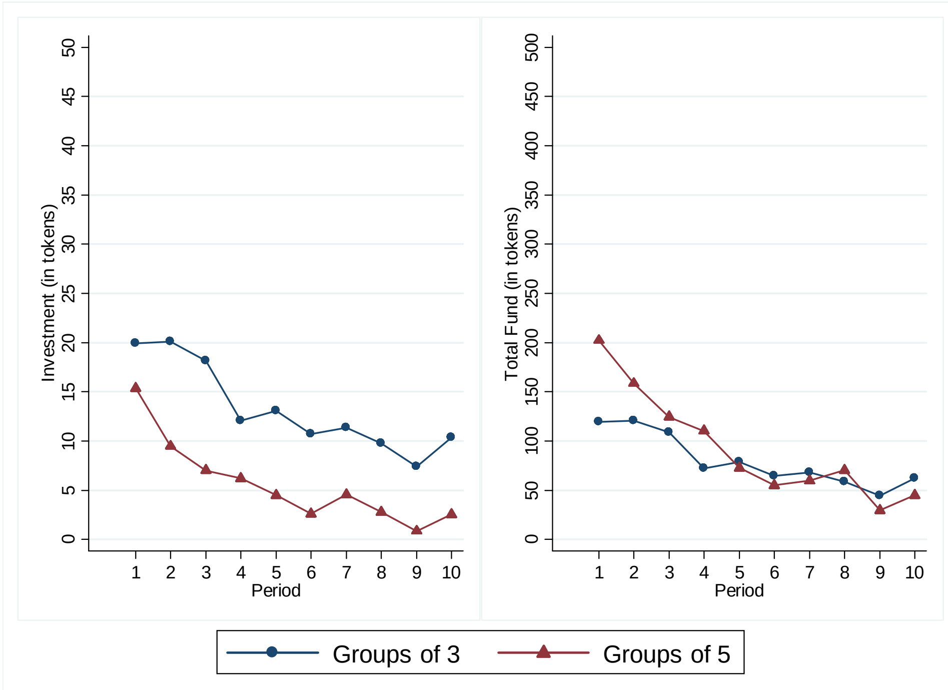

Figure 3: Average Contributions and Total Fund in Pre-distribution

The theory predicts that in groups of three the fund will be 200 tokens (two players invest fully) and 100 tokens in groups of five (one player invests). Thus in equilibrium, smaller committees are more efficient both in per capita and absolute terms. However, we do not find a significant difference in the size of the fund between treatments, if anything, groups of five produce significantly larger funds in the first two periods of play.

A summary of the bargaining outcomes can be found in Table 9 in the Appendix. Focusing on the last five games, we find that 52 percent of all proposals include equity to all members which implies that the agreed-upon equity shares in these cases are not high enough to provide productive incentives ($2 \times share < 1$).

In fact, only 20 percent of approved proposals follow the 50%-50% split predicted in equilibrium. In such cases investments average 16 tokens, an amount which is significantly larger than the 9 tokens invested on average under other equity agreements (p-value$= 0.018$).[42]

[42] P-value obtained from an OLS regression with session dummies (non are significant) clustering standard errors at the subject level.

Conclusion 6 Decreasing the size of committees in pre-distributive bargaining yields an increase in average contribution which provides qualitative support for the equilibrium predictions. Nevertheless, subjects mostly fail to agree on equity schemes that provide productive incentives, and even when they do so, full investments do not attain.

7. Discussion of the Results and Inequity Aversion

Our results for the game of redistribution are consistent with the theory of inequity developed by Adams (1963) who defines inequity as a perception by the individual that her ratio of rewards to inputs is different to the ratio of others in the group.[43] A key prediction of the theory is that inequity creates tensions, and our results show that these tensions materialize in bargaining delays. As in Selten (1987) who further develops the theory of Adams, we also argue in our setting that "it is unreasonable that experimental subjects perform complicated mathematical operations in an attempt to understand the strategic structure of the situation" (pg. 43). Instead, we observe that investments are used as an objective cue to determine what an equitable share should be. Clearly, not all subjects abide by the equity standard of contribution based redistribution, but there is a critical mass of equitable redistributors such that full efficiency is attained because of the likelihood of making a positive return.

One potential explanation for why investment incentives are not reached in pre-distributive bargaining is that the equilibrium agreement $(80\%, 10\%, 10\%, 0, 0)$, where the proposer keeps a share eight times larger than that of included coalition partners, appears to be very skewed in favor of the proposer. Nevertheless, final payoffs are 80 tokens for the proposer and 60 for the coalition partners, which is only 1.3 times larger than that of included coalition partners. Hence, ex ante inequality in ownership is reduced ex post in final payoffs, but subjects

[43] We have not invoked economic theories of inequality aversion such as Bolton and Ockenfels (2000) or Fehr and Schmidt (1999), because as Maria Montero (2007) shows, these preferences predict more unequal payoffs in favor of the proposer in the Baron and Ferejohn bargaining game. Moreover, aversion to inequality would imply that redistribution would tend to more equal payoffs even when players have contributed different amounts, contrary to what we observe in redisribution.

might not foresee this. To mitigate the effect of cognitive constraints, we provided a fully functional payoff calculator which allowed subjects to easily compute alternate scenarios.

It can also be that the symmetry of the environment might be used as a cue for equal divisions (or equal divisions within the coalition) which is mostly what we observe. In Hoffman et al. (1994), the authors argue that the first mover advantage in bilateral bargaining games may dissipate when the right to move first is randomly allocated as in our setting. They find that when the right to move first is earned in a legitimate way which is commonly known and accepted, a significant favorable payoff differential is observed for the proposer.[44] However, in a redistribution experimental treatment with an exogenous fund, Fréchette, Kagel, and Morelli (2005) report that the proposer typically holds a payoff advantage receiving close to 38% of the total fund.[45] Thus, the ex ante symmetry does not appear to be the driving force of the low proposer power observed in the pre-distributive bargaining game.

We again invoke the theory of inequity, but propose a slight modification for our setting. Instead of assigning rewards based on inputs as in the canonical theory of Adams (1963), rewards are assigned based on *expected* inputs. Our data clearly show that there is no significant difference between the investments of proposers and non-proposers (see Table 7). Thus, if both types of players are expected to contribute the same amount, the theory of inequity would imply that shares would tend to be allocated on equal proportions between members. This helps explain the prevalence of equal splits (31 percent of all approved allocations). Note that the fact that minimum winning coalitions are often formed does not contradict the theory, because the modal allocation in such cases is an equal split between members (72 percent of all MWC allocations) and the two excluded partners are expected to not contribute. Thus, there is no inequity in the sense of Adams.

[44] The authors introduce a quiz in which the best performers earn the right to propose.
[45] Based on the treatment with five members and no discounting in the last five games.

8. Conclusion

In this article we have examined theoretically how the timing of property rights negotiations affects incentives to invest in a common project and explored actual human behavior with incentivized laboratory experiments. In accordance with a large body of literature in contract theory, defining ownership shares prior to undertaking individually costly investments enhances efficiency beyond the levels that can be occur in a setting in which the surplus generated from joint production is unsettled. The rationale for such prediction hinges on economic agents negotiating the division of the common fund as if the investments that originated it were sunk and the prevalence of opportunistic bargaining behavior.

Nevertheless, our experimental findings definitively reject the aforementioned predictions: bargaining over the endogenous fund *a posteriori* yields almost full efficiency, while bargaining *a priori* to define ownership shares yields near zero investments. In our pre-distributive bargaining game, i.e. when shares are negotiated prior to production, subjects fail to agree on ownership shares that induce investments. Even when minimum winning coalitions form and incentives to invest are quite high, partners do not trust other committee members and free riding prevails. With redistributive bargaining, subjects do not treat investments as sunk, instead, investment-based redistribution strategies explain the high levels of efficiency.

Our theoretical framework is rooted in two classical games in the fields of Political Economy and Public Economics. The Baron and Ferejohn (1989) model of multilateral bargaining has been widely studied in theoretical and experimental applications as previously discussed. Here, it is employed as the negotiations protocol to divide the jointly produced surplus. When the surplus to distribute is endogenous, we are able to soundly reject the stationary equilibrium as an appropriate predictor of bargaining outcomes, a refinement that is universally adopted in the literature. Hence, our results call into question the descriptive validity of the stationary equilibrium concept when the surplus is endogenously determined in bargaining games.

The production technology we assumed is similar to the one employed in the linear public goods game, which has been the workhorse of a large body of literature studying the emergence of cooperation in human societies and the tragedy of the commons. Voting to impose sanctions in a centralized manner (Walker et al., 2000; Putterman, Tyran, and Kamei, 2011; Ertran, Page, and Putterman, 2009) decentralized sanctioning and rewarding (Fehr and Gächter, 2000; Sefton, Shupp, and Walker, 2007), have proven to be institutional mechanisms that foster efficiency. Our contribution to this stream of literature is that negotiations to determine property rights in the standard public goods game prior to investment decisions do not give rise to efficiency-inducing ownership shares and free-riding prevails as a result.

Our results regarding the equity schemes approved in the ex ante bargaining treatments provide weak evidence for the effectiveness of endogenous institutions in fostering cooperative or efficient outcomes. This contrasts with the findings by Kosfeld, Okada, and Riedl (2009) and Dal Bó, Foster, and Putterman (2010) who report that a significant portion of subjects form institutions that can lead to efficient outcomes. Certainly, more work is needed to further understand which institutional conditions are more conducive to the formation of efficiency-enhancing agreements.

We motivated our analysis as profit-sharing model of partnerships, but certainly we have overlooked several aspects of interest in our attempt to establish a tractable model. First, partner relations endure in time and reputation concerns (due to possibility of exclusion in the future) are likely to mitigate efficiency loss observed in the pre-distribution experiments. Also, the presence of production synergies, risk and uncertainty, and observability or not of others' actions can play important roles in profit-sharing and production decisions, especially by altering what might be perceived as a fair share (Karagözoğlu and Riedl, 2014; Reuben and Riedl, 2013; Capellen et al., 2007; Gantner, Horn, and Kerschbamer 2016; Selten 1987). It is well-known that asymmetries in bargaining games give rise to more complex strategic dynamics (see Eraslan 2002), thus we leave the development of these dimensions for future analysis.

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Appendix A. Proofs

Lemma 4 In equilibrium, $\mathbf{s} \notin S_0$.

Proof. By the contrary, assume that $\tilde{\mathbf{s}} \in S_0$ is an equilibrium. Then, $u(\tilde{\mathbf{s}}) = 1$ for each player which implies that the ex ante value of the game is equal to 1 for every player. As such, a voter will vote yes for any share, because it will yield at least a payoff of 1. A proposing member can deviate to $(1, 0, ..., 0)$ where the first entry is the proposer's share (without loss of generality). Every player would earn $u(\tilde{\mathbf{s}}) = u(1, 0, ..., 0) = 1$ which means they would vote in favor. The proposer who would find it profitable to invest and earn $\alpha > 1$.

■

Lemma 5 In equilibrium, $\mathbf{s} \notin S_2$.

Proof. By the contrary, assume that $\tilde{\mathbf{s}} \in S_2$. This means that exactly 2 players are offered a share of $s_{Inv} = 0.5$. Without loss of generality, the payoff vector that arises will be $(\alpha, \alpha, 1, ..., 1)$. This is, two players will earn α and the $n-2$ will earn only their endowment. Since ex ante any player can attain each payoff with equal chances, the equilibrium expected value of the game is $V = \frac{2}{n}\alpha + \frac{n-2}{n} > 1$. Here, we are imposing symmetry in the sense that what player i offers j is what j offers i. Recall that a member votes in favor if and only if her payoff resulting from the share received is greater than or equal to V. However, this proposal will never be approved, because only two players exhaust all the available equity and the proposal does not receive a majority vote. ■

Proof of Proposition 2. We now focus on the case of $\mathbf{s} \in S_1$ and will show that there exists an equilibrium with one productive member. Without loss of generality, we assume that the proposer assigns herself a share s^{prop} greater than or equal to 1/2 which means that she invests in equilibrium. We denote by s^{vote} the positive share offered to m coalition partners. The equity feasibility constraint is given by

$$s^{\text{prop}} + m \cdot s^{\text{vote}} = 1 \quad . \tag{7}$$

With probability $\frac{m}{n}$ a member is an included voter who earns a share of the fund s^{vote} and keeps his endowment. With probability $1 - \left(\frac{1+m}{n}\right)$ a member receives zero equity and only keeps his endowment. Hence, the ex ante value of the game is given by

$$V = \frac{\alpha s^{\text{prop}}}{n} + \frac{m}{n}(\alpha s^{\text{vote}} + 1) + 1 - \left(\frac{1+m}{n}\right) \tag{8}$$

which is simply the payoff associated to each role weighed by its probability. Imposing the equity constraint (7) we obtain that $V = \frac{\alpha-1}{n} + 1$. As such, the proposer faces the following problem:

$$\max_{s^{\text{prop}},s^{\text{vote}},m\in\{1,\ldots,n-1\}} \alpha \cdot s^{\text{prop}} \quad \text{subject to} \tag{9}$$

$$s^{\text{prop}} \in [1/2, 1] \tag{10}$$

$$s^{\text{prop}}\alpha \geq V \tag{11}$$

$$s^{\text{vote}} \in [0, 1/2) \tag{12}$$

$$s^{\text{vote}}\alpha + 1 \geq V \tag{13}$$

$$m \geq \frac{n-1}{2}\ . \tag{14}$$

The objective function states that the proposer is seeking to maximize his own payoff and must choose a share for himself, a share offerd to coalition partners s^{vote}, the number of shares s^{vote} that she will offer (m). Constraints (10) and (12) simply guarantee that the chosen equity scheme $\mathbf{s}$ is in S_1. Conditions (11) and (14) are ensure that the proposal receives at least the required number of votes in favor. The equity constraint (7) specifies that the sum of shares have to be feasible, i.e., less than one from which we obtain that $s^{\text{prop}} = 1 - m \cdot v^{\text{vote}}$. This implies that (14) binds at $m = \frac{n-1}{2}$, namely, that minimum winning coalitions are optimal. To obtain s^{vote} we use constraint (13) which clearly binds as well because if the share was higher the proposer could decrease it and still obtain a favorable vote. Thus, we have $s^{\text{vote}} = \frac{V-1}{\alpha} = \frac{\alpha-1}{\alpha n}$ and $s^{\text{prop}} = 1 - \frac{n-1}{2}\frac{\alpha-1}{\alpha n}$. With simple computations one verifies that (11) and (10) hold. ■

Proof of Proposition 3. From Lemma 4 we know that there will be positive production in equilibrium. The logic used to show that there cannot be two productive members when the voting requirement is larger than 3 is not applicable in this case because there is enough equity to compensate at least two voters. Hence, we must verify if two productive members may arise in equilibrium. If there are two productive members, the proposer must offer 50% to one voter and keep 50%. This would yield a payoff vector of $(2, 2, 1)$ where the last member

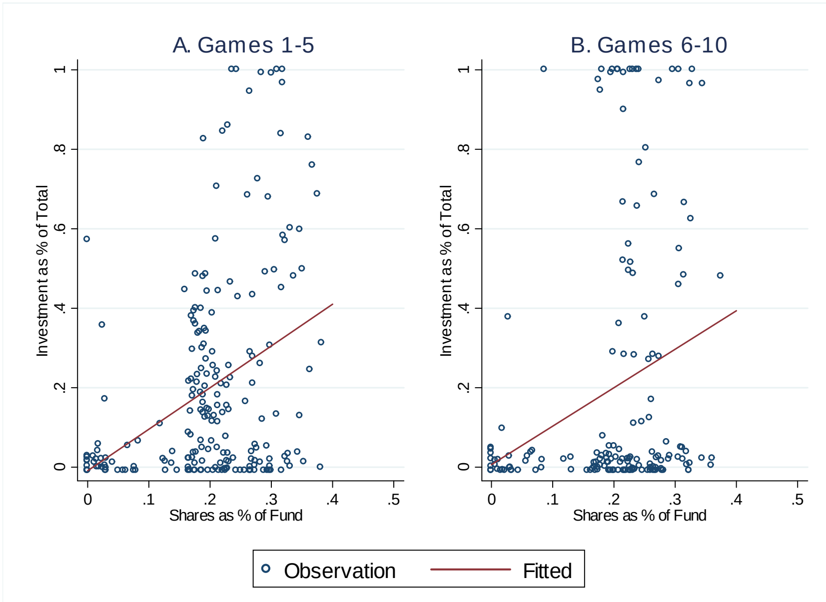

Figure 4: Investments and Approved Shares in Pre-distributive Bargaining.

only keeps her endowment. Note that the ex ante value of this game is $\frac{1}{3}(2+2+1) = \frac{5}{3}$. This implies that the both the proposer and included voter will vote in favor because their payoff is greater than $\frac{5}{3}$. If there was only one productive member in equilibrium (the proposer), payoffs would be $(2,1,1)$ and the ex ante value of the game $\frac{1}{3}(2+1+1) = \frac{4}{3}$. Hence, the propose would offer $s^{\text{vote}} = 1/6$ to one voter whose payoff would be $1+2\cdot\frac{1}{6} = \frac{4}{3}$ and she would vote in favor. Such a share is the smallest share that guarantees approval. The proposer's payoff would be $2\cdot\frac{5}{6} = \frac{5}{3}$ which is smaller than 2, the payoff to the proposer when there are two productive members. As such, the equilibrium allocation is $(0.5, 0.5, 0)$ in which the proposer shares half of the available equity with another member. ■

Appendix B. Tables and Figures

Table 7: Proposer and Voter Average Contributions in Predistribution [1]

	Games 1-5		Games 6-10	
	Voter	Proposer	Voter	Proposer
Distribution of Shares				
3-way split	9.96	8.92	1.77	5.73
	(2.871)	(3.661)	(.694)	(2.566)
4-way split	6.55	2.78	5.64	2
	(2.406)	(1.470)	(1.972)	(.866)
5-way split	10.90	12.86	2.75	2.19
	(1.379)	(2.193)	(.892)	(1.314)
Vote				
No	4.08	—	2.60	—
	(1.464)	—	(1.172)	—
Yes	11.05	9.63	3.22	3.36
	(1.288)	(1.646)	(0.783)	(1.097)
Share Range				
6-20%	10.83	10.67	2.97	2.35
	(1.458)	(2.485)	(0.981)	(1.611)
21-30%	6.79	6.29	3.62	2.31
	(1.680)	(1.990)	(1.159)	(0.999)
31-40%	13.53	13.89	2.19	6.45
	(4.599)	(4.985)	(1.205)	(3.293)

[1] Only accepted proposals of games 6-10.
[2] Only shares greater than 5% included.

Table 8: Random Effects Voting Probits for Redistribution

	$Surplus = \frac{Share - Investment}{Fund}$		$Surplus = \frac{Share}{Fund} - \frac{Investment}{\sum_{j \in Group} Investment_j}$	
	All Shares	Included Shares[1]	All Shares	Included Shares[1]
Own Surplus (OS)	39.00***	38.98***	41.44***	39.91***
	(5.599)	(5.607)	(7.364)	(7.642)
Proposer Surplus (PS)	-8.931**	-8.954**	-6.766**	-7.046*
	(2.886)	(2.913)	(2.544)	(2.747)
Fairness Index (FI)	0.764	0.797	-3.044	-2.667
	(3.515)	(3.559)	(2.033)	(2.291)
FI x VS	-58.86**	-58.94**	-89.29**	-86.30**
	(22.76)	(22.80)	(28.08)	(28.55)
Constant	-2.038**	-2.034**	0.685***	0.683***
	(0.647)	(0.650)	(0.187)	(0.187)
Observations	480	414	480	414
χ^2	70.61	70.41	60.26	54.48
ρ	0.181	0.181	0.146	0.144
χ^2 for L.R. test of $\rho = 0$	5.532	5.531	3.928	3.776

***,**,* denote significance at 1%,5%, and 10% respectively. Standard errors reported in parentheses below coefficient values. Session dummies are not displayed and were not significant at conventional levels.

[1] Included shares are those such that a member at least retrieves his investment. (Share $\geq$ Investment)

Table 9: Bargaining Outcomes for Predistribution in Groups of 3

	Games 1-5	Games 6-10
Proposals		
2-way split (MWC)	9.23	46.15
3-way split	90.77	52.31
Shares [1]		
Proposer's Share	39.58	43.38
	(0.92)	(1.45)
Voter's Share	31.67	37.40
	(0.83)	(1.08)
Proposer's Share in MWC	50.00	49.17
	(0.00)	(0.46)
Voter's Share in MWC	50.00	50.33
	(0.00)	(0.51)
Timing of Approval		
Round 1	84.62	83.08
Round 2	13.85	12.31

[1] Members receiving 5% of less are counted as excluded from the allocation.